TECHNISCHE UNIVERSITÄT MÜNCHEN

Fakultät für Sport- und Gesundheitswissenschaften

Lehrstuhl für Sport- und Gesundheitsmanagement

Essays on the adoption of the German company-bicycle leasing program

Stefan Gabriel Synek

Vollständiger Abdruck der von der Fakultät für Sport- und Gesundheitswissenschaften der Technischen Universität München zur Erlangung des akademischen Grades eines Doktors der Philosophie (Dr. phil.) genehmigten Dissertation.

Vorsitzender:	Prof. Dr. Filip Mess
Prüfer der Dissertation:	1) Prof. Dr. Jörg Königstorfer
	2) Assoc. Prof. Meghan Winters, Ph.D.

Die Dissertation wurde am 13.01.2021 bei der Technischen Universität München eingereicht und durch die Fakultät für Sport- und Gesundheitswissenschaften am 21.05.2021 angenommen.

Acknowledgements

I would like to thank the following people for their support while writing on this thesis and for empowering me to complete my doctoral studies. Thank you to:

- My family: My parents and my sister for their love and supporting me spiritually throughout writing this thesis and my life in general
- My mentor Prof. Dr. Jörg Königstorfer for his continuous guidance, support and feedback through the years, for his patience, motivation, and immense knowledge. I could not have imagined having a better advisor and mentor for my thesis
- Prof. Dr. Filip Mess for chairing the examination committee
- Associate Prof. Dr. Meghan Winters for supervising
- Prof. Dr. Stefan Wiedmann, Prof. Dr. Ludwig Hinkofer and Nicola Straub for enabling me to write my thesis besides my job at the Hochschule Fresenius GmbH
- My friends and colleagues for inspiring and supporting me
- Holger Tumat, Ulrich Prediger, Sabine Hammes, Alexandros Molphetas and Uwe Michaelis from the JobRad GmbH for providing me with data and promoting my research inside their company
- All other people that were important while writing this thesis

Abstract

Cycling is seen as a sustainable way of traveling and as a factor contributing to an active and healthy lifestyle. Policy makers around the world aim to promote cycling in various contexts and have installed measures to do so. Programs promoting cycling to work via monetary incentives to employers and/or employees are one of these measures. In Germany, a tax-subsidized company-bicycle leasing program was introduced in 2012, leading to a continuous increase in companies offering and employees participating in the program. To date, it is largely unknown what factors determine whether companies or employees adopt the concept of bicycle leasing. In addition, it is unclear what makes employees use their leasing bicycles to commute to work and if changes in commuting with leasing bicycles improves health. Focusing on the Diffusion of Innovations Theory, this thesis investigates adoption determinants of the company-bicycle leasing program at both the employer and the employee level, using a qualitative case study design. Furthermore, factors influencing the bicycle commuting behavior of employees participating in the program, as well as changes in their physical and mental wellbeing, are investigated via a two-wave longitudinal study of quantitative design. The results of the qualitative case study reveal 15 facets at both the employer and the employee level that may drive the adoption of the company-bicycle leasing program. Moreover, 10 facets at the employer level and 6 facets at the employee level were identified as barriers to the adoption. Findings of the quantitative study indicate that the use of company leasing bicycles is positively associated with physical and mental wellbeing. However, changes in bicycle commuting did not improve health over time. Compatibility is the only perceived innovation characteristic of the Diffusion of Innovations Theory with a positive impact on cycling to work. The thesis provides several managerial and policy implications to increase the adoption rate of leasing bicycles in companies and indicates factors that relate to active commuting and heath.

Kurzfassung

Radfahren gilt als nachhaltige Form der Mobilität und kann einen Beitrag zu einem aktiven und gesunden Lebensstil leisten. Politische Entscheidungsträger auf der ganzen Welt wollen das Radfahren in unterschiedlichen Kontexten fördern und haben entsprechende Maßnahmen ergriffen. Hierzu zählen Programme, die das Radfahren zur Arbeit für Arbeitgeber und/oder Arbeitnehmerinnen und Arbeitnehmer mittels finanzieller Anreize fördern. In Deutschland wurde im Jahr 2012 ein steuerlich gefördertes Dienstrad-Leasing-Programm eingeführt, das seitdem ein kontinuierliches Wachstum an teilnehmenden Unternehmen sowie Mitarbeiterinnen und Mitarbeitern verzeichnete. Bisher ist weitgehend unbekannt, welche Gründe Unternehmen und Mitarbeiterinnen und Mitarbeiter dazu bewegen, am Dienstrad-Leasing-Programm teilzunehmen. Es ist zudem unklar, welche Faktoren Mitarbeiterinnen und Mitarbeiter dazu bringen, ihre Leasingfahrräder für den Arbeitsweg zu verwenden und ob ein damit einhergehendes verändertes Pendlerverhalten eine Verbesserung der Gesundheit bewirkt. In dieser Doktorarbeit dient die Diffusionstheorie von Innovationen zur Untersuchung von Adoptionsdeterminanten des Dienstrad-Leasing-Programms sowohl aus Arbeitgeber- als auch aus Arbeitnehmersicht anhand eines qualitativen Fallstudiendesigns. Darüber hinaus werden die Einflussfaktoren auf die Radfahraktivitäten zur Arbeit der am Programm teilnehmenden Mitarbeiterinnen und Mitarbeiter sowie die damit einhergehenden Veränderungen auf ihre physische und psychische Gesundheit quantitativ mit Hilfe einer Zwei-Wellen-Längsschnittstudie untersucht. Die Ergebnisse der qualitativen Fallstudie zeigen je 15 Facetten auf Arbeitgeber- und Arbeitnehmerebene, die die Teilnahme am Dienstrad-Leasing-Programm fördern. Neun Facetten auf Arbeitgeberebene und sechs Facetten auf Arbeitnehmerebene wurden als Hindernisse für die Teilnahme am Programm identifiziert. Die Ergebnisse der quantitativen Studie veranschaulichen, dass die Nutzung von Leasingfahrrädern einen positiven Einfluss auf die physische und psychische Gesundheit hat. Kompatibilität ist das einzige wahrgenommene Innovationsmerkmal der Diffusionstheorie, das sich positiv auf die Radfahraktivität zur Arbeit auswirkt. Änderungen bei der Radfahraktivität zur Arbeit verbessern bei einer Längsschnittbetrachtung die Gesundheit jedoch nicht. In dieser Doktorarbeit werden verschiedene Empfehlungen für Entscheidungsträger aus Praxis und Politik geboten, um den Anteil an Leasingfahrrädern in Unternehmen zu erhöhen. Zudem werden Faktoren identifiziert, die die Radfahraktivität zur Arbeit und die Gesundheit beeinflussen.

Table of contents

List of figures

List of tables

1 Introduction

Policy makers around the world promote cycling to work as a sustainable method of transport contributing to an active lifestyle and better health (Hendriksen et al., 2010; Humphreys et al., 2013; Martin et al., 2014; Mytton et al., 2016; Schneider, 2016). Iacono et al. (2018) showed that a commuting distance of less than 10 kilometers from home to work is considered acceptable for using the bicycle as a mode of transport to work. This is the case for approximately 49% of employees in Germany, a country characterized by a car-dependent society (Wingerter, 2014). The implementation of various policy tools, such as investment in bicycle infrastructure or communication campaigns, has increased the number of bicycle commuters in different German cities in the past years (Lanzendorf and Busch-Geertsema, 2014; Wingerter, 2014). However, car commuting still dominates, and only 9% of German employees use the bicycle as a mode of transport for commuting to work. The potential for promoting bicycle commuting in Germany is particularly evident in its comparison with neighboring countries such as Denmark or the Netherlands, with 26% bicycle commuters (Haubold, 2014; Wingerter, 2014).

In 2012, Germany introduced a company-bicycle leasing program, following several other European countries that have introduced programs in recent years to promote cycling to work via financial incentives to companies and employees (BMF, 2012; DFT, 2011). Politicians changed the German tax law for speed pedelecs (s-pedelecs) and other electrically assisted bicycles (e-bikes) through tax treatment equal to that for company cars (BMF, 2012; Wesp, 2015). Companies with a bicycle-leasing contract can allow their employees to purchase their favorite bicycle for both private and business use and to take advantage of the favorable tax savings. The leasing providers promote a win–win situation for both employers and employees through the program, such as health promotion resulting from increased bicycle commuting. This may be one reason for the growing number of companies and employees participating in the company-bicycle leasing program since its introduction. In 2019, an estimated 400,000 leasing bicycles have already been adopted by employees, who work for more than 20,000 companies, leading to increased sales in the bicycle market (BVZF, 2019).

However, the adoption rates for leasing bicycles vary substantially between and within companies (DPA, 2017). To date, there have been no studies examining what drivers and barriers determine participation in the bicycle-leasing program by companies or by employees. In addition, it remains largely unknown what factors promote or hinder employees' commute to work when they have purchased a company leasing bicycle. This is an important aspect, as previous studies showed that it is use adoption and not the mere purchase of a new bicycle that increases health (Mytton et al., 2016; Shih and Venkatesh, 2004). Hence, research must focus on factors that influence commuting-to-work cycling (use) behaviors, as well as the health benefits associated with bicycle commuting.

This dissertation aims to fill this research gap by summarizing the results of two essays on the program. Essay 1 (study 1) explores the adoption drivers and barriers determining participation in the German bicycle-leasing program at both the employer level and the employee level, lending on Rogers' Diffusion of Innovations (DOI) Theory. Essay 2 (study 2) investigates whether the perceived innovation characteristics proposed by Rogers' DOI Theory (2003) are associated with the extent of employees' levels of cycling to work. In addition, study 2 aims to show if there is a relationship between physical and mental wellbeing and the extent to which employees commute to work with their company leasing bicycles. Finally, it investigates which of the innovation characteristics are associated with changes in bicycle-commuting behavior and whether these potential changes lead to better physical and mental wellbeing for employees.

The findings of this dissertation should help to inform relevant stakeholders about factors that can promote employees' bicycle-commuting behavior as a sustainable mode of transport with health and environmental benefits for society.

2 Theoretical background

This chapter first introduces the German company-bicycle leasing program, which is the central object of investigation in this dissertation. In the second section, as theoretical groundwork for study 1 and study 2, Rogers' (2003) concept of DOI is explained and placed in the context of the company-bicycle leasing program. Finally, the third section describes existing research on cycling to work and its effects on employees' health, as this is the core research objective of study 2. Based on the theory and the literature review, the research hypotheses are presented.

2.1 The German company-bicycle leasing program

During recent years, an increasing number of European countries have introduced tax incentives for cycling-to-work programs, and those countries with existing programs have extended them. The policies and financial incentives for these bicycle programs differ between European countries. France and Belgium, for example, have introduced a tax-free kilometric reimbursement scheme for employees who cycle to work while, in Luxembourg, Ireland and the United Kingdom, companies can take advantage of tax benefits when they provide bicycles to their employees (Haubold, 2014; Haubold, 2017).

In November 2012, Germany introduced a fiscal policy reform that taxed company leasing cars and company leasing bicycles under the same 1% tax rule (1% of the list price per month). In addition to normal bicycles, the tax break also applies to s-pedelecs and e-bikes (BMF, 2012). The new German company-bicycle leasing program arose from a fiscal

adjustment passed by federal state tax authorities (BMF, 2012). The fiscal reform was preceded by networking and the political influence of associations and companies in the bicycle sector (e.g., JobRad and German Cyclist's Association [ADFC]) between 2008 and 2012 to promote the implementation of the tax break scheme for company leasing bicycles. The inequality in the tax treatment of company leasing cars and company leasing bicycles was decisive for the legal amendment (BMF, 2012). After the German Federal Council initially rejected an amendment on July 06, 2012 (Bundesrat, 2012; Sürig, 2012), a retroactive decree on the equal tax treatment of company leasing cars and company leasing bicycles was passed by the finance ministers of the federal states, with the approval of the Federal Ministry of Finance, on October 23, 2012 (BMF, 2012). The legal amendment aimed to set tax equality in accordance with the German income tax law and to determine the evaluation of the noncash benefit of company leasing bicycles (Deutscher Bundestag, 2013). Therefore, the development of the company-bicycle leasing program was not a political intention to promote cycling to work, but the effect of fiscal amendments in Germany.

The company-bicycle leasing program is explained in more detail below. In order for employees to purchase a leasing bicycle, their employer must have first signed a contract with a leasing provider. Employees are then allowed to choose a bicycle from bicycle shops that cooperate with the leasing provider. There are no specifications for the type of bicycle, and employees can use the leasing bicycle both for private journeys and for commuting to work. The lease installments are paid by the employer over a 36-month lease period by deducting the monthly leasing rate from the gross salary of the employees using leasing bicycles (Wesp, 2015). Thus, the employees' taxable income decreases, which results in savings of up to 40% compared with the list price of bicycles. The amount of savings depends on the tax class, tax-exempt amount and income level of the particular employee. The program leads to maximum savings when employees have high tax burdens and lease expensive bicycles (ADFC, 2017). This, in combination with the monthly lease payment, may be one reason why approximately half of the leasing bicycles are s-pedelecs and e-bikes, which are relatively expensive bicycles (DPA, 2017). At the end of the lease period, employees can choose whether to return the bicycle or to purchase it for the residual value (Wesp, 2015). Until November 2019, approximately 400,000 employees had participated in the company-bicycle leasing program (BVZF, 2019). With the growth in the bicycle-leasing market, several leasing providers have appeared in Germany since 2012. The market leader, JobRad, counted approximately 30,000 company customers up to summer 2020, and approximately 3,000,000 employees within these companies have the option to lease bicycles (JobRad, 2020).

Leasing providers underline the possible advantages for both employers and employees when participating in the program. These include better employee health, increased employee commitment, cost savings for employers and employees, high employee

satisfaction, and employer branding (e.g., C2WA, 2011 for the UK; JobRad, 2017 for Germany). However, there are also some barriers and disadvantages. First, the legal regulations relating to the allowances for the residual value of leasing bicycles at the end of the leasing period had not been finalized when the research for this dissertation was conducted (Wehl, 2016). Potential additional costs can lead to uncertainties when both employers and employees have to decide whether to participate in the program. Secondly, there are restrictions on the eligibility of participation. For example, tariff regulations hinder the lease of bicycles by public servants and civil servants. Moreover, employees who are due to retire within 36 months, employees with fixed-term contracts and employees who are in training cannot participate in the program (BSW, 2017).

Therefore, different factors determine the adoption of the bicycle-leasing program by companies and employees, which in consequence may affect employees' chosen mode of transport for commuting to work and hence their health status.

2.2 Diffusion of Innovations Theory

Rogers' (2003) DOI Theory has been applied as a widely used framework in a broad variety of disciplines and research fields, such as eco-innovations, public health and transportation. The theory can explain the adoption and diffusion of innovations at both the organizational level and the individual level. The origins of the DOI Theory are grounded in multiple disciplines and span various socio-cultural factors, such as cultural values, social networks, beliefs and practices.

An innovation is defined as "an idea, practice, or project that is perceived as new by an individual or other unit of adoption" (Rogers 2003, p. 12). It may have been invented some time ago, but, if organizations or individuals perceive a newness for themselves, it is characterized as an innovation. For Rogers (2003), adoption is the "full use of an innovation as the best course of action available" (p. 177). The adoption process involves five steps: knowledge, persuasion, decision, implementation and confirmation (Rogers, 2003). Applied to the context of this dissertation, the adoption of the company-bicycle leasing program is defined in two ways: at the organizational level, when a company takes part and implements the program for the first time and, at the individual level, when an employee purchases and uses a bicycle via the program but has not participated in the program (or a similar program) before.

Rogers (2003) suggested five characteristics that affect the adoption of innovations: relative advantage, compatibility, complexity, trialability and observability. Previous studies revealed that these characteristics determine between 49% and 87% of the variance in the rate of adoption of innovations (Rogers, 2003; Sahin and Rogers, 2006). Each of the five characteristics is described as follows.

Relative advantage is “the degree to which an innovation is perceived as being better than the idea it supersedes” (Rogers, 2003, p. 229). Potential adopters evaluate the expected costs and benefits during the innovation-decision process. In the context of the current research, participation in the company-bicycle leasing program can involve savings in time and effort, low initial costs, an increase or decrease in comfort, economic profitability and social prestige (Rogers, 2003). In addition, Andersen et al. (2000) identified health benefits as a relative advantage in the context of cycling to work. Moreover, previous studies of company-bicycle leasing programs have mentioned different beneficial aspects, such as saving time, saving money and improving health (e.g., Avineri and Steven, 2011; C2WA, 2011, 2013; Caulfield and Leahy, 2011; Clarke et al., 2014), but these have not been classified as relative advantages in the context of the DOI Theory.

Compatibility describes “the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters” (Rogers, 2003, p. 15). A lack of compatibility can negatively affect the suitability to a person’s situation and promote uncertainty in the adopter. Nehme et al. (2016) applied the DOI Theory to cycling as a means of active transportation. They showed that the innovation adoption process is also a learning and identification process for adopters, because compatibility is perceived as highest in the later stages of Rogers’ adoption process. However, to date, the DOI characteristic of compatibility and its different facets have not been studied in the context of the adoption of the company-bicycle leasing program.

Complexity defines “the degree to which an innovation is perceived as relatively difficult to understand and use” (Rogers, 2003, p. 15). Rogers (2003) assumed that the perceived complexity of an innovation is negatively related to the rate of adoption. Innovations that tend to be easy to understand and use facilitate adoption, whereas innovations with high requirements for potential users hinder it. The literature research in this dissertation showed that no studies have been conducted to investigate the construct of complexity in the context of company-bicycle leasing programs.

Trialability is “the degree to which an innovation may be experimented with on a limited basis” (Rogers, 2003, p. 16). Testing of and experience of using an innovation before purchasing it can reduce uncertainty and are related to an increase in innovation adoption. The possibility of personally testing an innovation is also positively associated with the rate of adoption. No research could be identified on trialability as an innovation characteristic in the area of company-bicycle leasing programs.

Observability describes “the degree to which the results of an innovation are visible to others” (Rogers, 2003, p. 16). The easier it is to observe new ideas and communicate them to people, the more likely and faster they are adopted. Visibility of an innovation can lower

uncertainty and can stimulate the communication of and discussion about it. Observability has not yet been studied in the context of company-bicycle leasing programs.

A literature review on the adoption of bicycles revealed that several previous studies have mentioned one or more of Rogers' five perceived innovation characteristics or potential facets, while others considered alternative theories and adoption factors without reference to the DOI Theory in this context. However, no study has explored all five perceived innovation characteristics of Rogers' DOI Theory in the context of the company-bicycle leasing program. Table 1 has been published in Essay 1 (p. 241) and provides an overview of bicycle-leasing and general cycling literature that considers adoption drivers and barriers at both the employer and individual levels.

Table 1: Proposed adoption drivers and barriers of company leasing bicycles in reference to the perceived innovation characteristics at the organizational level and the individual level

Organizational level: Employers					
Adoption drivers			**Adoption barriers**		
Relative advantage	✓	Employee engagement[1], employee health[1], lower carbon footprint[1]	Relative disadvantage	×	No evidence
Compatibility	×	No evidence	Incompatibility	×	No evidence
Low complexity	×	No evidence	High complexity	×	No evidence
Trialability	×	No evidence	Low trialability	×	No evidence
Observability	×	No evidence	Low observability	×	No evidence

Individual level: Employees					
Adoption drivers			**Adoption barriers**		
Five perceived innovation characteristics			*Five perceived innovation characteristics*		
Relative advantage	✓C	Employee health[1,2,6-10], financial savings[1–4], time savings[2,3,10], traffic safety[2,3,11], convenience[2,10–14], flexibility[2,6]	Relative disadvantage	×C	Low safety due to crime[7,12,29,33], low safety due to inappropriate built environment[7,13,30,31], natural barriers[26,33,34], image and appearance[7,8,18,33], physical discomfort[9,13], health problems[9,17]
Compatibility	✓C	Past active or inactive mobility behavior[1,3–5,15], need for a new bicycle[1,3–5]	Incompatibility	×C	Past inactive mobility behavior[15], enjoying driving a car[26,14]
Low complexity	×C	Cycling ability and confidence[8]	High complexity	×C	Lack of skills[17], lack of cycling facilities at workplace[9,12,18,33]
Trialability	×C	Possibility to try out cycling[16]	Low trialability	×	No evidence
Observability	×C	Role models: colleagues, friends, and relatives[7,8,13,14,17–20]	Low observability	×	No evidence
Additional drivers					
Environmental benefit	✓C	Lower emissions[1,2,18]	Environmental harm	×	No evidence
High motivation	✓C	Higher intention to cycle[4,10,15,21]	Low motivation	×C	Lack of interest[17]
Home-work distance	✓C	Low distance to work[4,18,22,23]	Home-work distance	✓C	Large distance to work[4,18,22,23]
Sociodemographics	✓C	Male gender[4,23-25], higher income[4,24,26], higher education[4,27], younger age[4,23,26], family status (vs. single)[4,23]	Sociodemographics	✓C	See left (opposite relationships)

Notes. ✓ = Variable was proposed to be a driver (barrier) in the bicycle-leasing program literature; ✓C = Variable was proposed to be a driver (barrier) in the bicycle-leasing program and in the general cycling literature; × = No variables were proposed in both literature streams; ×C = Variable was not proposed in the bicycle-leasing program but was in the general cycling literature.

Studies on bicycle-leasing program literature: [1]C2WA (2011), [2]Caulfield and Leahy (2011), [3]Clark et al. (2014), [4]Avineri and Steven (2011), [5]C2WA (2013). Studies on general cycling literature: [6]Akar and Clifton (2009), [7]Bopp et al. (2012), [8]Emond and Handy (2012), [9]Gatersleben and Appleton (2007), [10]Heinen et al. (2011), [11]Sahlqvist and Heesch (2012), [12]Fernández-Heredia et al. (2014), [13]Titze et al. (2008), [14]Xing et al. (2010), [15]Bamberg et al. (2003), [16]Strömberg et al. (2016), [17]De Geus et al. (2012), [18]Heinen et al. (2010), [19]Simons et al. (2014), [20]Winters et al. (2015), [21]Eriksson and Forward (2011), [22]Dill and Gliebe (2008), [23]Muñoz (2016), [24]Parkin et al. (2008), [25]Sener et al. (2009), [26]Dill and Voros (2007), [27]Heesch et al. (2012),

[28]Titze et al. (2007), [29]Winters et al. (2011), [30]Winters et al. (2010), [31]Mertens et al. (2017), [32]Menghini et al. (2010), [33]Stinson and Bhat (2005), [34]Winters et al. (2007).

The literature review identified the following research gaps. First, previous studies have focused on the individual level, and only a self-report by the Cycle to Work Alliance (C2WA, 2011) has considered the organizational level. Secondly, the two perceived innovation characteristics trialability and observability have not been researched on an employee level. Thirdly, all previous studies on company-bicycle leasing programs have examined adoption determinants that refer to the purchase and not to the use of a bicycle. However, it is the bicycle use and therefore the use adoption, and not the mere purchase of a new bicycle, that leads to better health (Mytton et al., 2016; Shih and Venkatesh, 2004). This dissertation aims to partially fill these research gaps.

Based on the DOI Theory (Rogers, 2003), the present dissertation explores the adoption drivers and barriers of the German bicycle-leasing program proposed at both the employer and employee level. At the employer level, this research investigates the drivers (and barriers) that promote (or delay and hinder) the adoption of the bicycle-leasing program. At the employee level, drivers (and barriers) are explored in relation to bicycle lease and use (or delay and lack of lease and use) through the program.

Furthermore, Rogers' (2003) five perceived innovation characteristics may correlate with the bicycle-commuting (use) behaviors, because employees' evaluation of the program is crucial for use adoption (Shih and Venkatesh, 2004; see Nehme et al., 2016). Therefore, there is a need to consider the influence of these factors on the extent of cycling to work by employees when they participate in the program.

Based on the DOI theory, the following five hypotheses are proposed (see Figure 1).

H1: The higher employees perceive the relative advantage, (a) the more they use their bicycle to commute to work and (b) the more they increase their commuting behavior after participating in the program.

H2: The higher employees perceive the compatibility, (a) the more they use their bicycle to commute to work and (b) the more they increase their commuting behavior after participating in the program.

H3: The higher employees perceive the ease of use (low complexity), (a) the more they use their bicycle to commute to work and (b) the more they increase their commuting behavior after participating in the program.

H4: The higher employees perceive the trialability, (a) the more they use their bicycle to commute to work and (b) the more they increase their commuting behavior after participating in the program.

H5: The higher employees perceive the observability of the company-bicycle leasing program, (a) the more they use their bicycle to commute to work and (b) the more they increase their commuting behavior after participating in the program.

2.3 Cycling to work and employees' health

Active commuting (cycling and walking to work) has been related to multiple physical and mental health benefits (Bize et al., 2007; Humphreys et al., 2013; Martin et al., 2014; Petrunoff et al., 2016). Health improvements include the reduction of body weight (Faulkner et al., 2009; Xu et al., 2013), cardiovascular risks (Celis-Morales et al., 2017; Hamer and Chida, 2008; Xu et al., 2013), risk of diabetes (Saunders et al., 2013), perceived stress (Avila-Palencia et al., 2017) and sickness absence (Hendriksen et al., 2010; Mytton et al., 2016) and a positive impact on mental wellbeing (Mytton et al., 2016). Specifically, bicycle commuting has been inversely associated with all-cause mortality (Andersen et al., 2000; Dinu et al., 2019) and has been suggested to increase the health-related quality of life in previously untrained healthy adults (de Geus et al., 2008).

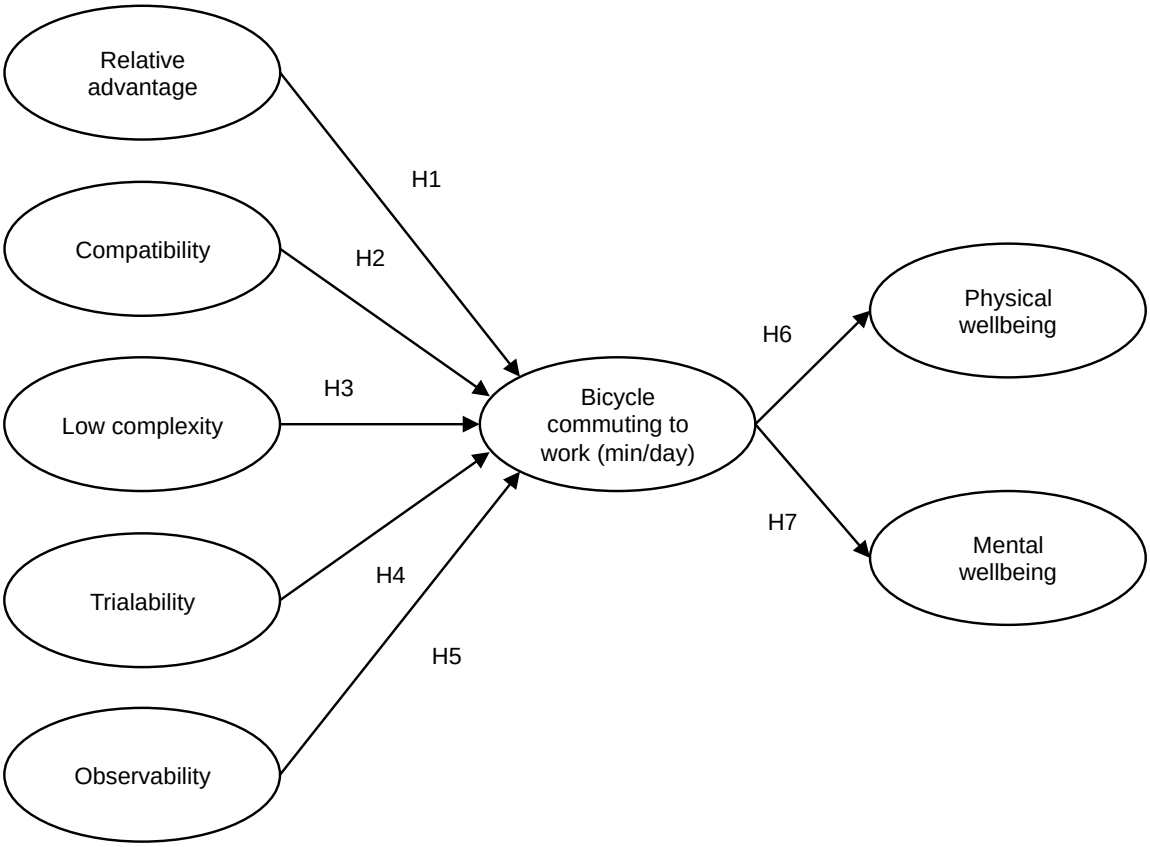
Furthermore, active commuting has been reported to have positive environmental and societal effects, associated indirectly with human health improvement. For example, a more active commuting lifestyle helps to reduce noise, greenhouse gas emissions and air pollution and improves social interaction (de Nazelle et al., 2011; Johan de Hartog et al., 2010). There is also broad evidence that bicycle commuting to work is positively related to physical activity and accordingly physical and mental wellbeing, such as reduced cardiovascular risk factors and stress, or improved fitness, posture and coordination (Johan de Hartog et al., 2010; Oja et al., 2011).

Based upon these research findings, this dissertation postulates a positive association between the amount of time spent by employees on commuting to work by bicycle and the employees' physical and mental health. Hence, an increase in levels of cycling to work should be related to an increase in employees' physical and mental health. While this dissertation does not aim to study all the possible interactions, the following hypotheses illustrated in Figure 1 (Essay 2, p. 3) are assumed.

H6: (a) The more employees cycle to work, the higher their physical wellbeing, and (b) an increase in the amount of time spent by employees on cycling to work leads to a positive change in physical wellbeing.

H7: (a) The more employees cycle to work, the higher their mental wellbeing, and (b) an increase in the amount of time spent by employees on cycling to work leads to a positive change in mental wellbeing.

Figure 1: Determinants of physical and mental wellbeing of participants in the German company-bicycle leasing program.



Notes. The same model was postulated for changes in bicycle commuting to work (minutes per day; wave 2 minus wave 1) and changes in physical and mental wellbeing (wave 2 minus wave 1).

3 Research methods and data analysis

A mixed-method research design was applied in this dissertation to investigate the research questions. Study 1 was of qualitative nature, employing a case study design while, in study 2, quantitative data were collected via a longitudinal research design. This chapter describes the research design, research context, sampling, research instruments, research procedures and analysis of the two empirical studies. Table 2 presents an overview of the studies' properties.

3.1 Study 1

Due to the explorative nature of the adoption drivers and barriers of the German company-bicycle leasing program, study 1 used a qualitative case study design. A case study can help to gain in-depth insights into processes or phenomena in real-world experiences, especially when the boundaries between context and phenomenon are not highly obvious.

Furthermore, a case study is appropriate when the researcher has minimal or no control over the behavior of the research participants and when contemporary events are objects of the research (Yin, 2018). As study 1 aimed to explore decision determinants that result from lived experiences from the perspective of multiple stakeholders, a qualitative research approach was applied (Creswell and Creswell, 2017; Yin, 2018). Case study research is particularly helpful for relatively new topics or areas where there is a shortage of information and literature (Yin, 2018), as is the case for study 1, as no scientific literature has been published on the German company-bicycle leasing program.

Data collection in study 1 involved multiple sources of evidence and in-depth information to ensure the high quality of and confidence in the study's results. In single case studies, triangulation of data types can increase the understanding of stakeholders' experiences and behaviors, providing deep insights into new research topics and helping to increase the credibility of the research results (Yin, 2018). Therefore, a combination of interview analysis (with both employees and company representatives as informants) and document analysis was applied in study 1.

Table 2: Overview of the studies' properties

	Study 1	**Study 2**
Main goals	To explore the adoption drivers and barriers of the German bicycle-leasing program at both the organizational level (i.e., from the perspective of employers) and the individual level (i.e., from the perspective of employees)	To assess the relationship between the five perceived innovation characteristics proposed by the DOI Theory and the company leasing bicycle-commuting behavior of German employees, as well as their physical and mental wellbeing. To determine whether the innovation characteristics relate to changes in commuting behavior and whether these changes have an effect on employees' physical and mental wellbeing
Statistical method	Qualitative case study design based on document analysis and content analysis of semi-structured interviews with employers and employees participating in the bicycle-leasing program	Two-wave longitudinal study design based on an online survey of employees participating in the bicycle-leasing program
Time of empirical data collection	Document analysis: June 2018 Interview analysis: November 2016 to March 2017	August 2017 to April 2018
Sample size	Documents: 13 Interviews: 22 employer representatives and 22 employees	462 employees from 62 companies

Constructs under consideration	Drivers of and barriers to the adoption of the German bicycle-leasing program from the perspective of German employers and employees	Five perceived innovation characteristics of DOI Theory: relative advantage, compatibility, complexity, trialability, observability Bicycle commuting to work (min/day) Physical wellbeing Mental wellbeing Changes in bicycle commuting to work (min/day; wave 2 minus wave 1) Changes in physical wellbeing (wave 2 minus wave 1) Changes in mental wellbeing (wave 2 minus wave 1)

To obtain a better understanding of the German company-bicycle leasing program, accessible and reliable information was collected through a document analysis (Silverman, 2001) conducted in June 2018. The data from document analysis can help in interpretating purposes, behaviors and meanings and increases the understanding in qualitative research designs by providing background information (Corbin and Strauss, 2008; Rapley, 2007). Here, the analysis of the documents aimed to gain insights into the historical development of the company-bicycle leasing program, how it works and what positive or critical aspects are mentioned that promote or hinder adoption. For the document analysis, various online sources, such as the websites of the most important stakeholders of the program (company-bicycle leasing providers, governmental organizations and bicycle associations) and press releases, were included. Electronic search engines (Google, Google Scholar, OPAC and ScienceDirect) provided additional relevant data using the following search terms: “bicycle” or “bike” was searched in combination with “company”, “firm”, “employer”, “leasing”, “tax” or “fiscal”. The online research results were extracted, analyzed in detail and evaluated according to their relevance. In addition, the citations and references of the saved documents were screened for further appropriate sources. Overall, the online research output consisted of 13 different documents with relevance to the adoption drivers and barriers of the company-bicycle leasing program at both the organizational and individual level.

As a second source of knowledge about the program, personal interviews were conducted with representatives of companies and employees participating in the company-bicycle leasing program. Study participants were selected through a purposeful sampling method combined with convenience sampling (Koerber and McMichael, 2008; Patton, 2014). Contact details of firm representatives were provided by the market leader in the company leasing bicycle sector, JobRad. To obtain rich information about the adoption determinants, a heterogeneous sample was selected, consisting of companies of different organizational size

and from different industries. In addition, different time periods since adopting the program (by signing the contract with the leasing provider, JobRad) as well as different past cycling-to-work cultures (with regards to past cycling promotion) were taken into account. The sample of company representatives included 9 women and 13 men from 21 firms. Appointments for interviews were scheduled via email, and the interviews were conducted at the informants' place of work, lasting between 18 and 44 minutes.

For the sampling strategy at the individual level, purposeful random sampling criteria were applied to recruit company-bicycle users (Patton, 2014). Contact details of employees with company leasing bicycles were provided by the leasing agency and the company representatives who took part in the interviews. The employee sample consisted of 5 women and 17 men aged between 31 and 61 years. Informants were contacted via email or telephone to schedule an interview appointment. The interviews lasted between 12 and 33 minutes and were carried out at their place of work or at their homes. Tables 3 and 4 have been published in Essay 1 (pp. 244–246) and give an overview of the interviewed informants at the individual and the organizational level.

Table 3: Overview of the characteristics of the companies for which the informants worked (organizational level)

Company number	Industry	Informant's department	Gender[2]	Number of employees	Number of leased bicycles during the time of the interview	Date of adoption of the program (DD.MM.YYYY)	(Main) motives for adoption of the program[1]	Additional subsidization by the company
1	Media	Human resources	F	70	3	31.03.2016	**nc**, es, hp, pp	No
2	Consulting	Managing director	M	70	10	17.02.2014	**hp**, eb	No
3	Media	Human resources	F	230	10	07.06.2016	**hp**, es	No
4	Stationary	Human resources	F	340	83	01.03.2016	**pp**, se	Yes: >60 days cycling per year: €35 per month
5	IT Consulting and services	Travel management	M	380	35	22.04.2016	**es**	No
6	Electrical engineering	Human resources	M	400	26	21.08.2016	**es**, hp, nc, se	No
7	Insurance	Human resources	F	450	27	28.06.2016	**eb**, hp	No
8	Bio-/Nanotechnology	Human resources	M	450	40	02.07.2015	**es**, eb, hp	No
9	Social service	Human resources	F	480	4	04.05.2016	**tw**, hp	No
10	Sports and outdoor equipment	CSR management	F	500	41	24.07.2015	**se**, hp	No
11	Media	Human resources	F	600	32	01.06.2016	**eb**, es, se	No
12	Pharmaceutical/Cosmetics	Human resources	M	750	131	01.05.2013	**se**, es, eb, hp, nc, pp	Yes: €4.30 per month
13	Software	Work council	M	800	59	01.08.2016	**pp**, hp	Yes: €18 per month
14	Building materials	Human resources	F	900	21	01.04.2015	hp, eb	No
15	Mechanical engineering	Human resources	M	900	238	01.06.2013	**hp**, eb	Yes: costs for insurance (before 01.01.2017)
16	Medical/Pharmaceutical	Human resources	F	1,100	98	13.05.2016	**pp**, se	No
17	Paper industry	Work council and human resources	M/M	2,400	605	16.03.2015	**hp**, nc	Yes: €10 per month
18	Metal industry	Human resources	M	2,700	832	14.03.2016	**hp**, es	No
19	Food and beverage	Human resources	M	4,800	437	11.05.2016	**eb**, hp, nc, pp, se	No
20	Software	Sustainability management	M	19,000	451	08.04.2015	**hp**, nc, se	No
21	Transportation and logistics	Mobility management	M	197,000	0	01.09.2016	eb, hp, se	No

Notes. [1]The main motive is shown in bold; es = employee satisfaction, eb = employer branding, hp = health promotion, nc = no costs, pp = parking problems for cars need to be solved, se = sustainability and environmental reasons, tw = means of transportation to work. [2]M = Male, F = Female.

Table 4: Overview of the characteristics of the employees who participated in the company-bicycle leasing program (individual level)

Company-bicycle adopters[1]	Company characteristics[2]	Gender[3]	Age (in years)	Position	Time since adoption (in months)	Number of bicycles and type of bicycles adopted	Home-work distance (in km)	Substitution or complementary bicycle[3]
Andreas	IT service provider; 30 employees	M	31	Software engineer	2	1 urban bike	17	Rw/oN
Florian	Engineering; 50 employees	M	39	Software engineer	5	1 mountain bike	12	Aw/oN
Stefan	Consulting; 70 employees (company 2)	M	46	Managing director	19	1 racing bike	10	Rw/oN
Erika	Stationary; 340 employees (company 4)	F	48	Human resources officer	9	1 e-bike	3	Rw/oN
Maria	Stationary; 340 employees (company 4)	F	61	Purchasing officer	10	1 e-bike	19	RwN
Karsten	Stationary; 340 employees (company 4)	M	60	Manufacturing planning officer	9	2 e-bikes	3.5	AwN
Christian	Non-profit organization; 530 employees	M	51	Purchasing officer	5	1 fat bike	20	Aw/oN
Erich	Packaging industry; 540 employees	M	31	Project manager	30	1 e-bike	25	AwN
Nils	Pharmaceutical/cosmetics; 750 employees (company 12)	M	NR	Technical engineer, work council member	5	1 e-bike	Not relevant (field work)	AwN
Peter	Software; 800 employees (company 13)	M	48	Consultant, work council member	3	1 e-bike	8	AwN
Franz	Software; 800 employees (company 13)	M	39	Head of software development department	3	1 mountain bike	4.5	AwN
Ingo	Mechanical engineering; 900 employees (company 15)	M	61	Head of industrial engineering department	12	1 e-bike	1.5	AwN
Linda	Mechanical engineering; 900 employees (company 15)	F	52	Human resources officer	4	1 mountain bike	2.5	Rw/oN
Gerhard	Automotive supplier; 1,000 employees	M	53	Machine operator	6	2 e-bikes	13	AwN
Tom	Medical/Pharmaceutical; 1,100 employees (company 16)	M	53	In-house consultant	18	2 e-bikes	9	AwN
Birte	Health and social services; 1,600 employees	F	38	Secretary	7	1 e-bike	25	RwN
Uwe	Paper industry; 2,400 employees (company 17)	M	58	Work council member (full-time)	19	2 e-bikes	3	AwN
Ingrid	Paper industry; 2,400 employees (company 17)	F	55	Human resources assistant	18	1 e-bike	10	AwN
Martin	Health and social services; 10,000 employees	M	46	IT coordinator	3	1 mountain bike	6	AwN
Paul	Transportation and logistics; 197,000 employees (company 21)	M	48	Purchasing officer	0.07	1 trekking bike	70	Aw/oN
Otto	Transportation and logistics; 197,000 employees (company 21)	M	43	Controller	2	1 e-bike	8	AwN
Dieter	Food retail; 233,000 employees	M	42	Food service manager	0.03	1 e-bike	20	Aw/oN

Notes. [1]Employees were given fictitious names for confidentiality reasons. [2]See Table 3 for information about the numbered companies. [3]M = Male, F = Female. [3]Need-based motivation for adoption: RwN = Replacement of an old bicycle and need for a new bicycle ("with need"), Rw/oN = Replacement of an old bicycle and no need for a new bicycle ("without need"), AwN = Additional bicycle and need for a new bicycle ("with need"), Aw/oN = Additional bicycle and no need for a new bicycle ("without need"). NR = Not revealed.

Interviews with employees and firm representatives were held between November 2016 and March 2017. An interview guide was developed to capture all relevant issues in the context of adoption determinants regarding the company-bicycle leasing program. The guide consisted of 16 semi-structured questions for employees with company leasing bicycles and 14 semi-structured questions for company representatives (Appendix). According to Bowen (2008) and Morse (2000), conducting semi-structured interviews with 20–30 informants enables rich and in-depth data collection. The semi-structured interview format allows the researcher to keep the focus on the aims of the study for cross-case analysis (Carson et al., 2001). It also provides flexibility for informants to clarify or expand their ideas and to mention new issues relating to a certain topic, enriching the data collected (Pope and Mays, 2006).

The point of data saturation was assessed and reached after interviews with 22 representatives from 21 companies and 22 employees with company leasing bicycles (Guest et al., 2006). With the permission of all participants, interviews were recorded, transcribed and translated from German into English. The transcripts were then paraphrased and coded into categories and themes to analyze the research question.

Transcripts were analyzed in an inductive process according to Mayring's (2000) qualitative content analysis. The inductive approach seemed useful in the context of the company-bicycle leasing program, as the literature review showed no existing additional characteristics or facets of adoption determinants besides Rogers' (2003) general conceptualization of the facets of the perceived innovation characteristics. Following the qualitative content analysis process of Elo and Kyngäs (2008), the coded categories were classified according to facets of either adoption drivers or adoption barriers within the five perceived innovation characteristics of the company-bicycle leasing program. The QCAmap software (Mayring and Fenzl, 2013) was used to support data categorization, coding and analysis. Data was coded by two raters and excellent inter-rater reliability was observed, with Cohen's $\kappa = 0.84$.

3.2 Study 2

For study 2, a longitudinal, quantitative research design was applied via an online survey. Employees with company leasing bicycles were asked to participate in a first-wave questionnaire between August 2017 and February 2018 and in a second-wave data collection between four and six weeks after the first wave.

Email addresses of employees were provided by 62 randomly selected companies that had signed a contract for the company-bicycle leasing program with the leasing provider JobRad. With the consent of the firm representatives, all employees with company leasing

bicycles were contacted via email, including a link to the online survey where protection of anonymity was explained. The participation was voluntary and without any incentives. At the request of several companies, no email reminders were sent. After the second wave of the survey, participants were fully debriefed.

Overall, 1,682 employees were contacted by email, and 817 individuals answered the questionnaire completely in the first wave of the study (49% response rate). These 817 employees were approached again for the second wave, with 462 participants filling in the survey completely (57% response rate). On average, these 462 respondents completed the survey 7.8 months (SD = 7.0) after they had purchased a leasing bicycle by signing the contract and 39.8 days (SD = 4.6) between the first and the second waves. All second-wave participants answered the questionnaire at least 4 weeks after the completion of the first-wave survey. This is important for the evaluation of physical activity and wellbeing, as the reference time-frame of the Recent Physical Activity Questionnaire (RPAQ) is 4 weeks. The RPAQ has been validated for use in different European countries (Golubic et al., 2014b) and was therefore appropriate to use in study 2. The final sample of the study consisted of 357 men (77.3%), with an above-average proportion of men compared with the general population in Germany (49% men; Statistisches Bundesamt, 2018). However, the sociodemographic variables age, household size, income and education had values similar to those reported for the German population in general (Statistisches Bundesamt, 2018). Furthermore, approximately 74.3% of the survey participants owned one or more bicycles (M = 1.20, SD = 1.03) and had purchased one or more company leasing bicycle(s) (M = 1.27, SD = 0.52). Table 5 has been published in Essay 2 (p. 5) and presents an overview of the sociodemographic characteristics of the sample.

Table 5: Sociodemographic characteristics of the sample

Variables	Percentage or Mean (±*SD*)
Gender (male)	78.6%
Age (18–24 years)	3.0%
(25–34 years)	16.9%
(35–44 years)	23.0%
(45–54 years)	38.5%
(55–64 years)	18.5%
Gross monthly household income (< EUR 1,300)	1.3%
(EUR 1,300–2,599)	24.0%
(EUR 2,600–3,599)	29.5%
(EUR 3,600–4,999)	28.5%
(> EUR 4,999)	16.8%
Education (9th grade [Mittelschule])	9.6%
(10th grade [Realschule])	29.9%
(High school [Hochschulreife])	11.8%
(University of Applied Sciences degree)	15.5%
(University degree or higher)	33.2%
Full-time employment	90.7%
Household size	*M* = 2.59 (±1.11)
Body mass index (kg/m^2)	*M* = 27.06 (±4.42)
Distance to workplace (km)	*M* = 26.41 (±38.71)

The variables used in the survey questionnaires are explained in more detail below. In the first-wave survey, respondents were first asked to answer some questions in terms of the five perceived innovation characteristics, with the use of single items that were measured by a seven-point rating scale ranging from 1 (“I strongly disagree”) to 7 (“I strongly agree”). According to Bergkvist and Rossiter (2007), single items are recommended for questionnaires when a construct's object is concretely singular, easy to understand and uniformly imagined, as was the case for study 2. Validated items from the studies of Moore and Benbasat (1991) and Petschnig et al. (2014) were extracted and adapted to the context of the company-bicycle leasing program. Respondents were asked to assess the following five items in relation to the perceived innovation characteristics:

- Relative advantage: “The use of a company leasing bicycle is very beneficial for me”
- Compatibility: “The use of a company leasing bicycle fits very well with my values, my lifestyle, and my needs”
- Low complexity: “The use of the company-bicycle leasing program is very easy to understand”
- Trialability: “I had enough opportunities to test my company leasing bicycle before I signed the contract”
- Observability: “The company-bicycle leasing program is highly visible in my organization.”

Furthermore, respondents were asked about their levels of general physical activity and in particular their bicycle-commuting behavior. The RPAQ was applied to evaluate employees’

levels of cycling to work using the following items: “On how many days in the past four weeks [20 working days] have you worked in your company/workplace on site?”; “On how many days in the past four weeks [20 working days] have you used the following mode of transport as the single mode of transport?”; “On how many days in the past four weeks [20 working days] have you used the following mode of transport in combination with other modes of transport?” Respondents had to indicate the exact number of days for answering these questions.

In order to evaluate the average time (in minutes) that employees with company leasing bicycles needed to travel to work and back, the respondents were asked to “Please indicate your average daily time with this mode of transport to get to work and for the way back home.” With this information, the average cycling-to-work time per working day in the previous four weeks was calculated and used for the later analysis. The validity and reliability of self-reported physical assessment with the help of the RPAQ has been proven by Golubic et al. (2014a).

In a subsequent section, the participants reported their physical and mental wellbeing. The Medical Outcomes Study Short Form Questionnaire (SF-8) was used according to the procedure of Ware et al. (2001) to measure physical and mental wellbeing. The SF-8 consists of eight questions assessing the wellbeing of a person (four for physical and four for mental wellbeing) in the previous four weeks. Different relative importance was applied to each question to calculate the physical component summary (PCS-8) and mental component summary (MCS-8) scores. The SF-8 scale has previously been shown to be both valid and reliable (Ellert et al., 2005). The survey ended with questions around some descriptive and sociodemographic variables. Finally, participants were informed about a second-wave survey taking place one month later. This second-wave survey was shorter than the first-wave survey, focusing on questions referring to levels of general physical activity and in particular bicycle-commuting behavior, as well as physical and mental wellbeing.

Mplus 7.0 (Muthén and Muthén, 2012) was used to perform statistical tests by employing the following two models of analysis. For model 1, a path analysis model approach was developed to test H1(a)–H7(a). Downstream variables consisted of the five perceived innovation characteristics in the first-wave survey, the average time spent on cycling to work per work day, and the scores of physical and mental wellbeing in the second-wave survey (Fig. 1). In model 2, another path analysis was used to test H1(b)–H7(b). The change in the time spent on cycling to work between wave 1 and wave 2 (wave 2 minus wave 1) was used as the mediator, and the changes in physical and mental wellbeing (wave 2 minus wave 1) were the dependent variables. The methodological approach of differentiating between mean scores of absolute values (applied in model 1) and mean scores of change values (applied in model 2) is similar to the procedure that has been described by Mytton et al. (2016). Regarding the

mediation analysis, the author of this dissertation followed the approach proposed by Preacher and Hayes (2008).

4 Essays

4.1 Essay 1: Exploring adoption determinants of tax-subsidized company leasing bicycles from the perspective of German employers and employees

Publication (peer reviewed): Synek, S. & Koenigstorfer, J. (2018). Exploring adoption determinants of tax-subsidized company-leasing bicycles from the perspective of German employers and employees, in: *Transportation Research Part A: Policy and Practice*, Vol. 117, 238–260.

Authors' contributions

Stefan Synek is the main author of the publication. All authors have contributed in writing the manuscript, read and approved the final version (Stefan Synek, Joerg Koenigstorfer). Stefan Synek contributed to study design, data collection and statistical analysis. Joerg Koenigstorfer made critical revisions of the article for important intellectual content. Both authors read and approved the final manuscript.

Summary

Introduction: Since 2012, when changes in German tax law were made, the purchases of tax-subsidized company-leasing bicycles (including s-pedelecs and electrically assisted bicycles) have increased in Germany. However, it is largely unknown what factors determine whether employers and employees adopt the bicycle-leasing program or not.
Methods: In the case study, the authors analyzed relevant documents as well as interviewed 22 employer representatives and 22 employees and analyzed their responses to explore both the adoption drivers and barriers.
Results: Informed by Diffusion of Innovations Theory, categories of perceived innovation characteristics as well as categories that go beyond this conceptualization were identified. In particular, the study explored various facets in relation to relative advantage and complexity, providing insights into how cost-benefit trade-offs determine the perceived value of the concept as well as how difficulties in usability may either postpone or hinder the adoption of the concept. Categories relating to compatibility, trialability, and observability as well as additional categories such as involvement of key stakeholders (employer and employee level) and seasonality (employee level) were explored.

Conclusions: The case study derives several policy and managerial implications that should help promote the adoption of company-leasing bicycles in particular and cycling as a means of active transportation in general.

4.2 Essay 2: Health effects from bicycle commuting to work: Insights from participants of the German company-bicycle leasing program

Publication (peer reviewed): Synek, S. & Koenigstorfer, J. (2019). Health effects from bicycle commuting to work: Insights from participants of the German company-bicycle leasing program, in: *Journal of Transport & Health*, Vol. 15, 100619, 1-9.

Authors' contributions

Stefan Synek is the main author of the publication. All authors have contributed in writing the manuscript, read and approved the final version (Stefan Synek, Joerg Koenigstorfer). Stefan Synek contributed to study design, data collection and statistical analysis. Joerg Koenigstorfer made critical revisions of the article for important intellectual content. Both authors read and approved the final manuscript.

Summary

Introduction: Company-bicycle leasing programs aim to promote employees' health via the advancement of cycling to work. To date, however, empirical evidence for the effects of participation in such programs is weak. This is also true for the German program. The present study aims to assess the relationship between the five perceived innovation characteristics proposed by the Diffusion of Innovations Theory and the company-leasing bicycle commuting behavior of German employees as well as their physical and mental wellbeing. Furthermore, the study aims to find out whether the innovation characteristics relate to changes in commuting behavior, and whether these changes have a positive effect on employees' physical and mental wellbeing.

Methods: Perceived innovation characteristics, physical activity, and health levels of 462 employees from 62 companies were assessed in a two-wave longitudinal study. The second wave took place 40 days after the first wave. Path analyses were used for hypotheses testing.

Results: The results showed that compatibility (but not relative advantage, low complexity, trialability, and observability) measured in the first wave had a positive impact on cycling to work (in minutes cycled per day), which in turn increased physical and mental wellbeing (all three variables were self-reports that were measured in the second wave). There were no significant relationships using change scores for both the mediator and the health outcomes.

Conclusions: The findings indicate that the use of company leasing bicycles relates positively with physical and mental wellbeing. Compatibility is a significant determinant of active

commuting, suggesting that company executives should endorse the perception that they share important values, lifestyles, and needs with employees. Changes in active commuting, however, did not increase health, most likely due to the short time scale under consideration. The findings help policy makers identify individual- and organization-level factors that relate to active commuting and health.

5 Findings

The purpose of this dissertation was to investigate the German company-bicycle leasing program for the first time and to introduce scientific insights regarding adoption determinants, bicycle-commuting behavior and health effects. A summary of the results of study 1 and study 2 follows.

Study 1 explored the adoption drivers of and barriers to the German bicycle-leasing program at both the organizational and the individual level. The document analysis and interview analysis highlighted various facets of Rogers' (2003) five perceived innovation characteristics, classified by both employers and employees as drivers or barriers relating to the participation in the program. The meaning of these facets and their relation to Rogers' (2003) adoption drivers and barriers were investigated by inductive coding.

The document analysis derived the following adoption determinants: employee health, employee satisfaction, employee commitment, employer branding, environmental benefit, no extra costs, reduction of parking problems, decrease in traffic safety, time investment, complex tax laws, handling of differences in employees' eligibility, and requirement for investment in complex bicycle infrastructure (at the organizational level); and health benefit, mobility benefit, monetary savings, and the possibility to lease more than one bicycle (at the individual level).

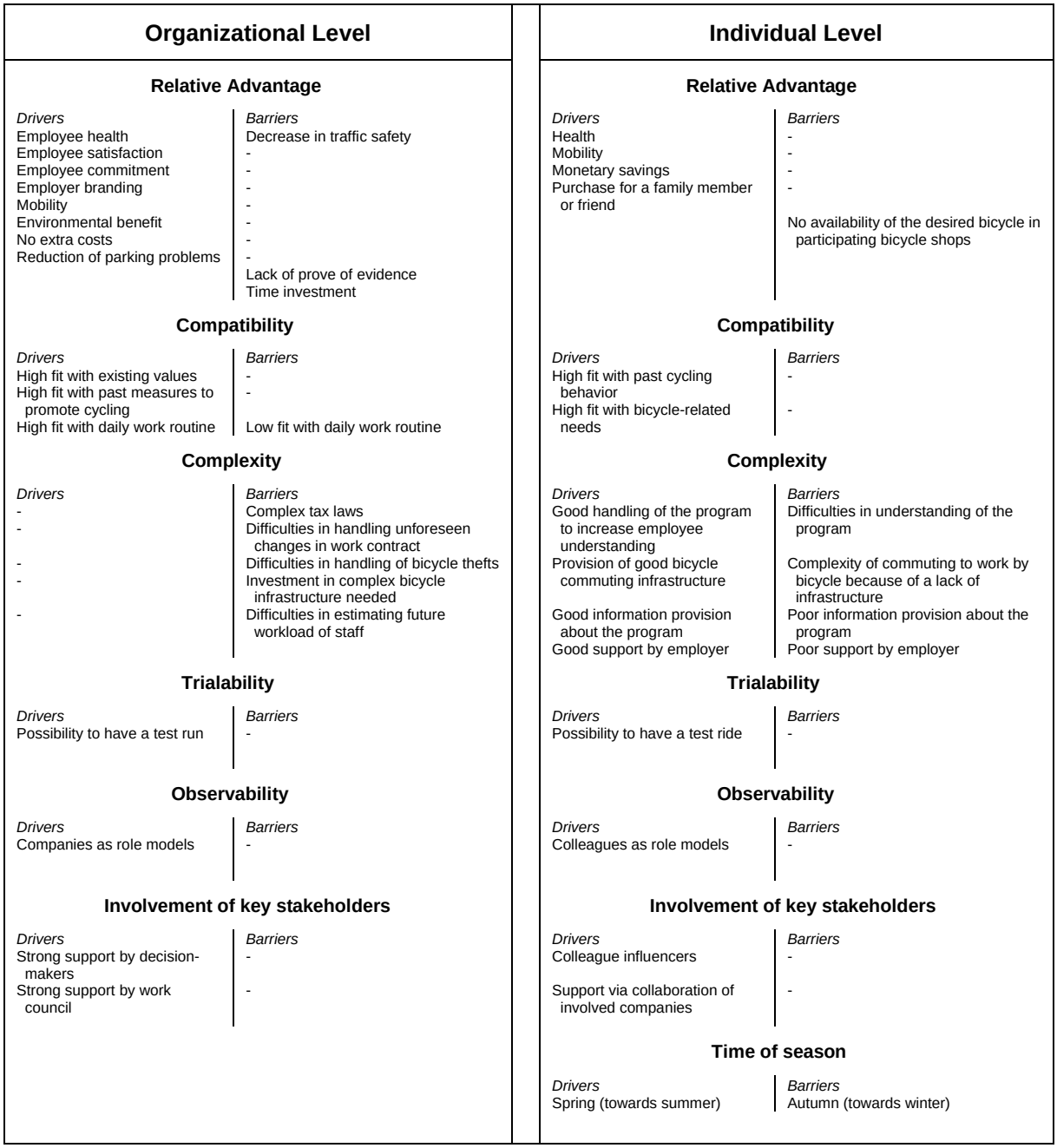
In addition, interviews with employees and firm representatives explored the following adoption drivers and barriers: mobility benefit, high fit with existing values, high fit with past measures to promote cycling, high fit with daily work routine, possibility of a test run, companies as role models, lack of proof of evidence, low fit with daily work routine, difficulties in handling unforeseen changes in work contracts, difficulties in handling bicycle thefts, difficulties in estimating the future workload of staff (at the organizational level); and high fit with past cycling behavior, high fit with bicycle-related needs, good handling of the program to increase employee understanding, provision of good bicycle-commuting infrastructure, good information provision about the program, good support by the employer, possibility of a test ride, colleagues as role models, lack of availability of the desired bicycle in participating bicycle shops, difficulties in understanding the program, complexity of commuting to work by bicycle

because of a lack of infrastructure, poor information provision about the program, and poor support by the employer (at the individual level).

Furthermore, the involvement of key stakeholders was explored as an additional driver, with two facets for both employers and employees: strong support by decision-makers and the work council (at the organizational level) and colleague influence and support via collaboration of involved companies (at the individual level). Moreover, seasonal effects were investigated as a facet that could either promote (spring to summer) or hinder (autumn to winter) the adoption of a company leasing bicycle.

Overall, the results indicated 15 facets as adoption drivers and 10 facets as adoption barriers at the organizational level, and 15 facets as adoption drivers and 6 facets as adoption barriers at the individual level. Figure 2 has been presented in Essay 1 (p. 253) and provides an overview of the findings.

Figure 2: Overview of the adoption determinants and facets that drive or hinder adoption of the German company-bicycle leasing program at the organizational and individual level



Study 2 examined the relationship between Rogers' (2003) five perceived innovation characteristics and the cycle-to-work commuting behavior of employees with leasing bicycles as well as the physical and mental wellbeing of these employees. Another aim was to investigate whether employees' perceptions of the innovation characteristics are associated with changes in commuting behavior and whether these changes have a positive impact on the employees' physical and mental wellbeing.

The findings of the study revealed that compatibility was the only one of the five perceived innovation characteristics that influenced bicycle commuting-to-work behavior and that the amount of time that employees spent on cycling to work was positively associated with physical and mental wellbeing. Hence, there was no significant relationship between changes in the amount of time that employees spent on bicycle commuting to work (wave 2 minus wave 1) and changes in their physical and mental health (wave 2 minus wave 1).

Table 6 has been published in Essay 2 (p. 6) and presents the employees' scores for the five perceived innovation characteristics (measured in wave 1) as well as the three dependent variables bicycle commuting to work, physical wellbeing and mental wellbeing (measured in wave 1 and wave 2). The results showed a significant increase in levels of bicycle commuting to work from wave 1 to wave 2 that did not relate to a positive change in wellbeing. Indeed, employees' physical health decreased marginally between the two waves, and no significant change in mental health was found. Both the physical and mental wellbeing scores measured in study 2 were comparable to the scores ($M_{Physical}$ = 50.30 and M_{Mental} = 53.25, respectively) that Beierlein et al. (2012) rated for men and women in Germany.

Table 6: Perceived innovation characteristics, bicycle commuting to work and physical and mental wellbeing

Factors	Wave 1		Wave 2	
	M	*SD*	*M*	*SD*
Physical wellbeing	51.23	7.97	50.04	8.89
Mental wellbeing	51.55	8.56	51.56	8.81
Bicycle commuting to work (min/day)	13.90	20.94	16.05	22.94
Relative advantage	5.97	1.20		
Compatibility	6.00	1.27		
Low complexity	5.20	1.97		
Trialability	3.31	1.73		
Observability	5.78	1.27		

Pearson correlations were used to analyze the relationships between the variables for model 1 and model 2. In model 1, correlations between the variables ranged from 0.00 to 0.55. Path analysis for model 1 showed that compatibility was the only one of the five perceived innovation characteristics with a significant influence on bicycle commuting-to-work levels (b = 0.20, SE = 0.06, $p < 0.001$). As relative advantage (b = 0.003, SE = 0.06, p = 0.96), low complexity (b = -0.06, SE = 0.06, p = 0.32), trialability (b = -0.06, SE = 0.05, p = 0.20) and observability (b = -0.02, SE = 0.05, p = 0.62) were not significant for the amount of time that

employees spent on cycling to work, only Hypothesis 2a was confirmed, while Hypotheses 1a and 3a–5a were not confirmed. Furthermore, the amount of time that employees spent on bicycle commuting to work had a significant influence on physical wellbeing (b = 0.12, SE = 0.05, p = 0.01; R^2 = 0.01) as well as mental wellbeing (b = 0.10, SE = 0.05, p < 0.05; R^2 = 0.01). Hypotheses 6a and 7a were therefore confirmed. Table 7 has been published in Essay 2 (p. 6) and shows the correlation matrix of the variables analyzed in model 1.

Table 7: Correlations between the variables (model 1)

Factors	1	2	3	4	5	6	7	8
1. Physical wellbeing	1.00							
2. Mental wellbeing	.13	1.00						
3. Bicycle commuting to work	.12	.09	1.00					
4. Relative advantage	.06	.09	.06	1.00				
5. Compatibility	.07	.10	.16	.55	1.00			
6. Low complexity	.04	.10	.00	.49	.41	1.00		
7. Trialability	-.04	.17	-.06	.25	.14	.34	1.00	
8. Observability	.07	.14	-.02	.24	.18	.23	.20	1.00

Testing of model 1 was completed by a mediation analysis, using the five perceived innovation characteristics as determinants influencing bicycle commuting to work, physical wellbeing and mental wellbeing. Full mediation was obtained for the amount of time spent on bicycle commuting to work mediating the effect of compatibility on physical wellbeing (marginal significance; b = 0.02, SE = 0.01, p = 0.06) and mental wellbeing (marginal significance; b = 0.02, SE = 0.01, p = 0.07). These results emphasize the positive association between the amount of time that employees spent on bicycle commuting to work and their perceived physical and mental health.

In model 2, scores for changes in commuting behavior from wave 1 to wave 2 were used for the dependent variables and the mediator. In the path analysis, no significant interaction between any of the five perceived innovation characteristics and the change in commuting behavior (b values between -0.07 and 0.05, p-values of >0.14) was identified. The same was found in the mediation analysis, where change in commuting behavior during the 40-day period between wave 1 and wave 2 did not induce changes in physical wellbeing (b = 0.08, SE = 0.05, p = 0.11; R^2 = 0.01) or mental wellbeing (b = 0.04, SE = 0.05, p = 0.44; R^2 = 0.01).

6 Theoretical and managerial contributions

Both studies provide first-time research-based insights into the German bicycle-leasing program, leading to several theoretical and managerial contributions. The results are particularly relevant for policy makers and companies in promoting cycling to work. The theoretical and managerial contributions of study 1 and study 2 to the main body of research are discussed in detail below.

With regard to the scientific literature, study 1 fills four research gaps. First, it is the first time that adoption determinants of bicycle-leasing programs have been explored at the organizational level. Secondly, new facets of adoption drivers of and barriers to bicycle-leasing programs from the perspective of employees were investigated by applying a qualitative research approach, complementing previous studies in this research area. Thirdly, adoption determinants additional to Rogers' (2003) five perceived innovation characteristics are proposed for the application of the DOI Theory to the adoption of active transportation modes. Fourthly, the study offers initial insights into potential positive impacts on health and the environment associated with the company-bicycle leasing program. This is of special relevance for Germany, with its historically car-dominated mobility culture and increasing pressure to reach emission targets in the transport sector.

Building on these findings of study 1, policy-makers and companies can derive adoption drivers of and barriers to the company-bicycle leasing program to promote cycling to work as a sustainable mode of transport leading to environmental and health benefits. Knowledge about specific adoption determinants at both the employer and the employee levels allow policy makers as well as leasing companies to create target-group-specific promotion campaigns for the program. They can specifically target companies that are interested in employer branding and incentives for their employees, with a commitment to environmental sustainability or a need to increase the health status of their employees.

Furthermore, the results also help companies that have already adopted the program in developing target-group-specific marketing campaigns. Target groups may include employees who are mainly attracted by financial benefits, by promoting the financial savings through leasing a bicycle compared with a regular purchase outside the program. Further monetary savings could arise from the possibility of leasing two or more bicycles, as well as from reduced mobility costs through decreased gas expenditure for car commuting or payments for public transport tickets. Companies can demonstrate these financial advantages by offering an online calculator for their employees. To reduce employees' concerns about the potential complexity of participating in the program, it is recommended that companies promote the concept and the ease of use of the program. This can be achieved by different communication strategies and channels; for example, by involving the work council, informing

via the intranet, producing information material such as flyers and posters, inviting representatives of the cooperating leasing company to explain the program, offering special bicycle days and installing bicycle-friendly infrastructure.

Moreover, the identification of adoption determinants helps companies in promoting the relevant drivers and diminishing the barriers, with the aim of increasing the number of bicycle commuters. Regarding the different facets of the investigated adoption determinants, the greatest variance was found for relative advantage and complexity. Although study 1 did not assess the importance of the factors regarding the adoption of leasing bicycles, benefit-and-cost trade-offs, in particular financial savings, seem to have a high impact on participation in the program.

In line with the literature examining the positive association between cycling facilities at the workplace and bicycle commuting behavior (Buehler, 2012; Heinen et al., 2010), the current results emphasize that companies participating in the program are also required to invest in a bicycle-friendly infrastructure at the workplace. In particular, providing charging facilities and safe parking is important, due to the high proportion of e-bikes in the leasing market. Furthermore, the specification of the German tax law and the leasing contracts can cause uncertainty for companies when participating in the program. Therefore, it is recommended that leasing providers develop communication strategies to explain the concept clearly and in detail to companies, to inform companies about the German tax law in relation to the peculiarities of the program and to provide customer service and support via online tools and the telephone, as well as personal consulting for larger companies. Overall, lowering complexity can increase the attraction of company leasing bicycles for employees, leading to more bicycle commuting, better employee health and positive environmental impacts. As employee health is associated with higher productive outcome and company performance (e.g., Collins et al., 2005; Zhang et al., 2011), firms may also benefit from the participation.

In addition to complexity, relative advantage emerged as the adoption determinant with the richest facets. The findings of study 1 suggest that monetary benefits have an important impact on employees' adoption of leasing bicycles and is associated with increased bicycle commuting. This is a crucial policy implication, especially for policy makers in countries where financial incentives for cycling, and in particular for cycling to work or subsidizing the purchase of e-bikes, are under consideration. However, German policy makers should note these associations between financial savings and cycling, because a national purchase subsidization, as recommended by the German Federal Council not only for e-cars but also for e-bikes, has so far not been considered for e-bikes in the white paper on the creation of a national regulation to promote electric mobility (Bundesrat, 2016).

Study 2 has different managerial implications and enriches the literature on active commuting to work in four ways. First, study 2 extends the findings of study 1, which investigated only the purchase adoption determinants, to additionally consider use adoption determinants. This is important, as it is not the mere purchase but the continuous use of a bicycle that has positive impacts on physical and mental health as well as on environmental and societal goals (Shih and Venkatesh, 2004). Furthermore, study 2 is the first research in the area of company-bicycle leasing programs analyzing relationships between variables and thus adding to the descriptive cross-sectional study results from the Cycle to Work Alliance (C2WA, 2011; Swift et al., 2016).

Secondly, study 2 delivers first-time insights into the relevance of the five perceived innovation characteristics of the DOI Theory in relation to cycling to work and health, going beyond the findings of study 1. Compatibility was found to have a significant influence on employees in using their company leasing bicycle to cycle to work. Consequently, companies should aim to create a cycling culture as part of their organizational ethos to encourage employees to bicycle commute to work. This can be achieved through shared values, beliefs, needs and lifestyles between companies and employees (see Nehme et al., 2016), leading to beneficial contextual settings for interactions and behaviors of individuals within an organization (Schein, 1985). The low explanatory power of the model for physical activity (R^2 = 0.04) and wellbeing (R^2 = 0.01) is typical for a study that investigates use behaviors and health, as the effects of different external factors on these variables always exist (e.g., Nigg et al., 2008).

Thirdly, study 2 is one of the few studies in the cycling-to-work literature using a longitudinal design to analyze the relationship between perceived characteristics of bicycle commuting and health. The findings indicate a positive association between the amount of time spent on the bicycle commuting to work and physical and mental wellbeing, but no association between increased cycling to work and health over a 40-day period. Both results are in accordance with findings by Mytton et al. (2016). Notably, cycling to work fully mediated the effect of compatibility on physical and mental health. Therefore, the mere purchase of a leasing bicycle does not induce better health (resulting in a feel-good effect at most), and it is the increased time that employees spent on bicycle commuting that is associated with better wellbeing.

Finally, findings of study 2 are in accordance with the scientific literature on the positive relationship between the adoption of e-bikes and an increased number of bicycle journeys and longer cycling distances (e.g., Fyhri and Fearnley, 2015), as well as the decrease in the number of car journeys (e.g., Johnson and Rose, 2015; Popovich et al., 2014). There is also consistence with the bicycle-leasing program literature that indicates that participating in the

program increases cycling levels (e.g., Caulfield and Leahy, 2011; Clarke et al., 2014). Overall, the findings indicate that the adoption of company leasing bicycles has a positive effect on more sustainable and active mobility behavior. This is an important topic, especially in Germany, where air quality standards have frequently been violated in various cities in the past (Eddy, 2018; EU, 2008; WHO, 2006), leading to a legal and political pressure to set emission-reduction strategies. The peculiarities of the company-bicycle leasing program in Germany lie in particular in the German tax regulations, but also in the historically car-oriented mobility culture and in the strong political influence of the car industry. These circumstances must be addressed when aiming to promote compatibility within the program.

7 Limitations and outlook

This dissertation has several limitations that are specifically addressed for each of the two studies below. In addition, directions for future research are proposed.

A purposive sampling approach, also known as subjective or judgmental sampling, was used in study 1 to recruit a subset of company-bicycle leasing program adopters. This sampling method was chosen to achieve a diverse sample of informants in a complex research field to explore the adoption drivers and barriers. Purposive sampling is one of the most common sampling strategies but generates biased samples. Different experiences from companies and employees may have been excluded, and additional facets of adoption determinants may exist. Although it was not the aim to generalize the findings from study 1, the representativeness of the facets of adoption determinants mentioned by the interviewees is limited, and the findings cannot reveal the views of all companies and employees participating in such a program. Furthermore, study 1 does not provide a ranking of the importance of the different determinants and facets, and only initial insights into the relevance of some of the factors can be assumed. Future studies should investigate which of the explored determinants and facets, at both the organizational and the individual level, are of particular importance in the adoption or rejection of the program to increase the effectiveness of promotion activities for the program.

In addition, future studies may use a comparative research design, including adopters and non-adopters to generate additional knowledge about adoption determinants, in particular adoption barriers. As shown, compatibility was explored as an adoption driver only in study 1, but could probably act as a hindering factor for non-adopters who usually commute by car to work: they may perceive this lack of compatibility with their past commuting behavior as an adoption barrier.

Furthermore, future studies could build upon the contextualization of the DOI Theory to examine the different stages of the adoption process when identifying perceived adoption

determinants and facets from the perspectives of companies or employees. The application of observational and survey research methods can help in investigating how adoption or diffusion develops over time, when focusing on the different stages of the adoption process and which mobility behavior (change) effects result from participating in the company-bicycle leasing program.

Another interesting research field for the company-bicycle leasing program may be the diffusion of company leasing bicycles as a dependent variable and the determination of which factors contribute the most to a high diffusion (i.e., percentage of employees with company leasing bicycles within a company).

Finally, as the company-bicycle leasing market is continuously growing and new leasing companies with different business strategies are entering the market, future studies should also consider competitors of the market leader, JobRad. Customers of other providers may perceive some adoption determinants differently due to differences in marketing, customer support, purchase processes, cooperation with bicycle shops and supply of additional services. The case study design used in study 1 did not serve to consider existing variance in these features regarding different leasing companies. Hence, the design was appropriate to the research aim of study 1, because the choice of leasing company would not affect most of the perceived adoption determinants (e.g., importance of health for companies and employees, facets of compatibility, tax regulations).

Study 2 used self-reports for measuring the time that employees spent on the bicycle commuting to work, as well as their perceived physical and mental wellbeing. Validity and reliability have been proven for the study, but findings of self-report measures may be weakened by self-report bias (e.g., social desirability in answers, over- or underestimation of variables). Future studies should integrate more objective criteria, such as laboratory-oriented measures of physical health.

In addition, as this research has not been carried out on a representative sample, the findings are not generalizable to all adopters of company leasing bicycles. There is no data set with the general population of adopters or sociodemographic variables of the employees or companies participating in the program. Hence, as study 2 mainly focuses on bicycle commuting levels and perceived physical and mental health by applying a longitudinal design and using the DOI Theory as a theoretical framework, this limitation does not affect the general research findings. Moreover, the dropout rate of 43% between the first and the second waves is usual for longitudinal studies (Mytton et al., 2016).

Future intervention studies may also include a control group to evaluate the findings of study 2. The incorporation of employees without company leasing bicycles as a control group would provide additional information about the effect of the intervention (here, the adoption of

the program) on bicycle commuting to work as well as physical and mental wellbeing. With regard to the time-frame between wave 1 and wave 2 (40 days), future studies may extend the length of time between the measures or integrate an additional third wave, as changes in travel behavior can be a long-term process and changes in wellbeing may not appear immediately.

Finally, the findings of study 2 could not explain why compatibility, as only one of the five perceived innovation characteristics, had a positive impact on the time spent on the bicycle commuting to work. In contrast, relative advantage has previously been found to be a major factor affecting use adoption of new services, products or concepts (Rogers, 2002, 2003). However, analysis of study 2 did not show a significant effect of relative advantage on the time spent on the bicycle. Future studies on cycle-to-work programs should investigate the reason behind the significant effect of compatibility on cycling levels of employees and whether other determinants may also have an influence. Other factors may exist in addition to Roger's perceived innovation characteristics that influence the time spent on the bicycle commute to work, such as promotion and communication activities for the program by the employers (e.g., continuous vs. one-time promotion), differences in company characteristics (e.g., facilities for bicycle commuters, sustainability policy, spatial situation, size) and differences in incentives (e.g., monetary incentives for purchasing a company leasing bicycle, rewards or monetary incentives for bicycle commuting to work). Furthermore, future research work could also focus on factors influencing the changes in variables (here, physical and mental wellbeing through cycling to work). In accordance with Mytton et al. (2016), study 2 could not explain changes in health.

8 Conclusion

The findings of this research demonstrated that political decision-makers can promote company-bicycle leasing programs by associating bicycle commuting to work with an improvement in employees' health. To achieve positive outcomes, adoption drivers must be strengthened, and barriers reduced.

Study 1 explored the adoption determinants of the German company-bicycle leasing program at both the organizational and the individual levels, based on the DOI Theory. The perceived innovation characteristics, namely relative advantage, compatibility, complexity, trialability and observability, as well as different facets of these five determinants, were categorized as adoption drivers or barriers at both the employer and the employee levels. In addition, the involvement of key stakeholders was explored as an adoption driver at both levels. At the individual level, the season was an influencing factor, with spring-to-summer being found to be a driver and autumn-to-winter to be a barrier. Analysis of the interviews showed that the participation in the program induced changes in the promotion of cycling-to-work topics within

the companies, as well as an increase in levels of cycling to work and/or in the private lives of employees. As the findings of study 2 indicate positive health effects and a shift to a more active and sustainable mobility behavior resulting from cycling-to-work programs, future research may evaluate the association between such policy instruments and positive behavioral effects resulting from bicycle adoption.

Study 2 is the first scientific study to reveal a positive relationship between the time spent on bicycle commuting to work and the physical and mental wellbeing of employees participating in the German bicycle-leasing program. Compatibility, such as lifestyles, shared values between companies and employees, and needs in the context of cycling to work, was found to be a significant determinant in increasing employees' cycling levels. Policy makers and employers participating in the program must focus on company leasing bicycle adoption drivers in order to motivate employees to display more sustainable commute-to-work behavior. In particular, the implementation and promotion of company-bicycle leasing programs may help countries with a high car-dependency to enhance cycling as a mode of transport in order to reach their environmental goals and to contribute to the Sustainable Development Goals brought forward by the United Nations.

References

ADFC (Allgemeiner Deutscher Fahrrad-Club), 2017. Dienstradleasing weiter attraktiv (Company-bicycle leasing continues to be attractive), 23 November 2017. Available at: <http://www.adfc.de/news/dienstradleasing-weiter-attraktiv> (last accessed January 2018).

Akar, G., Clifton, K., 2009. Influence of individual perceptions and bicycle infrastructure on decision to bike. Transp. Res. Rec. J. Transp. Res. Board 2140, 165–172. https://doi.org/10.3141/2140-18.

Andersen, L.B., Schnohr, P., Schroll, M., Hein, H.O., 2000. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Arch. Intern. Med. 160, 1621–1628. https://doi.org/10.1001/archinte.160.11.1621.

Astegiano, P., Tampère, C., Beckx, C., 2015. A preliminary analysis over the factors related with the possession of an electric bike. Transp. Res. Proc. 10, 393–402. https://doi.org/10.1016/j.trpro.2015.09.089.

Avila-Palencia, I., de Nazelle, A., Cole-Hunter, T., et al., 2017. The relationship between bicycle commuting and perceived stress: a crosssectional study. BMJ Open 7, e013542. https://doi.org/10.1136/bmjopen-2016-013542.

Avineri, E., Steven, F., 2011. Has the introduction of the cycle to work increased levels of cycling to work in the UK? Presented at the 92nd Annual Meeting of the Transp. Res. Board. Washington, DC.

Bachand-Marleau, J., Lee, B., El-Geneidy, A., 2012. Better understanding of factors influencing likelihood of using shared bicycle systems and frequency of use. Transp. Res. Rec. 2314, 66–71. https://doi.org/10.3141/2314-09.

Bamberg, S., Ajzen, I., Schmidt, P., 2003. Choice of travel mode in the theory of planned behavior: the roles of past behavior, habit, and reasoned action. Basic Appl. Soc. Psych. 25, 175–187. https://doi.org/10.1207/S15324834BASP2503_01.

Beierlein, V., Morfeld, M., Bergelt, C., Bullinger, M., Brähler, E., 2012. Messung der gesundheitsbezogenen Lebensqualität mit dem SF-8 (Measurement of health-related quality of life with SF-8). Diagnostica 58, 145–153.

Bergkvist, L., Rossiter, J.R., 2007. The predictive validity of multiple-item versus single-item measures of the same constructs. J. Mark. Res. 44 (2), 175–184. https://doi.org/10.1509/jmkr.44.2.175.

Bize, R.L., Johnson, J.A., Plotnikoff, R.C., 2007. Physical activity level and health-related quality of life in the general adult population: a systematic review. Prev. Med. 45 (6), 401–415. https://doi.org/10.1016/j.ypmed.2007.07.017.

BMF (Bundesfinanzministerium), 2012. Gleichlautende Erlasse der obersten Finanzbehörden der Länder. Steuerliche Behandlung der Überlassung von (Elektro-) Fahrrädern vom 23. November 2012 (Identical orders of the highest tax authorities of the federal states. Tax treatment of (electric) bicycles from 23 November 2012). Available at: <http://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Steuern/Steuerarten/Lohnsteuer/BMF_Schreiben_Allgemeines/2012-11-23-gleichlautende-erlasse-elektrofahrraeder-anlage.pdf?__blob=publicationFile&v=3> (last accessed March 2018).

Bowen, G.A., 2008. Naturalistic inquiry and the saturation concept: a research note. Qual. Res. 8, 137–152. https://doi.org/10.1177/1468794107085301.

BSW (Verbraucher-Service Beamten-Selbsthilfewerk e.V.), 2017. Kommen die Reifen ins

Rollen (Are the tires rolling)? Available at: <https://www.bsw.de/oeffentlicher-dienst/aktuelle-berichte/kommen-die-reifen-ins-rollen–22-03-2017.htm> (last accessed January 2018).

Buehler, R., 2012. Determinants of bicycle commuting in the Washington, D.C. region: the role of bicycle parking, cyclist showers, and free car parking at work. Transp. Res. Part D: Transp. Environ. 17, 525–531. https://doi.org/10.1016/j.trd.2012.06.003.plenary proceedings 899), 06 July 2012. Available at: <http://dipbt.bundestag.de/dip21/brp/899.pdf> (last accessed July 2018).

Bundesrat, 2016. Stellungnahme des Bundesrates. Entwurf eines Gesetzes zur steuerlichen Förderung von Elektromobilität im Straßenverkehr (Opinion of the Federal Council. Draft of a law on tax incentives for electric mobility in road traffic), Drucksache 277/16 (Beschluss), 08 July 2016. Available at: <http://www.bundesrat.de/SharedDocs/drucksachen/2016/0201-0300/277-16%28B%29.pdf?__blob=publicationFile&v=1> (last accessed June 2018).

BVZF (Bundesverband Zukunft Fahrrad), 2019. 8. November: 2019 Bundestag beschließt 0,25-Prozent-Regel“ für Elektro-Dienstfahrzeuge. 8 November: 2019 Bundestag passes „0.25 percent rule“ for electric company vehicles. Available at: <https://bvzf.org/2019/11/08/8-november-2019-bundestag-beschliesst-025-prozent-regel-fuer-elektro-dienstfahrzeuge> (last accessed March 2020).

C2WA (Cylce to Work Alliance), 2011. Behavioural Impact Analysis, February 2011. Cycle to Work Alliance. Available at: <http://www.cycletoworkalliance.org.uk/images/BehaviourImpactAnalysisFeb2011.pdf> (last accessed September 2017).

C2WA (Cycle to Work Alliance), 2013. The Green Way to Work – Sustainable Transport Report, May 2013. Cycle to Work Alliance. Available at: <http://cycletoworkalliance.org.uk/media/1018/news_41_2538974460.pdf> (last accessed September 2017).

Carson, D., Gilmore, A., Perry, C., Gronhaug, K., 2001. Qualitative Marketing Research. Sage, London. https://doi.org/10.4135/9781849209625.

Caulfield, B., Leahy, J., 2011. Learning to cycle again: examining the benefits of providing tax-free loans to purchase new bicycles. Res. Transp. Bus. Manag. 2, 42–47. https://doi.org/10.1016/j.rtbm.2011.08.005.

Celis-Morales, C.A., Lyall, D.M., Welsh, P., et al., 2017. Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study. BMJ 357, 1456. https://doi.org/10.1136/bmj.j1456.

Clarke, A., Laird, J.J., Shires, J.D., 2014. Cycle to work scheme – weekend warriors or daily commuters. Presented at the Scottish Transport Applications and Research (STAR) Conference, Glasgow.

Collins, J.J., Baase, C.M., Sharda, C.E., Ozminkowski, R.J., Nicholson, S., Billotti, G.M., Turpin, R.S., Olson, M., Berger, M.L., 2005. The assessment of chronic health conditions on work performance, absence, and total economic impact for employers. J. Occup. Environ. Med. 47 (6), 547–557. https://doi.org/10.1097/01.jom.0000166864.58664.29.

Corbin, J., Strauss, A., 2008. Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, third ed. Sage, Thousand Oaks, CA.

Creswell, J.W., Creswell, J.D., 2017. Research Design: Qualitative, Quantitative, and Mixed Methods Approach. Sage, Thousand Oaks, CA.

De Geus, B., De Bourdeaudhuij, I., Jannes, C., Meeusen, R., 2008. Psychosocial and

environmental factors associated with cycling for transport among a working population. Health Educ. Res. 23, 697–708. https://doi.org/10.1093/her/cym055.

De Nazelle, A., Nieuwenhuijsen, M.J., Antó, J.M., et al., 2011. Improving health through policies that promote active travel: a review of evidence to support integrated health impact assessment. Environ. Int. 37 (4), 766–777. https://doi.org/10.1016/j.envint.2011.02.003.

Deutscher Bundestag, 2013. Schriftliche Fragen mit den in der Zeit vom 24. Dezember 2012 bis 4. Januar 2013 eingegangenen Antworten der Bundesregierung (Written questions with the answers received from the Federal Government in the period from 24 December 2012 to 4 January 2013). Drucksache 17/12008, 04 January 2013. Available at: <http://dip21.bundestag.de/dip21/btd/17/120/1712008.pdf> (last accessed June 2018).

DFT (Department for Transport), 2011. Cycle to work scheme implementation guidance. Available at, (last accessed April 2019). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/11305/cycle-to-work-guidance.pdf.

Dill, J., Gliebe, J., 2008. Understanding and Measuring Bicycling Behavior: A Focus on Travel Time and Route choice. Final report OTREC-RR-08-03 prepared for Oregon Transportation Research and Education Consortium (OTREC), December 2008. <https://dx.doi.org/10.15760/trec.151>.

Dill, J., Rose, G., 2012. E-bikes and transportation policy: insights from early adopters. Transp. Res. Rec. 2314, 1–6. https://doi.org/10.3141/2314-01.

Dill, J., Voros, K., 2007. Factors affecting bicycling demand: initial survey findings from the Portland, Oregon, region. Transp. Res. Rec. J. Transp. Res. Board 2031, 9–17. https://doi.org/10.3141/2031-02.

Dinu, M., Pagliai, G., Macchi, C., Sofi, F., 2019. Active commuting and multiple health outcomes: a systematic review and meta-analysis. Sport. Med. 49 (3), 437–452. https://doi.org/10.1007/s40279-018-1023-0.

DPA (Deutsche Presse Agentur), 2017. Dienstfahrrad statt Dienstwagen. Geld sparen mit dem neuen Trend (Company bicycle instead of company car. Saving money with the new trend). In: Manager Magazin, 12 July 2017. Available at: <http://www.manager-magazin.de/unternehmen/industrie/dienstfahrrad-statt-dienstwagen-neuer-trend-in-leasing-branche-a-1157356.html> (last accessed February 2018).

Eddy, M., 2018. German court rules cities can ban vehicles to tackle air pollution. The New York Times, 27 February 2018. Available at: <https://www.nytimes.com/2018/02/27/business/energy-environment/germany-diesel-air-pollution.html> (last accessed March 2018).

Ellert, U., Lampert, T., Ravens-Sieberer, U., Messung der gesundheitsbezogenen Lebensqualität mit dem SF-8: Eine Normstichprobe für Deutschland (Measurement of health-related quality of life via the SF-8: a norm sample for Germany), 2005. Bundesgesundheitsblatt - Gesundheitsforsch. - Gesundheitsschutz 48 (12), 1330–1337. https://doi.org/10.1007/s00103-005-1168-5.

Elo, S., Kyngäs, H., 2008. The qualitative content analysis process. J. Adv. Nurs. 62, 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x.

Emond, C.R., Handy, S.L., 2012. Factors associated with bicycling to high school: insights from Davis, CA. J. Transp. Geogr. 20, 71–79. https://doi.org/10.1016/j.jtrangeo.2011.07.008.

Eriksson, L., Forward, S.E., 2011. Is the intention to travel in a pro-environmental manner and the intention to use the car determined by different factors? Transp. Res. Part D Transp. Environ. 16, 372–376. https://doi.org/10.1016/j.trd.2011.02.003.

EU, 2008. Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. Off. J. Eur. Communities 152, 1–43. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF>.

Faulkner, G.E.J., Buliung, R.N., Flora, P.K., Fusco, C., 2009. Active school transport, physical activity levels and body weight of children and youth: a systematic review. Prev. Med. 48 (1), 3–8. https://doi.org/10.1016/j.ypmed.2008.10.017.

Fernández-Heredia, Á., Monzón, A., Jara-Díaz, S., 2014. Understanding cyclists' perceptions, keys for a successful bicycle promotion. Transp. Res. Part A Policy Pract. 63, 1–11. https://doi.org/10.1016/j.tra.2014.02.013.

Frambach, R.T., Schillewaert, N., 2002. Organizational innovation adoption: a multi-level framework of determinants and opportunities for future research. J. Bus. Res. 55 (2), 163–176. https://doi.org/10.1016/S0148-2963(00)00152-1.

Fyhri, A., Fearnley, N., 2015. Effects of e-bikes on bicycle use and mode share. Transp. Res. Part D Transp. Environ. 36, 45–52. https://doi.org/10.1016/j.trd.2015.02.005.

Gatersleben, B., Appleton, K.M., 2007. Contemplating cycling to work: attitudes and perceptions in different stages of change. Transp. Res. Part A Policy Pract. 41, 302–312. https://doi.org/10.1016/j.tra.2006.09.002.

Golubic, R., Martin, K.R., Ekelund, U., et al., 2014a. Levels of physical activity among a nationally representative sample of people in early old age: results of objective and self-reported assessments. Int. J. Behav. Nutr. Phys. Act. 11 (1), 58. https://doi.org/10.1186/1479-5868-11-58.

Golubic, R., May A.M., Benjaminsen Borch K., et al., 2014b. Validity of Electronically Administered Recent Physical Activity Questionnaire (RPAQ) in Ten European Countries. PLoS One. 9 (3), e92829. https://doi.org/10.1371/journal.pone.0092829.

Guell, C., Panter, J., Jones, N.R., Ogilvie, D., 2012. Towards a differentiated understanding of active travel behaviour: using social theory to explore everyday commuting. Soc. Sci. Med. 75 (1), 233–239. https://doi.org/10.1016/j.socscimed.2012.01.038.

Guest, G., Bunce, A., Johnson, L., 2006. How many interviews are enough? An experiment with data saturation and variability. Field Methods 18 (1), 59–82. https://doi.org/10.1177/1525822X05279903.

Hamer, M., Chida, Y., 2008. Active commuting and cardiovascular risk: a meta-analytic review. Prev. Med. 46 (1), 9–13. https://doi.org/10.1016/j.ypmed.2007.03.006.

Haubold, H., 2014. Commuting: who pays the bill? Eur. Cycl. Fed. Available at: <http://ecf.com/sites/ecf.com/files/141117-Commuting-Who-Pays-The-Bill_2.pdf> (last accessed February 2018).

Haubold, H., 2017. Tax breaks for bike commuters – a European trend. Eur. Cycl. Fed. Available at: <https://ecf.com/news-and-events/news/tax-breaks-bike-commuters-european-trend> (last accessed February 2018).

Hazen, B.T., Overstreet, R.E., Wang, Y., 2015. Predicting public bicycle adoption using the technology acceptance model. Sustain. 7 (11). https://doi.org/10.3390/su71114558.

Heesch, K.C., Sahlqvist, S., Garrard, J., 2012. Gender differences in recreational and transport cycling: a cross-sectional mixed-methods comparison of cycling patterns, motivators, and constraints. Int. J. Behav. Nutr. Phys. Act. 9, 106. https://doi.org/10.1186/1479-5868-9-106.

Heinen, E., van Wee, B., Maat, K., 2010. Commuting by bicycle: an overview of the literature. Transp. Rev. 30, 59–96. https://doi.org/10.1080/01441640903187001.

Heinen, E., Maat, K., Van Wee, B., 2011. The role of attitudes toward characteristics of bicycle

commuting on the choice to cycle to work over various distances. Transp. Res. Part D Transp. Environ. 16, 102–109. https://doi.org/10.1016/j.trd.2010.08.010.

Hendriksen, I., Simons, M., Galindo Garre, F., Hildebrandt, V., 2010. The association Between commuter cycling and sickness absence. Prev. Med. 51 (2), 132–135. https://doi.org/10.1016/j.ypmed.2010.05.007.

Humphreys, D.K., Goodman, A., Ogilvie, D., 2013. Associations between active commuting and physical and mental wellbeing. Prev. Med. 57 (2), 135–139. https://doi.org/10.1016/j.ypmed. 2013.04.008.

Iacono, M., Krizek, K.J., El-Geneidy, A., 2008. Access to Destinations: How Close is Close Enough? Estimating Accurate Distance Decay Functions for Multiple Modes and Different Purposes. Minnesota Department of Transportation Research Services Section.

JobRad, 2017. JobRad, das Dienstfahrrad-Konzept (JobRad, the concept of company bicycle). Available at: <https://www.jobrad.org> (last accessed February 2018).

JobRad, 2020. Über uns (About us), Available at: <https://www.jobrad.org/ueber-uns.html> (last accessed August 2020).

Johan de Hartog, J., Boogaard, H., Nijland, H., Hoek, G., 2010. Do the health benefits of cycling outweigh the risks? Environ. Health Perspect. 118 (8), 1109–1116. https://doi.org/10.1289/ehp.0901747.

Johnson, M., Rose, G., 2015. Extending life on the bike: electric bike use by older Australians. J. Transp. Heal. 2, 276–283. https://doi.org/10.1016/j.jth.2015.03.001.

Jones, T., Harms, L., Heinen, E., 2016. Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility. J. Transp. Geogr. 53, 41–49. https://doi.org/10.1016/j.jtrangeo.2016.04.006.

Koerber, A., McMichael, L., 2008. Qualitative sampling methods: a primer for technical communicators. J. Bus. Tech. Commun. 22, 454–473. https://doi.org/10.1177/1050651908320362.

Langford, B.C., 2013. A Comparative Health and Safety Analysis of Electric-assist and Regular Bicycles in an On-campus Bicycle Sharing System. Thesis (Doctoral). The University of Tennessee, Knoxville, TN.

Lanzendorf, M., Busch-Geertsema, A., 2014. The cycling boom in large German cities: empirical evidence for successful cycling campaigns. Transp. Pol. 36, 26–33. https://doi.org/10.1016/j.tranpol.2014.07.003.

Lee, A., Molin, E., Maat, K., Sierzchula, W., 2015. Electric bicycle use and mode choice in the Netherlands. Presented at the 94th Annual Meeting of Transp. Res. Board, Washington, DC.

Ling, Z., Cherry, C.R., MacArthur, J.H., Weinert, J.X., 2017. Differences of cycling Experiences and perceptions between e-bike and bicycle users in the United States. Sustainability 9, 1662. https://doi.org/10.3390/su9091662.

MacArthur, J., Dill, J., Person, M., 2014. Electric bikes in North America: results of an online survey. Transp. Res. Rec. J. Transp. Res. Board 2468, 123–130. https://doi.org/10.3141/2468-14.

Martin, A., Goryakin, Y., Suhrcke, M., 2014. Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey. Prev. Med. 69, 296–303. https://doi.org/10.1016/j.ypmed.2014.08.023.

Mayring, P., Fenzl, T., 2013. QCAmap. Qualitative Content Analysis Program. Available at: <http://www.qcamap.org> (last accessed February 2018).

Mayring, P., 2014. Qualitative Content Analysis: Theoretical Foundation, Basic Procedures and Software Solution. Klagenfurt. Available at: <http://nbn-resolving.de/urn:nbn:de:0168-ssoar-395173> (last accessed February 2018).

Menghini, G., Carrasco, N., Schüssler, N., Axhausen, K.W., 2010. Route choice of cyclists in Zurich. Transp. Res. Part A Policy Pract. 44, 754–765. https://doi.org/10.1016/j.tra.2010.07.008.

Mertens, L., Compernolle, S., Deforche, B., Mackenbach, J.D., Lakerveld, J., Brug, J., Roda, C., Feuillet, T., Oppert, J.M., Glonti, K., Rutter, H., Bardos, H., De Bourdeaudhuij, I., Van Dyck, D., 2017. Built environmental correlates of cycling for transport across Europe. Heal. Place 44, 35–42. https://doi.org/10.1016/j.healthplace.2017.01.007.

Moore, G.C., Benbasat, I., 1991. Development of an instrument to measure the perceptions of adopting an information technology innovation. Inf. Syst. Res. 2 (3), 192–222. https://doi.org/10.1287/isre.2.3.192.

Morse, J.M., 2000. Determining sample size. Qual. Health Res. 10, 3–5. https://doi.org/10.1177/104973200129118183.

Munkácsy, A. 2017. User Profiles and Adoption Attributes of Innovative Bike-sharing Systems: The Case of BiciMAD (Madrid). Thesis (Doctoral), E.T.S.I. Caminos, Canales y Puertos (UPM). https://doi.org/10.20868/UPM.thesis.47849.

Muñoz, B., 2016. Integrating Bicycle Option In Mode Choice Models Through Latent Variables. Thesis (Doctoral). Universidad Politecnica de Madrid.

Muthén, L.K., Muthén, B.O., 2012. Mplus User's Guide, seventh ed. Muthén & Muthén, Los Angeles, CA.

Mutrie, N., Carney, C., Blamey, A., et al., 2002. “Walk in to Work Out”: a randomised controlled trial of a self help intervention to promote active commuting. J. Epidemiol. Community Health 56 (6), 407–412. https://doi.org/10.1136/jech.56.6.407.

Mytton, O.T., Panter, J., Ogilvie, D., 2016. Longitudinal associations of active commuting with wellbeing and sickness absence. Prev. Med. 84, 19–26. https://doi.org/ 10.1016/j.ypmed.2015.12.010.

Nehme, E.K., Pérez, A., Ranjit, N., Amick, B.C., Kohl, H.W., 2016. Behavioral theory and transportation cycling research: application of diffusion of innovations. J. Transp. Heal. 3, 346–356. https://doi.org/10.1016/j.jth.2016.05.127.

Nigg, C.R., Borrelli, B., Maddock, J., Dishman, R.K., 2008. A theory of physical activity maintenance. Appl. Psychol. 57, 544–560. https://doi.org/10.1111/j.1464-0597.2008.00343.x.

Oja, P., Titze, S., Bauman, A., et al., 2011. Health benefits of cycling: a systematic review. Scand. J. Med. Sci. Sport. 21 (4), 496–509. https://doi.org/10.1111/j.1600-0838.2011.01299.x.

Parkin, J., Wardman, M., Page, M., 2008. Estimation of the determinents of bycicle mode Share journey to work using census data. Transp. 35, 93–109. https://doi.org/10.1016/S1366-5545(02)00012-1.

Patton, M.Q., 2014. Qualitative Research & Evaluation Methods. Sage, Thousand Oaks, CA.

Petrunoff, N., Rissel, C., Wen, L.M., 2016. The effect of active travel interventions conducted in work settings on driving to work: a systematic review. J. Transp. Health 3 (1), 61–76. https://doi.org/10.1016/j.jth.2015.12.001.

Petschnig, M., Heidenreich, S., Spieth, P., 2014. Innovative alternatives take action – investigating determinants of alternative fuel vehicle adoption. Transp. Res. Part A Policy Pract. 61, 68–83. https://doi.org/10.1016/j.tra.2014.01.001.

Plazier, P.A., Weitkamp, G., van den Berg, A.E., 2017. “Cycling was never so easy!” An analysis of e-bike commuters’ motives, travel behaviour and experiences using GPS-tracking and interviews. J. Transp. Geogr. 65, 25–34. https://doi.org/10.1016/j.jtrangeo.2017.09.017.

Pope, C., Mays, N., 2006. Qualitative methods in health research. In: Pope, C., Mays, N. (Eds.), Qualitative Research in Health Care, 3rd ed., pp. 1–5. https://doi.org/10.1002/9780470750841.ch1.

Popovich, N., Gordon, E., Shao, Z., Xing, Y., Wang, Y., Handy, S., 2014. Experiences of electric bicycle users in the Sacramento, California area. Travel Behav. Soc. 1, 37–44. https://doi.org/10.1016/j.tbs.2013.10.006.

Preacher, K.J., Hayes, A.F., 2008. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behav. Res. Methods 40 (3), 879–891. https://doi.org/10.3758/BRM.40.3.879.

Rapley, T., 2007. Doing Conversation, Discourse and Document Analysis. Sage, London.

Rogers, E.M., 2003. The Diffusion of Innovations, fifth ed. Free Press, Simon & Shuster. Inc., New York.

Rose, G., 2012. E-bikes and urban transportation: emerging issues and unresolved questions. Transp. 39, 81–96.

Schneider, S., 2016. How does sport act? A biopsychosocial model. Public Health Forum 24 (2), 76–79. Wingerter, C., 2014. Berufspendler: Infrastruktur wichtiger als Benzin (Commuters: Infrastructure more important than gasoline). STATmagazin: Arbeitsmarkt 5, 1–4.

Sahin, I., Rogers, F., 2006. Detailed review of Rogers’ diffusion of innovations theory and educational technology-related studies based on Rogers. Turkish Online J. Educ. Technol. 5, 14–23. https://doi.org/10.1080/09687769.2010.529107.

Sahlqvist, S., Heesch, K.C., 2012. Characteristics of utility cyclists in Queensland, Australia: an examination of the associations between individual, social, and environmental factors and utility cycling. J. Phys. Act. Health 9, 818–828. https://doi.org/10.1123/jpah.9.6.818.

Saunders, L.E., Green, J.M., Petticrew, M.P., Steinbach, R., Roberts, H., 2013. What are the health benefits of active travel? A systematic review of trials and cohort studies. PLoS One 8 (8), e69912. https://doi.org/10.1371/journal.pone.0069912.

Seebauer, S., 2015. Why early adopters engage in interpersonal diffusion of technological innovations: an empirical study on electric bicycles and electric scooters. Transp. Res. Part A Policy Pract. 78, 146–160. https://doi.org/10.1016/j.tra.2015.04.017.

Sener, I., Eluru, N., Bhat, C., 2009. Who are bicyclists? Why and how much are they bicycling? Transp. Res. Rec. J. Transp. Res. Board 2134, 63–72. https://doi.org/10.3141/2134-08.

Shih, C.-F., Venkatesh, A., 2004. Beyond adoption: development and application of a use-diffusion model. J. Mark. 68 (1), 59–72. https://doi.org/10.1509/jmkg.68.1.59.24029.

Silverman, D., 2001. Interpreting Qualitative Data Methods for Analyzing Talk, Text and Interaction, second ed. Sage, Thousand Oaks, CA.

Simons, D., Clarys, P., De Bourdeaudhuij, I., de Geus, B., Vandelanotte, C., Deforche, B., 2014. Why do young adults choose different transport modes? A focus group study. Transp. Pol. 36, 151–159. https://doi.org/10.1016/j.tranpol.2014.08.009.

Statistisches Bundesamt (Destatis), 2018. Datenreport 2018 (Data Report 2018). Statistisches Bundesamt and Wissenschaftszentrum Berlin für Sozialforschung, Bonn.

Stinson, M.A., Bhat, C.R., 2005. A comparison of the route preferences of experienced and inexperienced bicycle commuters. Presented at the 84th Annual Meeting of the Transp. Res. Board, Washington, D.C.

Strömberg, H., Rexfelt, O., Karlsson, I.C.M.A., Sochor, J., 2016. Trying on change – trialability as a change moderator for sustainable travel behaviour. Travel Behav. Soc. 4, 60–68. https://doi.org/10.1016/j.tbs.2016.01.002.

Sürig, D., 2012. Umsatteln, bitte! Steuerliche Gleichstellung von Fahrrädern und Dienstwagen (Resaddle, please! Equal tax treatment of bicycles and company cars). Süddeutsche Zeitung, 04 December 2012. Available at: <https://www.sueddeutsche.de/geld/steuerliche-gleichstellung-von-fahrraedern-und-dienstwagen-umsatteln-bitte-1.1540716> (last accessed July 2018).

Swift, S., Green, M., Hillage, J., Nafilyan, V., 2016. Impact of the Cycle to Work Scheme: Evidence Report. Institute for Employment Studies Report 509.

Titze, S., Stronegger, W.J., Janschitz, S., Oja, P., 2007. Environmental, social, and personal correlates of cycling for transportation in a student population. J. Phys. Act. Health 4, 66–79. https://doi.org/10.1123/jpah.4.1.66.

Titze, S., Stronegger, W.J., Janschitz, S., Oja, P., 2008. Association of built-environment, social-environment and personal factors with bicycling as a mode of transportation among Austrian city dwellers. Prev. Med. 47, 252–259. https://doi.org/10.1016/j.ypmed.2008.02.019.

Ware, J., Kosinski, M., Dewey, J., Gandek, B., 2001. How to Score and Interpret Single-Item Health Status Measures: A Manual for Users of the SF-8 Health Survey. QualyMetric, Boston.

Wehl, R., 2016. Das Dienstrad als Steuerfalle (The company bicycle as a tax trap). Zeitschrift für Steuer- und Wirtschaftsrecht (NWB) 37, 1018.

Wesp, R., 2015. Work-Bike-Balance per Dienstrad (Work-bike balance with a company-Leasing bicycle). Available at:. Lebensm. Ztg. 43 (last accessed April 2019). https://www.lebensmittelzeitung.net/handel/Work-Bike-Balance-per-Dienstrad-112802.

WHO, 2006. Air quality guidelines: global update 2005, World Health Organiz., <https://doi.org/10.1016/0004-6981(88)90109-6>.

Wingerter, C., 2014. Berufspendler: Infrastruktur wichtiger als Benzin (Commuters: Infrastructure more important than gasoline). STATmagazin: Arbeitsmarkt 5, 1–4. Available at: <https://www.destatis.de/DE/Publikationen/STATmagazin/Arbeitsmarkt/2014_05/2014_05PDF.pdf?__blob=publicationFile> (last accessed June 2018).

Winters, M., Davidson, G., Kao, D., Teschke, K., 2011. Motivators and deterrents of bicycling: comparing influences on decisions to ride. Transp. 38, 153–168. https://doi.org/10.1007/s11116-010-9284-y.

Winters, M., Friesen, M.C., Koehoorn, M., Teschke, K., 2007. Utilitarian bicycling. a multilevel analysis of climate and personal influences. Am. J. Prev. Med. 32, 52–58. https://doi.org/10.1016/j.amepre.2006.08.027.

Winters, M., Sims-Gould, J., Franke, T., McKay, H., 2015. “I grew up on a bike”: cycling and older adults. J. Transp. Heal. 2, 58–67. https://doi.org/10.1016/j.jth.2014.06.001.

Winters, M., Teschke, K., Grant, M., Setton, E.M., Brauer, M., 2010. How far out of the way will we travel? Built environment influences on route selection for bicycle and car travel. Transp. Res. Rec. 2190, 1–18. https://doi.org/10.3141/2190-01.

Wolf, A., Seebauer, S., 2014. Technology adoption of electric bicycles: a survey among early

adopters. Transp. Res. Part Policy Pract. 69, 196–211. https://doi.org/10.1016/j.tra.2014.08.007.

Xing, Y., Handy, S.L., Mokhtarian, P.L., 2010. Factors associated with proportions and miles of bicycling for transportation and recreation in six small US cities. Transp. Res. Part D Transp. Environ. 15, 73–81. https://doi.org/10.1016/j.trd.2009.09.004.

Xu, H., Wen, L.M., Rissel, C., 2013. The relationships between active transport to work or school and cardiovascular health or body weight: a systematic review. Asia Pac. J. Public Health 25 (4), 298–315. https://doi.org/10.1177/1010539513482965.

Yin, R.K., 2018. Case Study Research and Applications: Design and Methods, sixth ed. Sage, Thousand Oaks, CA.

Zhang, W., Bansback, N., Anis, A.H., 2011. Measuring and valuing productivity loss due to poor health: a critical review. Soc. Sci. Med. 72, 185–192. https://doi.org/10.1016/j.socscimed.2010.10.026.

Appendix A: Semi-structured interview guides

Interviews with employer representatives

1. In which department do you work and what position do you hold there?
2. Why did you become the contact person for company-leasing bicycles in your company?
3. Since when do you offer company-leasing bicycles to your employees and how many bicycles have been leased until today?
4. Can you please explain the decision-making process for the adoption of company-leasing bicycles in your company? How did the topic come up, which company departments were involved in the decision-making process and how long did this process take?
5. For what reasons do you offer your employees company-leasing bicycles? What were the main motives for the adoption of the program?
6. Did you hope for certain effects on your employees and your company through the adoption of company-leasing bicycles. Can you see any positive effects today?
7. Did the management see potential problems and difficulties regarding the adoption of company-leasing bicycles in your company during the decision-process?
8. Has the adoption of company-leasing bicycles caused any problems, difficulties or other negative effects for, or on, your company?
9. Is the bicycle-leasing program integrated into any existing business strategies of your company, such as sustainability management, health management or mobility management?
10. How did you promote the bicycle-leasing program to your employees during the launch period and how do you promote the program today?
11. Do you communicate the program also to the outside world, for example via your webpage, press releases or mention in job interviews?
12. Is there an active exchange or communication process with employees who adopted a company-leasing bicycle?
13. Does your company offer cycling facilities, such as showers, bicycle racks or charging stations for e-bike batteries for bicycle commuters? Has there been any special investment in cycling facilities triggered by the adoption of company-leasing bicycles?
14. Has there been any other changes in your company triggered by the adoption of company-leasing bicycles, for example in the personnel or organizational area, or in daily working processes of certain departments?

Interviews with employees

1. In which department do you work and what position do you hold there?
2. For how long have you had a company-leasing bicycle?
3. Why and how did you become aware of the bicycle-leasing program?
4. How did you find out about how the bicycle-leasing program works?
5. Did you exchange with colleagues about the program before you signed the contract? If yes, what were the topics?
6. Have you had any direct contact or communication with the leasing provider? If yes, what were the topics?
7. In the decision-making process, did you see any possible problems or difficulties that might be associated with the purchase of a company-leasing bicycle?
8. For what reasons did you decide to lease a company bicycle?
9. Did you own a bicycle before you leased a company bicycle? How many bicycles do you have besides the company-leasing bicycle?
10. Did you want to buy a new bicycle anyway, independently of the bicycle-leasing program?
11. How often have you cycled both for private trips and to get to work, before you leased a company bicycle?
12. Has your mobility behavior changed both for private trips and to get to work, since you have leased a company bicycle?
13. Does your company advertise the bicycle-leasing program to employees? If yes, to what extent?

14. Does your company offer cycling facilities, such as showers, bicycle racks or charging stations for e-bike batteries for bicycle commuters? Are you aware of any special investment in cycling facilities since the bicycle-leasing program was adopted in your company?
15. Are you aware of any other changes in your company since the bicycle-leasing program was adopted in your company? If yes, to what extent precisely?
16. How far do you live from your place of work?

Appendix B: Publications

Permission to print

Re: letter of approval for publishing article in my dissertation [210702-017352]

Transportation Research Part A <tra@elsevier.com>
Mo 05.07, 07:09
Synek, Stefan

Posteingang

Aus Datenschutzgründen wurden einige Inhalte in dieser Nachricht blockiert. Um die blockierten Funktionen wieder zu aktivieren, klicken Sie hier.

Um den Inhalt dieses Absenders immer anzuzeigen, klicken Sie hier.

How was our service today? ~~Thumbs up~~ Thumbs down

Dear Dr. Synek,

Thank you for your email.

May I request you to follow the below link for more details on re-using the article.

Rightslink® by Copyright Clearance Center

If you need any further assistance, please let me know.

Kind Regards,
Vinaya

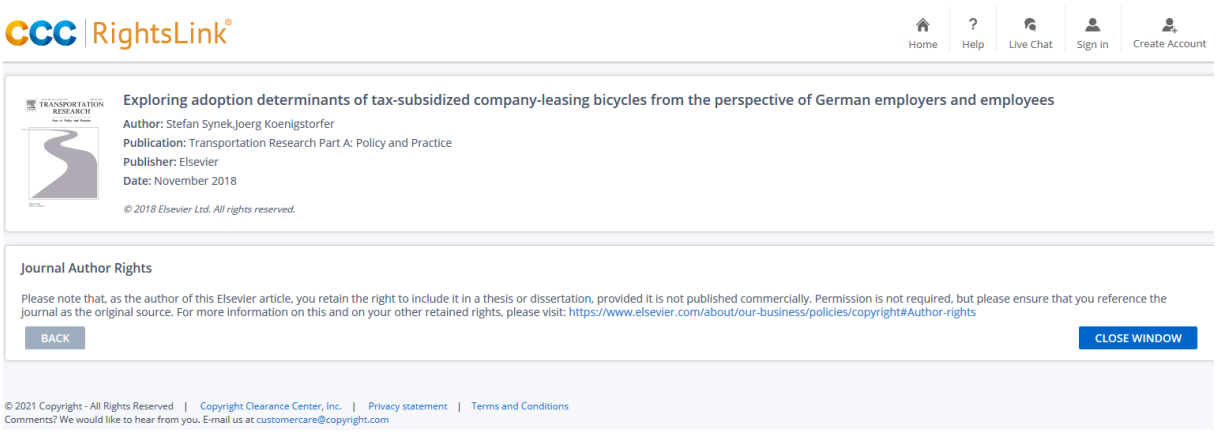
Vinaya Sundar
Journal Manager
Tel: +44 (0)4299 4633
ELSEVIER | Operations | Research Content Operations

From: Stefan Synek
Date: Friday, July 02, 2021 02:08 PM GMT

Dear Sir or Madam,
I published the article "Exploring adoption determinants of tax-subsidized company leasing bicycles from the perspective of German employers and employees" in the Journal Transportation Research Part A 117 (2018) 238-260.
The articel was one of two articles for my cumulative dissertation. The doctoral degree regulations of the Technical University of Munich say, that I have to ask the journal of my published articles for a letter of approval for publishing my article in my dissertation. So, I would kindly ask you to send me a short confirmation to my email address that I am allowed to publish the article in my disseratation.
Email address: stefan.synek@tum.de

Thank you very much.

Kind regards,
Stefan Synek



Copyright

Overview

In order for Elsevier to publish and disseminate research articles, we need certain publishing rights from authors, which are determined by a publishing agreement between the author and Elsevier.

For articles published open access, the authors license exclusive rights in their article to Elsevier where a CC BY-NC-ND end user license is selected, and license non-exclusive rights where a CC BY end user license is selected.

For articles published under the subscription model, the authors transfer copyright to Elsevier.

Regardless of whether they choose to publish open access or subscription with Elsevier, authors have many of the same rights under our publishing agreement, which support their need to share, disseminate and maximize the impact of their research.

For open access articles, authors will also have additional rights, depending on the Creative Commons end user license that they select. This Creative Commons license sets out the rights that readers (as well as the authors) have to re-use and share the article: please see here for more information on how articles can be re-used and shared under these licenses.

This page aims to summarise authors' rights when publishing with Elsevier; these are explained in more detail in the ↓ publishing agreement between the author and Elsevier.

Irrespective of how an article is published, Elsevier is committed to protect and defend authors' works and their reputation. We take allegations of infringement, plagiarism, ethical disputes, and fraud very seriously.

Author rights

The below table explains the rights that authors have when they publish with Elsevier, for authors who choose to publish either open access or subscription. These apply to the corresponding author and all co-authors.

Author rights in Elsevier's proprietary journals	Published open access	Published subscription
Retain patent and trademark rights	√	√
Retain the rights to use their research data freely without any restriction	√	√
Receive proper attribution and credit for their published work	√	√
Re-use their own material in new works without permission or payment (with full acknowledgement of the original article): 1. Extend an article to book length 2. Include an article in a subsequent compilation of their own work 3. Re-use portions, excerpts, and their own figures or tables in other works.	√	√
Use and share their works for scholarly purposes (with full acknowledgement of the original article): 1. In their own classroom teaching. Electronic and physical distribution of copies is permitted 2. If an author is speaking at a conference, they can present the article and distribute copies to the attendees 3. Distribute the article, including by email, to their students and to research colleagues who they know for their personal use 4. Share and publicize the article via Share Links, which offers 50 days' free access for anyone, without signup or registration 5. Include in a thesis or dissertation (provided this is not published commercially) 6. Share copies of their article privately as part of an invitation-only work group on commercial sites with which the publisher has a hosting agreement	√	√
Publicly share the preprint on any website or repository at any time.	√	√
Publicly share the accepted manuscript on non-commercial sites	√	√ using a CC BY-NC-ND license and usually only after an embargo period (see Sharing Policy for more information)
Publicly share the final published article	√ in line with the author's choice of end user license	×
Retain copyright	√	×

Essay 1

Transportation Research Part A 117 (2018) 238–260

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Exploring adoption determinants of tax-subsidized company-leasing bicycles from the perspective of German employers and employees

Stefan Synek, Joerg Koenigstorfer*

Chair of Sport and Health Management, Technical University of Munich, Georg-Brauchle-Ring 60/62, 80992, Germany

ARTICLE INFO

Keywords:
Perceived innovation characteristics
Diffusion of Innovations Theory
Active transportation
Commuting by bike

ABSTRACT

Since 2012, when changes in German tax law were made, the purchases of tax-subsidized company-leasing bicycles (including s-pedelecs and electrically assisted bicycles) have increased in Germany. However, it is largely unknown what factors determine whether employers and employees adopt the bicycle-leasing program or not. In the case study, the authors analyzed relevant documents as well as interviewed 22 employer representatives and 22 employees and analyzed their responses to explore both the adoption drivers and barriers. Informed by Diffusion of Innovations Theory, categories of perceived innovation characteristics as well as categories that go beyond this conceptualization were identified. In particular, the study explored various facets in relation to relative advantage and complexity, providing insights into how benefit-and-cost trade-offs determine the perceived value of the concept as well as how difficulties in usability may either postpone or hinder the adoption of the concept. Categories relating to compatibility, trialability, and observability as well as additional categories such as involvement of key stakeholders (employer and employee level) and seasonality (employee level) were explored. The case study derives several policy and managerial implications that should help promote the adoption of company-bicycle leasing bicycles in particular and cycling as a means of active transportation in general.

1. Introduction

Since cycling is a sustainable way of traveling and a factor contributing to an active and healthy lifestyle (Hendriksen et al., 2010; Humphreys et al., 2013; Martin et al., 2014; Mytton et al., 2016; Schneider, 2016), transportation policy makers are interested in promoting cycling to work in countries around the world. In Germany, for about 49% of the employees, the distance from people's home to their work is less than ten kilometers (Wingerter, 2014). If there is an appropriate infrastructure for cycling, such distance is considered acceptable for commuting to work by bicycle (Iacono et al., 2008).

Various policy tools (e.g., improvements in bicycle infrastructure and communication campaigns) have attempted to make more German residents prefer the bicycle to the car to commute to work. The tools have increased the use of bicycle in various cities, such as Munich and Berlin (Lanzendorf and Busch-Geertsema, 2014; Wingerter, 2014). However, the car still remains the most popular mode of transport to commute and only 9% of German employees cycle to work – a relatively low number compared to 26% bicycle commuters in the Netherlands (Haubold, 2014; Wingerter, 2014). Thus, there is some potential to increase bicycle commuting in

* Corresponding author.
E-mail address: joerg.koenigstorfer@tum.de (J. Koenigstorfer).

https://doi.org/10.1016/j.tra.2018.08.011
Received 20 March 2018; Received in revised form 9 August 2018; Accepted 13 August 2018

Germany, a historically car-dominated country.

In 2012, politicians changed the German tax law through expanding the so-called "company-car privilege" so it would apply to bicycles (including s-pedelecs and electrically assisted bicycles [e-bikes]) (BMF, 2012; Wesp, 2015). Since then, German companies can participate in the bicycle-leasing program that allows their employees to purchase bicycles[1] for both business and private use at a cheaper price (compared to a non-tax-subsidized purchase of a bicycle that is made outside of the program). The number of companies offering and employees participating in the company-bicycle leasing program has grown since 2012. However, despite the fact that the bicycle-leasing program aims to generate a win-win effect for all employers and employees, adoption rates vary substantially between and within companies (DPA, 2017). Some companies are reluctant to adopt the program, while others embrace it; the same is true for employees.

To date, it remains largely unknown what factors determine whether companies or employees adopt the bicycle-leasing program or not. This study therefore aims to explore the adoption drivers and barriers of the German bicycle-leasing program at both the organizational level (i.e., from the perspective of employers) and the individual level (i.e., from the perspective of employees).

Research on the adoption of the German bicycle-leasing program is relevant for two reasons: (1) to inform policy makers and companies about drivers and barriers at both the organizational and the individual level so that they can act in more sustainable ways (e.g., reduce emissions from commuting employees) and develop target-group specific programs; (2) to help German employees lead a healthier lifestyle and help reduce the impact on the environment by commuting to work by bicycle; this can be done by promoting drivers and reducing barriers.

Informed by the present research, German policy makers may promote drivers and reduce barriers to reach the goal of 15% of trips done by bicycle (as opposed to 9% observed in 2016) until 2020. This would be in accordance with the goal set by the German National Cycling Plan (2013–2020), introduced by the Federal Ministry of Transport, Building, and Urban Development (FMTBUD, 2012). Policy makers in other countries may also use the findings of the study to increase cycling levels. In sum, the findings should help the working society achieve sustainability goals by informing relevant stakeholders about how the employees' commuting behaviors can be changed toward the use of bicycles as a means of active as well as sustainable transportation (and away from high-emission commuting behaviors with few health and environmental benefits).

The paper is structured as follows. First, an overview of the German company-bicycle leasing program is provided. Then the theoretical background, lending to Rogers' (2003) Diffusion of Innovations (DOI) Theory, as well as an overview of the results of previous studies are provided. The methods and results of a case study are presented that generated data from documents as well as interviews with German employers and employees. Next, the study discusses the results of the empirical work and outlines how stakeholders can influence the adoption process of the bicycle-leasing program. The study concludes by discussing the limitations of the research and providing directions for future research.

2. The German tax-subsidized company-bicycle leasing program

2.1. Background of the concept

The idea of rewarding sustainable commuting behavior (here, cycling) through favorable tax treatment is gaining popularity in Europe. In recent years, different countries have introduced tax breaks for cycling-to-work programs, or extended existing ones. The policy instruments that are used to promote cycling to work differ between European countries. Belgium and France, for example, have introduced a tax-free reimbursement scheme based on the kilometers cycled to and from work, while Ireland, Luxembourg, and the United Kingdom offer tax benefits to companies that provide bicycles to their employees (Haubold, 2014; Haubold, 2017).

In November 2012, a fiscal reform was introduced in Germany. The so-called 1% tax rule that applies to company-leased cars (1% of the list price per month) was applied to bicycles, s-pedelecs, and e-bikes (BMF, 2012). The rise of the German tax-subsidized company-bicycle leasing program resulted from the fiscal adjustment made by federal state tax authorities (BMF, 2012). A network of companies and associations of the bicycle industry (e.g., German Cyclist's Association [ADFC] and JobRad) has worked towards the implementation of the fiscal reform between 2008 and 2012. After the German Federal Council rejected an initial amendment on July 06, 2012 (Bundesrat, 2012; Sürig, 2012), the finance ministers of the federal states passed a retroactive decree on the equal treatment of company-leasing bicycles and company-leasing cars on October 23, 2012 (BMF, 2012). To facilitate the evaluation of the noncash benefit from the leasing of company bicycles, the highest tax authorities of the federal states in Germany issued, with the approval of the Federal Ministry of Finance, identical decrees to set average values in accordance with the German income tax law (Deutscher Bundestag, 2013). The development of the program was therefore not a policy-led outcome of politicians' intentions to promote cycling to work, but the result of tax amendments that were made in Germany. As a result, various companies and employees adopted the program.

The program works as follows: Companies sign a contract with a leasing provider. Then, their employees are allowed to select a bicycle from a participating bicycle shop. The invoice is sent to the leasing providers first, which in turn send the invoice for the leasing installments to the respective employers. Since the lease payment is deducted from the employees' monthly gross salary, taxable income decreases. Employees can save up to 40% compared to a regular bicycle purchase. The possible savings from the lease depend on income level, tax class, and tax-exempt amount of the employees. Those with the highest tax burden tend to benefit most. Employees can use the bicycle both for commuting to work and for private purposes (Wesp, 2015). At the end of the 36-month lease

[1] In what follows, s-pedelecs and e-bikes are included when "bicycles" are referred to.

period, employees can purchase the bicycle for the residual value. The program leads to maximum savings when employees lease expensive bicycles (ADFC, 2017). This might be one reason why about half of the employees who participated in the program purchased s-pedelecs and e-bikes (DPA, 2017). In total, until summer 2017, about 200,000 employees have leased bicycles via the program (DPA, 2017). Also, several leasing providers appeared on the market between 2012 and today. The market leader in the company-leasing bicycle sector, JobRad, has more than 7500 company customers, which in turn offer the possibility to participate in the program to about 1.5 million employees within these companies (JobRad, 2018).

Leasing providers emphasize the win-win situation for both employers and employees. The possible advantages can be cost savings for employers and employees, employer branding, high employee satisfaction and employee commitment, and better employee health (e.g., C2WA, 2011 for the UK; JobRad, 2017 for Germany). However, there are also some disadvantages. First, not all employees are eligible to lease bicycles. German companies do not offer the participation in the program to employees who are in training, employees with fixed-term contracts, and employees who will retire within 36 months, for example. Also, due to tariff regulations, civil servants and public servants are not allowed to participate in the program in Germany (BSW, 2017). Second, there is some legal uncertainty, because German lawmakers have not finally determined allowances for the residual value of leasing bicycles at the end of the leasing period at the time when the present study was conducted (Wehl, 2016). If there are discrepancies between use-in-practice and legal regulations, additional costs or burdens may incur. These uncertainties can be a barrier to the participation in the program.

2.2. Diffusion of Innovations Theory as a theoretical frame for exploring adoption drivers and barriers of the program

Rogers' (2003) concept of DOI is a well-established theory that explains the adoption and diffusion of innovations in a variety of research fields, such as transportation and eco-innovations. The theory can be used to study the adoption of innovations at both the organizational level and the individual level. The theory is grounded in sociology and takes into account various socio-cultural factors, such as social networks, cultural values, practices, and beliefs. According to Rogers (2003, p. 12), an innovation is "an idea, practice, or project that is perceived as new by an individual or other unit of adoption". An innovation may have been invented some time ago, but if individuals or organizations perceive it as new, it is still considered an innovation. According to Rogers (2003), adoption represents the "full use of an innovation as the best course of action available" (p. 177). The adoption process can be divided into five stages: knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003). Applied to the context of the present research, the adoption of the company-bicycle leasing program can be assumed when a company takes part and implements the program for the first time (i.e., the organizational level). The adoption (i.e., purchase and use) of company-leased bicycles by employees can be assumed when an employee purchases and uses a bicycle via the program but has not participated in the program (or a similar program) before (i.e., the individual level).

Rogers (2003) proposed five characteristics that determine the adoption of innovations: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability. Between 49% and 87% of the variance in the rate of adoption of innovations can be explained by the five characteristics (Rogers, 2003; Sahin and Rogers, 2006). In what follows, each of the five characteristics are briefly explained.

First, relative advantage is "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003, p. 229). The variable refers to the expected benefits and costs of an innovation. In the present context, it includes aspects such as economic profitability, low initial cost, an increase or a decrease in comfort, social prestige, and savings in time and effort (Rogers, 2003). In the context of cycling to work, health benefits have been identified (Andersen et al., 2000). Even though some of the previous studies on company-bicycle leasing programs have made references to health aspects and other aspects such as saving money and saving time (e.g., Avineri and Steven, 2011; C2WA, 2011, 2013; Caulfield and Leahy, 2011; Clarke et al., 2014), they have not been contextualized as relative advantage drivers of the adoption of the company-bicycle leasing program.

Second, compatibility is "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers, 2003, p. 15). A highly compatible innovation is more certain to adopters, shows greater fit to a person's situation, and is perceived as more familiar. Previous research that has applied the DOI Theory to cycling as a means of active transportation showed that compatibility is perceived as highest in the later stages of Rogers' adoption process (Nehme et al., 2016). This indicates that learning and identification processes take place. To date, however, no studies have been published in the area of the adoption of the company-bicycle leasing program that describe the different facets that compatibility has, and what their relevance is.

Third, complexity is "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 2003, p. 15). While some ideas tend to be obvious in their understanding for adopters, others are not. The former facilitate, whereas the latter hinder adoption. Therefore, Rogers (2003) suggested that the degree of complexity of an innovation is negatively related to the rate of adoption. As for compatibility, the authors of the present study are not aware of any studies in the area of company-bicycle leasing programs that referred to the construct.

Fourth, trialability is "the degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003, p. 16). In general, innovations that can be tested before a purchase is made are adopted more quickly than innovations that cannot. As the possibility of personal testing can reduce uncertainty about an innovation, the trialability is supposed to be positively related to the rate of adoption. The present study therefore considers it as a relevant characteristic, which has not been explored from the perspective of the adoption of company-bicycle leasing programs yet.

Lastly, observability can be defined "as the degree to which the results of an innovation are visible to others" (Rogers, 2003, p. 16). The variable is positively related to the adoption rate. While some ideas are easily observed and communicated to people, others

Table 1
Proposed acoption drivers and barriers of company-leased bicycles in reference to the perceived innovation characteristics at both the organizational level and the individual level.

Organizational level: Employers					
Adoption drivers			Adoption barriers		
Relative advantage	✓	Employee engagement,[1] employee health,[1] lower carbon footprint[1]	Relative disadvantage	✗	No evidence
Compatibility	✗	No evidence	Incompatibility	✗	No evidence
Low complexity	✗	No evidence	High complexity	✗	No evidence
Trialability	✗	No evidence	Low trialability	✗	No evidence
Observability	✗	No evidence	Low observability	✗	No evidence

Individual level: Employees					
Adoption drivers *Five perceived innovation characteristics*			Adoption barriers *Five perceived innovation characteristics*		
Relative advantage	✓[C]	Employee health,[1,2,6,7,8,9,10] financial savings,[1,2,3,4,7,10,11,17] time savings,[2,3,10] traffic safety,[2,3,10,11] convenience,[2,10,11,12,13,14] flexibility[2,6,9,12]	Relative disadvantage	✗[C]	low safety due to crime,[7,12,33] low safety due to inappropriate built environment,[6,7,13,27,29,30,31,33] natural barriers,[24,25,26,27,33,34] image and appearance,[7,8,18,33] physical discomfort,[9,13] health problems[9,17]
	✓[e]	Increase in speed,[35,36,37] reduction in physical exertion,[35,36,37,38] substitution of motorized transport,[35,36,37,38,39,40] allowance for longer and more complex journeys[36,38,39,41,42]		✓[e]	Costs,[36,38,40,45] fear of theft,[40] image/stigma,[39,40] road danger due to high speed[38,40,45]
Compatibility	✓[C]	Past active or inactive mobility behavior,[1,3,4,5,15] need for a new bicycle[1,3,4,5]	Incompatibility	✗[C]	Need for a car (instead of a bicycle),[8], past inactive mobility behavior,[9,15] enjoyment of driving a car[14,26]
	✓[e]	Physical limitations[27,43,44]			
Low complexity	✗[C]	Cycling ability and confidence[8]	High complexity	✗[C]	lack of skills,[17] lack of cycling facilities at workplace[9,12,18,33]
				✓[e]	battery range anxiety,[38,40,45] lack of supportive infrastructure[38,40]
Trialability	✗[C]	Possibility to try out cycling[16]	Low trialability	✗	No evidence
Observability	✗[C]	Role models: colleagues, friends, and relatives[7,8,13,14,17,18,19,20]	Low observability	✗	No evidence
Additional drivers					
Environmental benefit	✓[C]	Lower emissions[1,2,9,18,25]	Environmental harm	✗	No evidence
High motivation	✓[C]	Higher intention to cycle[4,10,15,21]	Low motivation	✗[C]	lack of interest[17]
Home-work distance	✓[C]	Low distance to work[4,18,19,22,23,25]	Home-work distance	✓[C]	large distance to work[4,18,22,23]
Sociodemographics	✓[C]	Male gender,[4,6,23,24,25,26,27,34] higher income,[4,24,26] higher education,[4,27,34] younger age,[4,23,26,34] family status (vs. single)[4,23]	Sociodemographics	✓[C]	See left (opposite relationships)
Car ownership	✓[C]	No ownership,[11,13,26]	Car ownership	✓[C]	See left (opposite relationship)

Notes. ✓ = Variable was proposed to be a driver (barrier) in the bicycle-leasing program literature; ✓[C] = Variable was proposed to be a driver (barrier) in the bicycle-leasing program and in the general cycling literature; ✓[e] = Variable was proposed to be a driver (barrier) for e-bikes in the e-bike literature; ✗ = No variables were proposed in both literature streams; ✗[C] = Variable was not proposed in the bicycle-leasing program but in the general cycling literature. Studies on the bicycle-leasing program:
[1]C2WA (2011), [2]Caulfield and Leahy (2011), [3]Clark et al. (2014), [4]Avineri and Steven (2011), [5]C2WA (2013). Studies on cycling in general: [6]Akar and Clifton (2009), [7]Bopp et al. (2012), [8]Emond and Handy (2012), [9]Gatersleben and Appleton (2007), [10]Heinen et al. (2011), [11]Sahlqvist and Heesch (2012), [12]Fernández-Heredia et al. (2014), [13]Titze et al. (2008), [14]Xing et al. (2010), [15]Bamberg et al. (2003), [16]Strömberg et al. (2016), [17]De Geus et al. (2008), [18]Heinen et al. (2010), [19]Simons et al. (2014), [20]Winters et al. (2015), [21]Eriksson and Forward (2011), [22]Dill and Gliebe (2008), [23]Muñoz (2016), [24]Parkin et al. (2008), [25]Sener et al. (2009), [26]Dill and Voros (2007), [27]Heesch et al. (2012), [28]Titze et al. (2007), [29]Winters et al. (2013), [30]Winters et al. (2010), [31]Mertens et al. (2017), [32]Menghini et al. (2010), [33]Stinson and Bhat (2005), [34]Winters et al. (2007), studies on e-bikes: [35]Johnson and Rose (2015), [36]Ling et al. (2017), [37]MacArthur et al. (2014), [38]Jones et al. (2016), [39]Plazier et al. (2017), [40]Popovich et al. (2014), [41]Astegiano et al. (2015), [42]Lee et al. (2015), [43]Langford (2013), [44]Rose (2012), [45]Dill and Rose (2012)

are more difficult to observe or describe. To date, there is no research on the role of observability for the adoption of the company-bicycle leasing program. The present study considers observability as another potential adoption driver.

Other studies mentioned potential facets of the five characteristics described above (either referring to alternative theories or without reference to Rogers' DOI Theory) in the context of the literature on the adoption of bicycles. Previous studies have considered the adoption of bicycle sharing programs (e.g., Bachand-Marleau et al., 2012; Hazen et al., 2015; Munkácsy, 2017; Parkes et al., 2013) and factors influencing the adoption of e-bikes (e.g., Astegiano et al., 2015; Dill and Rose, 2012; Fyhri and Fearnley, 2015; Johnson and Rose, 2015; Jones et al., 2016; Langford, 2013; Lee et al., 2015; Ling et al., 2017; MacArthur et al., 2014; Plazier et al., 2017; Popovich et al., 2014; Rose, 2012; Seebauer, 2015; Wolf and Seebauer, 2014). To the knowledge of the authors of the present study, however, there are no studies that have appeared in the area of the company-bicycle leasing program that referred to all of the five characteristics of the DOI Theory.

Table 1 provides an overview of the literature and highlights those studies that particularly considered bicycle-leasing programs (see Notes in Table 1). As the present study investigates the drivers and barriers of the adoption of company-leasing bicycles at the organizational and the employee levels, Table 1 refers to both levels. At the organizational level, the study investigates the drivers (barriers) that promote (or delay and hinder) the adoption of the bicycle-leasing program. At the individual level, the study investigates the drivers and barriers that make employees lease and use (or delay and not lease and not use) bicycles via the program. Since e-bikes are often leased via the program, Table 1 also summarizes the drivers and barriers that have been identified for the adoption of e-bikes.

As Table 1 shows, the organizational level of adoption has largely been neglected in the previous studies, with one notable exception (C2WA, 2011), which is a self-report. Also, the previous studies remain partially silent on what factors hinder the adoption of leasing bicycles (see right column in Table 1). For example, little is known about the role of low (or high) trialability and low (or high) observability within the context of adopting the bicycle-leasing programs at the individual level. The present study aims to partially fill this void and aims to explore the adoption drivers and barriers of the German bicycle-leasing program at both the organizational level and the individual level. In what follows, the methodological procedure of the study is described.

3. Methods

3.1. Case study approach

Case study methodology was used to get insights into the adoption drivers and barriers of the German company-bicycle leasing program. It is used to obtain an in-depth understanding of phenomena or processes in real-world experiences and where it is believed that contextual conditions are highly pertinent (Yin, 2018). This is the case in the present study. A case study methodology is appropriate when the investigators have minimal or no control over the behavior of the research participants, and when the study focuses on contemporary events (Yin, 2018). This is also the case in the present study. Thus, the single case study approach was deemed appropriate to provide answers to the research questions.

Due to the exploratory nature of the research questions, a qualitative case study design was chosen for the study. Qualitative case studies emphasize lived experiences and interrelations between actors in relation to a phenomenon (Yin, 2018), whereas quantitative case studies focus on the identification of trends in attitudes and opinions of a population, as well as testing relationships between variables (Creswell and Creswell, 2017). Since the present study sought to explore decisions that result from lived experiences as well as decisions from multiple stakeholders, a qualitative approach was deemed to serve the purpose of the study.

The exploratory case study approach is particularly helpful when a research topic is relatively new, or when the topic suffers from a shortage of information and literature (Yin, 2018), which is the case in this study, as there is no scientific literature on the German company-bicycle leasing program. Multiple sources of evidence were used in this case study to increase the quality, accuracy, and confidence in the study's findings. The combination of document analysis and interview analysis (using both company representatives and employees as informants) in a single case study helps increase the understanding of stakeholders' diverse lived experiences. It allows to gain deep insights, taking into account differing perspectives and behaviors through triangulation; this should increase the credibility of the research findings (Yin, 2018).

3.2. Document analysis

The accessible information on the German company-bicycle leasing program was subjected to a document analysis (Silverman, 2001). Via a document analysis, data are extracted to increase one's understanding as well as to explore meanings and purposes. The data are often used as background material in qualitative research designs (Corbin and Strauss, 2008; Rapley, 2007). The analysis provides a better understanding of the development of the company-bicycle leasing program (against the background of policy making), how the program works, and what arguments are used to promote adoption and reduce barriers to adoption.

The first step of the analysis was to identify relevant documents. They were identified via searching the homepages of the most important stakeholders of the program (governmental organizations, providers, and associations). Also, online press releases that focused on the program were searched. Additional material was collected using electronic search engines (Google and Google Scholar, OPAC, and ScienceDirect). The following search terms were used: "bicylce" (or "bike") was connected with (AND) "company" (or "firm", "employer", "leasing", "tax", "fiscal"). The hits were saved, screened, and selected for an in-depth investigation (according to their relevance). The documents were then reviewed for citations and additional references. The following thirteen documents provided the data for the document analysis: press release of the German Cyclists Association (ADFC, 2017), report of a

Civil Servants Association (BSW, 2017), paper on orders of the highest tax authorities of the federal states (BMF, 2012), minutes of plenary proceedings of the Federal Council of Germany (Bundesrat, 2012), questions and answers provided by the German Federal Government (Deutscher Bundestag, 2013), press release of the German Press Agency (DPA, 2017), two press releases of the market leader in the company-bicycle leasing market (JobRad, 2017, 2018), and five articles (ACE, 2016; Firlus, 2018; Sürig, 2012; Wehl, 2016; Wesp, 2015). These documents were read and examined to identify key themes (thematic analysis) related to the adoption drivers and barriers of the company bicycle leasing program at both the employer and employee level.

3.3. Informants during interviews

Beside the document analysis, personal interviews were conducted to enrich the understanding as well as triangulate the results of the document analysis. The present study combined the purposeful sampling technique with convenience sampling to take into account the peculiarities of the setting that was considered in the study (Koerber and McMichael, 2008; Patton, 2014). At the organizational level, the authors collaborated with the market leader in the company-leasing bicycle sector to receive information about companies that have already adopted the program, taking into account companies from different industries, of different organizational size, and with different past cycling-to-work cultures (in particular as regards their past means to promote cycling).

After the different companies were identified, the authors of the study contacted their representatives (who were key decision-makers in regard to the bicycle leasing program), made appointments for interviews with them, and interviewed the informants until saturation was reached. The informants included 13 men and 9 women from 21 companies. In the case of one company (no. 17; see Table 2), two interviews were conducted, one with a member of the work council and one with the head of the human resources department. Both were responsible for the adoption of the bicycle-leasing program in their company. The interviews with the 22 firm representatives lasted between 18 and 44 min and were conducted at the informants' place of work.

At the individual level, company-bicycle users were selected based on the principle of purposeful random sampling (Patton, 2014). The population of the employees who participated in the company-bicycle leasing program was identified with the help of the leasing agency (who has all the information because they make and store the leasing contracts) and the companies that took part in the interviews (as described above). Both gave their informed consent and the research was conducted in agreement with customer data management regulations and market research standards. Informants were then contacted and, if they agreed to participate in the study, interviewed. More informants were contacted until saturation was reached. The informants included 17 men and 5 women between the ages of 31 and 61 years. The interviews with the employees lasted between 12 and 33 min and took place at informants' preferred location, that is, either at their homes or at their workplace.

Tables 2 and 3 give an overview of the companies and employees who took part in the study. All interviews were held between November 2016 and March 2017. An interview guide with a set of 14 semi-structured questions for firm representatives and 16 semi-structured questions for company-bicycle users was developed (Appendix). The interview questions were open-ended and interviewers were able to prompt respondents for more information about specific issues that were mentioned. Semi-structured interviews were conducted to keep the interviews focused and facilitate cross-case analysis (Carson et al., 2001) but also to provide data collection flexibility to allow the researchers room to explore new and relevant issues that emerged during the interview (Pope and Mays, 2006). The interview guide was designed to capture the context, content, and process regarding the adoption of company-bicycles and focused on the drivers and barriers. Semi-structured interviews with 20–30 informants as for the present study allowed rich and in-depth data collection according to (Bowen, 2008) and (Morse, 2000).

With the concurrent data collection and data analysis approach, data saturation (the point in data collection and analysis where no new ideas emerge; Guest et al., 2006) was subsequently checked and achieved during content analysis after 22 informants from companies and 22 informants in their role as employees had been interviewed.

All informants gave their informed consent for participation in the study. With their permission, audio recordings were made of all interviews, which were then transcribed and paraphrased before the abstracted text was reduced to categories. Then, relevant parts of the interviews were translated from German into English. A native speaker checked the content of the translation (back-and-forth method). For confidentiality reasons, employees were given fictitious names.

3.4. Data analysis of the interviews

The study used content analysis procedures (Mayring, 2000) to inductively code information provided in the interviews; the information coding process is crucial to the analysis (Hsieh and Shannon, 2005; Mayring, 2014). The inductive procedure was considered to be appropriate as there are no existing conceptualizations of the facets of the perceived innovation characteristics beside Rogers' (2003) general conceptualization into the following five components: relative advantage, compatibility, complexity, trialability, and observability. The QCAmap software (Mayring and Fenzl, 2013), which aims to standardize rule-guided qualitative categorization, was used to support the coding and the analysis.

The analysis began by extracting, sighting, and carefully reading the text. In the second step, the transcribed material was organized into meaningful coding units using an inductive open coding approach. Codes emerged as the reading of the text progressed. The aim of categorizing inductively is to classify data as belonging to a particular group (Elo and Kyngäs, 2008), here to driver and barrier facets within the five perceived innovation characteristics that may determine the adoption of the company-bicycle leasing program. The coded content units consist of 25 subcategories (six main categories) at the organizational level and 21 subcategories (seven main categories) at the individual level. To obtain a further categorization and abstraction into a conceptual model (Elo and Kyngäs, 2008), the subcategories (they are later called "facets", see results) were grouped into the five perceived innovation

Table 2
Overview of the characteristics of the companies that the informants worked for (organizational level).

Company number	Industry	Informant's department	Gender[1]	Number of employees	Number of leased bicycles during the time of the interview	Date of adoption of the program (DD.MM.YYYY)	(Main) motives for adoption of the program[2]	Companies' past measures to promote cycling[3]	Development of bicycle facilities due to the adoption of the program[4]	Additional subsidization by the company
1	Media	Human resources	F	70	3	31.03.2016	**nc**, es, hp, pp	br, df, sh	No	No
2	Consulting	Managing director	M	70	10	17.02.2014	**hp**, eb	sh	Planned: sh	No
3	Media	Human resources	F	230	10	07.06.2016	**hp**, ec, es	br, cre, sh	No	No
4	Stationary	Human resources	F	340	83	01.03.2016	**pp**, se	bf, br	Installed: br Demand: sh	Yes: greater than 60 days cycling per year: €35 per month
5	IT consulting and services	Travel management	M	380	35	22.04.2016	**es, nc**	br lbs, sh	No	No
6	Electrical engineering	Human resources	M	400	26	21.08.2016	**es**, hp, nc, se	br	No	No
7	Insurance	Human resources	F	450	27	28.06.2016	**eb**, hp	Nothing	No	No
8	Bio-/nanotechnology	Human resources	M	450	40	02.07.2015	**es**, eb, hp	chf, lo, sh	Planned: cre	No
9	Social service	Human resources	F	480	4	04.05.2016	**tw**, hp	br	Planned: lbs	No
10	Sports and outdoor equipment	CSR management	F	500	41	24.07.2015	**se**, hp	bdt, bf, br, btm, bw, chf, cre, lbs, lo, rew, sh	No	No
11	Media	Human resources	F	600	32	01.06.2016	**eb**, es, se	br, chf, sh	No	No
12	Pharmaceutical/ Cosmetics	Human resources	M	750	131	01.05.2013	**se**, es, eb, hp, nc, pp	br, sh	Installed: br Planned: cre	Yes: €4.30 per month
13	Software	Work council	M	800	59	01.08.2016	**pp**, hp	br	Installed: chf, cre, df, lbs, sh	Yes: €18 per month
14	Building materials	Human resources	F	900	21	01.04.2015	hp, eb	br, sh	No	No
15	Mechanical engineering	Human resources	M	900	238	01.06.2013	**hp**, eb	bdt, br, chf, lo, sh	Installed: br, df Demand: cre	Yes: costs for insurance (before 01.01.2017)
16	Medical/ pharmaceutical	Human resources	F	1100	98	13.05.2016	**pp**, se	bf, br, chf, cre, sh	Planned: lo	No
17	Paper industry	Work council/ human resources	M/M	2400	605	16.03.2015	**hp**, nc	br, chf, sh	No	Yes: €10 per month
18	Metal industry	Human resources	M	2700	832	14.03.2016	**hp**, es	br, chf, sh	Installed: br	No
19	Food and beverage	Human resources	M	4800	437	11.05.2016	**eb**, ec, hp, nc, pp, se	br	No	No
20	Software	Sustainability management	M	19,000	451	08.04.2015	**hp**, nc, se	br lbs, sh	Installed: br	No
21	Transportation and logistics	Mobility management	M	197,000	0	01.09.2016	eb, hp, se	No information due to different locations	No information due to different locations	No

Notes. [1]M = Male, F = Female. [2]The main motive is shown in bold; eb = employer branding, eb = employer branding, ec = employer commitment, hp = health promotion, nc = no costs, pp = parking problems for cars need to be solved, se = sustainability and environmental reasons, tw = means of transportation to work. [3]bdt = bicycle days and tours for employees, bf = provision of a bicycle fleet, br = provision of bicycle racks, btm = provision of a bicycle tube machine, bw = bicycle workshops for employees, chf = provision of changing facilities, cre = provision of charging facilities for e-bikes, df = provision of drying facilities, lbs = provision of lockable bicycle storage, lo = provision of lockers, rew = installment of a reward for bicycle-commuting employees, sh = provision of showers. [4]Demand = Demand for new or additional bicycle facilities due to the adoption of the program. Planned = Planned installation of new or additional bicycle facilities due to the adoption of the program. Installed = Newly or additionally installed bicycle facilities due to the adoption of the program. See [3] for abbreviations.

Table 3
Overview of the characteristics of the employees who participated in the company-bicycle leasing program (individual level).

Company-bicycle adopters	Company characteristics[1]	Gender[2]	Age (in years)	Position	Time since adoption (in months)	Number of bicycles and type of bicycles adopted	Home-work distance (in km)	Substitution or complementary bicycle[3]	Change in mobility patterns according to informants[4]
Andreas	IT service provider; 30 employees	M	31	Software engineer	2	1 urban bike	17	Rw/oN	No change
Florian	Engineering; 50 employees	M	39	Software engineer	5	1 mountain bike	12	Aw/oN	No change
Stefan	Consulting; 70 employees (company 2)	M	46	Managing director	19	1 racing bike	10	Rw/oN	Re+
Erika	Stationary; 340 employees (company 4)	F	48	Human resources officer	9	1 e-bike	3	Rw/oN	Lo, PS+, Re+, SC, Sh+
Maria	Stationary; 340 employees (company 4)	F	61	Purchasing officer	10	1 e-bike	19	RwN	No change
Karsten	Stationary; 340 employees (company 4)	M	60	Manufacturing planning officer	9	2 e-bikes	3.5	AwN	Lo, Re+, SC, SWo
Christian	Non-profit organization; 530 employees	M	51	Purchasing officer	5	1 fat bike	20	Aw/oN	No change
Erich	Packaging industry; 540 employees	M	31	Project manager	30	1 e-bike	25	AwN	Lo, Re+
Nils	Pharmaceutical/cosmetics; 750 employees (company 12)	M	NR	Technical engineer, work council member	5	1 e-bike	Not relevant (field work)	AwN	Lo, PS+, Re+, SC
Peter	Software; 800 employees (company 13)	M	48	Consultant, work council member	3	1 e-bike	8	AwN	PS+, Re+
Franz	Software; 800 employees (company 13)	M	39	Head of software development department	3	1 mountain bike	4.5	AwN	Re+, SC, SWo
Ingo	Mechanical engineering; 900 employees (company 15)	M	61	Head of industrial engineering department	12	1 e-bike	1.5	AwN	Lo
Linda	Mechanical engineering; 900 employees (company 15)	F	52	Human resources officer	4	1 mountain bike	2.5	Rw/oN	No change
Gerhard	Automotive supplier; 1000 employees	M	53	Machine operator	6	2 e-bikes	13	AwN	Lo, Re+
Tom	Medical/Pharmaceutical; 1100 employees (company 16)	M	53	In-house consultant	18	2 e-bikes	9	AwN	Lo, PS+, Re+, SC, Wo+
Birte	Health and social services; 1600 employees	F	38	Secretary	7	1 e-bike	25	RwN	No change
Uwe	Paper industry; 2400 employees (company 17)	M	58	Work council member (full-time)	19	2 e-bikes	3	AwN	Lo, PS+, Re+, SC, Sh+, Wo+
Ingrid	Paper industry; 2400 employees (company 17)	F	55	Human resources assistant	18	1 e-bike	10	AwN	Lo, PS+, Re+, SC, Sh+, SWo
Martin	Health and social services; 10,000 employees	M	46	IT coordinator	3	1 mountain bike	6	AwN	No change
Paul	Transportation and logistics; 197,000 employees (company 21)	M	48	Purchasing officer	0.07	1 trekking bike	70	Aw/oN	No information (time since adoption was too short)
Otto	Transportation and logistics; 197,000 employees (company 21)	M	43	Controller	2	1 e-bike	8	AwN	Lo, PS+, Re+

(continued on next page)

Table 3 (continued)

Company - bicycle adopters	Company characteristics[1]	Gender[2]	Age (in years)	Position	Time since adoption (in months)	Number of bicycles and type of bicycles adopted	Home-work distance (in km)	Substitution or complementary bicycle[3]	Change in mobility patterns according to informants[4]
Dieter	Food retail; 233,000 employees	M	42	Food service manager	0.03	1 e-bike	20	Aw/oN	No information (time since adoption was too short)

Notes. [1]See Table 2 for information about the companies. [2]M = Male, F = Female. [3]Need-based motivation for adoption: RwN = Replacement of an old bicycle and need for a new bicycle ("with need"), Rw/oN = Replacement of an old bicycle and no need for a new bicycle ("without need"), AwN = Additional bicycle and need for a new bicycle ("with need"), Aw/oN = Additional bicycle and no need for a new bicycle ("without need"). NR = Not revealed. [4]Perceived change in mobility patterns after the adoption according to the informants: Lo = Longer cycling trips (distance and/or duration), PS + = More cycling trips for personal and social activities (e.g., visiting friends or family members, seeing the doctor), Re+ = More cycling trips for recreation, SC = substitution of car trips, Sh + = More cycling trips for shopping activities, SWo = Start to cycle to work, Wo + = More cycling to work.

characteristics, where possible, and complemented by additional inductively coded main categories; they are called "adoption determinants", see results). All subcategories and main categories emerged from the data and were defined by the authors.

Two coders performed the coding; inter-rater reliability was excellent with Cohen's $\kappa = 0.84$. After completing the coding and grouping, the two coders engaged in an iterative process to further elucidate the meaning of the identified subcategories and the relationships between them. The final interpretation of the findings, as presented in this manuscript, emerged through active discussion among the co-authors.

4. Results

In both the documents and interviews, a number of different facets of the drivers and barriers were mentioned at the organizational and individual level. The inductive coding initially explored the meaning of the facets, followed by the relation to the five perceived innovation characteristics. In the document analysis, the following adoption drivers (or barriers) were coded: employee health, employee satisfaction, employee commitment, employer branding, environmental benefit, no extra costs, reduction of parking problems, decrease in traffic safety, time investment, complex tax laws, dealing with differences in employees' eligibility, and unforeseen financial burden (organizational level); as well as healthand environmental benefits; mobility, monetary savings, possibility to lease more than one bicycle, and loss of social security contributions (individual level).

In what follows, the results that emerged from the interviews are provided. They provide rich insights into the adoption drivers and barriers. The results from interviews with the company representatives are presented first. Then, insights into the perspective of the employees are provided. Links between document and interview data coding are outlined.

4.1. Drivers and barriers at the organizational level

Tables 4–7 provide an overview of the different facets that were identified in the data, and their relation to the adoption determinants. Eight different facets of relative advantage drivers were mentioned in the interviews; three additional facets were identified as barriers and may thus be considered as a relative *dis*advantage (Table 4). The eight driving facets are the following:

Table 4
Adoption drivers and barriers of company-leased bicycles in relation to relative advantage at the organizational level.

Facet (*characteristic*)	Example statement
Relative advantage	
Employee health	"We believe that exercise is good for our people." (Company 17) "Health aspects were the main motive for the implementation (…) that actually appeared to be true (…). Last year, we did a study on absenteeism and saw that the so-called JobRad users have about a third fewer days off than the rest of the staff." (Company 15)
Employee satisfaction	"We are a very employee-friendly company and try to have as many benefits as possible for the employees (…) just as another measure to make our people happy." (Company 5)
Employee commitment	"For us, this also means an instrument for employee commitment." (Company 3) "We have a strong orientation toward increasing the commitment of our employees in our corporate culture (…). And that's how I would see it." (Company 19)
Employer branding	"The second motive was (…) employer branding, to make companies (…) attractive as an employer brand and also to show applicants (…) doing something for its employees." (Company 15) "When it comes to recruiting specialized staff (…) you put all the aspects on the table. (…) one or two colleagues (…) explicitly asked for it [the bicycle-leasing program] when they were hired." (Company 19)
Mobility	"The main motive is actually that many of our employees visit families in the urban or working area (…). Thus, they are traveling a lot. And then we thought about it, you could do that just in the urban area, it's also wonderful with the bike and it offers many advantages. Therefore, the company had already partially focused on the bike idea through the type of work of our employees (…) many actually use it for their trips during working hours." (Company 9)
Environmental benefit	"We have been EMAS-certified since 2008, and with EMAS you have to analyze your environmental aspects and that's where it turned out (…) that transportation, business travels, and commuting account for almost half of our carbon footprint." (Company 10) "At that time, I think it [the bicycle-leasing program] was very much a matter of pure sustainability. (…) hey, that's a great topic to save carbon dioxide." (Company 20)
No extra costs	"(…) if there are no costs involved, then you can do it." (Company 1) "Of course, we took care that there are no extra costs." (Company 5) "(…) and there are no costs involved, that's the advantage." (Company 12)
Reduction of parking problems	"It started with the fact that we had a relocation (…). We had about 900 parking spaces in the old building and in the new one, only 360 parking spaces. Now, we have rented a large outdoor parking lot with about 500 parking spaces. And this parking lot is only available for five years and then it is over, i.e. within five years, we have to get the staff into developing alternatives to the car." (Company 13)
Relative disadvantage	
Lack of proof of evidence	"This is a kind of small experimental object, you know. We'll do it and then we'll have a look, how it is accepted and what effects we get." (Company 7) "We said in terms of money, it should be plus minus zero in hope of achieving positive effects (…) and let's see what kind of effects we get." (Company 17)
Decrease in traffic safety	"Some managers from the management board said then, oh, that's too dangerous now. After all, the risk of accidents increases when we have e-bikes when they rush through the traffic at 25 or 30 km per hour." (Company 13) "(…) and road safety. That was briefly discussed in advance, riding a bike in traffic (…) we thought about that." (Company 8)
Time investment	"(…) whenever there is something special, when an employee has a claim we have to care about, that costs time of course." (Company 17) "I have to follow up with my human resources director if we advertise again. Because there is some work to be done for it." (Company 14)

Table 5
Adoption drivers and barriers of company-leased bicycles in relation to compatibility at the organizational level.

Facet (*characteristic*)	Example statement
High compatibility	
High fit with existing values	"We live and breathe sports (…)." (Company 10) "We want to continue to promote our three main areas of activities, quality leadership, top employer, and pioneer in environmental protection. And, of course, it [the bicycle-leasing program] fits very well with this concept and with achieving these goals." (Company 21)
High fit with past measures to promote cycling	"Regarding the topic of bicycle commuting, I think there is nothing that we have not already implemented. Yes, we have showers, we have changing rooms, we have illuminated, centrally located and easily accessible bicycle parking spaces protected from rain and with lockers, we have free charging stations for e-bike batteries (…) we have a bicycle workshop, we have a bicycle tube machine." (Company 10) "We are also ADFC certified, for the second time now (…). And therefore, we must have a special number of bicycle racks on site. So, we are already supporting and promoting the cyclists and that was, of course, another opportunity." (Company 11)
High fit with daily work routine	"It's just a sideline. That has to run next to all the other work. In the beginning, it took a bit longer, but meanwhile, we got 30 bicycles, so it's a routine now." (Company 14) "This is an established process. We tried to put an FAQ document on the server to answer most questions. There are references to the bike dealers and there are references to JobRad where you can also inquire. So, from now on, our effort actually approaches zero." (Company 13)
Low compatibility	
Low fit with daily work routine	"(…) it really adds up. We, in the human resources department, have to deal with it (…) we do not hire people to do it (…). We therefore really try to keep the workload low." (Company 17). "Right now, we have more than 600 bikes in total and you can't just handle them additionally (…) you need to install new processes." (Company 17)

Table 6
Adoption barriers of company-leased bicycles in relation to complexity at the organizational level.

Facet (*characteristic*)	Example statement
Complex tax laws	"We then regulated the taxation with the tax office, but that was not so easy." (Company 4) "Yes, the residual value problem is there. To say that the bike has a higher value afterwards than it actually costs. The residual value paid by the people is ten percent. But actually, the bike has at least a value of 30. And then the question, what does it mean? Is this just a hidden installment purchase? And if it was a hidden installment purchase, the deduction from the gross salary is not possible. And that's the difficulty. Then the whole thing is taxable and therefore not profitable anymore regarding the tax advantages. So, this tax problem remains." (Company 19)
Difficulties in handling unforeseen changes in work contracts	"(…) and also, wage garnishment against employees was a specific topic (…) or continuation of payment for employees who are absent. These were the only topics that gave us quite a headache and where we had to look for solutions." (Company 15) "What gave us quite a headache was what we should do when an employee leaves the company before the leasing contract ends, for whatever reason (…) how do we deal with it." (Company 11)
Difficulties in handling of bicycle thefts	"At the beginning, we also felt quite uncertain about the topic of thefts. Because if there are a lot of them, our insurance premium would probably go up." (Company 15) "And, of course, there is much work to do if there is a theft." (Company 16)
Dealing with differences in employees' eligibility	"The biggest problem is actually that we have no opening clause in our labor agreement and only the employees who have an above the general pay scale allowance or are non-tariff employees who can apply deferred compensation benefit from the social insurance. That's the biggest hurdle." (Company 14) "The biggest problem we've stumbled upon is that we have employees on fixed-term contracts. How to communicate the offer, that they have no right to order a bike." (Company 11)
Investment in complex bicycle infrastructure needed	"When we moved into the new building, there were priorities, of course, and the bicycle storage room was not one of the top priorities. It was just a big empty room and there was slight anger. Meanwhile, the whole thing is developing. We now have four bike racks and a drying area for clothing and so on. But that was important, otherwise the staff is quite dissatisfied." (Company 13) "We wanted to make it perfect (…) and immediately bought a charging tower to charge the batteries with such a chip card (…). This thing was a bad investment from the beginning, it never really worked. In the meantime, we do not have it any more, we charge the batteries quite normally at the socket. (…) it cost us only time, money, and nerves at the end (…). Since only one type of rechargeable battery fits, if somebody has a different brand, then it does not work." (Company 10)
Difficulties in estimating future workload of staff	"Stumbling blocks were, let me say, from the point of view of our human resources department, oh, how much work it [the bicycle-leasing program] is (…). But looking back, we see that it was not so bad. But there were reservations." (Company 17) "We cannot yet assess how the process execution will be managed after three years and what to expect then. The model has been introduced for 18 months." (Company 20)

employee health; employee satisfaction; employee commitment; employer branding; mobility (meaning that employees become more mobile); environmental benefit (meaning that the environmental dimension of sustainability is promoted); no extra costs; and reduction of parking problems. These findings coincide with the seven drivers at organizational level investigated in the previous document analysis. Only the facet mobility was not mentioned in the documents. The barriers are the following: lack of proof of

Table 7
Adoption drivers of company-leased bicycles in relation to trialability, observability, and stakeholder involvement at the organizational level.

Characteristic	Facet	Example statement
Trialability	Possibility to have a test run	"We started about two and a half years ago with the prototype and it has proven successful. And then we called for proposals." (Company 21) "They decided to test it with two employees first, to be able to estimate a bit how much work it would actually mean and how exactly it would work." (Florian)
Observability	Companies as role models	Seekers: "In the end, we have heard of human resources managers from other companies who also have JobRad (…). We tried to talk to other companies who already implemented it, (…) how does it work? (…) what JobRad or any other representative tells, is it consistent with your experience as company? (…) and then (…) we decided that we (…) want to start." (Company 17) Givers: "(…) and we went public, there were many reports in the local press. And a lot of companies asked us about it [bicycle-leasing program], there were a lot of calls from other companies. And meanwhile, we have noticed that many other companies in the region also offer the concept." (Company 15)
Involvement of key stakeholders	Strong support by decision-makers	"The human resources manager and also a member of the management board are enthusiastic cyclists. And that's how they stumbled on the topic and got some information about it." (Company 18) "I thought about who I can win over for it [company bicycle-leasing program]. (…) I thought about it, where do I find fellow combatants for the cause. And there was one colleague in the human resources department who loves cycling. And it was an important point when I won him over for the topic. You have to work strategically." (Company 12) "Our boss is very environmentally-friendly and for such things, it's easy to win him over." (Company 4) "We discussed this with our managing director (…) and he is a passionate cyclist himself and he said right away, yes, we do it." (Company 3)
	Strong support by work council	"The basic idea, the intention and the persistent demand for it actually came from the work council, which in hindsight was also really positive, because in the end the employee representatives were the ones who pushed this forward (…). All the consulting service in advance or the conclusion of contracts was done by the work council." (Company 17) "We agreed upon our own bike policy with our social partners and the work council." (Company 20)

evidence; decrease in traffic safety; and time investment. Only the facet lack of proof of evidence was not mentioned in the documents. One sample statement from the documents is the following: "Security concerns regarding company bicycles are voiced. In fact, the higher speeds of e-bikes or unfavorable weather can lead to accidents." (ACE, 2016)

With regard to compatibility, the inductive coding revealed high compatibility facets with values, past activities in the area of the promotion of cycling, and past work routines. Table 5 shows the following four facets: high fit with existing values, high fit with past measures to promote cycling, and high fit with daily work routine (three drivers) and low fit with daily work routine (one barrier). Sample statements that were mentioned in the interviews are presented in Table 5. With regard to companies' measures to encourage cycling to work, some of the informants stated that their company had already promoted cycling to work before the leasing program started. Other companies already had facilities such as showers, bicycle racks, and lockers that could be used by bicycle commuters. Two companies have received the "bicycle-friendly employer" certificate from the ADFC (i.e., the German Cyclists Association), signaling above-average commitment to, and offers for, cyclists. However, the low fit with daily work routine means that participation in the program leads to additional work that needs to be newly structured and organized. Some informants complained about this, but none of the companies has created a dedicated job for the bicycle-leasing program, an indicator that the participation may have increased the workload on the current staff.

Table 6 summarizes the coding results with regard to complexity. The adoption determinant includes barriers only. The following facets were coded: complex tax laws, difficulties in handling unforeseen changes in work contracts, difficulties in handling bicycle thefts, dealing with differences in employees' eligibility, investment in complex bicycle infrastructure needed, and difficulties in estimating future staff workload. In particular, German tax laws were perceived to be complex, which was also emphasized as an important potential barrier in various sources of the document analysis: "The actual fiscal risk of contract design is overlooked by many employers. This may turn the company bicycle into a tax trap (…). The risk of additional tax charge exists for the entire lease period." (Wehl, 2016) Furthermore, special cases relating to company bicycles can hinder or at least delay the implementation of the program. For example, companies worry about bicycle accidents, thefts, and employees with wage garnishment, sick leave, and termination of employment before the leasing runs out. Companies with labor agreements often have to negotiate with the trade unions in order to reach a consent for the employees to lease a company bicycle. Developing additional complex bicycle infrastructure (e.g., installing showers where there is no easy access to water) can be a hindering factor for adopting the bicycle-leasing program. The interviews showed that the investment in cycling facilities lag behind the demands of commuters in some companies (Table 2). Special cases and potential expenditures such as investment in bicycle infrastructure coincide with unforeseen financial burden for companies, a barrier detected in the document analysis. "For companies, costs are incurred for administration and employee remuneration." (Firlus, 2018) Also, statements of firm representatives indicated that some company representatives find it difficult to validly forecast the workload that is associated with the implementation of the program because of the complexity of the topic and to handle differences in employee's eligibility to lease a company bicycle (the latter is in line with findings from the document analysis). The document analysis revealed the following statement: "Since 2012, bicycles have been equated with company cars in the private sector - not so in public service. The labor agreement with employees in the public service does not yet provide this possibility (…).

Table 8
Adoption drivers and barriers of company-leased bicycles in relation to relative advantage at the individual level.

Facet (*characteristic*)	Example statement
Relative advantage	
Health	"I thought an e-bike was the best alternative, the healthiest alternative (…) for me." (Birte) "(…) I want to leave the car at home to do something for my health." (Uwe)
Mobility	"I cycle for leisure but not regularly (…). But now with the new trekking bike (…) I am riding to the city or go shopping (…). I just leave the car at home." (Paul) "So, I have 25 km to work (…) that was previously not doable with the old bike (…) I do that from time to time to go to work by bike (…) that has already changed. Well, let's say, any visits you normally did by car, 10 km away, I do it all with my e-bike now, of course." (Erich) "We live in a hilly area and do not cycle so much in the mountains. And with the e-bike, it's no problem at all now. Since then, you ride on routes that you would not otherwise. You ride more often (…) longer distances (…) just hop on your bicycle in the evening and go shopping." (Ingrid)
Monetary savings	"I am in tax class five, which saves me 28%, that is quite a bit. Well, others do not save that much, but with tax class five, it's a lot. And then the bike costs you less than if you buy it directly. And as you pay it in 36 monthly leasing installments, then you don't even feel that you pay so much for the bike." (Linda)
Purchase for a family member or friend	"There is the opportunity to get one for the spouse, which means for the two of us. I have leased two pedelecs, two e-bikes (…). That was a very important argument for me, yes." (Tom) "I ordered one for my wife, an e-bike, and you know, now I can ride with her at eye level (…). Because I have a normal bike and I leased an e-bike for my wife and through this, it is easier now to ride together." (Nils)
Relative disadvantage	
No availability of the desired bicycle in participating bicycle shops	"For me, I do not consider it [to lease a company bicycle] (…). We have found a small dealer in Austria (…) who has a bike (…) that weighs only 15 kilos, not 25. But unfortunately, it's in Austria and they are probably not part of the JobRad dealers (…)." (Otto) "I would have liked to have a different bike than the one I got, but unfortunately (…) not every bike shop participates." (Martin)

The necessary change of law, however, takes time." (BSW, 2017)

Table 7 summarizes the results with regard to trialability and observability, which include one facet each. Involvement of key stakeholders (referring to both decision-makers and work council) is another adoption determinant. The possibility to have a test run was a driver (and relates substantively to the complexity adoption determinants, as shown in the statements in Table 6). Also, during the innovation-decision process, companies seek to gather information from best- and worst-practice examples in order to reduce uncertainty. In particular, company representatives find it helpful to talk to other company representatives who have already set up the company-bicycle leasing program.

According to Rogers (2003), attitudes of organizational decision-makers are likely to mediate the relationships between the five perceived innovation characteristics and the adoption decision. The statements made by the informants reveal that it was important to win one or several key persons with decision-making authority for the program. The management board and the department of human resources seem to be of particular importance. The work council can play an important role in the program in various ways too. Since its goal is to represent employees' interests, they devote their time to discuss the pros and cons of the program. Some informants emphasized that, in their company, the work council is responsible for all the communication, advertising, and consulting with respect to the program.

To conclude, the results on the drivers and barriers at the organizational level indicated 15 facets that drive adoption and 10 facets that can delay or hinder adoption. In what follows, the study presents the results of the coding at the individual level.

4.2. Drivers and barriers at the employee level

Tables 8–11 provide an overview of the different facets that were identified in the data, and their relation to the adoption determinants. There were four different facets of relative advantage drivers that were mentioned in the interviews: one facet was identified as a barrier (Table 8). The drivers are the following: health; mobility; monetary savings; and purchase for a family member or friend. They are congruent with results of the document analysis (e.g., monetary savings indicated by Jobrad (2017): "Your newly won freedom on two wheels has not only environmental and health benefits, but also financial benefits: the company bicycle is taxed

Table 9
Adoption drivers of company-leased bicycles in relation to compatibility at the individual level.

Facet	Example statement
High fit with past cycling behavior	"I have always ridden a bicycle. I (…) bought it through JobRad." (Birte) "I have already been cycling with an e-bike for the last four years, to get to work and for private trips." (Maria) "I used to go to work from time to time with my normal bike in the past." (Tom)
High fit with bicycle-related needs	"I knew already that I wanted to buy a bike." (Franz) "I would have bought a new one anyway, because the range of the old one was not enough anymore (…)." (Ingo) "I wanted to buy such a bike anyway and that's why it came at the right time." (Peter)

Table 10
Adoption drivers and barriers of company-leased bicycles in relation to complexity at the individual level.

Facet (*characteristic*)	Example statement
High complexity	
Difficulties in the understanding of the program	"Then I asked a bit about the conditions, additional costs and such things or what it means for my wage or the topic of insurance, I have asked such things in the in-house payroll office. I didn't fully understand the whole program." (Karsten) "We had to spend some time to understand this concept." (Gerhard)
Complexity of commuting to work by bicycle because of a lack of infrastructure	"(…) Our cycling infrastructure (…) I am skeptical toward this, because riding such an expensive bike, I do not want to leave it outside while working eight hours, even if you store it safely. And there isn't any possibility to take a shower before or after work. And charging stations, as you might know them from other companies, do not exist here." (Dieter) "(…) inside the building, we definitely need adjustments to meet the needs of the cyclist's logistics chain, starting when a cyclist enters the building and ending up in a completely different place in the building, but not with his cycling clothes, but with his business clothes (…). And that's a challenge that's not that easy." (Peter)
Poor information provision about the program	"There wasn't really much I got from my company, and yeah, I would have liked a bit more information." (Erich) "There's an intranet site just on the homepage, and it said that there's JobRad right now and so on, but great advertising is not going on now." (Martin) "We are a subsidiary (…) that has not been passed on to us, not from the human resources department, pure word-of-mouth (…)." (Paul)
Poor support by the employer	"My order was rejected in the first instance, without comment, without reason, point (…) I guess probably 50% have received a rejection (…) and then, of course, I immediately called Leaserad (…) and they did not know the reason for it (…). The reason was probably the same as with me, the personnel number. We have two personnel numbers (…) and I checked it. I have also indicated the wrong personnel number (…) The company's support wasn't very good." (Paul)
Low complexity	
Good handling of the program to increase employee understanding	"That was all very clearly formulated and also the whole process was very simple (…) that went through the human resources department (…) and went off without problems." (Birte) "With the webpage of JobRad (…) it wasn't a problem at all. Everything was well explained, that was all very clear." (Andreas) "You just have to use the calculator, look if it's worth it and then you look for a bike and that's it (…) I did not find it difficult." (Martin)
Provision of good bicycle commuting infrastructure	"I got access to the showers, it was offered to me to use it after cycling (…). And we also have a bicycle cage, a lockable one, and there are individual boxes, bike boxes. I have one now. You can rent them and there is only space for one bike." (Birte) "There was a quite good upgrade of bike racks, such bike racks, where you can chain your bike to it, because of the insurance. So, this installation was a good improvement." (Karsten)
Good information provision about the program	"(…) and I went on this platform and had a look at a nearby bicycle dealer and then selected one and with this activity, let me say, my interest was aroused (…) and there was a cost calculator on the platform, what do I have to pay for the bike for a certain price? This made sense to me, what do I have to pay for the bike? (…). I prefer to pay 57 euros per month compared to 2,400 euros in cash (…). It became very interesting for me and I said, yes, I think about it." (Paul) "Communication measures of various kinds (…) in company meetings (…) e-mail, Yammer (…) e-bike providers have been invited (…). There is also a notice board in our house with contact persons who can be contacted at any time." (Peter) "So, the first time I heard about it was on an information day. Bicycle dealers came to our company and then someone from JobRad came and showed how the concept worked." (Erika)
Good support by the employer	"Since introducing JobRad, the company has organized several things (…). So, a lot of different actions (…). And all that was positive." (Ingo) "We have a department in the company that takes care of it, of occupational safety and also of JobRad. And I inquired there about the program, about technical questions, like what's the best engine, the best brand. The advice was quite helpful." (Tom)

according to the 1% rule"). If the desired bicycle is not available in the participating bicycle shops, adoption is hindered (barrier). Environmental benefit as a driver and loss of social security contributions as a barrier (as found in the document analysis) were not mentioned by the informants. In the data, some interactions between these determinants and the activities that were implemented by the companies were identified. Table 8 describes these interactions by presenting sample statements from employers when they referred to the drivers and barriers at the individual level.

Thirteen employees stated that there was a change in their mobility behavior after they had adopted a company-leasing bicycle (Table 3). The interviews with these informants indicate that the number of trips and/or the distance of the trips increased after the adoption of the progam. Some informants used their bicycle for new and different travel purposes. Some informants substituted car trips, especially when adopting an e-bike. These findings complement the findings reported in Table 8.

Five companies offered their employees additional financial support (Table 2). They either provided a monetary contribution to the installment or paid the insurance. The subsidization increases the attractiveness of the financial incentive of participation, as stated by the following company representatives: "What we do - and this is also a financial benefit to the employee - is that we pay the theft insurance for the employee, so it's the cost of this theft insurance." (Company 13) Another company connects the financial incentive to performances in cycling to work: "If an employee commutes to work at least 60 working days a year, then he or she gets a

Table 11
Adoption drivers of company-leased bicycles in relation to trialability, observability, and stakeholder involvement at the individual level.

Characteristic	Facet	Example statement
Trialability	Possibility to have a test ride	"I went to my bike dealer (…). I just wanted to look what he got there. I was not sure if I would take an e-bike (…) and there, I have to admit, there was an e-bike in such nice colors that convinced me (…). Then I tried it out, up the mountain (…), so I took it." (Erika) "I took an e-bike, because I tested an e-bike a few months ago. And then I knew, I want to get an e-bike and the leasing program was the opportunity." (Peter)
Observability	Colleagues as role models	"I've seen it with colleagues of mine who told me about it, the program (…) and then, I also exchanged for the purchase of e-bikes and checked their bikes, got advice on the engine and all that." (Gerhard) "(…) so many bikes around, so many people who ride a bike to work, especially last summer." (Ingrid)
Involvement of key stakeholders	Colleague influencers	"(…) advertising (…) generally nothing at all from my employer. That's pure word-of-mouth (…). We are a subsidiary (…) that has not been passed on to us, not from the human resources department, pure word-of-mouth (…) I am also quite communicative. I said, guys, if you order, then please (…) and that got around quickly." (Paul) "That was announced once and got around by word-of-mouth." (Ingrid)
	Support via collaboration of involved companies	"We even had JobRad days in Frankfurt, many people got there. There were people from the local environmental office in Frankfurt. There were representatives from JobRad who presented the financing. There were bike dealers who showed their bikes, e-bikes and stuff. That was in September, a lot of promotion was going on there." (Otto)

subsidy of EUR 35 per month (…) believe me, people find it out through word-of-mouth. There is a real competition among the employees about who cycles more (…) who has signed up for the subsidization; and that is controlled by the employees themselves (…). At the end of the year, you have to enter the number of your trips and this is posted on the intranet, who has the most trips and who has the most kilometers (…) and the winner can cycle for free for a year." (Company 4)

The company representatives also realized that employees appreciate the fact that they can get more than only one bicycle: "About 40 people at our location have three or four bikes. So, we are fully aware of the fact that cycling is also a partnership activity." (Company 17) "Most of them really fully utilized the option to lease three bikes, for their families, or if they were single, they leased for their brother or neighbor or someone else." (Company 18)

One hindering program participation factor is the occasional limited availability of desired bicycles. Bicycles can only be ordered from dealers that have a cooperation agreement with the employer's leasing provider. If some employees cannot get the desired bicycles, they do not participate in the program, according to some informants.

Compatibility perceptions (Table 9) relate to two facets: high fit with past cycling behavior and high fit with bicycle-related needs. Values as facet of compatibility according to Rogers (2003) were not mentioned by individuals. None of the informants mentioned the lack of compatibility as a barrier. Table 9 summarizes the findings and provides some sample statements.

Complexity perceptions at the individual level refer to difficulties in the understanding of the program, complexity of commuting to work by bicycle because of a lack of infrastructure (including fear of theft of the bicycle), poor information provision about the program, and poor support by the employer (four facets that delay or hinder adoption; Table 10). However, other statements revealed how the reduction of complexity can drive adoption: opposites were coded as drivers. For example, installing lockable bike boxes on-site can provide theft protection. After they had adopted the program, ten companies felt pressure to develop new or additional bicycle facilities for their employees (Table 2). Thus, a change in infrastructure may be necessary to leverage the program.

Interestingly, adding the company representatives' perspective to these findings, the provision of little information is sometimes intended by the company, as revealed in the following statement of a representative: "We were careful with regards to advertising for the offer and waited to see how everything developed." (Company 3) This indicates that some companies were hesitant to promote the concept because the consequences could not be fully evaluated (see Table 4 in relation to relative disadvantages from the employers' perspective). However, others mentioned the following: "Of course, it [the bicycle-leasing program] goes over the work council, we hear a lot about that. And they talked about it in the last staff meeting, it's great." (Company 19) If communication is facilitated during events such as staff meetings, the concept is typically promoted well. Thus, there is some variance with regard to the efforts that companies put into communication with employees and promotion of the concept.

Table 11 summarizes the results with regard to trialability and observability, which include one facet each. Involvement of key stakeholders (referring to both colleagues and collaborating companies) is another adoption determinant.

Several representatives from companies also highlighted the relevance of trials. One example is the following: "The start was in the context of a big health day (…) a regional bicycle dealer was also on board (…) and test rides could be carried out. Leaserad sent an employee who helped us with the marketing and informed the staff (…). We thought (…) that we could get ten bicycles to our staff in the first year, but that accelerated very quickly in the following weeks after the health day. In the first year, we already had about 90 leasing bicycles." (Company 15)

Some representatives from companies also reported that visibility of company-leasing bicycles at the workplace attracts the attention of employees and can hence promote the program. The following statements highlight the observability as an adoption determinant at the individual level: "And when you ask how we communicate this today, we do not really need to communicate it. The people who do it, who participate, make other people envious with their bike and that's actually the main source of information that goes on today. What a great bike, it feels good. What do I have to do to get one?" (Company 19) Furthermore, role models were

identified to be relevant: "Then the role model effect of the management and executives (…) is really important. (…) all four members of the management really constantly cycle to work. (…) that has an incredible signaling effect and also the middle management, many of them joined (…) of course that's another motivating factor." (Company 10) "He [a company bicycle user] certainly weighed over 100 kilos and he lost quite a bit. And then, that was the idea, how to win those colleagues where you do not really expect it. And I said to him, write a short report, a short interview in our company magazine. (…). That worked really well, to win such people over as an ambassador." (Company 12) Also, the relevance of colleagues as influencers has been mentioned: "(…) they talked about it, where did you buy your bike, that's great, and so on." (Company 4) Thus, there are some important interactions between the perception of the company representatives and the (potential) adopters at the employee level.

The involvement of, and collaboration between, stakeholders is highly relevant, according to some company representatives: "Once a year, we organize a health marketplace, where all internal and external health service providers present themselves. And I regularly have colleagues from JobRad here and also from a bike shop, who provide test bikes, so that the topic is in the mind of our employees. And in the spring we organize it again." (Company 12)

This leads us to another adoption determinant, namely seasonal effects: adoption was reported to be more likely in spring (towards summer time) than in autumn (towards winter time). This is reflected in the following statements: "25 km (…). I do it [cycling to work] when it's warmer." (Birte) "Yes, I used it [company bicycle] already (…) when it was reasonably warmer." (Andreas) "Well, I'll buy a second JobRad soon, in the spring." (Ingo) This is supported by a statement from a company representative: "Some people said, ok, it's autumn now, we don't do it now. We will do it next spring." (Company 14) Seasonality is thus considered an adoption determinant at the individual level (with spring [towards summer time] as driving facet and autumn [towards winter time] as hindering facet).

To conclude on the drivers and barriers at the individual level, the results indicated 15 facets that drive adoption and six facets that delayed or hindered adoption. Fig. 1 provides an overview of the findings.

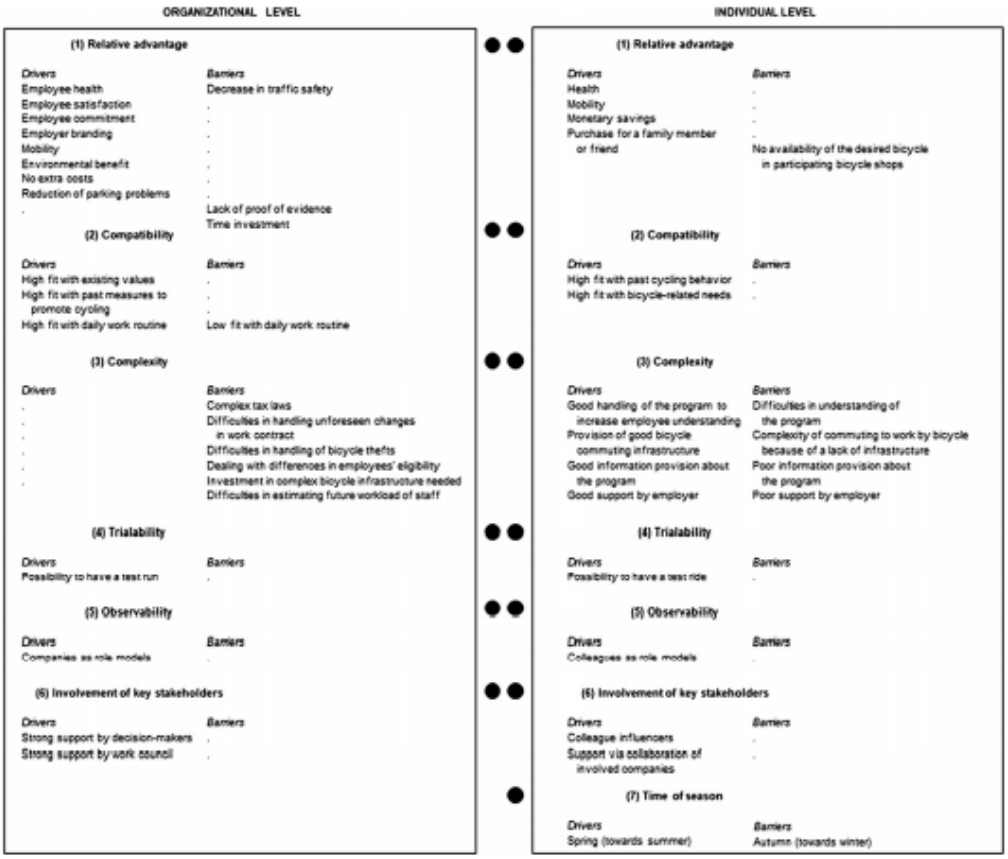


Fig. 1. Overview of the adoption determinants and facets that drive or hinder adoption of the German company-bicycle leasing program at the organizational and individual level.

5. Discussion

The purpose of the study was to explore the drivers and barriers of the adoption of the German bicycle-leasing program from the perspective of German employers and employees. The results of the case study showed that there are different facets that drive and that can delay or hinder adoption. These facets can be related to the following determinants at both the organizational and the individual level: relative advantage, compatibility, complexity, trialability, observability, and involvement of key stakeholders. At the individual level, seasonal effects were explored further with spring (towards summer time) as a driver and autumn (towards winter time) as barrier. According to interviews with informants, the adoption of the program led to changes in how companies promoted cycling within their company and in the mobility behaviors of employees (in both commuting to work and private life).

The study contributes to the scientific literature in four ways. First, the study is the first one to systematically explore the facets that drive, delay, or hinder the adoption of bicycle-leasing programs at the organizational level (employers). Second, the study complements previous studies that were conducted in the area of employee adoption of bicycle-leasing programs that have taken a quantitative approach in the sense that it proposes several facets that have been neglected so far. Third, the study contributes to the DOI Theory when applied to the adoption of means of active transportation in the sense that additional adoption determinants are proposed. Lastly, the study provides first insights into the German company-bicycle leasing program and its potential effects, a relevant topic in a country that is historically connected with the car industry and that has frequently violated pro-environmental standards in the past, such as urban air pollution standards - violations that might be reduced in magnitude and frequency via cycling. In what follows next, these contributions are described in more detail.

First, previous studies have remained largely silent about what factors influence the adoption of bicycle-leasing programs at the organizational level. A study conducted by the C2WA (2011) found that companies adopt the program for three reasons: employee health, employee engagement, and lower carbon footprint. However, the methodology of the study remains unclear und no other factors were mentioned, which is surprising given that both actual and anticipated costs were found to inhibit the adoption of innovations (e.g., Damanpour and Schneider, 2009, 2006; Frambach and Schillewaert, 2002). The results of the present study supported the existence of the three facets of relative advantage that were addressed in the study by the C2WA (2011), but in addition to previous research found that costs as well as other employee-related attributes (satisfaction, mobility) and company-related attributes (branding, reduction of parking problems) matter. Furthermore, compatibility, complexity, trialability, observability, and involvement of key stakeholders were identified as additional determinants of the adoption - factors that the study conducted by the C2WA (2011) neglected. In particular, actual and anticipated additional workload was a topic that was often addressed in the interviews and that is reflected in various relative (dis)advantage and (high or low) complexity facets.

Second, the study complements previous studies in the area of employee adoption of bicycle-leasing programs that have taken a quantitative approach in the sense that it proposes several facets that have not been considered to date. C2WA's (2011) survey of employees in the United Kingdom found that health benefits (including increased fitness, weight loss, and improved mental health, well-being, and happiness) as well as financial savings and emission reduction made employees participate in the program. The results of the present study revealed deeper insights into the perceived characteristics that likely influence the adoption of the German company-bicycle leasing program than both C2WA (2011) and the study conducted by Caulfield and Leahy (2011), which conceptualized health, cost saving, time saving, convenience, flexibility, safety, and emission reduction motives (these factors mostly relate to relative advantage). It is not surprising that the C2WA (which has a genuine interest in promoting the program) did not take into account any barriers in their survey. The present study partially fills this void that is also prevalent in other studies (C2WA, 2013; Caulfield and Leahy, 2011) and considers barriers in addition to drivers. The results also complement the financial and cost-benefit analysis conducted by Clarke et al. (2014), who did not consider the effects of multiple bicycle purchases or employer branding as an economic benefit, for example.

Third, the study contributes to DOI Theory when applied to the adoption of active transportation means. In particular, Nehme et al.'s (2016) study is limited to compatibility as one of the five perceived innovation characteristics only. They conceptualized compatibility as a variable that includes the enjoyment of riding a bicycle, the physical fitness of people, safety along commuting routes, and what type of person someone is ("I am not the kind of person that rides a bike for transportation" was the item for the latter facet). In the present case study, two components were identified: high fit with past cycling behavior and high fit with bicycle-related needs. Although enjoyment might be relevant, it provides some benefit to individuals and can likely be classified as a relative advantage facet. (The higher enjoyment of riding the car instead of riding the bicycle is a relative disadvantage.) The same argument can be made for traffic safety. Physical fitness was treated as a desirable outcome that is beneficial to individuals in the present study when they ride their bicycle.

Besides compatibility, the five factors of relative advantage, complexity, trialability, observability, and involvement of key stakeholders were identified in the present study at both levels. Thus, while it appears that Rogers' (2003) DOI Theory might be useful for studying the adoption of the company-bicycle leasing program, the study proposes to add the involvement of key stakeholders to Rogers' (2003) characteristics. Although it does not relate to the innovation itself, but to the companies behind the innovation, the results on this particular dimension provide suggestive evidence that adoption might be more likely if the various stakeholders work together to set up and run the company-bicycle leasing program. As this category was coded for both the organizational level and the individual level, the variable might be of relevance at both levels. The importance of winning key stakeholders is supported by the literature, as effective advocacy is a crucial part of efforts to increase active transportation to work (Richards et al., 2010).

Also, the results of the present study suggest that the promotion of a driving facet of an adoption determinant may not be the same as the prevention of a hindering facet of an adoption determinant. For example, cost aspects were mentioned as a driver at the organizational level, while time aspects were seen as barriers. Ontologically, the innovation adoption literature has discussed about

whether adoption and rejection determinants are conceptually different or not (e.g., Nabih et al., 1997). The results support Gatignon and Robertson's (1989) perspective that the determinants can be conceptually different both with regard to their substantive meaning and with regard to their potential influence on adoption decisions.

Lastly, the study provides first insights into the company-bicycle leasing program as it is set up in Germany. The results indicate that adopting a company-leasing bicycle might lead to a change in the mobility behaviors in the sense of a more active and sustainable transport lifestyle (i.e., an increase in the number of cycling trips and their distance, the usage of bicycles for new and different travel purposes, and the substitution of car trips). This is in accordance with findings from the e-bike literature (e.g., Fyhri and Fearnley, 2015, for increased number of trips and their distance; Johnson and Rose, 2015; Popovich et al., 2014, for the substitution of car trips) and studies on bicycle-leasing programs (e.g., Caulfield and Leahy, 2011; Clarke et al., 2014, for increased cycling levels). At the moment, active transportation is a relevant topic in Germany, because cities have frequently violated pro-environmental standards in the past, such as air pollution levels (which, for some indicators, are even allowed to be higher in the EU compared to the WHO's recommendation; Eddy, 2018; EU, 2008; WHO, 2006) and there is political and legal pressure to counteract this trend. Aspects that are peculiar to Germany relate to German tax laws, the strong influence of the work council (if present), compatibility concerns because of the prominence and emotional connection of German residents to their cars, and the strong influence of car industry lobbyists, among others. The authors of the present study are not aware of any studies that have assessed whether, and when, the concept of the company-bicycle leasing program is adopted by German employers or employees, and whether the adoption leads individuals to change their mobility patterns. The present study partially fills this void in research by interviewing 44 German stakeholders in this area and analyzing thirteen relevant documents.

6. Managerial and policy implications

The study provides several managerial and policy implications. First, the study informs companies and policy makers about drivers and barriers at both the organizational and the individual level so that they can act in more sustainable ways (e.g., reduce emissions from commuting employees) and develop target-group specific programs. The most positive environmental effects should occur when commuters switch from the use of cars to the use of active transportation (e.g., walking, biking) (C2WA, 2011; Clarke et al., 2014). Leasing companies as well as policy makers can develop target-group specific programs and target particularly those companies that may be interested in the promotion of sustainability in their company (because of an environmental strategy or high emissions, for example); target those companies that may be interested in employer branding (because of challenges in recruiting personnel, for example); or target those companies that may be interested in increasing the health status of their employees (because of high rates of absenteeism and presenteeism, for example). Also, within companies that are already participating in the program, target-group specific programs can be realized by incentivizing employees who are mostly driven by financial savings via campaigns that highlight or extend financial benefits (e.g., savings when a bicycle is leased [vs. purchased outside the program] can be calculated online, additional savings when another bicycle for a family member or friend is purchased are outlined, savings of expenditure on gas when the car is left at home can be calculated online); convincing employees who mention concerns about the high complexity of the program via campaigns that increase ease of use of the program (e.g., informing via the intranet, providing personal support, installing bicycle-friendly infrastructure); promoting the concept by allowing collaborations between stakeholders depending on the needs of the employees (e.g., including bicycle shops that offer many e-bikes if this is desired, including specialty bike shops if this is desired, allowing leasing companies to explain the program during important meetings with staff).

Second, the list of facets that drive, delay, or hinder adoption should help companies identify relevant drivers and barriers, and promote drivers and reduce barriers accordingly. It is important that the companies take into account all characteristics that were identified when they promote the concept, and their various facets: relative advantage, compatibility, complexity, trialability, observability, and involvement of key stakeholders. Although the present research did not have the purpose to indicate which factors are more important and which are less important for the adoption of a leasing bicycle, greatest facet variance was found for relative advantage and complexity. In particular, benefit-and-cost trade-offs (savings seemed to be most important here) determine the perceived value of the concept. Difficulties in usability may make employees either postpone or hinder the adoption of the concept. Low complexity drives adoption. In accordance with the positive relationship between trip-end facilities and bicycle commuting found in the literature (Buehler, 2012; Heinen et al., 2010), the present study's results indicate the importance of investment in bicycle facilities by companies, particularly in regard to providing safe parking and charging facilities for e-bikes. The need for such investment is also created due to the high proportion of e-bikes in the leasing market. Overall, the means identified in the present study that reduce complexity might be important to increase the adoption rate inside companies. Then, more German employees attracted to the program may increase their health and may promote the environment by commuting to work by bicycle. The company may benefit from the campaign too, because health is related to higher productivity (e.g., Collins et al., 2005; Zhang et al., 2011). Other benefits may add to this (see above).

Third, the peculiarities of the German program are the specification of the leasing contracts and the German tax law. Here, a clear communication and explanation of the leasing concept and a simple outline of the tax law can be recommended. Leasing providers should explain the legal regulations in detail to companies and provide assistance with emerging questions and problems. The reduction of uncertainty to lower the perceived complexity was the adoption determinant that provided the richest information in the interviews on facets, beside relative advantage and compatibility. Thus, German leasing companies may particularly take into account these three aspects when they want to promote the concept to potential customers. German employees may be better able to estimate the tax savings when they adopt the concept.

Fourth, one important policy implication of the results of the present study is that fiscal incentives, such as Germany's company-

bicycle leasing program, might be effective in increasing cycling levels. The monetary savings appeared to be a crucial driver for employees' participation in the program. This is an important message to policy-makers in countries with ongoing discussions on monetary incentives for cycling and especially for subsidizing the purchases of e-bikes on a national level. Austria, for example, is one of the few countries with a national subsidy program for e-bikes purchased by companies, local authorities as well as non-profit and religious organizations, besides numerous local incentive programs (BMNT, 2018). It is among the countries with the highest purchases of e-bikes per capita in Europe (Haubold, 2016).

In Germany, bicycle associations have so far unsuccessfully demanded a national purchase premium for e-bikes, and the recommendation by the German Federal Council to consider the introduction of purchase premiums not only for e-cars, but also for e-bikes, has not been considered in the white paper on the creation of a national regulation to promote electric mobility (Bundesrat, 2016). This seems surprising, as in 2015, the German government has introduced generous financial incentives to encourage individuals to purchase e-cars (EUR 4000 for buying a new e-car and EUR 3000 for a hybrid car). Yet the aim of the Transport Ministry to reach an adoption of one million cars onto Germany's streets by 2020 seems almost impossible to reach with less than 100,000 electric cars sold by January 2018 (Deutscher Bundestag, 2018). At the same time, e-bikes were widely adopted despite the absence of public subsidies. In 2017, approximately 3.5 million e-bikes are in use in Germany with a market share of 19% of all bicycles (ZIV, 2018).

To conclude, one may assume that fiscal incentives, when complemented by companies' investments in bicycle infrastructure (e.g., secure bicycle parking spaces and charging stations for e-bike batteries), increase adoption rates of company-leasing bicycles. Subsidies and monetary incentives provided by the companies provide further financial benefits. The collaboration with the companies' work council and other stakeholders may be one strategy to increase the adoption rates further.

7. Limitations and outlook

This research is not free of limitations. First, the study used purposive sampling for the recruitment of interviewees and has a selection bias toward company-bicycle program adopters. This procedure was chosen because of the complexity of the particular program. Companies or employees who have not experienced the complexity may not be able to provide as many details on the facets as found in the study. Future studies might use a comparative design and compare the perspective of adopters and non adopters (potentially referring to different stages of the adoption process) on adoption determinants and facets. Compatibility, for example, was not mentioned as barrier of company-leased bicycle adoption in the study, whereas for non-adopters who are used to commute by car, a lack of compatibility with past commuting behavior could emerge as a hindering factor. Future studies may also consider the different stages of the adoption process beginning with awareness of the program to the full use of the program when studying differences between companies or employees.

Second, since the main goal of the study was to explore adoption determinants (and not to generalize the findings), the samples that were considered in the study are not representative. Thus, the results of this research do not reflect the views of all program participants. Also, no generalization can be made about the importance of the different determinants and facets. Future studies might aim to find out which one of the determinants or facets predicts adoption (or rejection) of the program best, both at the organizational and the individual level. The diffusion of the program might also be a dependent variable of interest to both researchers and practitioners.

Future studies can build upon the study's contextualization and may refer to the DOI Theory to study the adoption of the company-bicycle leasing program. Survey and observational research should be employed to find out about success factors (and barriers), how adoption or diffusion develops over time, as well as what the effects of the participation in the program on transportation choices are, potentially depending on different policy implementation or adherence. Such work would provide novel insights into the behavioral effects of the adoption of the company-bicycle leasing program.

Third, the leasing company that collaborated with the authors of the present study to get insights into companies' perspectives is the market leader in the company-bicycle leasing market. It is desirable that future studies consider competitors too, because there might be inherent differences in management processes, such as customer support, marketing, and provision of additional services (e.g., organization of a health fair). The present case study does not reflect the variance in these features between different leasing companies. Still, the procedure followed in the present study serves its purpose because many of the contextual settings that determine perceptions and potential outcomes can be assumed not to vary among different companies depending on the leasing company they collaborate with (e.g., German tax laws, employee health management efforts in companies, and the importance of health and active transportation as a general concept).

8. Conclusion

The present case study provides insights into adoption drivers and barriers of the German company-bicycle leasing program by exploring categories at both the organizational level and the individual level. It showed that there are various determinants at both the organizational and the individual level: relative advantage, compatibility, complexity, trialability, observability, and involvement of key stakeholders, as well as their counterparts (barriers and drivers, respectively). At the individual level, seasonal effects were explored further with spring (towards summer time) as a driver and autumn (towards winter time) as barrier. According to interviews with informants, the adoption of the program led to changes in how companies promoted cycling within their company and to changes in the mobility behaviors of their employees (when commuting to work and/or in their private life). As positive health and environmental effects stemming from such programs likely depend on policy implementation, future research is needed to assess the

interrelationship between different policy instruments and actual behavioral variables that indicate transportation choices further, be it related to non-electronic bicycles or e-bikes.

Conflict of interest

The authors declare no conflicts of interest.

Financial support

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Semi-structured interview guides

Interviews with employer representatives

1. In which department do you work and what position do you hold there?
2. Why did you become the contact person for company-leasing bicycles in your company?
3. Since when do you offer company-leasing bicycles to your employees and how many bicycles have been leased until today?
4. Can you please explain the decision-making process for the adoption of company-leasing bicycles in your company? How did the topic come up, which company departments were involved in the decision-making process and how long did this process take?
5. For what reasons do you offer your employees company-leasing bicycles? What were the main motives for the adoption of the program?
6. Did you hope for certain effects on your employees and your company through the adoption of company-leasing bicycles? Can you see any positive effects today?
7. Did management see potential problems and difficulties regarding the adoption of company-leasing bicycles in your company during the decision-process?
8. Has the adoption of company-leasing bicycles caused any problems, difficulties or other negative effects for, or on, your company?
9. Is the bicycle-leasing program integrated into any existing business strategies of your company, such as sustainability management, health management or mobility management?
10. How did you promote the bicycle-leasing program to your employees during the launch period and how do you promote the program today?
11. Do you communicate the program to the outside world as well (for example, via your webpage, press releases or mention in job interviews)?
12. Is there an active exchange or communication process with employees who adopted a company-leasing bicycle?
13. Does your company offer cycling facilities, such as showers, bicycle racks or charging stations for e-bike batteries for bicycle commuters? Has there been any special investment in cycling facilities triggered by the adoption of company-leasing bicycles?
14. Have there been any other changes in your company triggered by the adoption of company-leasing bicycles, for example in the personnel or organizational area, or in daily working processes of certain departments?

Interviews with employees

1. In which department do you work and what position do you hold there?
2. For how long have you had a company-leasing bicycle?
3. Why and how did you become aware of the bicycle-leasing program?
4. How did you find out about how the bicycle-leasing program works?
5. Did you exchange opinions with colleagues about the program before you signed the contract? If so, what were the topics?
6. Have you had any direct contact or communication with the leasing provider? If so, what were the topics?
7. In the decision-making process, did you see any possible problems or difficulties that might be associated with the purchase of a company-leasing bicycle?
8. For what reasons did you decide to lease a company bicycle?
9. Did you own a bicycle before you leased a company bicycle? How many bicycles do you have besides the company-leasing bicycle?
10. Did you want to buy a new bicycle anyway, independently of the bicycle-leasing program?
11. How often have you cycled both for private trips and to get to work, before you leased a company bicycle?
12. Has your mobility behavior changed both for private trips and to get to work since you have leased a company bicycle?
13. Does your company advertise the bicycle-leasing program to employees? If so, to what extent?
14. Does your company offer cycling facilities, such as showers, bicycle racks or charging stations for e-bike batteries for bicycle commuters? Are you aware of any special investment in cycling facilities since the bicycle-leasing program was adopted in your company?
15. Are you aware of any other changes in your company since the bicycle-leasing program was adopted in your company? If so, to

what extent precisely?
16. How far do you live from your place of work?

References

ACE (Auto Club Europa), 2016. Infoblatt Diensträder (Information sheet company bicycles), 28 January 2016. Available at: <https://www.arbeitsschutz-portal.de/beitrag/flyer/4876/infoblatt-dienstraeder.html> (last accessed July 2018).

ADFC (Allgemeiner Deutscher Fahrrad-Club), 2017. Dienstradleasing weiter attraktiv (Company-bicycle leasing continues to be attractive), 23 November 2017. Available at: <http://www.adfc.de/news/dienstradleasing-weiter-attraktiv> (last accessed January 2018).

Akar, G., Clifton, K., 2009. Influence of individual perceptions and bicycle infrastructure on decision to bike. Transp. Res. Rec. J. Transp. Res. Board 2140, 165–172. https://doi.org/10.3141/2140-18.

Andersen, L.B., Schnohr, P., Schroll, M., Hein, H.O., 2000. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Arch. Intern. Med. 160, 1621–1628. https://doi.org/10.1001/archinte.160.11.1621.

Astegiano, P., Tampère, C., Beckx, C., 2015. A preliminary analysis over the factors related with the possession of an electric bike. Transp. Res. Proc. 10, 393–402. https://doi.org/10.1016/j.trpro.2015.09.089.

Avineri, E., Steven, F., 2011. Has the introduction of the cycle to work increased levels of cycling to work in the UK? Presented at the 92nd Annual Meeting of the Transp. Res. Board. Washington, DC.

Bachand-Marleau, J., Lee, B., El-Geneidy, A., 2012. Better understanding of factors influencing likelihood of using shared bicycle systems and frequency of use. Transp. Res. Rec. 2314, 66–71. https://doi.org/10.3141/2314-09.

Bamberg, S., Ajzen, I., Schmidt, P., 2003. Choice of travel mode in the theory of planned behavior: the roles of past behavior, habit, and reasoned action. Basic Appl. Soc. Psych. 25, 175–187. https://doi.org/10.1207/S15324834BASP2503_01.

Bopp, M., Kaczynski, A.T., Besenyi, G., 2012. Active commuting influences among adults. Prev. Med. 54, 237–241. https://doi.org/10.1016/j.ypmed.2012.01.016.

Bowen, G.A., 2008. Naturalistic inquiry and the saturation concept: a research note. Qual. Res. 8, 137–152. https://doi.org/10.1177/1468794107085301.

BSW (Verbraucher-Service Beamten-Selbsthilfewerk e.V.), 2017. Kommen die Reifen ins Rollen (Are the tires rolling)? Available at: <https://www.bsw.de/oeffentlicher-dienst/aktuelle-berichte/kommen-die-reifen-ins-rollen--22-03-2017.htm> (last accessed January 2018).

Buehler, R., 2012. Determinants of bicycle commuting in the Washington, D.C. region: the role of bicycle parking, cyclist showers, and free car parking at work. Transp. Res. Part D: Transp. Environ. 17, 525–531. https://doi.org/10.1016/j.trd.2012.06.003.

BMF (Bundesfinanzministerium), 2012. Gleichlautende Erlasse der obersten Finanzbehörden der Länder. Steuerliche Behandlung der Überlassung von (Elektro-) Fahrrädern vom 23. November 2012 (Identical orders of the highest tax authorities of the federal states. Tax treatment of (electric) bicycles from 23 November 2012). Available at: <http://www.bundesfinanzministerium.de/Content/DE/Standardartikel/Themen/Steuern/Steuerarten/Lohnsteuer/BMF_Schreiben_Allgemeines/2012-11-23-gleichlautende-erlasse-elektrofahrraeder-anlage.pdf?__blob=publicationFile&v=3> (last accessed March 2018).

BMNT (Bundesministerium für Nachhaltigkeit und Tourismus), 2018. Förderung rund ums Fahrrad - jetzt einreichen (Subsidy for bicycles - submit now). Available at: <https://www.klimaaktiv.at/foerderungen/rad_foerderungen.html> (last accessed July 2018).

Bundesrat, 2016. Stellungnahme des Bundesrates. Entwurf eines Gesetzes zur steuerlichen Förderung von Elektromobilität im Straßenverkehr (Opinion of the Federal Council. Draft of a law on tax incentives for electric mobility in road traffic), Drucksache 277/16 (Beschluss), 08 July 2016. Available at: <http://www.bundesrat.de/SharedDocs/drucksachen/2016/0201-0300/277-16%28B%29.pdf?__blob=publicationFile&v=1> (last accessed June 2018).

Bundesrat, 2012. Plenarprotokoll 899. Stenografischer Bericht (Stenographic minutes of plenary proceedings 899), 06 July 2012. Available at: <http://dipbt.bundestag.de/dip21/brp/899.pdf> (last accessed July 2018).

Carson, D., Gilmore, A., Perry, C., Gronhaug, K., 2001. Qualitative Marketing Research. Sage, London. https://doi.org/10.4135/9781849209625.

Caulfield, B., Leahy, J., 2011. Learning to cycle again: examining the benefits of providing tax-free loans to purchase new bicycles. Res. Transp. Bus. Manag. 2, 42–47. https://doi.org/10.1016/j.rtbm.2011.08.005.

Clarke, A., Laird, J.J., Shires, J.D., 2014. Cycle to work scheme – weekend warriors or daily commuters. Presented at the Scottish Transport Applications and Research (STAR) Conference, Glasgow.

Collins, J.J., Baase, C.M., Sharda, C.E., Ozminkowski, R.J., Nicholson, S., Billotti, G.M., Turpin, R.S., Olson, M., Berger, M.L., 2005. The assessment of chronic health conditions on work performance, absence, and total economic impact for employers. J. Occup. Environ. Med. 47 (6), 547–557. https://doi.org/10.1097/01.jom.0000166864.58664.29.

Corbin, J., Strauss, A., 2008. Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, third ed. Sage, Thousand Oaks, CA.

Creswell, J.W., Creswell, J.D., 2017. Research Design: Qualitative, Quantitative, and Mixed Methods Approach. Sage, Thousand Oaks, CA.

C2WA (Cylce to Work Alliance), 2011. Behavioural Impact Analysis, February 2011. Cycle to Work Alliance. Available at: <http://www.cycletoworkalliance.org.uk/images/BehaviourImpactAnalysisFeb2011.pdf> (last accessed September 2017).

C2WA (Cycle to Work Alliance), 2013. The Green Way to Work – Sustainable Transport Report, May 2013. Cycle to Work Alliance. Available at: <http://cycletoworkalliance.org.uk/media/1018/news_41_2538974460.pdf> (last accessed September 2017).

Damanpour, F., Schneider, M., 2009. Characteristics of innovation and innovation adoption in public organizations: assessing the role of managers. J. Public Adm. Res. Theory 19, 495–522. https://doi.org/10.1093/jopart/mun021.

Damanpour, F., Schneider, M., 2006. Phases of the adoption of innovation in organizations: effects of environment, organization and top managers. Br. J. Manag. 17, 215–236. https://doi.org/10.1111/j.1467-8551.2006.00498.x.

De Geus, B., De Bourdeaudhuij, I., Jannes, C., Meeusen, R., 2008. Psychosocial and environmental factors associated with cycling for transport among a working population. Health Educ. Res. 23, 697–708. https://doi.org/10.1093/her/cym055.

Deutscher Bundestag, 2018. Antwort der Bundesregierung auf die Kleine Anfrage der Abgeordneten Oliver Krischer, Kerstin Andreae, Stephan Kühn (Dresden), weiterer Abgeordneter und der Fraktion Bündnis 90/Die Grünen (Answer of the Federal Government to the small question of the delegates Oliver Krischer, Kerstin Andreae, Stephan Kühn (Dresden), another member of the parliament and the Alliance 90/The Green Party). Drucksache 19/1536, 04 April 2018. Available at: <http://dip21.bundestag.de/dip21/btd/19/015/1901526.pdf> (last accessed June 2018).

Deutscher Bundestag, 2013. Schriftliche Fragen mit den in der Zeit vom 24. Dezember 2012 bis 4. Januar 2013 eingegangenen Antworten der Bundesregierung (Written questions with the answers received from the Federal Government in the period from 24 December 2012 to 4 January 2013). Drucksache 17/12008, 04 January 2013. Available at: <http://dip21.bundestag.de/dip21/btd/17/120/1712008.pdf> (last accessed June 2018).

DPA (Deutsche Presse Agentur), 2017. Dienstfahrrad statt Dienstwagen. Geld sparen mit dem neuen Trend (Company bicycle instead of company car. Saving money with the new trend). In: Manager Magazin, 12 July 2017. Available at: <http://www.manager-magazin.de/unternehmen/industrie/dienstfahrrad-statt-dienstwagen-neuer-trend-in-leasing-branche-a-1157356.html> (last accessed February 2018).

Dill, J., Gliebe, J., 2008. Understanding and Measuring Bicycling Behavior: A Focus on Travel Time and Route choice. Final report OTREC-RR-08-03 prepared for Oregon Transportation Research and Education Consortium (OTREC), December 2008. <https://dx.doi.org/10.15760/trec.151>.

Dill, J., Rose, G., 2012. E-bikes and transportation policy: insights from early adopters. Transp. Res. Rec. 2314, 1–6. https://doi.org/10.3141/2314-01.

Dill, J., Voros, K., 2007. Factors affecting bicycling demand: initial survey findings from the Portland, Oregon, region. Transp. Res. Rec. J. Transp. Res. Board 2031, 9–17. https://doi.org/10.3141/2031-02.

Eddy, M., 2018. German court rules cities can ban vehicles to tackle air pollution. The New York Times, 27 February 2018. Available at: <https://www.nytimes.com/2018/02/27/business/energy-environment/germany-diesel-air-pollution.html> (last accessed March 2018).

Elo, S., Kyngäs, H., 2008. The qualitative content analysis process. J. Adv. Nurs. 62, 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x.

Emond, C.R., Handy, S.L., 2012. Factors associated with bicycling to high school: insights from Davis, CA. J. Transp. Geogr. 20, 71–79. https://doi.org/10.1016/j.jtrangeo.2011.07.008.

Eriksson, L., Forward, S.E., 2011. Is the intention to travel in a pro-environmental manner and the intention to use the car determined by different factors? Transp. Res. Part D Transp. Environ. 16, 372–376. https://doi.org/10.1016/j.trd.2011.02.003.
EU, 2008. Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. Off. J. Eur. Communities 152, 1–43. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF>.
Fernández-Heredia, Á., Monzón, A., Jara-Díaz, S., 2014. Understanding cyclists' perceptions, keys for a successful bicycle promotion. Transp. Res. Part A Policy Pract. 63, 1–11. https://doi.org/10.1016/j.tra.2014.02.013.
FMTBUD (Federal Ministry of Transport, Building and Urban Development), 2012. National Cycling Plan 2020: joining forces to evolve cycling. Available at: <http://edoc.difu.de/edoc.php?id=1u032rd6> (last accessed June 2018).
Firlus, 2018. So bezahlt das Finanzamt das neue E-Bike mit (How the tax office pays the new e-bike), 03 July 2018. Available at: <https://www.wiwo.de/finanzen/steuern-recht/steuern-sparen-mit-dem-dienstrad-so-bezahlt-das-finanzamt-das-neue-e-bike-mit/13679266.html> (last accessed July 2018).
Frambach, R.T., Schillewaert, N., 2002. Organizational innovation adoption: a multi-level framework of determinants and opportunities for future research. J. Bus. Res. 55 (2), 163–176. https://doi.org/10.1016/S0148-2963(00)00152-1.
Fyhri, A., Fearnley, N., 2015. Effects of e-bikes on bicycle use and mode share. Transp. Res. Part D Transp. Environ. 36, 45–52. https://doi.org/10.1016/j.trd.2015.02.005.
Gatersleben, B., Appleton, K.M., 2007. Contemplating cycling to work: attitudes and perceptions in different stages of change. Transp. Res. Part A Policy Pract. 41, 302–312. https://doi.org/10.1016/j.tra.2006.09.002.
Gatignon, H.A., Robertson, T.S., 1989. Technology diffusion: an empirical test of competitive effects. J. Mark. 53, 35–49. https://doi.org/10.2307/1251523.
Guest, G., Bunce, A., Johnson, L., 2006. How many interviews are enough ? An experiment with data saturation and variability. Field Methods 18 (1), 59–82. https://doi.org/10.1177/1525822X05279903.
Haubold, H., 2014. Commuting: who pays the bill? Eur. Cycl. Fed. Available at: <http://ecf.com/sites/ecf.com/files/141117-Commuting-Who-Pays-The-Bill_2.pdf> (last accessed February 2018).
Haubold, H., 2016. Electromobility for all – financial incentives for e-cycling. Eur. Cycl. Fed. Available at: <https://ecf.com/sites/ecf.com/files/FINAL%20for%20web%20170216%20ECF%20Report_E%20FOR%20ALL-%20FINANCIAL%20INCENTIVES%20FOR%20E-CYCLING.pdf> (last accessed June 2018).
Haubold, H., 2017. Tax breaks for bike commuters – a European trend. Eur. Cycl. Fed. Available at: <https://ecf.com/news-and-events/news/tax-breaks-bike-commuters-european-trend> (last accessed February 2018).
Hazen, B.T., Overstreet, R.E., Wang, Y., 2015. Predicting public bicycle adoption using the technology acceptance model. Sustain. 7 (11). https://doi.org/10.3390/su71114558.
Heesch, K.C., Sahlqvist, S., Garrard, J., 2012. Gender differences in recreational and transport cycling: a cross-sectional mixed-methods comparison of cycling patterns, motivators, and constraints. Int. J. Behav. Nutr. Phys. Act. 9, 106. https://doi.org/10.1186/1479-5868-9-106.
Heinen, E., Maat, K., Van Wee, B., 2011. The role of attitudes toward characteristics of bicycle commuting on the choice to cycle to work over various distances. Transp. Res. Part D Transp. Environ. 16, 102–109. https://doi.org/10.1016/j.trd.2010.08.010.
Heinen, E., van Wee, B., Maat, K., 2010. Commuting by bicycle: an overview of the literature. Transp. Rev. 30, 59–96. https://doi.org/10.1080/01441640903187001.
Hendriksen, I.J.M., Simons, M., Garre, F.G., Hildebrandt, V.H., 2010. The association between commuter cycling and sickness absence. Prev. Med. 51, 132–135. https://doi.org/10.1016/j.ypmed.2010.05.007.
Hsieh, H.-F., Shannon, S.E., 2005. Three approaches to qualitative content analysis. Qual. Health Res. 15, 1277–1288. https://doi.org/10.1177/1049732305276687.
Humphreys, D.K., Goodman, A., Ogilvie, D., 2013. Associations between active commuting and physical and mental wellbeing. Prev. Med. 57, 135–139. https://doi.org/10.1016/j.ypmed.2013.04.008.
Iacono, M., Krizek, K.J., El-Geneidy, A., 2008. Access to Destinations: How Close is Close Enough? Estimating Accurate Distance Decay Functions for Multiple Modes and Different Purposes. Minnesota Department of Transportation Research Services Section.
JobRad, 2017. JobRad, das Dienstfahrrad-Konzept (JobRad, the concept of company bicycle). Available at: <https://www.jobrad.org> (last accessed February 2018).
JobRad, 2018. Unternehmensporträt (Company profile), Available at: <https://www.presseportal.de/download/document/483054-2018-hintergrundtext-jobrad-unternehmensportr-t.pdf> (last accessed June 2018).
Johnson, M., Rose, G., 2015. Extending life on the bike: electric bike use by older Australians. J. Transp. Heal. 2, 276–283. https://doi.org/10.1016/j.jth.2015.03.001.
Jones, T., Harms, L., Heinen, E., 2016. Motives, perceptions and experiences of electric bicycle owners and implications for health, wellbeing and mobility. J. Transp. Geogr. 53, 41–49. https://doi.org/10.1016/j.jtrangeo.2016.04.006.
Koerber, A., McMichael, L., 2008. Qualitative sampling methods: a primer for technical communicators. J. Bus. Tech. Commun. 22, 454–473. https://doi.org/10.1177/1050651908320362.
Langford, B.C., 2013. A Comparative Health and Safety Analysis of Electric-assist and Regular Bicycles in an On-campus Bicycle Sharing System. Thesis (Doctoral). The University of Tennessee, Knoxville, TN.
Lanzendorf, M., Busch-Geertsema, A., 2014. The cycling boom in large German cities: empirical evidence for successful cycling campaigns. Transp. Pol. 36, 26–33. https://doi.org/10.1016/j.tranpol.2014.07.003.
Lee, A., Molin, E., Maat, K., Sierzchula, W., 2015. Electric bicycle use and mode choice in the Netherlands. Presented at the 94th Annual Meeting of Transp. Res. Board, Washington, DC.
Ling, Z., Cherry, C.R., MacArthur, J.H., Weinert, J.X., 2017. Differences of cycling experiences and perceptions between e-bike and bicycle users in the United States. Sustainability 9, 1662. https://doi.org/10.3390/su9091662.
MacArthur, J., Dill, J., Person, M., 2014. Electric bikes in North America: results of an online survey. Transp. Res. Rec. J. Transp. Res. Board 2468, 123–130. https://doi.org/10.3141/2468-14.
Martin, A., Goryakin, Y., Suhrcke, M., 2014. Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey. Prev. Med. 69, 296–303. https://doi.org/10.1016/j.ypmed.2014.06.023.
Mayring, P., 2000. Qualitative content analysis. Forum: Qual. Soc. Res. 1 (2), 20. Available at: <http://www.qualitative-research.net/index.php/fqs/article/view/1089> (last accessed February 2018).
Mayring, P., Fenzl, T., 2013. QCAmap. Qualitative Content Analysis Program. Available at: <http://www.qcamap.org> (last accessed February 2018).
Mayring, P., 2014. Qualitative Content Analysis: Theoretical Foundation, Basic Procedures and Software Solution. Klagenfurt. Available at: <http://nbn-resolving.de/urn:nbn:de:0168-ssoar-395173> (last accessed February 2018).
Menghini, G., Carrasco, N., Schüssler, N., Axhausen, K.W., 2010. Route choice of cyclists in Zurich. Transp. Res. Part A Policy Pract. 44, 754–765. https://doi.org/10.1016/j.tra.2010.07.008.
Mertens, L., Compernolle, S., Deforche, B., Mackenbach, J.D., Lakerveld, J., Brug, J., Roda, C., Feuillet, T., Oppert, J.M., Glonti, K., Rutter, H., Bardos, H., De Bourdeaudhuij, I., Van Dyck, D., 2017. Built environmental correlates of cycling for transport across Europe. Heal. Place 44, 35–42. https://doi.org/10.1016/j.healthplace.2017.01.007.
Morse, J.M., 2000. Determining sample size. Qual. Health Res. 10, 3–5. https://doi.org/10.1177/104973200129118183.
Munkácsy, A. 2017. User Profiles and Adoption Attributes of Innovative Bike-sharing Systems: The Case of BiciMAD (Madrid). Thesis (Doctoral), E.T.S.I. Caminos, Canales y Puertos (UPM). https://doi.org/10.20868/UPM.thesis.47049.
Muñoz, B., 2016. Integrating Bicycle Option In Mode Choice Models Through Latent Variables. Thesis (Doctoral). Universidad Politecnica de Madrid.
Mytton, O.T., Panter, J., Ogilvie, D., 2016. Longitudinal associations of active commuting with wellbeing and sickness absence. Prev. Med. 84, 19–26. https://doi.org/10.1016/j.ypmed.2015.12.010.
Nabih, M.I., Bloem, S.G., Poiesz, T.B.C., 1997. Conceptual issues in the study of innovation adoption behavior. Adv. Consum. Res. 24, 190–197.
Nehme, E.K., Pérez, A., Ranjit, N., Amick, B.C., Kohl, H.W., 2016. Behavioral theory and transportation cycling research: application of diffusion of innovations. J. Transp. Heal. 3, 346–356. https://doi.org/10.1016/j.jth.2016.05.127.

Parkes, S.D., Marsden, G., Shaheen, S.A., Cohen, A.P., 2013. Understanding the diffusion of public bikesharing systems: evidence from Europe and North America. J. Transp. Geogr. 31, 94–103. https://doi.org/10.1016/j.jtrangeo.2013.06.003.
Parkin, J., Wardman, M., Page, M., 2008. Estimation of the determinents of bycicle mode share journey to work using census data. Transp. 35, 93–109. https://doi.org/10.1016/S1366-5545(02)00012-1.
Patton, M.Q., 2014. Qualitative Research & Evaluation Methods. Sage, Thousand Oaks, CA.
Plazier, P.A., Weitkamp, G., van den Berg, A.E., 2017. "Cycling was never so easy!" An analysis of e-bike commuters' motives, travel behaviour and experiences using GPS-tracking and interviews. J. Transp. Geogr. 65, 25–34. https://doi.org/10.1016/j.jtrangeo.2017.09.017.
Pope, C., Mays, N., 2006. Qualitative methods in health research. In: Pope, C., Mays, N. (Eds.), Qualitative Research in Health Care, 3rd ed., pp. 1–5. https://doi.org/10.1002/9780470750841.ch1.
Popovich, N., Gordon, E., Shao, Z., Xing, Y., Wang, Y., Handy, S., 2014. Experiences of electric bicycle users in the Sacramento, California area. Travel Behav. Soc. 1, 37–44. https://doi.org/10.1016/j.tbs.2013.10.006.
Rapley, T., 2007. Doing Conversation, Discourse and Document Analysis. Sage, London.
Richards, R., Murdoch, L., Reeder, A.I., Rosenby, M., 2010. Advocacy for active transport: advocate and city council perspectives. Int. J. Behav. Nutr. Phys. Act. 7 (5). https://doi.org/10.1186/1479-5868-7-5.
Rogers, E.M., 2003. The Diffusion of Innovations, 5th ed. Free Press, New York.
Rose, G., 2012. E-bikes and urban transportation: emerging issues and unresolved questions. Transp. 39, 81–96.
Sahin, I., Rogers, F., 2006. Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies based on Rogers. Turkish Online J. Educ. Technol. 5, 14–23. https://doi.org/10.1080/09687769.2010.529107.
Sahlqvist, S., Heesch, K.C., 2012. Characteristics of utility cyclists in Queensland, Australia: an examination of the associations between individual, social, and environmental factors and utility cycling. J. Phys. Act. Health 9, 818–828. https://doi.org/10.1123/jpah.9.6.818.
Schneider, S., 2016. How does sport act? A biopsychosocial model. Public Health Forum 24 (2), 76–79.
Seebauer, S., 2015. Why early adopters engage in interpersonal diffusion of technological innovations: an empirical study on electric bicycles and electric scooters. Transp. Res. Part A Policy Pract. 78, 146–160. https://doi.org/10.1016/j.tra.2015.04.017.
Sener, I., Eluru, N., Bhat, C., 2009. Who are bicyclists? Why and how much are they bicycling? Transp. Res. Rec. J. Transp. Res. Board 2134, 63–72. https://doi.org/10.3141/2134-08.
Silverman, D., 2001. Interpreting Qualitative Data Methods for Analyzing Talk, Text and Interaction, second ed. Sage, Thousand Oaks, CA.
Simons, D., Clarys, P., De Bourdeaudhuij, I., de Geus, B., Vandelanotte, C., Deforche, B., 2014. Why do young adults choose different transport modes? A focus group study. Transp. Pol. 36, 151–159. https://doi.org/10.1016/j.tranpol.2014.08.009.
Stinson, M.A., Bhat, C.R., 2005. A comparison of the route preferences of experienced and inexperienced bicycle commuters. Presented at the 84th Annual Meeting of the Transp. Res. Board, Washington, D.C.
Strömberg, H., Rexfelt, O., Karlsson, I.C.M.A., Sochor, J., 2016. Trying on change – trialability as a change moderator for sustainable travel behaviour. Travel Behav. Soc. 4, 60–68. https://doi.org/10.1016/j.tbs.2016.01.002.
Sürig, D., 2012. Umsatteln, bitte! Steuerliche Gleichstellung von Fahrrädern und Dienstwagen (Resaddle, please! Equal tax treatment of bicycles and company cars). Süddeutsche Zeitung, 04 December 2012. Available at: <https://www.sueddeutsche.de/geld/steuerliche-gleichstellung-von-fahrraedern-und-dienstwagen-umsatteln-bitte-1.1540716> (last accessed July 2018).
Titze, S., Stronegger, W.J., Janschitz, S., Oja, P., 2008. Association of built-environment, social-environment and personal factors with bicycling as a mode of transportation among Austrian city dwellers. Prev. Med. 47, 252–259. https://doi.org/10.1016/j.ypmed.2008.02.019.
Titze, S., Stronegger, W.J., Janschitz, S., Oja, P., 2007. Environmental, social, and personal correlates of cycling for transportation in a student population. J. Phys. Act. Health 4, 66–79. https://doi.org/10.1123/jpah.4.1.66.
Wehl, R., 2016. Das Dienstrad als Steuerfalle (The company bicycle as a tax trap). Zeitschrift für Steuer- und Wirtschaftsrecht (NWB) 37, 1018.
Wesp, R., 2015. Work-Bike-Balance per Dienstrad (Work-bike-balance with a company bicycle). Lebensmittel Zeitung 43. Available at: <http://www.lebensmittelzeitung.net/handel/WorkBike-Balance-per-Dienstrad-112802> (last accessed January 2018).
WHO, 2006. Air quality guidelines: global update 2005, World Health Organiz., <https://doi.org/10.1016/0004-6981(88)90109-6>.
Wingerter, C., 2014. Berufspendler: Infrastruktur wichtiger als Benzin (Commuters: Infrastructure more important than gasoline). STATmagazin: Arbeitsmarkt 5, 1–4. Available at: <https://www.destatis.de/DE/Publikationen/STATmagazin/Arbeitsmarkt/2014_05/2014_05PDF.pdf?_blob=publicationFile> (last accessed June 2018).
Winters, M., Davidson, G., Kao, D., Teschke, K., 2011. Motivators and deterrents of bicycling: comparing influences on decisions to ride. Transp. 38, 153–168. https://doi.org/10.1007/s11116-010-9284-y.
Winters, M., Friesen, M.C., Koehoorn, M., Teschke, K., 2007. Utilitarian bicycling. a multilevel analysis of climate and personal influences. Am. J. Prev. Med. 32, 52–58. https://doi.org/10.1016/j.amepre.2006.08.027.
Winters, M., Sims-Gould, J., Franke, T., McKay, H., 2015. "I grew up on a bike": cycling and older adults. J. Transp. Heal. 2, 58–67. https://doi.org/10.1016/j.jth.2014.06.001.
Winters, M., Teschke, K., Grant, M., Setton, E.M., Brauer, M., 2010. How far out of the way will we travel? Built environment influences on route selection for bicycle and car travel. Transp. Res. Rec. 2190, 1–18. https://doi.org/10.3141/2190-01.
Wolf, A., Seebauer, S., 2014. Technology adoption of electric bicycles: a survey among early adopters. Transp. Res. Part Policy Pract. 69, 196–211. https://doi.org/10.1016/j.tra.2014.08.007.
Xing, Y., Handy, S.L., Mokhtarian, P.L., 2010. Factors associated with proportions and miles of bicycling for transportation and recreation in six small US cities. Transp. Res. Part D Transp. Environ. 15, 73–81. https://doi.org/10.1016/j.trd.2009.09.004.
Yin, R.K., 2018. Case Study Research and Applications: Design and Methods, sixth ed. Sage, Thousand Oaks, CA.
Zhang, W., Bansback, N., Anis, A.H., 2011. Measuring and valuing productivity loss due to poor health: a critical review. Soc. Sci. Med. 72, 185–192. https://doi.org/10.1016/j.socscimed.2010.10.026.
ZIV (Zweirad-Industrie-Verband), 2018. Zahlen - Daten - Fakten zum Deutschen Fahrradmarkt 2017. Umsätze der Branche im Jahr 2017 erneut gestiegen (Figures - numbers - facts about the German bicycle market in 2017. Revenues in the sector increased again in 2017), press release, Bad Soden, 13 March 2018. Available at: <http://www.ziv-zweirad.de/fileadmin/redakteure/Downloads/Marktdaten/PM_2018_13.03._Fahrradmarkt_und_E-Bike_Markt_2017.pdf> (last accessed June 2018).

Essay 2

Journal of Transport & Health 15 (2019) 100619

Contents lists available at ScienceDirect

Journal of Transport & Health

journal homepage: www.elsevier.com/locate/jth

Health effects from bicycle commuting to work: Insights from participants of the German company-bicycle leasing program

Stefan Synek, Joerg Koenigstorfer*

Chair of Sport & Health Management, Technical University of Munich, Germany

ARTICLE INFO

Keywords:
Active transportation
Active commuting
Cycling to work
Wellbeing
Perceived innovation characteristics
Diffusion of innovations theory

ABSTRACT

Introduction: Company-bicycle leasing programs aim to promote employees' health via the advancement of cycling to work. To date, however, empirical evidence for the effects of participation in such programs is weak. This is also true for the German program. The present study aims to assess the relationship between the five perceived innovation characteristics proposed by the Diffusion of Innovations Theory and the company-leasing bicycle commuting behavior of German employees as well as their physical and mental wellbeing. Furthermore, the study aims to find out whether the innovation characteristics relate to changes in commuting behavior, and whether these changes have a positive effect on employees' physical and mental wellbeing.

Methods: Perceived innovation characteristics, physical activity, and health levels of 462 employees from 62 companies were assessed in a two-wave longitudinal study. The second wave took place 40 days after the first wave. Path analyses were used for hypotheses testing.

Results: The results showed that compatibility (but not relative advantage, low complexity, trialability, and observability) measured in the first wave had a positive impact on cycling to work (in minutes cycled per day), which in turn increased physical and mental wellbeing (all three variables were self-reports that were measured in the second wave). There were no significant relationships using change scores for both the mediator and the health outcomes.

Conclusions: The findings indicate that the use of company leasing bicycles relates positively with physical and mental wellbeing. Compatibility is a significant determinant of active commuting, suggesting that company executives should endorse the perception that they share important values, lifestyles, and needs with employees. Changes in active commuting, however, did not increase health, most likely due to the short time scale under consideration. The findings help policy makers identify individual- and organization-level factors that relate to active commuting and health.

1. Introduction

Policy makers around the world aim to promote active commuting to work (or school). Active commuting has a vast potential to generate positive effects on the physical activity—and hence wellbeing—levels in the general population (Dinu et al., 2019; Saunders et al., 2013). Cycling is a particularly attractive means of active commuting to work, because short to medium distances can be covered in an acceptable time period (Whitt and Wilson, 1982), traffic-related problems can be reduced (e.g., less congestion, fewer parking spots needed at the work site), and on-site mobility of employees can be facilitated (Synek and Koenigstorfer, 2018).

* Corresponding author. Campus D Uptown Munich, Georg-Brauchle-Ring 60/62, 80992, Munich, Germany.
E-mail address: joerg.koenigstorfer@tum.de (J. Koenigstorfer).

https://doi.org/10.1016/j.jth.2019.100619
Received 16 April 2019, Received in revised form 25 June 2019, Accepted 21 August 2019

In Europe, several countries have introduced programs that promote cycling to work via monetary incentives to employers and/or employees (BMF, 2012; DFT, 2011). In Germany, the so-called company-car privilege has been extended so that company-leased bicycles are also eligible for tax exemptions (BMF, 2012). Since 2012, despite a slow start of the program, more and more employers and employees have participated in the program, and the adoption drivers and barriers have been explored in a recent qualitative study (Synek and Koenigstorfer, 2018). The program offers excellent health promotion opportunities to employers and employees. Also, sales have increased in the bicycle market due to purchases of new bicycles, including s-pedelecs and e-bikes. This resulted from a reported adoption of 250,000 leasing bicycles by employees who work for an estimated 10,000 companies (ADFC, 2019).

While previous studies have considered the determinants that influence whether employees adopt the company-bicycle leasing program—that is, whether they *purchase* a new bicycle (e.g., Synek and Koenigstorfer, 2018)—to our knowledge, there are no studies that have examined what makes employees *use* their bicycles to commute to work when they participate in such a program. However, use adoption is what increases health—the mere purchase of a new bicycle is not enough (Mytton et al., 2016; Shih and Venkatesh, 2004). Thus, there is a need to study the factors that influence commuting-to-work cycling (*use*) behaviors, as well as the downstream effects of cycling to work.

The present study aims to partly fill this void and considers the five perceived innovation characteristics proposed by the Diffusion of Innovations Theory (Rogers, 2003). The perceived innovation characteristics might be relevant in the context of the present study, because the program has only recently been established (BMF, 2012) and because consumers' evaluations of the program's features are crucial for use adoption (Shih and Venkatesh, 2004; see Nehme et al., 2016). As Synek and Koenigstorfer (2018) show in their case study, there are several innovation characteristics-like factors that influence the potential purchase and use of bicycles as part of the German taxation-policy program.

The paper is structured as follows. First, we briefly review previous studies that considered the effects of active bicycle commuting on employees' health. Second, we propose a conceptual model in reference to the Diffusion of Innovations Theory that guided our empirical study. Next, we present the methods and the results of the study, and discuss the results. We conclude by describing the limitations of our study and providing an outlook on future research.

1.1. Cycling to work and employees' health

Active commuting has been found to increase the levels of physical and mental wellbeing (Bize et al., 2007; Humphreys et al., 2013; Martin et al., 2014; Petrunoff et al., 2016), including reduction of cardiovascular risks (Celis-Morales et al., 2017; Hamer and Chida, 2008; Xu et al., 2013), body weight (Faulkner et al., 2009; Xu et al., 2013), perceived stress (Avila-Palencia et al., 2017), and risk of diabetes (Saunders et al., 2013). Furthermore, active commuting is associated with reduced sickness absence (Hendriksen et al., 2010; Mytton et al., 2016) and high self-reported wellbeing (Mytton et al., 2016). In agreement with these findings, bicycle commuting has been inversely associated with all-cause mortality (Andersen et al., 2000; Dinu et al., 2019) and seems to improve health-related quality of life in previously untrained healthy adults (de Geus et al., 2008).

Besides these direct health effects, active commuting has also been reported to generate positive effects for the environment, thus indirectly promoting human health. For example, active commuting helps reduce air pollution, greenhouse gas emissions, and noise—factors that provide healthier environmental contexts to all people in society (de Nazelle et al., 2011; Johan de Hartog et al., 2010).

There is ample evidence that cycling to work correlates positively with physical activity and hence physical health—particularly in regard to the human cardiovascular system—and mental health. Yet, it is largely unknown what factors induce people to cycle to work more (Petrunoff et al., 2016). While many people own bicycles, they are often *not* used to commute to work, for several reasons. The main factors are: time constraints, traffic safety concerns, concerns related to distance, concerns about appearance, as well as factors such as the built environment, physical discomfort, and health problems (among others; Bopp et al., 2012; see also Synek and Koenigstorfer, 2018). In this study, we look at factors that relate to the adoption of the German company-bicycle leasing program: relative advantage, compatibility, low complexity, trialability, and observability, lending to the Diffusion of Innovations Theory (Rogers, 2003; see also Nehme et al., 2016; Synek and Koenigstorfer, 2018).

1.2. Diffusion of Innovations Theory and perceived innovation characteristics

Rogers (2003) introduced the Diffusion of Innovations Theory in 1962. According to Rogers, persons who are interested in a new concept (or product or service) seek for, and process, information in order to reduce their uncertainty. Rogers (2003) describes five general attributes of an innovation that influence people's evaluations as part of this process. The so-called perceived innovation characteristics are: relative advantage, compatibility, complexity, observability, and trialability.

Relative advantage describes 'the degree to which an innovation is perceived as being better than the idea it supersedes' (Rogers, 2003, p. 229). Compatibility is defined as 'the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters' (Rogers, 2003, p. 15). Low complexity is 'the degree to which an innovation is perceived as relatively difficult to understand and use' (Rogers, 2003, p. 15). Observability is 'the degree to which the results (…) are visible to others' (Rogers, 2003, p. 16). Lastly, trialability reflects 'the degree to which an innovation may be experimented with on a limited basis' (Rogers, 2003, p. 16).

A number of adoption and diffusion studies have demonstrated the relevance of these innovation characteristics. They were shown to explain between 49% and 87% of the variance in the adoption rate (Sahin and Rogers, 2006). In the present study, we postulate that the five innovation characteristics would influence employees' *use adoption*, that is, to what extent employees commute

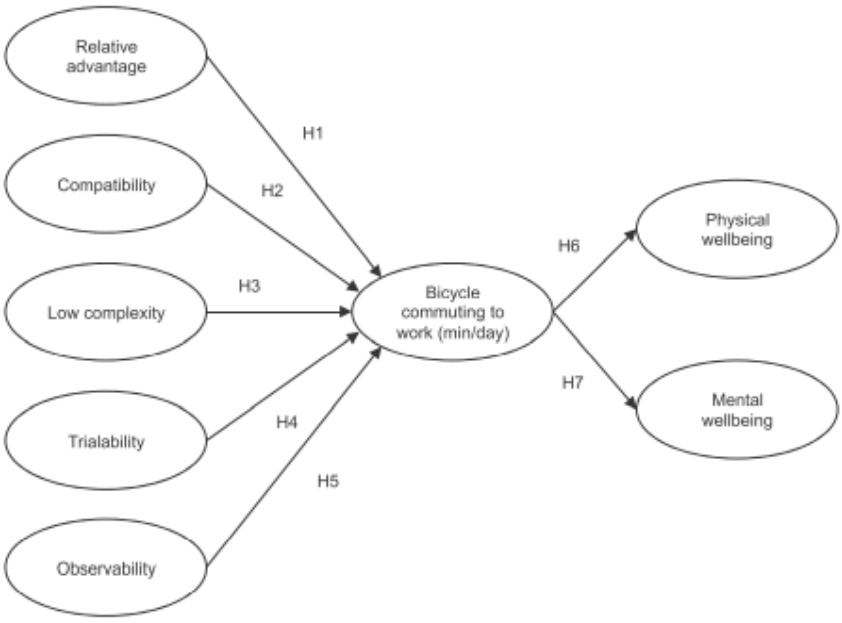


Fig. 1. Determinants of Physical and Mental Wellbeing of Participants of the German Company-bicycle Leasing Program.
Notes. The same model was postulated for changes in bicycle commuting to work (minutes per day; wave 2 minus wave 1) and changes in physical and mental wellbeing (wave 2 minus wave 1).

to work by bicycle when they are part of the program.

Fig. 1 provides an overview of the conceptual framework of the study. A set of hypotheses (H1–H5) was developed based on Diffusion of Innovations Theory. These were:

H1–H5. The higher the (1) relative advantage, (2) compatibility, (3) ease of use (low complexity), (4) trialability, and (5) observability of the company-bicycle leasing program (as perceived by employees), (a) the more they use their bicycle to commute to work, and (b) the more they increase their commuting behavior after the adoption of the program.

Hypotheses 6–7 postulate that the level of physical activity correlates with, and when employees become more active increases physical and mental wellbeing. The development of these hypotheses will be described next.

1.3. Positive health effects of active commuting to work

In agreement with the literature on positive physical and mental health effects of cycling to work (Humphreys et al., 2013; Martin et al., 2014; Petrunoff et al., 2016), we postulate that there is a positive relationship between the amount employees cycle to work and their physical and mental wellbeing. Accordingly, an increase in the amount employees cycle to work should lead to an increase in physical and mental wellbeing. The mechanisms have been researched extensively, such as an increase in fitness, a physiological adaptation that reduces cardiovascular risk factors, stress relief, and improved posture and coordination (Johan de Hartog et al., 2010; Oja et al., 2011). While we do not aim to review all the possible mechanisms in the present study, we assume the following hypotheses:

H6a. The more employees use their bicycle to commute to work, the higher their physical wellbeing. **H6b.** An increase in the amount employees cycle to work leads to a positive change in physical wellbeing.

H7a. The more employees use their bicycle to commute to work, the higher their mental wellbeing. **H7b.** An increase in the amount employees cycle to work leads to a positive change in mental wellbeing.

1.4. Summary of the study goals and hypotheses

The purpose of the study is to, firstly, find out whether perceived innovation characteristics proposed by Rogers (2003) determine the extent to which employees use their bicycle to commute to work and to assess the relationship between company leasing bicycle commuting behavior of employees and their physical and mental wellbeing. Secondly, the study aims to find out whether perceptions

of the innovation characteristics relate to changes in commuting behavior, and whether these potential changes have a positive effect on the changes in employees' physical and mental wellbeing.

2. Methods

2.1. Research context: the German Company-bicycle leasing program

In November 2012, a fiscal reform in Germany, the so-called 1% tax rule that applies to company-leased cars (i.e., the noncash benefit amounts to 1% of the car's list price per month), was applied to bicycles, s-pedelecs, and e-bikes (BMF, 2012). Since then, German companies can participate in the bicycle-leasing program that allows their employees to purchase bicycles. As the lease payment is deducted from the employees' monthly gross salary, taxable income decreases and employees can save up to 40% compared to a regular bicycle purchase (Wesp, 2015). The present study was conducted in 2017 and 2018. About 250,000 leasing bicycles (compared to 75.5 million bicycles in Germany [0.3%]; Statista, 2019a) and about 10,000 companies (compared to 3.3 million companies in Germany [0.3%]; Statista, 2019b) have adopted the program until 2018 (ADFC, 2019), which means that it can be assumed that the present study still works with early adopters (early growth stage according to Rogers, 2003).

2.2. Participants

Email addresses of employees from 62 German companies (all customers of JobRad, the German market leader in the leasing service provider industry; randomly selected) were provided to the authors of the present study, and the authors then—after having received the consent from the respective company representatives—contacted all the employees who had purchased a leasing bicycle via JobRad. There were no incentives provided to the participants and the participation in the study was both voluntary and anonymous. No reminders were sent out in order to avoid annoyance and to adhere to companies' communication policies.

2.3. Procedure

A longitudinal research design was employed in this study. The survey was administered online. The first-wave data collection took place between August 2017 and February 2018; the second-wave data collection took place between four and six weeks after the first wave.

In the first-wave survey, participants first provided their informed consent for participation in the survey. They next answered some questions capturing the five perceived innovation characteristics. Also, they reported on their levels of physical activity (in particular when commuting to work), their physical and mental wellbeing, as well as some descriptive variables and socio-demographics. The survey ended with an announcement of the second-wave survey about one month later. In the second-wave survey, participants were again asked to indicate their levels of physical activity (in particular when commuting to work) as well as their physical and mental wellbeing. Participants were fully debriefed after participation in the second wave.

2.4. Variables

The five perceived innovation characteristics were measured via single items, using a seven-point rating scale ranging from 1 ('I strongly disagree') to 7 ('I strongly agree'). The use of single-item measures is justified when a construct's object is concrete singular and when it is easily and uniformly imagined, as was the case for the present study (Bergkvist & Rossiter, 2007). The items were taken from Moore and Benbasat (1991) as well as Petschnig et al. (2014) and adapted to the context of the present study. The items are as follows: 'The use of a company leasing bicycle is very beneficial for me' (relative advantage); 'The use of a company leasing bicycle fits very well with my values, my lifestyle, and my needs' (compatibility); 'The use of the company-bicycle leasing program is very easy to understand' (low complexity); 'I had enough opportunities to test my company leasing bicycle before I signed the contract' (trialability); and 'The company-bicycle leasing program is highly visible in my organization' (observability).

The Recent Physical Activity Questionnaire (RPAQ) was used to assess the extent to which employees commuted to work by bicycle. Participants were first asked the following questions: 'On how many days in the past four weeks [20 working days] have you worked in your company/workplace on site?'; 'On how many days in the past four weeks [20 working days] have you used the following mode of transport as *single mode* of transport?'; 'On how many days in the past four weeks [20 working days] have you used the following mode of transport *in combination with* other modes of transport?' The options were then listed.

Participants next indicated the average time they needed for a journey to get to work and back: 'Please indicate your average daily time with this mode of transport to get to work and for the way back home.' Based on the responses, the average bicycle commuting time per working day in the past four weeks was calculated (in minutes). This variable was then used in the analysis. The validity and reliability of the scale has been shown previously (Golubic et al., 2014).

Physical and mental wellbeing were assessed via the Medical Outcomes Study Short Form Questionnaire (SF-8). The questionnaire is composed of eight questions that concern a person's wellbeing, referring to the past four weeks. Different weights are applied to each question to derive the Physical Component Summary (PCS-8) and Mental Component Summary (MCS-8) scores. We followed this procedure as described by Ware et al. (2001). The scale has been shown to be valid and reliable (Ellert et al., 2005).

2.5. Data analysis

Mplus 7.0 (Muthén and Muthén, 2012) was used to analyze the data. Two models were tested. In model 1, a path analysis was conducted using the five perceived innovation characteristics measured in the first wave, as well as time spent commuting to work by bicycle (per work day) and physical and mental wellbeing measured in the second wave as downstream variables (Fig. 1). Model 1 tested H1a-H7a. In model 2, a path analysis was conducted, using changes in time spent commuting to work from wave 1 to wave 2 (wave 2 minus wave 1) as the mediator and changes in physical and mental wellbeing (wave 2 minus wave 1) as the dependent variables. Model 2 tested H1b-H7b. A similar procedure that differentiates between mean scores of absolute values (here: model 1) and mean scores of change values (here: model 2) has been described by Mytton et al. (2016). We followed the approach proposed by Preacher and Hayes (2008) for the mediation analysis.

3. Results

3.1. Sample characteristics

Of the 1682 employees who were approached online to participate in the survey, 817 persons filled in the survey completely at the first wave of the study (49% response rate). In the second wave, 462 persons filled in the survey completely (equivalent to 57% of the wave-1 participants). These 462 persons were interviewed 7.8 months (SD = 7.0) after they had signed the contract to take part in the program.

The sample consisted of 357 men (77.3%) and thus proportionately contained more men than women compared to the German population (49% men; Statistisches Bundesamt, 2018). Age, education, income, and household size distributions in our sample, however, come close to the values that have been reported for the general population in Germany (Statistisches Bundesamt, 2018). About 74.3% of the sample owned one or more bicycles (M = 1.20, SD = 1.03) in addition to one or more leasing bicycle(s) (M = 1.27, SD = 0.52). Table 1 presents an overview of the sample characteristics.

The average time difference between the first and the second wave was 39.8 days (SD = 4.6). Importantly, all second-wave respondents filled in the survey at least four weeks after the completion of the first-wave survey. This is crucial because the reference time frame for the assessment of physical activity and wellbeing was four weeks (see 2.4 Variables).

3.2. Descriptive statistics and difference testing between waves

The means of the ratings of the perceived innovation characteristics (assessed in wave 1) as well as the dependent variables (bicycle commuting to work as well as physical and mental wellbeing, assessed both in wave 1 and in wave 2) are shown in Table 2. There were significant changes in bicycle commuting to work: bicycle commuting increased over time. Furthermore, we observed a decrease in physical wellbeing from wave 1 to wave 2, and no significant change in mental wellbeing during the course of the 40-day period. We note that the ratings for physical and mental wellbeing are similar to the values that have been reported for the German population ($M_{Physical}$ = 50.30 and M_{Mental} = 53.25; Beierlein et al., 2012).

Table 1
Sociodemographic characteristics of the sample.

Variables	Percentage or Mean (± SD)
Gender (female)	78.6%
Age (18–24 years)	3.0%
(25–34 years)	16.9%
(35–44 years)	23.0%
(45–54 years)	38.5%
(55–64 years)	18.5%
Gross household income (< EUR 1300)	1.3%
(EUR 1300–2599)	24.0%
(EUR 2600–3599)	29.5%
(EUR 3600–4999)	28.5%
(> EUR 4999)	16.8%
Education (9th grade [Mittelschule])	9.6%
(10th grade [Realschule])	29.9%
(High school [Hochschulreife])	11.8%
(University of Applied Sciences degree)	15.5%
(University degree or higher)	33.2%
Full time employment	90.7%
Household size	M = 2.59 (± 1.11)
BMI (kg/m^2)	M = 27.06 (± 4.42)
Distance to workplace (km)	M = 26.41 (± 28.71)

Table 2
Perceived innovation characteristics, bicycle commuting to work, as well as physical and mental wellbeing.

Factors	Wave 1		Wave 2	
	M	*SD*	*M*	*SD*
Physical wellbeing	51.23	7.97	50.04	8.89
Mental wellbeing	51.55	8.56	51.56	8.81
Bicycle commuting to work (min/day)	13.90	20.94	16.05	22.94
Relative advantage	5.97	1.20		
Compatibility	6.00	1.27		
Low complexity	5.20	1.97		
Trialability	3.31	1.73		
Observability	5.78	1.27		

Notes. There were significant differences between wave 1 and 2 for physical wellbeing, $t(460) = -2.73$, $p = .01$, and bicycle commuting to work, $t(460) = 2.58$, $p = .01$, but no significant difference for mental wellbeing, $t(460) = 0.02$, $p = .99$.

3.3. Hypotheses testing for mean scores of the variables (model 1; H1a-H7a)

The correlation matrix of the variables considered in model 1 is shown in Table 3. The correlations between the variables range between 0.00 and 0.55.

The results of the path analysis for model 1 reveal that compatibility ($b = 0.20$, $SE = 0.06$, $p < 0.001$), but not relative advantage ($b = 0.003$, $SE = 0.06$, $p = 0.96$), low complexity ($b = -.06$, $SE = 0.06$, $p = 0.32$), trialability ($b = -0.06$, $SE = 0.05$, $p = 0.20$), and observability ($b = -0.02$, $SE = 0.05$, $p = 0.62$) had a significant influence on the time spent on the bicycle commuting to work ($R^2 = 0.04$). Thus, Hypothesis 2a is supported, while Hypothesis 1a as well as Hypotheses 3a-5a are not. The time spent on the bicycle commuting to work had a significant relation with both physical wellbeing ($b = 0.12$, $SE = 0.05$, $p = 0.01$; $R^2 = 0.01$) and mental wellbeing ($b = 0.10$, $SE = 0.05$, $p < 0.05$; $R^2 = 0.01$). Thus, Hypotheses 6a and 7a are supported.

A further mediation analysis (modeling the five perceived innovation characteristics as determinants of both bicycle commuting to work and the two wellbeing variables) shows that the time spent on the bicycle commuting to work fully mediates the effect of compatibility on physical wellbeing (marginal significance; $b = 0.02$, $SE = 0.01$, $p = .06$) and mental wellbeing (marginal significance; $b = 0.02$, $SE = 0.01$, $p = .07$). The result of the mediation analysis highlights the importance of the time spent on the bicycle for positive relation with health.

3.4. Hypotheses testing for mean change scores of the variables (model 2; H1b-H7b)

Model 2 used difference scores instead of wave-2 scores for the mediator and the dependent variables. The testing of model 2 reveals that there were no significant relationships between any of the five perceived innovation characteristics and the change in commuting behavior (b's between -0.07 and 0.05, p's > 0.14). Also, the change in minutes spent on the bicycle commuting to work did not cause changes in physical wellbeing ($b = 0.08$, $SE = 0.05$, $p = 0.11$) or mental wellbeing ($b = 0.04$, $SE = 0.05$, $p = 0.44$; R^2 for each = 0.01).

4. Discussion

4.1. Theoretical and managerial contribution

The purpose of the study was to assess the relationship between company leasing bicycle commuting behavior of employees and their physical and mental wellbeing, as well as to find out whether perceived innovation characteristics proposed by Rogers (2003) determine the extent to which employees use their bicycle to commute to work. Another purpose was to find out whether perceptions of the innovation characteristics relate to changes in commuting behavior, and whether these changes have a positive effect on

Table 3
Correlations between the variables (model 1).

Factors	1	2	3	4	5	6	7	8
1. Physical wellbeing	1.00							
2. Mental wellbeing	0.13	1.00						
3. Bicycle commuting to work	0.12	0.09	1.00					
4. Relative advantage	0.06	0.09	0.06	1.00				
5. Compatibility	0.07	0.10	0.16	0.55	1.00			
6. Low complexity	0.04	0.10	0.00	0.49	0.41	1.00		
7. Trialability	-0.04	0.17	-0.06	0.25	0.14	0.34	1.00	
8. Observability	0.07	0.14	-0.02	0.24	0.18	0.23	0.20	1.00

changes in both physical and mental wellbeing. The results of the study show that the amount spent on the bicycle commuting to work relates positively with health, and that compatibility is the only determinant of the bicycle commuting to work. None of the determinants of the changes in the amount spent on the bicycle commuting to work and health outcomes was significant. This is not surprising, as the employees considered in the present study did only marginally increase their cycling-to-work behavior after the adoption of the leasing-bicycle program (considering a time frame of 40 days after the initial assessment). The slight change in commuting to work by bicycle did not relate to a change in physical and mental wellbeing.

The study contributes to the literature on active commuting to work by (1) considering the use (rather than the mere adoption) of the company-bicycle leasing program; (2) revealing that compatibility—that is, the match between what a company does and what an employee feels with regard to values, lifestyles, and needs—relates to bicycle commuting to work considered after a specified time window (here: 40 days); and (3) modeling changes in physical and mental wellbeing that might have been due to an increase in cycling to work, using a longitudinal design. The particular consideration of change variables in the model shows that the variables included in the model do not explain the changes in physical or mental health. In what follows, we explain the contributions and limitations.

First, the study extends previous work that considered purchase adoption determinants (e.g., Synek and Koenigstorfer, 2018) to account for *use* adoption determinants. The use concept is important, because positive health and environmental effects from commuting to work are triggered by the continuous use of the bicycle (and not the mere purchase of a bicycle; Shih and Venkatesh, 2004). While it might be important that companies and employees adopt programs to promote cycling, and make bicycles more available and affordable, the usage by employees will determine the successful contribution to societal goals. Our results thus add to the descriptive findings from the Cyle to Work Alliance, which administered a one-time survey but did not study any relationships between variables (C2WA, 2011; Swift et al., 2016).

Second, the study provides novel insights into the importance of the five perceived innovation characteristics to promote bicycle commuting to work and health. The study thus adds to the findings from Synek and Koenigstorfer (2018), who used a case study approach taking into account documents and interviews to postulate that the five perceived innovation characteristics might be relevant for the adoption and use of the program. While other authors have used different theoretical groundings (e.g., the trans-theoretical model of behavior change; Mutrie et al., 2002; social practice theory; Guell et al., 2012), the general assumption that employee-perceived characteristics influence the adoption and implementation of the program is similar. The findings from the present study indicate that compatibility is important in order to persuade employees to use their company leasing bicycles to commute to work. Thus, shared values, lifestyles, and needs between employers and their employees are relevant (see Nehme et al., 2016), and activities to promote them should be encouraged. This mostly relates to organizational culture, that is, the values and beliefs within an organization that provide the contextual setting for interactions and behaviors of individuals (Schein, 1985). We note that the explanatory power of the model was quite low for physical activity ($R^2 = 0.04$) and wellbeing ($R^2 = 0.01$). This is typical for studies that look at use behaviors (particularly episodes of behaviors) and health, where habits and other external factors have a strong influence (e.g., Nigg et al., 2008).

Last, the study is among the few studies in the cycling-to-work literature that applied a longitudinal design to study the mechanisms of how the perceived characteristics (particularly compatibility, as shown in the analysis) associate with health. Positive relations (but no health effects explained by increased cycling to work) were found for physical and mental wellbeing. Both findings—the significant ones and the non-significant ones—are in agreement with Mytton et al. (2016). The evidence for full mediation (regarding the relation of compatibility with wellbeing via bicycle commuting to work) is particularly interesting. It indicates that those employees who spent more time on their bicycle reported better health. This makes sense, because the mere purchase of a company leasing bicycle might induce a feel-good effect at maximum; only the usage relates positively with wellbeing. The change in usage, however, did not relate to changes in health over the course of 40 days (as shown in the present study).

4.2. Limitations and outlook

As with any empirical study, our work is not free of limitations. First, time spent on the bicycle commuting to work as well as both physical and mental wellbeing were measured using self-reports. While the validity and reliability of these measures have been shown before, we cannot rule out that these variables were subject to over- or underestimation. Future studies may use objective criteria to strengthen the level of evidence.

Second, the sample is not representative for all leasing bicycle program adopters. Currently, there is no database specifying which companies or which employees have adopted the program. Thus, the general population of adopters is unknown. The generalizability of the results might therefore be limited. We feel that this limitation is acceptable, because the main focus of our work was to contribute to theory and provide process evidence of how health outcomes can be explained or increased using a longitudinal design. The dropout rate of 43% between the two waves is common for this type of longitudinal research (Mytton et al., 2016).

Third, it would be interesting to find out whether an intervention study with a control group could replicate our findings. The addition of a control group allows the researcher(s) to calculate the effect of the program's implementation on the main dependent variables considered in the present study: bicycle commuting to work as well as physical and mental wellbeing. Besides adding a control group, the time frame under consideration might be extended. The time frame considered in the present study might have been too short to capture changes in wellbeing.

Last, we note that we cannot explain why compatibility, but not the other four perceived innovation characteristics, influenced the time spent on the bicycle. Relative advantage is typically a strong indicator for the use adoption of new concepts, products, or services (Rogers, 2002, 2003). In our study, however, the impact of relative advantage on the self-reported time spent on the bicycle

commuting to work was nonsignificant. Future studies may reveal whether this result is replicated for other cycle-to-work programs and what the reasons might be. In addition, other factors that were not be considered in this study but might influence cycling to work could be modeled in future research, such as differences in incentives (incentives for purchasing vs. incentives for active commuting) and differences in employer characteristics (e.g., provision of parking, showers, and other infrastructure). Future work might also be interested in finding solutions to better predict changes in variables. Similarly to Mytton et al. (2016), the present study could not explain changes in health via changes in bicycle commuting to work.

5. Conclusion

Many countries struggle to reduce their citizens' dependency on cars and promote cycling instead. Company-bicycle leasing programs are one policy instrument to promote cycling to work. The present study shows that the time spent 'in the saddle' relates positively with health of employees who participated in the German bicycle leasing program. It remains a challenge to motivate not only these people, but all employees, to use sustainable commute-to-work options and thus contribute to the Sustainable Development Goals brought forward by the United Nations. At least for participants of the program, shared values, lifestyles, and needs between employers and employees seem important when applied to the context of cycling to work.

Financial disclosure

The authors did not receive any specific funding for this work.

References

ADFC (Allgemeiner Deutscher Fahrrad-Club), 2019. Steuerfreiheit für Diensträder (Tax exemption for company bicycles), 29 January 2019. Available at:. (last accessed April 2019). https://www.adfc.de/neuigkeit/steuerfreiheit-fuer-dienstraeder/.

Andersen, L.B., Schnohr, P., Schroll, M., Hein, H.O., 2000. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Arch. Intern. Med. 160 (11), 1621–1628. https://doi.org/10.1001/archinte.160.11.1621.

Avila-Palencia, I., de Nazelle, A., Cole-Hunter, T., et al., 2017. The relationship between bicycle commuting and perceived stress: a crosssectional study. BMJ Open 7, e013542. https://doi.org/10.1136/bmjopen-2016-013542.

Beierlein, V., Morfeld, M., Bergelt, C., Bullinger, M., Brähler, E., 2012. Messung der gesundheitsbezogenen Lebensqualität mit dem SF-8 (Measurement of health-related quality of life with SF-8). Diagnostica 58, 145–153.

Bergkvist, L., Rossiter, J.R., 2007. The predictive validity of multiple-item versus single-item measures of the same constructs. J. Mark. Res. 44 (2), 175–184. https://doi.org/10.1509/jmkr.44.2.175.

Bize, R.L., Johnson, J.A., Plotnikoff, R.C., 2007. Physical activity level and health-related quality of life in the general adult population: a systematic review. Prev. Med. 45 (6), 401–415. https://doi.org/10.1016/j.ypmed.2007.07.017.

BMF (Bundesministerium der Finanzen), 2012. Gleichlautende Erlasse der obersten Finanzbehörden der Länder. Steuerliche Behandlung der Überlassung von (Elektro-)Fahrrädern vom 23. November 2012 (Identical orders of the highest tax authorities of the federal states. Tax treatment of [electric] bicycles from 23 November 2012). Available at:. (last accessed March 2019). https://betriebs-berater.ruw.de/news/media/1/Volltext_der_Erlasse-4672.pdf.

Bopp, M., Kaczynski, A.T., Besenyi, G., 2012. Active commuting influences among adults. Prev. Med. 54 (3–4), 237–241. https://doi.org/10.1016/j.ypmed.2012.01.016.

C2WA (Cycle to Work Alliance), 2011. Cycle to Work Alliance: behavioural impact analysis. Available at, (last accessed April 2019). https://www.cycling-embassy.org.uk/sites/cycling-embassy.org.uk/files/documents/Cycle%20to%20Work%20Alliance%20Behavioural%20Impact%20Analysis%20-%20February%202011.pdf.

Celis-Morales, C.A., Lyall, D.M., Welsh, P., et al., 2017. Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study. BMJ 357, 1456. https://doi.org/10.1136/bmj.j1456.

de Geus, B., van Hoof, E., Aerts, I., Meeusen, R., 2008. Cycling to work: influence on indexes of health in untrained men and women in Flanders. Coronary heart disease and quality of life. Scan. J. Med. Sci. Sport. 18 (4), 498–510. https://doi.org/10.1111/j.1600-0838.2007.00729.x.

de Nazelle, A., Nieuwenhuijsen, M.J., Antó, J.M., et al., 2011. Improving health through policies that promote active travel: a review of evidence to support integrated health impact assessment. Environ. Int. 37 (4), 766–777. https://doi.org/10.1016/j.envint.2011.02.003.

DFT (Department for Transport), 2011. Cycle to work scheme implementation guidance. Available at, (last accessed April 2019). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/11305/cycle-to-work-guidance.pdf.

Dinu, M., Pagliai, G., Macchi, C., Sofi, F., 2019. Active commuting and multiple health outcomes: a systematic review and meta-analysis. Sport. Med. 49 (3), 437–452. https://doi.org/10.1007/s40279-018-1023-0.

Eilert, U., Lampert, T., Ravens-Sieberer, U., Messung der gesundheitsbezogenen Lebensqualität mit dem SF-8: Eine Normstichprobe für Deutschland (Measurement of health-related quality of life via the SF-8: a norm sample for Germany), 2005. Bundesgesundheitsblatt - Gesundheitsforsch. - Gesundheitsschutz 48 (12), 1330–1337. https://doi.org/10.1007/s00103-005-1168-5.

Faulkner, G.E.J., Buliung, R.N., Flora, P.K., Fusco, C., 2009. Active school transport, physical activity levels and body weight of children and youth: a systematic review. Prev. Med. 48 (1), 3–8. https://doi.org/10.1016/j.ypmed.2008.10.017.

Golubic, R., Martin, K.R., Ekelund, U., et al., 2014. Levels of physical activity among a nationally representative sample of people in early old age: results of objective and self-reported assessments. Int. J. Behav. Nutr. Phys. Act. 11 (1), 58. https://doi.org/10.1186/1479-5868-11-58.

Guell, C., Panter, J., Jones, N.R., Ogilvie, D., 2012. Towards a differentiated understanding of active travel behaviour: using social theory to explore everyday commuting. Soc. Sci. Med. 75 (1), 233–239. https://doi.org/10.1016/j.socscimed.2012.01.038.

Hamer, M., Chida, Y., 2008. Active commuting and cardiovascular risk: a meta-analytic review. Prev. Med. 46 (1), 9–13. https://doi.org/10.1016/j.ypmed.2007.03.006.

Hendriksen, I., Simons, M., Galindo Garre, F., Hildebrandt, V., 2010. The association between commuter cycling and sickness absence. Prev. Med. 51 (2), 132–135. https://doi.org/10.1016/j.ypmed.2010.05.007.

Humphreys, D.K., Goodman, A., Ogilvie, D., 2013. Associations between active commuting and physical and mental wellbeing. Prev. Med. 57 (2), 135–139. https://doi.org/10.1016/j.ypmed. 2013.04.008.

Johan de Hartog, J., Boogaard, H., Nijland, H., Hoek, G., 2010. Do the health benefits of cycling outweigh the risks? Environ. Health Perspect. 118 (8), 1109–1116. https://doi.org/10.1289/ehp.0901747.

Martin, A., Goryakin, Y., Suhrcke, M., 2014. Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey. Prev. Med. 69, 296–303. https://doi.org/10.1016/j.ypmed.2014.08.023.

Moore, G.C., Benbasat, I., 1991. Development of an instrument to measure the perceptions of adopting an information technology innovation. Inf. Syst. Res. 2 (3),

192–222. https://doi.org/10.1287/isre.2.3.192.
Muthén, L.K., Muthén, B.O., 2012. Mplus User's Guide, seventh ed. Muthén & Muthén, Los Angeles, CA.
Mutrie, N., Carney, C., Blamey, A., et al., 2002. "Walk in to Work Out": a randomised controlled trial of a self help intervention to promote active commuting. J. Epidemiol. Community Health 56 (6), 407–412. https://doi.org/10.1136/jech.56.6.407.
Mytton, O.T., Panter, J., Ogilvie, D., 2016. Longitudinal associations of active commuting with wellbeing and sickness absence. Prev. Med. 84, 19–26. https://doi.org/10.1016/j.ypmed.2015.12.010.
Nehme, E.K., Pérez, A., Ranjit, N., Amick, B.C., Kohl, H.W., 2016. Behavioral theory and transportation cycling research: application of diffusion of innovations. J. Transp. Health 3, 346–356. https://doi.org/10.1016/j.jth.2016.05.127.
Nigg, C.R., Borrelli, B., Maddock, J., Dishman, R.K., 2008. A theory of physical activity maintenance. Appl. Psychol. 57, 544–560. https://doi.org/10.1111/j.1464-0597.2008.00343.x.
Oja, P., Titze, S., Bauman, A., et al., 2011. Health benefits of cycling: a systematic review. Scand. J. Med. Sci. Sport. 21 (4), 496–509. https://doi.org/10.1111/j.1600-0838.2011.01299.x.
Petrunoff, N., Rissel, C., Wen, L.M., 2016. The effect of active travel interventions conducted in work settings on driving to work: a systematic review. J. Transp. Health 3 (1), 61–76. https://doi.org/10.1016/j.jth.2015.12.001.
Petschnig, M., Heidenreich, S., Spieth, P., 2014. Innovative alternatives take action – investigating determinants of alternative fuel vehicle adoption. Transp. Res. Part A Policy Pract. 61, 68–83. https://doi.org/10.1016/j.tra.2014.01.001.
Preacher, K.J., Hayes, A.F., 2008. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behav. Res. Methods 40 (3), 879–891. https://doi.org/10.3758/BRM.40.3.879.
Rogers, E.M., 2002. Diffusion of preventive innovations. Addict. Behav. 27 (6), 989–993. https://doi.org/10.1016/S0306-4603(02)00300-3.
Rogers, E.M., 2003. The Diffusion of Innovations, fifth ed. Free Press, Simon & Shuster. Inc., New York.
Sahin, I., Rogers, F., 2006. Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies based on Rogers. Turkish Online J. Educ. Technol. 5, 14–23. https://doi.org/10.1080/09687769.2010.529107.
Saunders, L.E., Green, J.M., Petticrew, M.P., Steinbach, R., Roberts, H., 2013. What are the health benefits of active travel? A systematic review of trials and cohort studies. PLoS One 8 (8), e69912. https://doi.org/10.1371/journal.pone.0069912.
Schein, E.H., 1985. Defining organizational culture. Class. Organ. Theor. 3, 490–502.
Shih, C.-F., Venkatesh, A., 2004. Beyond adoption: development and application of a use-diffusion model. J. Mark. 68 (1), 59–72. https://doi.org/10.1509/jmkg.68.1.59.24029.
Statista, 2019a. Development of bicycle ownership in Germany between 2005 and 2018. Available at, (last accessed June 2019). https://de.statista.com/statistik/daten/studie/154198/umfrage/fahrradbestand-in-deutschland/.
Statista, 2019b. Number of companies in Germany between 2005 and 2017. Available at, (last accessed June 2019). https://de.statista.com/statistik/daten/studie/246358/umfrage/anzahl-der-unternehmen-in-deutschland/.
Statistisches Bundesamt (Destatis), 2018. Datenreport 2018 (Data Report 2018). Statistisches Bundesamt and Wissenschaftszentrum Berlin für Sozialforschung, Bonn.
Swift, S., Green, M., Hillage, J., Nafilyan, V., 2016. Impact of the Cycle to Work Scheme: Evidence Report. Institute for Employment Studies Report 509.
Synek, S., Koenigstorfer, J., 2018. Exploring adoption determinants of tax-subsidized company-leasing bicycles from the perspective of German employers and employees. Transp. Res. Part A Policy Pract. 117, 238–260. https://doi.org/10.1016/j.tra.2018.08.011.
Ware, J., Kosinski, M., Dewey, J., Gandek, B., 2001. How to Score and Interpret Single-Item Health Status Measures: A Manual for Users of the SF-8 Health Survey. QualyMetric, Boston.
Wesp, R., 2015. Work-Bike-Balance per Dienstrad (Work-bike balance with a company-leasing bicycle). Available at:. Lebensm. Ztg. 43 (last accessed April 2019). https://www.lebensmittelzeitung.net/handel/Work-Bike-Balance-per-Dienstrad-112802.
Whitt, F., Wilson, D., 1982. Bicycling Science. Massachusetts Institute of Technology, Cambridge, MA.
Xu, H., Wen, L.M., Rissel, C., 2013. The relationships between active transport to work or school and cardiovascular health or body weight: a systematic review. Asia Pac. J. Public Health 25 (4), 298–315. https://doi.org/10.1177/1010539513482965.