Promoting Sustainable Travel Behavior through IS-Enabled Feedback – Short-Term Success at the Cost of Long-Term Motivation?

Completed Research Paper

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Abstract

The shaping of sustainable future transportation systems is posing serious challenges for policy-makers today and massive investments are made into infrastructures and travel demand management. Meanwhile, Green IS research is addressing the potential of information systems as high-scale, low-cost means of influencing human actions and has successfully been applying psychological theories. However, research is still in its early stages and while positive short-term effects are relatively well understood, little is known about the long-term effects of such measures. This study, investigates the impact of an IS-enabled social normative feedback intervention on the intrinsic motivation of participants of an e-bike commuting competition. The results of a four-month field study show a negative effect of the intervention on participants' intrinsic motivation, thus challenging long-term benefits of the measure. Additionally, our findings lend support to the reasoning of Cognitive Evaluation Theory that a dissatisfaction of participants' need for autonomy may underlie this effect.

Keywords: Green IS, social norms, motivation theory

Introduction

Transportation systems as they are known today cannot be considered sustainable. Vehicle combustion engines are a significant contributor to global climate change, accounting for more than one fifth of global carbon dioxide emissions (Burns 2013). In addition, not only road traffic injuries but also noise and air pollution exposure as well as lacks of physical activity have seriously damaging effects on human health (Dora et al. 2011; OECD 2012). For instance, exposure to heavy traffic from merely living near major transportation routes has been associated with poorer health of adults and children as well as increased mortality rates (Brugge et al. 2007). In addition, new challenges, such as an increasing urbanization, growing levels of migration and mobility as well as the ageing of populations especially in Western societies are further accentuating the challenges, which policy-makers are facing in the shaping of sustainable and efficient transportation systems for the future (European Commission 2009). Consequently, significant investments are being made into the improvement of urban infrastructures as well as into so-called travel demand management (TDM) measures. TDM measures aim to influence people's travel behavior and actively manage the demand for specific travel modes in order to enhance mobility while at the same time reducing the dependence on cars and trucks, thus alleviating congestion and pollution (Fujii and Kitamura 2003; Meyer 1997). A broad set of actions are being explored in this context, for instance including subsidies for specific modes of transportation, congestion pricing and conversion of selected streets to exclusive public transport use (Meyer 1999).

At the same time, rapid technological advancements are finding their way into everyday life and researchers have started to investigate the potential of information systems (IS) to influence human actions and contribute to changes for more sustainable lifestyles, in the context of Green IS literature (Dedrick 2010; Watson et al. 2010). Particularly the idea of utilizing modern information systems as high-scale and low-cost means of communication to apply psychological theories and enable large-scale feedback campaigns to promote socially desirable behaviors, has recently been attracting the interest of researchers (Loock et al. 2013). One such psychological theory, which has successfully been applied in Green IS studies e.g. to reduce energy consumption of residential customers (Loock et al. 2011), refers to social norms. The activation of social norms through the delivery of social normative feedback has been found to be a powerful tool for influencing a wide range of human behaviors, not only reducing individuals' energy consumption (Abrahamse et al. 2007; Loock et al. 2011), but also e.g. increasing the reuse of towels in hotels (Goldstein et al. 2008). With regard to transportation systems, first studies have demonstrated the capacity of so-called travel feedback programs (TFPs), which seek to influence travel behaviors by providing information on the basis of reported travel behavior, to increase public transport usage and reduce car usage (Fujii and Taniguchi 2005, 2006; Gärling and Fujii 2009; Taniguchi et al. 2007). In addition, Graham et al. (2011) have specifically shown that an IS-enabled online intervention, in which participants were given feedback about CO_2 and money saved by avoiding to drive, was effective in decreasing participants' car usage.

However, research into Green IS and the application of such psychological mechanisms is still in its early stage and further research is required in order to understand how IT artifacts need to be shaped in order to achieve the desired effects and contribute to the establishment of sustainable behaviors (Loock et al. 2013; Melville 2010; Watson et al. 2010). The need to carefully design in particular social normative feedback measures is for instance further emphasized by the findings of Schultz et al. (2007). The authors show that descriptive normative feedback may cause undesired boomerang effects in which participants who already display above-average desired behaviors adjust back to the norm and that such boomerang effects may however be eliminated if injunctive messages are added to the feedback intervention. While such findings certainly provide valuable guidance regarding the design of IS-enabled interventions, they focus on potential negative effects during an intervention. Researchers in the social psychology and economic domains have additionally pointed out that extrinsic interventions may turn out as problematic in the long term after an intervention has ended. Known as Motivation Crowding Theory (Frey and Jegen 2001) in economic literature, a concept which has been extensively investigated also by social psychologists suggests that extrinsic rewards may have an undermining effect on intrinsic motivation, leading to below baseline post-reward behaviors. This effect has been evidenced in numerous studies and different settings and it has been found to be relevant not only for financial extrinsic rewards, but also for other external factors such as competitions (Deci et al. 2001). Deci and Ryan (1985) explain the effect on the grounds of Cognitive Evaluation Theory (CET) and argue that in the case of competitions, such a

negative effect on intrinsic motivation mostly stems from a dissatisfaction of participants' needs for autonomy (Deci and Ryan 2000).

In this paper, we discuss the potential and impact of IS-enabled social normative feedback interventions with regard to the usage of electric bicycles (e-bikes) for commuting. E-bikes represent a relatively new means of transportation and have been enjoying remarkable market success in recent years (ZIV 2014). Compared to traditional bicycles, e-bikes offer a number of advantages with regard to e.g. effort, reach and independence from local topography, which could make them an important element of sustainable future transportation systems, especially if they are used in replacement of cars, for instance for commuting to work. We build upon previous research, in which we have shown that an IS-enabled e-bike commuting competition including social normative usage feedback can be an effective means of promoting e-bike usage (Flüchter et al. 2014) and investigate the effect of such a competition on the intrinsic motivation of participants to use their e-bikes. For this purpose, we evaluate the findings of a field study in which we provided 32 users with e-bikes for the duration of approximately four months. As part of the study, participants were randomly assigned to an experimental and a control group and the participation in a three-week e-bike commuting competition was designed as between-subject factor, which was present in the treatment group and absent in the control group. The competition included social normative feedback on e-bike usage at the end of each week and was complemented by surveys before and after the experimental phase as well as in-depth interviews at the beginning and end of the field study. We apply a t-test to derive insights into the effect of the intervention on participants' intrinsic motivation and explore the potential role of the psychological need for autonomy in this context by means of a chi-squared test. Our research contributes to existing work in the areas of information systems, social psychology and transportation as we are seeking to advance a deeper understanding of the effects of extrinsic motivation and the sources of intrinsic motivation (Davis et al. 1992; Gerow et al. 2012) in a real-world situation (Vansteenkiste and Deci 2003) by applying information systems technology in the mobility management domain (Taniguchi et al. 2007) to influence travel behaviors, thus contributing to the fostering of energy efficiency through Green IS (Watson et al. 2010).

Theoretical Background and Related Work

Promoting Sustainable Behavior on the Basis of IS

The potential of information systems to influence human actions and thereby contribute to the formation of sustainable behaviors and an ecologically sustainable society has recently attracted much attention in theory as well as practice (Dedrick 2010; Loock et al. 2011; Watson et al. 2010; Wunderlich et al. 2013). Literature on Green IS has been addressing the design and implementation of information systems that enhance sustainability across the economy and enable the implementation of sustainable business processes (Vom Brocke and Seidel 2012; Dedrick 2010). In this sense, the concept of Green IS goes beyond what is commonly discussed as Green IT. It recognizes potential impacts on the environment not only as a result of first-order effects from the production, usage and disposal of IT hardware (Green IT), but also from second-order effects, influences of information and communication technologies (ICT) on industrial production and transportation processes, and third-order effects, referring to changes in lifestyles and economic structures as a result of the widespread use of ICT (Dedrick 2010; Köhler and Erdmann 2004; Wunderlich et al. 2013).

While many works in the area of Green IS are conceptual in nature and focusing on the organizational level of analysis (Jenkin et al. 2011; Loock et al. 2011), IS researchers have recently started to address the idea that individuals play an important role in the realization of environmental sustainability. For instance, Watson et al. (2010) suggest to address consumers in a research question of how information systems can be used to change social norms to increase energy efficiency. However, research into the topic is still in its early stage and only few studies have to date investigated how individual consumption behavior could be influenced through IT artifacts (Loock et al. 2011).

Nonetheless, first results of individual studies, which utilize findings from psychological research to enhance the design of their IS-enabled interventions, appear promising. For example, Loock et al. (2013) showed that users of a utility company's web portal, who used a goal-setting functionality to set an energy-saving goal, saved on average 2.3% more energy than users in a non-goal condition. Similarly, research in the domain of persuasive technology has produced promising results. Focusing on the design

of interactive computing systems to change peoples' behaviors or attitudes (Fogg 2003; Oinas-Kukkonen and Harjumaa 2009), researchers have e.g. found evidence for the persuasive potential of mobile applications to influence users' travel mode choices (Froehlich et al. 2009; Reitberger et al. 2007). Such findings hint to the opportunity, which a combination of technological expertise with psychological theories may constitute (Lim et al. 2009; Zhang 2007) and underline the requirement for further research to understand how IT artifacts should be designed and shaped in order to achieve the desired positive effects and help build a sustainable future (Loock et al. 2013; Melville 2010; Watson et al. 2010).

Social Normative Feedback

As we have discussed in a previous paper (Flüchter et al. 2014), one such psychological theory, which has been associated with the potential to promote sustainable behaviors in the domain of Green IS, refers to social norms (Jenkin et al. 2011; Watson et al. 2010). Social norms are sets of beliefs about the behavior of others (Schultz 1999). As Cialdini et al. (1991) lay out in their prominent Focus Theory of Normative Conduct, social norms can further be classified as descriptive norms or injunctive norms. Descriptive norms are beliefs of what most people are doing, while injunctive norms refer to beliefs about what most people approve or disapprove of (Cialdini et al. 1991). A significant body of research has demonstrated that the activation of social norms may serve as a powerful tool for influencing human behavior (Cialdini 2001). Numerous studies have utilized social norms to successfully influence a wide range of behaviors, such as littering (Cialdini 2003), towel reuse (Goldstein et al. 2008) and energy consumption (Abrahamse et al. 2007; Loock et al. 2011).

One of the most practical and common approaches for the activation of social norms is through the use of feedback (Schultz 1999). Feedback interventions have been defined as "actions taken by (an) external agent(s) to provide information regarding some aspect(s) of one's task performance" (Kluger and DeNisi 1996, p.255). Schultz et al. (2007) point out that in the design of such feedback interventions, it is critical to pay attention to a careful crafting of the right messages. The authors show that descriptive normative messages may lead to undesired boomerang effects in which consumers who already demonstrate above-average desired behaviors adjust back to the norm. However, adding an injunctive message to the feedback intervention was found to eliminate this boomerang effect.

Recently, researchers in the area of travel behavior have also been recognizing that psychological measures, such as social normative feedback, may constitute a powerful means of modifying human behavior. Gärling and Fuji (2009) for instance point out that so-called travel feedback programs (TFPs) have been found to successfully change travel behavior, specifically increasing public transport usage and reducing car usage. TFPs are behavior modification programs for changing travel behavior, usually from automobile to non-automobile use (Fujii and Taniguchi 2005). The specific nature of such TFPs may vary, ranging from individualized marketing of travel mode alternatives to personalized feedback on travel behavior based on travel diary surveys. However, they all share the common feature that participants are provided with information which is intended to modify their travel behavior based on reported travel behavior (Fujii and Taniguchi 2005, 2006; Gärling and Fujii 2009). In a meta-study of travel feedback programs in Japan, Taniguchi et al. (2007) found that such measures can reduce car use by up to 19% and increase public transport use by up to 69%.

While TFPs may involve various forms of communication, including face-to-face communication, regular mail, telephone and e-mail (Fujii and Taniguchi 2006), Graham et al. (2011) have specifically demonstrated that an IS-enabled online intervention, in which college students received feedback about pollution and financial expenses avoided, was effective in reducing participants' use of their cars. In our previous research (Flüchter et al. 2014), we have moreover been able to demonstrate that IS-enabled social normative feedback in the form of an e-bike commuting competition has a positive effect on the usage of e-bikes for commuting.

Intrinsic Motivation and Cognitive Evaluation Theory

While such positive impact of IS-enabled feedback on individual travel behaviors appears promising, it is crucial to examine in more detail how precisely such measures take effect in order to gain a deeper understanding of the potential longer-term effects of IS-enabled social normative feedback measures. A significant body of literature has been employing motivation theory (Deci and Ryan 1985; Vallerand 1997)

to understand and predict human behavior. Motivation theorists distinguish between two basic types of motivation, i.e. extrinsic motivation, which refers to "doing something because it leads to a separable outcome" (Ryan and Deci 2000a, p.55) and intrinsic motivation, which refers to "doing something because it is inherently interesting or enjoyable" (Ryan and Deci 2000a, p. 55). Within the information systems domain, motivation research has been dominated by Davis et al.'s (1992) motivational model, which applies motivational theory to understand new technology adoption and use (Gerow et al. 2012; Malhotra et al. 2008; Venkatesh et al. 2003). Many studies in IS research have since revisited the theme of motivation in user acceptance research, typically operationalizing extrinsic motivation as perceived usefulness and intrinsic motivation as perceived enjoyment or playfulness (Gerow et al. 2012). As such, the concepts of extrinsic and intrinsic motivation are also to be found in other models of technology acceptance, e.g. extrinsic motivation is considered to be captured in Davis' (1989) Technology Acceptance Model (TAM) by the perceived usefulness construct and in the Unified Theory of Acceptance and Use of Technology (UTAUT) by the performance expectancy construct (Venkatesh 2000; Venkatesh et al. 2003). Studies which explicitly investigate extrinsic and intrinsic motivation in the IS domain mostly focus on the relationship between the utilitarian or hedonic purpose of a system and the influence of extrinsic or intrinsic motivational drivers respectively on the adoption of such systems (Gerow et al. 2012; van der Heijden 2004; Wu and Lu 2013).

While Davis et al. (1992) emphasize that more research is needed to understand mutually reinforcing or countervailing effects of extrinsic and intrinsic incentives, little attention has to date been placed by IS researchers on the interplay between and sources of extrinsic and intrinsic motivation (Gerow et al. 2012; von Krogh et al. 2012). By contrast, a lively debate has been ongoing in the social psychology as well as economic literature, pointing out, that while extrinsic rewards can have incentive effects as long as they are offered, an undermining effect of extrinsic rewards on intrinsic motivation may emerge as problematic in the long run after incentives have been removed (Bénabou and Tirole 2003; Cameron et al. 2001; Deci et al. 2001; Frey and Jegen 2001; Gneezy et al. 2011). In economic research, interest in what is now also discussed as Motivation Crowding Theory (Frey and Jegen 2001), i.e. the idea that particularly monetary rewards may negatively affect intrinsic motivation, was sparked by Titmuss (1970), who argued that paying people for donating blood undermined established social values about voluntary donations and would therefore reduce people's willingness to donate blood. In social psychology research, first laboratory experiments by Deci (1971) similarly found monetary rewards to weaken people's intrinsic motivation and consequently lead to below baseline post-reward behavior. Numerous studies have in the meantime provided support for this motivational effect in different settings and for different types of external rewards (Deci et al. 2001). For instance, Deci et al. (1981) found a significant main effect in which competition reduced intrinsic motivation in an experiment where participants were asked to solve puzzles in a competitive setting. Similarly, other external factors, such as threats (Deci and Cascio 1972), deadlines (Amabile et al. 1976), evaluations (Harackiewicz et al. 1984) and externally imposed goals (Mossholder 1980) have been associated with negative effects on intrinsic motivation, while under other conditions, e.g. if rewards are unexpected or task-noncontingent, intrinsic motivation must not necessarily be undermined (Deci et al. 1999).

In light of the above-mentioned research findings, which suggest a crowding out of intrinsic motivation in consequence of extrinsic rewards such as competitions, we assume that the participation in an e-bike commuting competition, i.e. the receiving of competitive social normative feedback on e-bike usage, will have a negative effect on the intrinsic motivation of participants to use their e-bikes. We thus hypothesize:

H1: IS-enabled competitive social normative feedback has a negative effect on intrinsic motivation

The negative interaction between extrinsic rewards and intrinsic motivation has been explained by Deci and Ryan (1985) in the context of cognitive evaluation theory (CET), a sub-theory within self-determination theory (SDT). While SDT proposes that three psychological needs, i.e. the needs for autonomy, competence and relatedness, are underlying human motivation, CET focuses on the needs for autonomy and competence to explain the effects of positive and negative rewards on intrinsic motivation (Deci et al. 2001; Ryan and Deci 2000b). Following CET, the impact which external events such as rewards, evaluations or competitions have on intrinsic motivation is dependent on how these events influence a person's perceptions of autonomy (controlling aspect) and competence (informational aspect). The theory suggests that events which decrease perceived autonomy will diminish intrinsic motivation, while events which increase perceived autonomy will enhance intrinsic motivation. In addition, events

which decrease perceived competence will undermine intrinsic motivation, whereas events which increase perceived competence may enhance intrinsic motivation, albeit only if they are accompanied by perceived autonomy (Deci et al. 2001; Ryan and Deci 2000b).

Specifically addressing competition, Deci et al. (1981) point out that trying to win can often be quite controlling, but may also contain an informational aspect as competence feedback is provided. The authors acknowledge that competition can enhance motivation and improve performance, but argue that the motivation is extrinsic in nature. They suggest that the controlling aspect of competition will in general decrease intrinsic motivation for the activity itself and thus outweigh any potentially positive impact of competence feedback. More recent research has been providing evidence for positive effects of competition on intrinsic motivation (Reeve and Deci 1996; Tauer and Harackiewicz 2004; Vansteenkiste and Deci 2003). For instance, Reeve and Deci (1996) found winning a competition in a non-pressuring context to enhance intrinsic motivation relative to a no feedback and no competition control group. However, such effects appear less relevant than the effect of competition per se, thus at most moderating to some extent the negative controlling effect of competition on intrinsic motivation, which has been replicated by various researchers (Deci and Ryan 2000; Tauer and Harackiewicz 2004; Vansteenkiste and Deci 2003).

Following CET and the discussed research findings which highlight the role of the controlling aspect of competition, i.e. the negative impact of competition on the need for autonomy, in the undermining of competitors' intrinsic motivation, we hypothesize that the participation in an e-bike commuting competition, i.e. the receiving of competitive social normative feedback on e-bike usage, will similarly dissatisfy participants' need for autonomy. Hence, we suggest:

H2: IS-enabled competitive social normative feedback has a negative effect on participants' perceived autonomy

Field Study

Design and Participants

In order to test our research hypotheses, we evaluate findings from the same field study, by means of which we were able to demonstrate the effectiveness of social normative feedback in increasing the usage of e-bikes for commuting (Flüchter et al. 2014). The study comprised two experimental groups to which 32 participants were randomly assigned. 20 participants were allotted to the experimental group and 12 to the control group. An e-bike commuting competition was conducted as part of the field study and the participation in the competition was designed as between-subject factor, which was absent in the control group and present in the treatment group.

The participants (14 women, 18 men) were provided with electric bicycles for the duration of approximately four months in order to assess the suitability of e-bikes as a means of transportation for commuting to work. All participants worked at the same office location in Eastern Switzerland as employees of a Swiss insurance company (30) or the local university (2) and they were 22 to 64 years old ($M = 35.3$; $SD = 11.9$). The decision to approach this group of participants was made for two reasons. First, due to the research focus on the activity of commuting by e-bike, it was important to recruit participants with the same office location so that a distortion of results from disparate conditions at the workplace, e.g. with respect to showers and bike racks, could be avoided (Heinen et al. 2013). Second, the topographic situation of the office location was taken into consideration. The workplace of the selected participants is located on a hill, which made it practically impossible for any of the participants to commute to work without overcoming some degree of altitude. In that way, the potential influence on the results of differences between individual participants with regard to their commuting routes' altitude profiles could be limited (Heinen et al. 2010; Parkin et al. 2008).

Procedure and Measurements

For the purpose of the field study, we equipped all participants with an e-bike for the period of approximately four months. Individual e-bike models were allocated to the field study participants based on their height, weight, age, gender as well as the distance of their commute and personal preferences, which the participants had specified in an online survey. In this way, the comparability of e-bike usage

conditions across participants was further enhanced as a good fit between each participant and his or her respective e-bike could be achieved. In an intention to automate the collection of e-bike usage data, which could serve as the foundation of an IS-enabled e-bike commuting competition, all e-bikes were equipped with prototype GPS sensors, which we had received from a large German technology manufacturer. The sensors collected GPS position information and transmitted the data to a backend via a built-in GSM connection. To ensure sufficient power supply for the entire duration of the field study, the sensors were connected to the e-bike battery system. Unfortunately, we incurred several problems regarding the GPS sensors and found the completeness of the transmitted GPS data to be insufficient for the purpose of our intervention (c.f. Flüchter and Wortmann 2014). Hence, we reverted to a self-reporting design to gather e-bike usage information from participants. In order to account for a potential influence on the intensity of e-bike usage from the newness of the e-bikes to the participants and avoid a corresponding distortion of results, measurements only started after ten weeks into the field study.

The field study participants were then asked to submit information about their weekly e-bike usage for the duration of five weeks. In recognition of the challenges associated with any form of self-reporting-based data collection, particular care was taken with regard to the design, administration and evaluation of the self-reporting questionnaire. First, in order to encourage high response rates and at the same time facilitate respondents' recall of their e-bike usage, only a short online survey (Barker et al. 2002; Burchell and Marsh 1992) was sent to participants once a week, at the end of each week, inquiring respondents' e-bike usage for the reference period of only the past week (Schwarz and Oyserman 2001). Next, the questionnaire consisted of simple, mostly closed-end questions (Barker et al. 2002; Bradburn et al. 2004), asking participants to set one to four checkmarks for each day of the past week to indicate whether they had used their e-bike on that day to a) go from home to work, b) go home from work, c) in their leisure time or d) not at all. In addition, only one further non-compulsory information was inquired, capturing the total mileage of the e-bike at the end of the week, which could easily be found on the e-bike tachometer. Finally, a self-report bias of responses and possible overstating of e-bike usage by participants can of course not be entirely ruled out (Barker et al. 2002; Schwarz and Oyserman 2001). However, the requested information was not of sensitive nature (Donaldson and Grant-Vallone 2002) and the extent of a potential overstating limited by the maximum frequency of one commute per day. In addition, selected cross-checks of the self-reported data with data collected through the GPS sensors did not raise any concerns with regard to self-report bias.

The five-week measurement period was further complemented by two more elaborate surveys, one at the beginning and one at end of the period, as well as in-depth interviews with the participants at the beginning and at the end of the four-months field study, which allowed us to gain further insights into the participants' e-bike usage and their experiences with the e-bikes. We also utilized these surveys to measure the participants' intrinsic motivation to use their e-bikes. Intrinsic motivation has commonly been operationalized by means of two different measures. In the so-called free-choice measure, the amount of time is observed, which participants spent on a target activity when being left alone after an experimental period with the freedom to pursue either the target activity or alternative activities. An alternative approach to measure intrinsic motivation relies on self-reports, asking participants how interesting or enjoyable they find the activity to be (Vansteenkiste and Deci 2003). Following the latter approach, we requested the participants to rate in our surveys at the beginning and at the end of the five-week measurement period, how much fun they had when riding their e-bike on a scale from 1 (no fun at all) to 7 (very much fun). Similar items have commonly been used by researchers to assess intrinsic motivation on self-report scales (Epstein and Harackiewicz 1992; Reeve and Deci 1996; Tauer and Harackiewicz 2004). Finally, investigating the perceived autonomy of participants during the self-reporting phase, we asked participants to indicate whether or not they somehow felt controlled during the field study or obliged to use their e-bikes, thereby building upon existing works assessing perceived autonomy (Van den Broeck et al. 2010; Reeve and Deci 1996; Vallerand 1997).

Intervention

After two weeks into the measurement period, participants in the treatment group were invited to take part in an e-bike commuting competition. As part of the invitation, they were informed that the competition would span a duration of three weeks and that the winner of the competition would be the person who used the e-bike the most often to commute to work during this timeframe. Furthermore, the participants also learned that they would be receiving an overview of their respective rankings in the

competition at the end of each week and a comparison of their own e-bike usage during the past week with that of the other participants.

Figure 1. Feedback provided to participants of e-bike commuting competition (translated from German)

Subsequently, at the end of each of the three competition weeks, participants in the treatment group (competitors) received an e-mail containing social normative feedback with regard to the competition. As illustrated in figure 1, the feedback informed them of their current ranking in the competition and in addition provided a more detailed overview of the participants' e-bike usage during the past week. To calculate the ranking in the competition, solely the number of commutes by e-bike, which the respective participant made during the three-week competition period, was taken into consideration. In order to eliminate any potential undesired boomerang effects, which may occur if descriptive normative feedback

is given (Schultz et al. 2007), we used an injunctive message in the form of a podium to display this information. In the lower section of the feedback e-mail, the competitors received additional descriptive normative feedback about their e-bike usage during the past week. Specifically, the number of e-bike commutes during the past week by the participant was displayed and contrasted with the corresponding average value for the treatment group. Similarly, the participant's e-bike usage in terms of kilometers during the past week was illustrated and compared to the group average. Finally, an overview was provided which showed the share of competitors who had used their e-bikes for commuting on each day of the past week. Days on which the feedback recipient had used his or her e-bike for commuting were additionally marked.

Analysis and Results

Descriptive Results

In order to provide a basic overview of the field study participants' e-bike usage during the period of observation as well as the effect of the e-bike commuting competition on competitors' e-bike usage, we start with an overview of some basic results, on which we have elaborated in more detail in a previous piece of research (Flüchter et al. 2014).

Figure 2 illustrates some descriptive statistics for the experiment concerning participants' e-bike usage. It is evident that not all field study participants used their e-bike to commute to work on every day. Rather, the share of participants who used their e-bike for commuting at least one way, i.e. either to go to work or to go home from work, varied between 12% and 57% on any given day during the period of measurement, excluding a bank holiday for which no e-bike commuting was reported. The highest share of e-bike commuters was observed on the first day of week two and the lowest on the last day of week five. All in all, the levels of e-bike usage for commuting show a declining trend during the five weeks of observation.

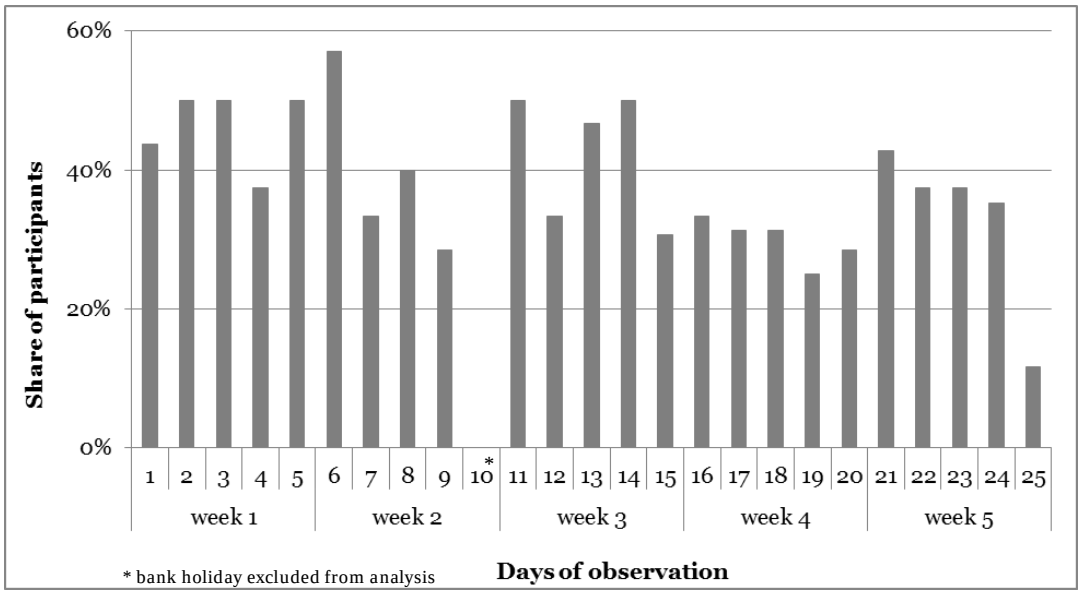

Figure 2. Overview of share of field study participants who used e-bike for commuting per day

Social Normative Influence on the Usage of E-Bikes for Commuting

As highlighted in table 1, we applied mixed effects logistic regression analysis to examine the impact of the social normative feedback, which we provided to the participants as part of the e-bike commuting competition, on competitors' e-bike usage (Flüchter et al. 2014). This method was chosen for two reasons. First, our outcome variable was binary (e-bike used for commuting: yes/no), and second, we had multiple outcomes per subject (e-bike usage per day of the experiment) so that the variable "subject" was treated as a random effect. One non-binary predictor variable, temperature, and three binary predictor variables were used in the model, not only to test hypotheses but also to eliminate time and group effects, which

could have potentially biased the results. The binary predictor variables referred to the phase of the experiment (competition phase or baseline phase), the experimental group membership of the e-bike rider (competitor or non-competitor) and the commuting distance of the subject (long distance rider or short distance rider). We then analyzed self-reported e-bike usage data of 23 participants, from which we obtained valid data for our analysis, 14 in the experimental and 9 in the control group.

With regard to the influence of social normative feedback on e-bike commuting, we found support for two hypotheses in our analysis. A significant interaction effect between competitors and competition phase provided support for our hypothesis that social normative feedback has a positive effect on the usage of e-bikes for commuting. And a significant three-way interaction effect between competitors, competition phase and long distance riders confirmed our second hypothesis, that frequency of usage-focused social normative feedback would have a negative effect on the usage of e-bikes for commuting by long distance commuters. Overall, the model was significant (Wald $\chi^2(7) = 17.09$, $p < 0.05$). We also saw our findings further corroborated by comments of field study participants on the commuting competition, relating to the overall positive impact of the social normative feedback provided as well as to the negative effect on long distance commuters: "Good idea.", "Very good comparison among participants.", "It would have been motivating to compare myself to the other participants if the weather had been better.", "It was interesting to see how often the others use their e-bikes.", "The comparison with other users was interesting.", "It somehow wasn't measurable, as distances were too diverging. If it had been about kilometers only, I would e.g. have been in the top ranks. Therefore, it's not measurable for me."

	Odds Ratio	Std. Err.	z	P>z
Main Effects				
Temperature	1.03	0.03	1.04	0.151
Competition phase (CP)	0.19	0.15	-2.07	0.019
Competitors (C)	5.19	5.76	1.49	0.069
Long distance riders (LDR)	0.09	0.10	-2.21	0.014
Interaction Effects				
CP x C	6.30	5.21	2.22	0.013
CP x LDR	18.52	23.46	2.30	0.011
CP x LDR x C	0.03	0.04	-2.56	0.005

Table 1. Results of mixed effects logistic regression analysis

Hypothesis Testing

To understand the impact of participation in the e-bike commuting competition on the intrinsic motivation of participants and test our first hypothesis, we applied a t-test. We analyzed participants' assessments of how much fun they had when riding their e-bike on a scale from 1 (no fun at all) to 7 (very much fun), which they provided before as well as after the five-week measurement period. The assessment of participants in the competition group (8 respondents) fell from an average of 6.625 (SD = .74) at the beginning of the self-reporting period to an average of 6.0 (SD = .93) after the competition. The evaluation of participants in the control group (9 respondents) remained stable, at an average of 5.444 before (SD = 1.67) as well as after the measurement phase (SD = 1.59). Intrinsic motivation of non-competitors thus stayed constant over the duration of the five-week self-reporting period (M = 0, SD = .50) while competitors' intrinsic motivation on the other hand showed a decline (M = -.625, SD = .74). Overall, we found this difference to be significant, $t(15) = -2.06$, $p < .05$, thus providing support for H1.

To test H2 and investigate whether a potential reduction of intrinsic motivation can be explained on the basis of a dissatisfaction of the participants' need for autonomy due to the competitive setting, we conducted a chi-squared test. Our findings demonstrate that participants in the treatment group, who had taken place in the e-bike commuting competition, had significantly more concerns with respect to their feeling of autonomy than participants in the control group, i.e. they more often agreed to having somehow felt controlled during the field study or obliged to use their e-bikes (n = 14, 50%) than participants who

had not taken part in the e-bike commuting competition (n = 8, 0%), χ^2 (1, N = 22) = 4.71, p < .05, hence providing support for H2. Additional remarks, which participants in the treatment group made during the interviews at the end of the field study further illustrate this aspect, e.g. "In some way I felt controlled because my data was transmitted and compared to that of others".

Discussion

Key Findings

In this paper we investigated whether IS-enabled social normative feedback on e-bike commuting may have negative implications on recipients' intrinsic motivation. We build upon previous research by which we have demonstrated the effectiveness of social normative feedback in the form of an e-bike commuting competition to enhance the usage of e-bikes for commuting (Flüchter et al. 2014) and derive our findings from a four-months field study as part of which we equipped 32 participants with e-bikes and conducted a social normative feedback experiment over the course of five weeks.

Our first hypothesis, that IS-enabled competitive social normative feedback has a negative effect on intrinsic motivation, was confirmed in our analysis. Intrinsic motivation, which was operationalized as the fun of e-bike riding, deteriorated in an experimental group, which received social normative feedback in the context of an e-bike commuting competition. Competitors on average reported to have more fun e-bike riding before the competition than afterwards, whereas the assessments of participants in a control group, who did not receive such feedback, remained constant over the duration of the experimental phase. We analyzed the results by means of a t-test and found the difference to be significant. This finding was surprising in view of the positive effect, which the social normative feedback had shown on the e-bike usage of competitors during the competition. It was also unexpected against the background of positive comments, which the participants in the experimental group had made about the competition, such as: "Good idea.", "Very good comparison among participants." and "It was interesting to see how often the others use their e-bikes." Yet, the result is in line with an effect, which has been recognized in economic as well as social psychology literature, i.e. that external rewards such as competitions may have a negative impact on intrinsic motivation.

Our second hypothesis, that IS-enabled competitive social normative feedback has a negative effect on participants' perceived autonomy, was also confirmed by our results. We conducted a chi-squared test and found that field study participants, who had taken part in the competition, significantly more often voiced concerns about having somehow felt controlled during the study, than participants in the control group. This finding lends support to an argumentation in existing research based on Cognitive Evaluation Theory (Deci and Ryan 1985), which suggests that the negative effect of external rewards such as competitions on intrinsic motivation is to be attributed to a dissatisfaction of competitors' need for autonomy, causing a crowding out of intrinsic by extrinsic motivation.

Implications for Theory and Practice

Our findings may suggest a number of implications for theory as well as practice. Extrinsic rewards and motivational feedback play an important role in a wide range of activities in everyday life. They not only find application in order to motivate students to learn and athletes to work out but also to e.g. encourage utility customers to save energy. Of course, the discussed evidence that extrinsic rewards may undermine intrinsic motivation does not mean that the usage of such external incentives to elicit changes in behavior must always be counterproductive. Sometimes it is sufficient if incentives work in the short term. In the transportation environment for instance, municipalities may be interested in motivating residents to switch to a certain mode of transportation or modify the routes they are taking only for a limited amount of time, e.g. when a large event is taking place in the city or major construction work has to be carried out. In addition, researchers have been pointing out that the specific effects of external incentives are influenced by a number of aspects, including the exact design of the rewards and the form in which they are given (Deci et al. 1999; Gneezy et al. 2011). Existing literature further suggests that extrinsic motivation may be internalized under the right circumstances (Ryan and Deci 2000b), and studies have also found evidence for some kind of habit formation following extrinsic incentivizing at least in the middle run, e.g. with regard to gym attendance rates (Acland and Levy 2010; Charness and Gneezy 2009).

Hence, although the investigation of such mitigating effects was not part of the scope of this study, we would argue that motivational feedback should not be abandoned, but it rather needs to be understood how the positive behavioral effects of such incentive measures can be sustained in the long term.

From a scientific point of view, our research adds to existing works in the areas of information systems and Green IS, transportation, as well as social psychology. Specifically, we follow Watson et al.'s (2010) call for research into the question of how information systems can be used to change social norms to increase energy efficiency by assessing the effectiveness of IS-enabled social normative feedback to increase the usage of electric bicycles. We further hope to contribute to a deeper understanding of the effects of extrinsic motivation and the sources of intrinsic motivation, thus following the suggestions for future research by Davis et al. (1992) and Gerow et al. (2012). By applying information systems technology in the mobility management domain, we address a need for research pointed out by Taniguchi et al. (2007) in the transportation literature. And finally, we have tested the concept of social normative feedback and investigated the effect of extrinsic rewards on intrinsic motivation in a real-world setting. This is addressing a gap in existing social psychology research pointed out by Vansteenkiste and Deci (2003), who note that most studies exploring the impact of competition on intrinsic motivation have been conducted in psychology laboratories and there is only little evidence with regard to how the findings generated in such studies would generalize to real-world situations.

Limitations and Future Research

Some limitations should be considered in the assessment of our contribution. First, we undertook the endeavor of conducting a field-study in a real-world setting and moreover focused our investigation on a relatively new means of transportation, the e-bike. Seeking to establish an experimental setting, which would avoid as many potential sources of bias in our results as possible, we not only took particular care in the selection of the field study participants and the location of their offices, but also cooperated with a project partner from the e-bike industry, which allowed us to provide a high-value e-bike to each field study participant for the duration of four months. Unfortunately, this setup at the same time restricted the size of our field study to a relatively small sample of 32 participants and smaller subsets of participants from which valid data could be obtained to investigate individual research questions. This obviously limits the generalizability of our results and calls for further research and repetitions on a larger scale. In addition, the field study was geographically confined to Eastern Switzerland and the duration of our measurement period was restricted to a timeframe of five weeks, which could further limit the generalizability of our findings. Next, the social normative feedback experiment was conducted in the months of October and November. Since bike riding is primarily a warm weather endeavor, we cannot rule out that our experiment may have produced different results if it had been carried out in summer. Furthermore, all participants took part in our field study on a voluntary basis, so that we cannot exclude the possibility that they might have had a particular interest in cycling, thus creating a bias of our results. Likewise, as the field study participants were working in the same company, they could communicate across treatment conditions and it is unclear if and how this may have influenced our findings. With regard to the measurements, we had to rely on a self-reporting approach for the collection of e-bike usage data. It is hence possible that participants may have incorrectly filled out the surveys. Finally, we chose to operationalize intrinsic motivation as the fun of e-bike riding. While this is in line with previous research (Epstein and Harackiewicz 1992; Reeve and Deci 1996; Tauer and Harackiewicz 2004), alternative, more context-specific approaches (c.f e.g. Guay et al. 2000; von Krogh et al. 2012) could be considered and might yield different results.

Nonetheless, our reseach clearly supports the notion that the utilization of Green IS as a high-scale and low-cost means of promoting sustainable travel behaviors appears promising. Future research should certainly continue to investigate the potential of Green IS and particularly IS-enabled social normative feedback to influence travel mode choice decisions, ideally based on a broader data basis and larger samples. Such research may want to address not only the question of how such motivational feedback should be designed in order to achieve positive effects in the short and long term, but might also explore how IS can contribute to an automation of behavioral feedback programs, e.g. with regard to the data collection that precedes the construction of concrete feedback measures. Also, further research on how an internalization of extrinsic motivation might be achieved appears highly relevant. In addition, an exploration of how habits may be activated as a result of social normative feedback and how this may mitigate the crowding out of intrinsic motivation, should be very valuable. Finally, an investigation of

social effects on external incentives such as social normative feedback measures might yield greatly intersting findings. Aside from the much-discussed group effects on motivation, studies have for instance recently reported that even a minimal social connection to another person or group, i.e. mere belonging, may have an effect on achievement motivation (Babcock and Hartman 2010; Gneezy et al. 2011; Walton et al. 2012).

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