The choice to report cycling crashes in Denmark: the role of attitudes, norms and perceived difficulty.

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Abstract

This study explores the behavioral factors underlying the reporting intentions of cycling accidents. The proposed analytical framework is an adapted version of the Theory of Planned Behavior (TPB), accounting for the linkage between attitudes and the perceived difficulties, in order to understand the barriers impeding cycling accident reporting intentions. The barriers consist of attitudes that accident reporting is useless, preference to allocate time to other activities, concerns about family distress and social image, distrust in the police, and medical consultation aversion. The framework was validated by means of a survey, which yielded 1,512 complete responses from cyclists. The estimated structural equation models revealed: (i) the perceived difficulties are related to reporting intentions, to attitudes that accident reporting is useless, and to the reference to allocate time to other activities; (ii) medical consultation aversion has a higher weight than distrust in the police in demotivating cycling accident reporting intentions; (iii) the latent factors are mainly related to the socio-economic characteristics and the characteristics of the last cycling accident; (iv) information provision regarding the societal benefits of accident reporting is important for increasing the reporting rate.

Introduction

Encouraging people to cycle is one of the main public health challenges of the modern era because it carries both advantages and concerns. The advantages are the physical activity, body structure and weight and preventing heart diseases, while the concerns regard the exposure to traffic pollution and crash risk. Considering that fear of cycling crashes is the most significant disincentive to cycling, investigating the risk factors underlying cycling crashes is fundamental for increasing the appeal of cities and regions to potential cyclists.

National statistics are often used to identify the factors underlying cycling crash occurrence and severity. Such studies can reveal insights regarding the crash location, the presence of cycling facilities, traffic conditions and cyclist characteristics. From the location perspective, intersections (e.g., 1, 2) and roundabouts (e.g., 3, 4) are considered contributing to higher crash rates, while signalized intersections are associated with higher likelihood of severe and fatal injuries to cyclists (5), but in general intersections are linked to reduced injury severity (6). From the infrastructure perspective, the presence of cycling facilities (e.g., 7, 8) is related to an increase in the crash rates of cyclists, although recent evidence contradicts initial findings and proclames bicycle lanes as safer (6, 9). Also, higher numbers of light injuries among cyclists are recorded in proximity of parking facilities and public transport stops (e.g., 10, 11, 12). From the traffic condition perspective, both peak and off-peak hours observe less crashes (e.g., 1, 3), but the severity is lower in peak hours because of the reduced speed differential between fast and slow transport modes and higher in off-peak hours because of high vehicle speeds (e.g., 6, 10, 13). From the individual perspective, cyclists' fragility and intoxication level contribute to more severe consequences among cyclists (6), and type of maneuvers and vehicles involved play a role in the injury severity outcome (6, 14, 15). Yet, national statistics are well-known to suffer from severe under-reporting, particularly for crashes involving cyclists. In order to overcome this limitation the analysis is often limited to bicycle crashes with motorized transport, which are documented to determine fault or an insurance claim, excluding single cyclist falling or colliding against another vulnerable road user or a fixed object, although they can also result in serious injuries (e.g., 6, 16, 17).

The under-reporting of non-fatal casualties, particularly for crashes involving cyclists is well documented (18, 19). Recent studies focus on the magnitude of the phenomenon, namely on estimating the under-reporting rate of cycling crashes in various countries by using the capture-recapture method. In New-Zealand the estimated completeness of cycling crashes in the national statistics is 73.7% (20). In La Réunion in France, only 15.7% of the hospital cycling crash records have a matched police record (19). In León, Nicaragua, only 2.9% of the cycling crashes reported to hospitals were recorded by the police (21). In Rhône County in France, only 20% of the cycling crashes reported in the registry data have a matched police record (18). In Switzerland it has been suggested that while all the fatal cycling accidents are reported, only 25% of the severe bicycle injuries, 15% of the slight injuries and 3% of the very slight cycling injuries are reported (19). In Denmark, 17,500 cyclists seek medical care at hospitals every year. Nevertheless, only 10 % of the cyclist crashes reported to the hospital have been recorded in the official crash data collected by the police (22). The under-reporting rate is even lower for light injuries and solo cyclist crashes (6). An important knowledge gap in the literature regarding under-reporting of traffic crashes in general and bicycle crashes in particular is the very little is known regarding the human factors and the social conditions underlying cyclists' choice to report crashes in which they are involved. Recent studies provide evidence that under-reporting is not randomly distributed across crashes but suffers from selection bias. In France, under-reporting was found to vary by crash severity, location in urban or rural area, road user type, police control area and a third party involvement (18). The reasons stated by people who did not report their crashes suggest that reporting usefulness and police distrust may play a role in under-reporting (18). Nevertheless, the relationship between the choice to report a crash and behavioral factors has never been systematically explored.

This study is the first to explore the factors associated with the intentions to report an accident to the police and/or hospital, with a particular focus on cyclists in Denmark. Understanding the socio-economic background, attitudes, norms and perceived difficulties involved in road users' choice to report cycling crashes can help in designing policy measures and incentives aimed at gaining information about road safety hazards by increasing the overall reporting rates, and reducing the under-reporting bias associated with location, road user type, and crash characteristics, thus eventually leading to better accident and injury analysis and prevention. Moreover, encouraging incident reporting is well in line within the new approach to road safety, consisting of the combination of planning forgiving infrastructure along with encouraging safe, aware, alert, consistent and compliant behavior through enhancing safety culture and the sense of shared responsibility (23, 24). Creating a road-user focused environment, open to feedback including incident reporting and successful and emphatic handling of accident reporting could be important components in such a system. In fact, from the medical literature it has been recently proven that incident reporting is related to improvement in the perception of 11 out of 13 safety culture aspects (25). Incident reporting is hypothesized to create positive safety attitudes and increase alertness, and indeed a positive relationship between higher assessment of safety climate and a higher level of incident reporting has also been found in the maritime transport sector (26). Besides extremely low reporting rate of cycling accidents, particularly in the case of light injuries and solo accidents (6), the focus on accident reporting by cyclists is due to the high number of near-miss incidents experienced regularly by cyclists, around 0.7-0.9 incidents per day cycled (27), and the resulting emotional stress that leads to cycling avoidance (28).

The chosen behavioural framework for the analysis is Ajzen's (29) theory of planned behaviour (TPB), adapted to the research context of under-reporting cycling accidents. Since there is currently no information regarding the underlying reasons for under-reporting of traffic accidents in general and cycling accidents in particular, the proposed framework is based on incident under-reporting from other types of incidents involving personal harm and material damage from other sectors. The proposed framework, is the first of its kind both in the context of traffic accident reporting, and in the general context of incident reporting including work-related accidents, maritime transport incidents, and incidents of intentional harm. We hypothesize that a-priori, cyclists' intentions to report a cycling accident/incident to the police and/or the hospital are related to their attitudes towards reporting usefulness and efficiency in term of time management, the opinions of family and friends shaping the social norms towards reporting, and perceived difficulties including distrust in the police and medical consultation aversion. The data for the analysis was collected via a custom-designed web-based questionnaire and a structural equations models (SEM) was employed for modelling the cyclists' intention to report a cycling accident in the future. These models are particularly useful in accommodating the latent nature attitudinal constructs with the observed nature of travel patterns and socio-economic characteristics.

The paper is structured as follows. The next section presents the behavioral framework and research hypotheses. The following section presents the mathematical modelling approach. Then, the results are presented and discussed, and conclusions are drawn.

Methods
Behavioral framework

The behavioral framework was built upon the TPB (29). We hypothesized that the TPB is use full for describing the underlying mechanisms of reporting intentions due to its established support for incident reporting in other fields, such as sport and health-care. While there is some information regarding the association between accident under-reporting, demographic variables and accident characteristics, there is little or no information regarding the underlying psychological and sociological factors for accident under-reporting. Notably, the problem of under-reporting is not unique to traffic crashes. Rather, it is general also for incidents involving both unintended and intended harm. Severe under-reporting of similar magnitude has been identified also for other incidents involving unintended harm such as work-related accidents (e.g., Probst and Graso, 2013) and sport injuries (e.g., Westman et al., 2010; Fraas et al., 2014). Severe under-reporting has also been documented for incidents involving intended harm, namely crime reporting with or

without seeking medical help (Kääriäinen et al., 2011; Feng et al., 2005; Jones et al., 2009; Leshem et al., 2015). Therefore, to overcome the lack of information about the reasons for under-reporting traffic crashes, we formulated our research hypotheses based on a critical review of incident reporting in critical events that involve harm to people and property damage, thus requiring medical examination and a formal report to the relevant authorities.

The hypothesized framework include attitudes regarding the perceived personal and societal usefulness and time-related efficiency associated with accident reporting, social norms in the form of perceived family distress and social image, as well as the perceived difficulties associated with police distrust and medical consultation aversion form the barriers for cycling accident reporting. The model structure is portrayed in Figure 1. The two structural forms are hypothesized and tested in the current study. The first model form is the traditional TPB configuration (29) in which attitudes, norms and perceived behavioral control are associated independently with reporting intentions, although they are correlated through the error terms, because they belong to the same individual. The second model form is inspired by the type of cognitive dissonance manifested in the technology acceptance model (41). Cognitive dissonance theory people experience the feeling of stress and discomfort when they hold contradicting attitudes and behaviour, and will either change their behavior to match their attitudes or vice versa (42). When behavioral change is difficult, such as in the case of additive behavior and moral choices, the cognitive dissonance mitigation strategy includes changing the attitudes in order to justify the behavior. In the technology acceptance model, attitudes towards the perceived usefulness of a technology are positively motivated by the perceived ease of use, and both are related to usage intentions (41). Accordingly, in this study we hypothesize that the perceived difficulties are not only demotivating factors for accident non-reporting, but they are also the underlying constructs of the attitudes regarding the usefulness and the efficiency of cycling accident reporting, which are formed in order to justify the non-reporting behavior.

Attitudes regarding the usefulness of accident reporting - Anecdotal evidence shows that a possible reason for not reporting an accident is the perception that the report is useless, either because there was no third party involvement, an amicable agreement has been reached or there was no serious injury (18). Hence, it seems that personal gain, for example for insurance purposes, for resolving conflicts and determining fault, plays a role in the decision to report a traffic accident. In addition, the belief that incident reporting is use full for organizational learning, contributing insights and leading to safety improvements is an important motivator for incident reporting in the maritime transport and the health-care sectors (26,30). Accordingly, we hypothesize that perceived lack of personal or societal gains forms a barrier for accident reporting.

Attitudes regarding time-related efficiency of accident reporting - studies regarding incident reporting in the health-care sector and in the maritime transport field report time constraints as major barriers for incident reporting, even incidents with severe consequences, because incident reporting systems are perceived as non-flexible, cumbersome, complex and time consuming to complete (26,30,31,32). Traffic accident reporting is also cumbersome and time consuming, and can take several hours, considering the need to report separately to the police and the health-care system, the access and egress time to the police station and/or the health-care facility, as well as the waiting time at the facility. Additionally, reporting an accident, immediately after it is done may not always be practical or convenient due to pre-scheduled activities. Although the Danish authorities are flexible in terms of the accident reporting time-frame, and allow the accident reporting to occur within a "reasonable" time, the need to report in the case of light or damage only accidents decreases with time. Therefore, we hypothesized that unwillingness to allocate time is a barrier for accident reporting.

Social norms – create a projection of reality that motivate people's action regardless of the factual reality and thus are an important motivator of intentions. The lack of support from family and friends, feelings of guilt and shame, fear of family distress, perceived social image and peer-pressure have been found to be associated with incident under-reporting in various types of incidents including sexual assault, community violence and severe sport injuries (33,34). Fear of disciplinary action and embarrassment are also barriers for incident reporting in the maritime transport sector (26). This is because while social networks can act as

supportive environments, they can also transmit judgement, which translates into stigma and shame (33). Recent studies shows that traffic accident victims, both drivers and passengers, experience self-blame, guilt and family distress (35). Since it is a common convention that human error poor behavior plays a major role in traffic accidents, we hypothesize that fear of family distress and perceived social image are barriers for accident reporting intentions.

Distrust in the police – We hypothesize that police distrust may play a role in accident reporting. Indeed, reporting an accident requires a communication between an individual to the police as an institution with a dual role both as a service provider and an authority, and is thus possibly related to trust issues. Institutional trust was recently found to be related to attitudes regarding the usefulness of e-government services (36). Distrust in the police, interpreted as a psychological state with negative feelings towards an institution, is mentioned in studies involving domestic violence and sexual assault as a severe impeding factor for incident reporting (37). Last, a study conducted in Finland shows that police distrust along with high societal trust is related to low crime reporting rate (38). In this study, police distrust is hypothesized to be related to indicators of perceived general trust in the police, perceived service courtesy and friendliness, perceived competence, reliability and effectiveness.

Medical consultation aversion – the under-reporting of accidents is known to be associated with injury severity (6,18). While in work-related accidents, in particular in hospitals, the perceived self-efficacy, namely the ability to assess the accident severity underlies reporting intentions. Nevertheless, for a reasonable person without prior medical knowledge, seeking medical help is more likely driven by medical help-seeking habits then by self-efficacy in assessing the incident severity. This is in line with findings from the medical literature that intentions to undergo tests for the early detection of serious illnesses are related to health system utilization and health seeking habits, rather than to perceived self-efficacy (39). While serious injuries resulting in severe pain or difficulties to move are easily detected and assessed as requiring medical treatment, in the case of very light injuries, the decision to seek help is hypothesized to relate to medical-care seeking habits. In this study, in line with the medical-help seeking scale (40), indicators are hypothesized to be related to aversion from medical examination, trust in the medical system, habitual medical consultation for various purposes, and perceived self-efficacy in assessing one's health.

The TPB constructs are hypothesized to be related to the individual characteristics cycling habits, exposure to cycling accidents in the last 10 years and previous reporting experience. Individual characteristics include gender, age, education, income, family status, residential location and degree of rurality. Cycling habits are measured by the weekly cycling frequency, the daily cycling distance, cycling experience in years and the main cycling purpose for utilitarian purposes, recreation or both. The details about cycling accident involvement comprise the number of cycling accidents and incidents in the last 10 years, and the details of the most recent accident, namely the approximate date, presence of friends or relatives at the scene, type of road users involved, time of day, location of the accident with respect to the residential location and to the nearest hospital and police station, associated health symptoms, and various reporting options (i.e., police, hospital, own medical doctor, emergency hotline and a pharmacy).
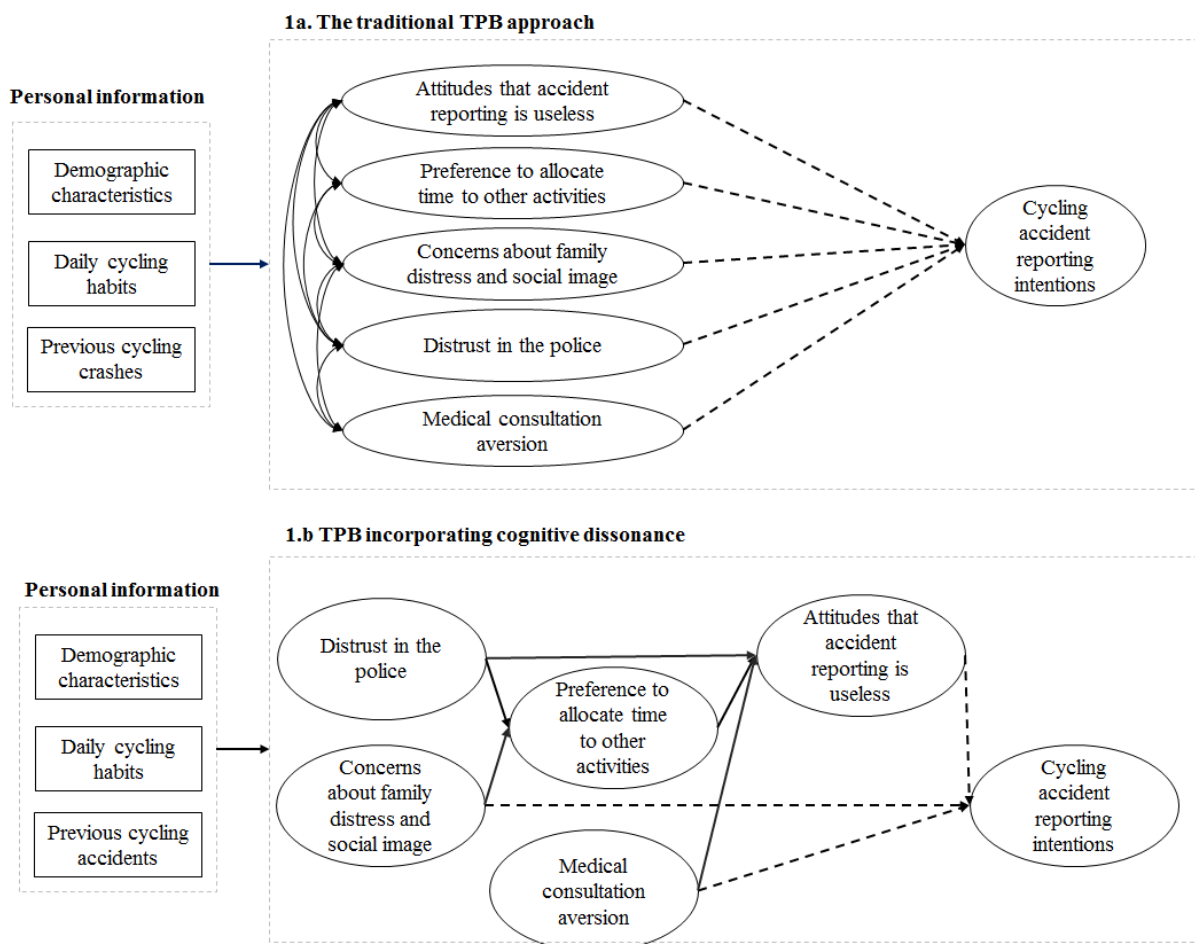
1a. The traditional TPB approach

Personal information

- Demographic characteristics
- Daily cycling habits
- Previous cycling crashes

- Attitudes that accident reporting is useless
- Preference to allocate time to other activities
- Concerns about family distress and social image
- Distrust in the police
- Medical consultation aversion

Cycling accident reporting intentions

1.b TPB incorporating cognitive dissonance

Personal information

- Demographic characteristics
- Daily cycling habits
- Previous cycling accidents

- Distrust in the police
- Concerns about family distress and social image
- Preference to allocate time to other activities
- Attitudes that accident reporting is useless
- Medical consultation aversion

Cycling accident reporting intentions

FIGURE 1: Behavioral framework.

Survey design and administration

The data for the analysis was collected via a custom-designed web-based questionnaire.

Eliciting future accident reporting intentions could result in an ill-defined variable due to the uncertainty involved with future events. Previous studies resolved this problem by asking about general reporting tendencies and past reporting behavior (e.g., Probst and Graso, 2013; Fraas, 2014). The problem with general reporting attitudes is that they are generated based on fuzzy concepts and thus may not be relevant to a particular situation. The problem with using past reporting behavior is that it may not much the current attitudes, social norms and perceived difficulties by the individual. Using a well-specified future accident situation may trigger other problems, such as feeling of discomfort associated with evil-eye beliefs resulting in high non-response rate, lack of relevance of the described situation to a large share of the respondents and inability to generalize the results. To resolve this issue, the survey concerned engaging in a voluntary past-oriented mental time travel exercise to recall the last cycling accident as a reference point anchoring the hypothetical exercise of cycling accident reporting intentions, without triggering the superstitious evil-eye belief. The relevance of past memories for a hypothetical future situation is because hypothetical thinking involves recombining episodic memories into a representation of the future (Berntsen & Bohn, 2010). The importance of recalling the last cycling accident is also related to generating relevant and realistic accident situations as well as representing cycling accident heterogeneity so that the accident reporting intentions can be modelled as a function of the accident characteristics. Therefore, the survey elicited the respondents' last cycling accident in terms of time-of-day, distance from the nearest hospital and nearest police station, distance from the residence, health symptoms experienced, accompanying persons and collision partners. Cycling reporting intentions were asked after the participants had to recall

their last accidents and to state their attitudes, norms and difficulties in order to enhance the clarity and realism associated with the hypothetical situation. The respondents were asked both about the willingness to report a future cycling accident provided that the information is used for improving cycling safety, and provided several alternative reporting methods (i.e., via internet or phone app, and provided that each report resulted in a 10 DKK (1.5 USD) investment in road safety).

The attitudes, subjective norms, and perceived behavioural control that serve as barriers for reporting a cycling accident were measured on a 5-point Likert scale ranging from strongly disagree to strongly agree. Due to the scarce information regarding the underlying factors of incident reporting in general and of traffic accident reporting in particular, the factor items were constructed on the basis on the available literature on incident reporting and a brainstorming process of a small focus group of cyclists including researchers and students.

The elicited cyclists' socio-economic characteristics included age, gender, income, place of residence, and relationship status and having children. The elicited cycling habits included the monthly cycling frequency, the estimated daily cycling distance, cycling experience in years, cycling purpose for utilitarian purposes, pure recreation or both, and cycling accident frequency.

The survey was administered in Danish via three types of large on-line cyclists social networks during September and October 2014. The first type consist of formal social networks for promoting cycling. The used networks are the network of Odense- city of cyclists, and the network of the Danish cyclist federation. The second type consists of academic social networks in several universities including The Technical University of Denmark, University of Copenhagen, Aalborg University, Soenderborg Gymnasium, and Roskilde University, since students form an important part of the cyclist population in Denmark. The third type of social networks include the professional and personal networks of people working in the transport sector and are interested in cycling research: The Danish Road Directorate, the police, Insurance companies, Municipalities, and the Danish Council for Traffic Safety. The survey administration through the third type of social networks was promoted by an official newsletter followed by personal correspondence.

Mathematical model

The hypothesized behavioral model structure was investigated by applying SEM. The model in this study contained three sets of equations: measurement equations (eq. 1), structural equations (eq. 2) linking the latent attitudinal constructs to the cyclists characteristics, cycling habits and previous experience with cycling accident and reporting, , and structural equations (eq. 3) relating the latent attitudinal constructs to cycling accident reporting intentions.

$$(1) \quad I_{rn} = Z_{ln}^{*}\alpha_r + \upsilon_{rn} \quad and \quad \upsilon_n \; \square \; N\left(0, \Sigma_{\upsilon}\right) \quad for \; r = 1,...,R$$

$$(2) \quad Z_{ln}^{*} = \left(SC_{ln} + CH_{ln} + CA_{ln}\right)\beta_l + \omega_{ln} \quad and \quad \omega_n \; \square \; N\left(0, \Sigma_{\omega}\right) \quad for \; l = 1,...,L$$

$$(3) \quad RI_{in}^{*} = Z_{ln}^{*}\beta_z + \xi_{in} \quad and \quad \xi_n \; \square \; N\left(0, \Sigma_{\xi}\right) \quad for \; i = 1,...,I$$

where I_{rn} is the value of an indicator r of the latent construct Z*ln as perceived by cyclist n, Z*ln is the value of latent construct l for cyclist n, SC_{ln} , CH_{ln} , and CA_{ln} respectively are a vector of the cyclists socio-economic characteristics, cycling habits and previous experience with cycling accidents. RI_{in} is a vector of cyclists' accident reporting intentions. Error terms are expressed as elements ω_{ln}, υ_{rn} and ξ_{in} of the vectors following a normal distribution with respective covariance matrix Σω, Συ and Σξ, while parameters to be estimated are αr, βl, βz, and βs. Considering R indicators translates into writing R measurement equations and estimating an (R×1) vector ⬚ of parameters (i.e., one parameter is estimated for each equation), while considering L latent constructs translates into writing L structural equations and estimating an (M×L) matrix of β parameters (i.e., M parameters are estimated for each equation).

The model was estimated with M-Plus. The vector ⊡ of parameters of the measurement equations and the vectors β's of parameters of the structural equations were estimated simultaneously by using Maximum Likelihood with Huber-White covariance adjustment (43). Standard errors were calculated by adopting the White's sandwich-based method that produces robust statistics in the presence of non-normality of the indicators and the categorical variables (44). Alongside the traditional descriptive measure of chi-square test of absolute model fit and the Root Mean Square of Approximation (45).

Results
Sample characteristics

The survey yielded 1,867 questionnaires, of which 1,512 (81%) questionnaires were completed without missing data, and thus served for the data analysis and model estimation. The sample size is much larger than Nunnally's (46) widely applied rule of thumb for SEM analysis, requiring 10 observations for each of the 33 indicators used in this study in setting a lower bound for the sample size adequacy.

The sample demographics suggest reasonable sample heterogeneity and distribution across the variable categories. 48.7%% of the respondents are males. In terms of age, 19.6% are adolescents and young adults (15-20 year olds), 25.6% are in their early twenties, 21.6% are in their late twenties, 8.5% are in their early thirties, and 24.7% are in their late thirties and forties. In terms of family status, 38.9% are single without children, 36.8% are in a relationship without children, 20.3% are in a relationship with children and the remaining 4.0% are single with Children. Most of the respondents have academic education. 51.8% have a university degree, 15.0% have college education, 32.1% attended vocational or upper secondary school, and only 1.1% have elementary school education. Income wise, 47.8% earn a monthly salary of 10,000 DKK or less, 20.3% earn between 10,000-30,000 DKK, 22.4% earn a higher salary and 9.5% preferred not to reveal their income. In terms of their regional distribution across the five regions in Denmark, 48.5% live in the Copenhagen Capital region, 4.6% live in the Capital region outskirts, 22.4% live in the region of Southern Denmark, 21.2% reside in the North Jutland region and 3.3% reside in the Middle of Jutland region.

The cycling habits of the respondents show that they are dedicated cyclists. 90.0% of the respondents have been cycling five years or more. 67.2% of the respondents cycle daily, 15.5% cycle at least twice a week, 5.3% cycle once a week, and only 12.0 cycle in a lesser frequency. The estimated distance per day cycled is 57.1% cycle 10 kilometers or less, 30.8% cycle 11-20 kilometers daily, 8.1% cycle 21-30 kilometers daily and 4.0% cycle longer distances. The majority of the respondents use the bicycle for utilitarian purposes. 49.0% view the bicycle only as a transport mode, while 47.4% use it both as a transport mode and as a sport activity. Only 3.6% use the bicycle exclusively for recreation.

61.6% of the respondents indicated that they were involved in a cycling accident during the last 10 years. For the purpose of this study a cycling accident was defined to the respondents as either falling off the bike on the road or a bike path, running into another cyclist or pedestrian and an accident involving a motorized vehicle. Of the respondents, 33.0% indicated that they were involved in a single incident, 31.0% recalled their involvement in two incidents, 16.6% remembered three incidents, and 19.5% were involved in a higher number of cycling incidents. The respondents were requested to provide information only regarding their most recent cycling accident in in order to reduce respondents' recall bias and burden associated with the survey length. 33.5% had their last cycling accident in the last year, 26.9% had it 1-2 years ago, 24.0% had it 3-5 years ago, and 15.6% had a cycling accident more than 5 years prior to the survey. In 54.7% of the accidents, only the cyclist was involved (solo accident), 24.0% involved a motor vehicle and 24.3% involved another cyclist or a pedestrian. Most accidents occurred in close proximity to the residence. 58.4%

occurred less than 10 minutes cycling from home, and another 27.1% occurred 11-20 minutes cycling from home. Of the reported injuries, 66.1% are limb bruising or abrasions, 18.1% are intense limb pain and swelling, and 5.9% are back and neck pain, and 9.9% include memory loss, missed balance and nausea. Only 38.4% reported their cycling accidents. Of the reported accidents, 14.7% reported to the police, 41.8% reported to the hospital, 30.5% reported to their personal doctor, 7.8% called the emergency hotline and 5.3% went to the pharmacy.

Accident reported intentions

The respondents were asked whether they knew that the data gathered from accident reporting is used for research purposes. Only 21.8% of the respondents answered they knew that the information is used for research purposes. 62.1% answered that they didn't but that it is good to know and another 12.8% indicated that they were unsure but they assumed that it was the case. The remaining 3.3% indicated that they did not know and were not interested in such information. The respondents were also asked whether they would report an accident in the future, provided that the information is used for improving traffic safety. 57.8% indicated that they will report an accident in the future. Of these people, 18.2%, 31.9% and 49.9% indicated that they will report it to the hospital, the police and to both authorities, respectively. The respondents were also asked which incentives would encourage them to report future cycling accidents. 49.3% of the entire sample said that they are willing to report a future accident in the same way it is done now. However, the willingness to report rises significantly with measures that facilitate reporting and conveying the utility in reporting. Most of the respondents would report future accidents if it was mandatory (84.1%), if it would serve for research purposes (93.8%), if they could have done it via a mobile app (72.8%) or via the internet (81.2%), if each report would result in an investment of 10 DKK for cycling infrastructure (66.1%).

Attitudes, subjective norms and perceived behavioral control related to accident reporting were elicited by means of exploratory factor analysis. The items obtained in the survey show good internal consistency (Cronbach's alpha = 0.847) and good sampling adequacy according to Kaiser-Meyer-Olkin (KMO) measure, at both the overall (KMO = 0.864) and the single item level (KMO = 0.768 - 0.924). Exploratory principal axis factor analysis with Varimax orthogonal rotation uncovered the expected five factors: "Attitudes that accident reporting is useless", "Preference to allocate time to other activities", "concerns about family distress and social image", "distrust in the police", and "medical consultation aversion". The factors were incorporated as the measurement equations of the SEM model.

Goodness-of-fit indices indicate that the proposed TPB approach, in which the attitudes are related to the perceived behavioral control, is by far better suited for the data compared to the traditional TPB approach. For the traditional TPB approach the CFI is 0.691, the ratio between chi-square and degrees of freedom is 5.68, the RMSEA is equal to 0.056, the Weighted Root Mean Square Residual (WRMR) is 3.13. For the proposed TPB approach the CFI is 0.849, the ratio between chi-square and degrees of freedom is 3.50 the RMSEA is equal to 0.041, the Weighted Root Mean Square Residual (WRMR) is 2.40. The results are presented only for the model with the best fit. Tables 1 through 3 present the model parameter estimates and their critical ratios (C.R.): measurement equations in Table 1, structural equations linking the TPB constructs to cyclist characteristics in Table 2, structural equations linking the reporting intentions to the TPB constructs in Table 3.

The TPB constructs are mainly related to the respondents' demographics and the characteristics of the last bicycle accident and to a lesser extent to the respondents' cycling habits.

Attitudes that bicycle accident reporting is useless are stronger for respondents who (i) are female, (ii) have children, (iii) reside in the Capital Region of Copenhagen, (iv) are both recreational and utilitarian cyclists have high income. The characteristics of the last accident are related to the attitudes. Respondents who were involved in an accident with another VRU and had symptoms of concussion have stronger attitudes that reporting is useless, while the attitudes are weaker for people who reported their last cycling accident to the authorities, either the police, a hospital or a medical doctor.

The preference to allocate time to other activities instead of reporting the bicycle accident are stronger for males and respondents with high education, and for people that is their last accident had only bruises on their legs. The preference to allocate time to other activities instead of reporting is weaker for people who have children, reside in the Central region of Denmark and estimated their cycling distance to be less than 20 kilometers per cycling day.

The concerns regarding family distress and social image are stronger for males and with a lesser degree of statistical significance also for people who cycle less than 10 kilometers daily. The concerns are stronger for respondents who only had leg bruises in their last accident, and are weaker for respondents who were involved in an accident with a car, and for respondents chose to report their last accident to the authorities, either to the police, the hospital or to their personal doctor.

The distrust in the police is stronger for respondents who are males, have low or medium income, or reside in the Copenhagen Capital region. In terms of cycling habits the distrust is lesser for people who cycle a distance between 20-30 kilometers on a cycling day. With respect to the last cycling accident, the distrust in the police is higher for respondents who have symptoms of concussion, or cannot remember their symptoms.

The medical consultation aversion is stronger for males, respondents who reside in rural areas, for respondents who have low income and for respondents who do not have children. The medical consultation aversion is negatively related to longer cycling experience but only at the 0.10% significance level. The medical consultation aversion is weaker for people who reported their last cycling accident to their personal doctor and with a lesser statistical significance also to the emergency hotline. The medical consultation aversion is stronger for respondents who suffered from concussion in the last cycling accident or can't remember their symptoms and for people who can't remember if they were accompanied.

Table 1 – Measurement Equations

Indicator	Estimate	C.R.
Attitude that cycling accident reporting is useless		
I think that the police can help with determining the party at fault (R)	1.000	999.00
I think it is my civil duty to report (R)	1.467	13.50
I do not think the police usually write report on bicycle accidents	0.972	9.71
I think it will take a long time for the emergency forces to arrive to the scene	1.453	12.34
I think, that the police will not be able to help, because the damage is already done	1.841	13.51
I do not want to disturb the police or the hospital	1.247	10.81
I will not report if I do not think that I am injured	1.718	12.91
Police and the hospital authorities think it is unnecessary to report a bicycle accident	1.433	11.65
Generally, people tend not to report a bicycle accident	2.010	14.13
Preference to allocate time to other activities		
I think my work is more important than reporting a bicycle accident	1.000	999.00
I think my time could be better spent on other things than to report a bicycle accident	1.053	63.34

I do not think it is necessary to report a bicycle accident	0.800	41.94
Concerns about family distress and social image		
People I know who have had a bicycle accident, reported it (R)	1.000	999.00
My family thinks it is a waste of time to report a bicycle accident	1.751	17.83
My friends and colleagues think it is a waste of time to report a bicycle accident	1.681	17.59
My friends will think I'm clumsy, if they knew I had a bicycle accident	0.696	10.45
Distrust in the police		
I will not report because I do not trust the police	1.000	999.00
I think that the police think they are better than everyone else	1.279	34.05
I do not think that police officers are friendly	1.264	34.03
I think that the police are always happy to help (R)	1.251	34.00
I think that the police are good at doing their job (R)	1.307	34.65
I do not think that the police are effective	1.147	32.39
I do not think that the police help when you finally need them	1.138	31.70
Medical consultation aversion		
I do not want to be checked by a doctor	1.000	999.00
I always think that doctors are there to help (R)	0.969	12.26
I have had some bad experiences with doctors	1.202	12.25
I go to the doctor when I need advice. Better once too often than once too little (R)	1.361	12.86
I go to the doctor if I think I need prescription for medication or a vaccine (R)	1.585	13.34
I go to the doctor if I feel very sick(e.g. troubles to get out of bed, severe pain)(R)	1.381	13.09
I never go to the doctor	1.404	12.60
I am generally good at evaluating my own health (R)	0.852	9.91
I am generally do not have time to think about my own health	1.278	12.52
I prefer not to undergo health checks, so they would not find anything	1.334	12.22
I generally use my energy to be in good health (R)	0.733	8.73

Table 2 – Structural Equations Explaining the TPB Constructs

Attitudes that cycling accident reporting is useless			Preference to allocate time to other activities		
Variable	Est.	C.R.	Variable	Est.	C.R.
Demographics:			**Demographics:**		
Male	-0.081	-4.25	Male	0.128	2.61
Has children	0.098	4.10	Has children	-0.247	-3.87
Region of Southern Denmark	-0.050	-1.81	Central Denmark Region	-0.314	-2.07
Central Denmark Region	-0.073	-1.51	High Education	0.234	2.25
North Denmark Region	-0.069	-2.32	Monthly income: 10-30K	-0.129	-1.78
Monthly income: 10-30K	0.052	2.23	**Cycling habits:**		
Monthly income: unknown	-0.122	-3.33	Daily distance :< 11 km	-0.251	-2.15
Cycling habits:			Daily distance: 11-20 km	-0.351	-2.96
Experience: 3-5 years	0.088	1.47	Daily distance: 21-30 km	-0.277	-1.90
The last cycling accident:			**The last cycling accident:**		
3-5 years ago	0.125	1.61	Bruises on the legs	0.133	2.23
VRU involved as other party	0.080	2.54			
Symptoms of concussion	0.099	2.32			
Severe pain in hand/arm	0.053	1.52			
Reported to police	-0.180	-3.88			
Reported to hospital	-0.124	-3.77			
Reported to 1813	0.116	1.55			
Reported to pharmacy	-0.232	-2.85			

Concerns about family distress and social image		
Variable	Est.	C.R.
Demographics:		
Male	0.088	2.88
21-24 years old	-0.062	-1.57
Monthly income: Unknown	0.085	1.41
Cycling habits:		
Daily distance: < 11 km	0.130	1.72
Daily distance: 11-20 km	0.100	1.31
The last cycling accident:		
Accident < 1 year ago	0.362	2.04
Accident 1-2 years ago	0.310	1.74
Accident 3-5 years ago	0.252	1.56
Accident > 5 years ago	0.373	2.05
Car involved as other party	-0.130	-2.57
Bruises on the legs	0.113	2.87
Reported to police	-0.261	-3.08
Reported to hospital	-0.123	-2.12
Reported to personal doctor	-0.143	-2.16

Distrust in the police		
Variable	Est.	C.R.
Demographics:		
Male	0.094	2.55
21-24 years old	-0.074	-1.60
Has children	-0.089	-1.87
Region of Southern Denmark	-0.119	-2.43
Central Denmark Region	-0.190	-1.82
North Denmark Region	-0.170	-3.29
Monthly income < 10K	0.179	3.31
Monthly income 10-30K	0.111	2.04
Monthly income: Unknown	0.306	4.21
Cycling habits:		
Daily distance 21-30 km	-0.241	-2.25
The last cycling accident:		
Accompany: Can't remember	0.389	1.52
Symptoms of concussion	0.227	2.60
Pains in arm/hand	0.102	1.56
Can't remember symptoms	0.276	1.89
Reported to pharmacy	-0.270	-1.65

Medical Consultation aversion		
Variable	Est.	C.R.
Demographics:		
Male	0.112	4.29
Has children	-0.087	-2.53
Residence in rural areas	0.142	2.90
Monthly income: < 10K	0.071	1.86
Monthly income: Unknown	0.215	3.92
Cycling habits:		
Experience:> 5 years	-0.091	-1.72
The last cycling accident:		
Accident 3-5 years ago	-0.246	-2.00
Accident > 5 years ago	-0.187	-1.56
Accompany: Child	0.230	1.58
Accompany: Teen	0.215	1.96
Accompany: Adult	0.170	1.49
Accompany: Alone	0.157	1.38
Accompany: Can't remember	0.282	2.04
Symptoms of concussion	0.148	2.47
Can't remember symptoms	0.162	1.79
Reported to personal doctor	-0.094	-1.86
Reported to 1813	-0.128	-1.31

Table 3 – Structural Equations Explaining Bicycle Accident Reporting Intentions

Variable	Estimate	C.R.
Accident reporting intentions		
Attitudes that cycling accident reporting is useless	-1.000	-6.62
Medical consultation aversion	-0.226	-2.43
Concerns about family distress and social image	-0.458	-4.38
Attitudes that cycling accident reporting is useless		

Distrust in the police	*0.067*	*5.39*
Medical consultation aversion	*0.241*	*7.43*
Preference to allocate time to other activities	*0.328*	*13.79*
Preference to allocate time to other activities		
Distrust in the police	*0.165*	*4.73*
Concerns about family distress and social image	*1.188*	*16.98*

As expected, the intentions to report the next cycling accident are directly and negatively related to the attitudes that cycling accident reporting is useless (attitudes), to concerns about family distress and social image (social norms) and medical consultation aversion (perceived behavioral control). The results confirm the research hypothesis that the attitudes are directly related to the perceived behavioral control. The most important factor are the attitudes that cycling accident reporting is useless, followed by the concerns regarding family distress and social image. The most important factor related to the attitudes that cycling accident reporting is useless is related to the preference to allocate time to other activities. The most important factor in the preference to allocate time to other activities is the concerns about the family distress and social image.

Conclusions

This study proposes a new behavioral framework, based on a non-traditional formulation of the TPB approach, for exploring the behavioral factors motivating the intentions to report cycling accidents. The results stimulate thoughts about policy implications for increasing accident reporting in general and bicycle accident reporting in particular.

Firstly, our research results confirm the hypothesis that not only the reporting intentions but also the attitudes towards cycling accident reporting are directly related to the perceived difficulties to report. Applying the traditional TPB framework, where attitudes and perceived behavioral control are only related in the error terms because they pertain to the same individual, implies that policy measures can be applied for changing people's attitudes towards reporting without resolving the difficulties. Confirming the hypothesis of our newly proposed TPB approach considering the possibility of the existence of a cognitive dissonance, where the attitudes are directly related to the difficulties to report, implies that the difficulties associated with accident reporting need to be resolved in combination or prior to accident reporting awareness campaigns. This result has an implication also on incident reporting in general. In particular, assuming the traditional TPB without testing for the existence of cognitive dissonance can generate suboptimal and biased solutions, leading to ineffective policy solutions.

Secondly, attitudes that accident reporting is useless the most important factor correlated with lack of intentions to report future accidents. The perceived uselessness of accident reporting is in contradiction to the factual usefulness of accident reporting for improving traffic safety. The reason is that the perceived uselessness of reporting is directly related to the subjective norms and perceived difficulties to report, rather on factual knowledge regarding the societal benefits of reporting. From the survey results, the respondents exhibited a general lack of knowledge regarding the societal importance of accident reporting and the use of accident reports for research that can improve traffic safety. Most of the survey respondents were happy to learn about the societal benefits of accident reporting and indicated that they would report their future accidents provided that the report would be used to improve traffic safety. Relating the reporting system to direct monetary incentives for improving cycling safety is also appealing to the respondents. Therefore, campaigns that address the usefulness of accident reporting, and awareness

campaigns to increase road incident reporting, could serve as tool to increase the awareness and knowledge regarding the factual usefulness of accident reporting, and to generate social norms in favor of accident reporting.

Thirdly, concerns about family distress and social image are the second most important factor influencing both non-reporting intentions and the preference to allocate time to other activities. Policy measures aimed at (i) generating a wider acceptance of the occurrence of accidents, (ii) reducing the embarrassment and guilt associated with such accidents, (iii) emphasizing the importance of allocating time to accident reporting, for example by monetary incentives, are important in order to generate more favorable social norms towards cycling accident reporting. Needless to say that social norms should be addressed both with respect to traffic accidents in general and with respect to cycling accidents in particular.

Last, the perceived difficulties to report to the authorities, mainly medical consultation aversion, and concerns regarding social distress are positively correlated with non-reporting intentions and the preference to allocate time to other activities. Most of the cycling incidents occur close to the residence place, likely discouraging or postponing accident reporting. Two possible courses of action are needed in order to resolve this situation. The first course of action is related to enhancing the speed and privacy of accident reporting and allowing the possibility to report without direct communication with the relevant authorities. The respondents indicated that facilitating the reporting process by providing a mobile app or an internet access would encourage them to report future cycling accidents. The internet and the mobile app enable people to report accidents in real time, in a fast manner, without the need for direct contact with the authorities and without the need to inform the close social circle. The results of this research suggest that such options are valuable not only as time saving instrument but also as means to mitigate the perceived difficulties involving communication with the authorities and the distress associated with social image. The second course of action, is related to enhancing the service quality management of the reporting burocracy. In particular, this study associates under-reporting of cycling accidents with cyclists' internal perceptions and attitudes and difficulties related to the accident reporting beurocracy. As further research, the authors aim at understanding the external stimuli underlying cyclists perceptions of the reporting system as a whole, and in particular the relationship between cyclist perceptions of reporting difficulty and their relation to quality service management of the accident reporting beurocracy. Such a research direction would enable the police and the medical system improve the customer service and experience with respect to accident reporting, especially in the case of light injuries or material damage.

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