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ORIGINAL ARTICLE

Comparing responses from a paper-based survey with a web-based survey in environmental criminology

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Abstract

This article aims to compare the pattern of responses obtained by a web-based and a paper-based survey used to investigate the transit safety of travellers in railway stations in Sweden. This aim is achieved by evaluating whether the response and the completion rates change as the surveys progress, assessing the effect of the survey mode on respondents' answers (after controlling for the surveys' internal consistency and differences in the samples), and the potential impact of the order of alternatives in multiple-choice questions on the responses. To carry out the study, a sample of 500 responses was taken from each population and later compared using a series of statistical tests. Findings indicate that despite the surveys' high internal consistency, the prevalence of victimisation, fear of crime, and precautions detected in the web survey was higher than those found in the paper survey. The web survey shows a major drop just after the initial questions, while the paper survey shows a more stable pattern of responses, but was also affected by a single compulsory question that pushed the completion rate down. Finally, the order of alternatives in multiple-choice questions (fixed or random) did not affect the answers given by the respondents, providing a solid base for safety interventions in transit environments, regardless of survey mode. The article concludes by making suggestions for both research and practice.

Keywords Survey · Questionnaire · Paper survey · Web survey · Internal consistency · Transit safety · Response rate · Self-selection bias

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Introduction

Surveys have for decades been useful research tools in environmental criminology both in urban (e.g. Nourani et al. 2020; Tseloni et al. 2018; Van Dijk and Steinmetz 1983a, b) and rural environments (e.g. Harkness et al. 2022). Yet, there has been limited knowledge about the potential qualities and/or challenges they may present, especially when traditional paper surveys are compared with web-based surveys. Since research methodology in environmental criminology is an evolving field, there is a need to report the results of such comparisons of survey instruments. For instance, whether survey respondents provide similar responses when using different survey formats or when the goal is to identify which method can be less vulnerable to bias. This information can contribute to the ongoing development of best research practices when using surveys, consequently improving the quality of research findings with clear implications for safety interventions and practice.

The rapid advancement of technology in research, in particular the advent of web-based surveys, has significantly changed how people interact with surveys (Evans and Mathur 2005). Traditional surveys may be paper-based or administered face-to-face, while web surveys are conducted online. These differences can affect the validity of responses due to varying modes of interaction (Neuman 2012) and there have been expectations that web surveys could be less demanding and decrease the respondents' perception of the burden of answering the survey, although this has not been confirmed (Haas et al. 2021). To check for the consistency of web-based surveys and traditional surveys, researchers may compare data collected through web-based surveys with data collected through traditional methods (e.g. paper surveys). By doing this, researchers can assess the validity of both methods for capturing real-world phenomena or measuring constructs of interest. It is equally important to assess the internal consistency of the surveys, which tells us how well the items within a survey are related to each other or how consistently respondents reply to questions that are framed slightly differently.

This article aims to compare the pattern of responses obtained by two semi-identical surveys (a web and a paper survey) used to investigate the transit safety of travellers at railway stations in Sweden. To achieve this aim, we first assess the response rates within the surveys, we check whether the response rate changes as the respondents progress through the survey, and if so, how it changes. Then, by observing how the respondents answered in different categories of the survey we explore how the survey mode affects the respondents' answers after we have checked for differences in the sample, and if so, how. It is particularly relevant to assess whether the act of writing the answer on paper makes respondents less willing to finish the survey. Finally, we also investigate whether the order of the alternatives affects respondent answers when comparing two surveys. Here, we compare the order of the paper survey, which is fixed, and the web-based survey which is automatically randomised for each respondent. To carry out the study, a comparable sample of responses was selected from each group of respondents. Two matching sub-samples (of 500 responses each) were created to account for variations in each sample's characteristics that could have an impact on the outcomes.

Surveys in criminological research

The utilisation of surveys is a common research method for collecting data and gathering information from individuals or groups of people (Rossi et al. 1983). They can serve various purposes, but are often designed to gather specific data on a particular topic or research question when the available knowledge of the issue is limited (Forza 2002). Surveys allow researchers to collect information directly from respondents, providing insights into their opinions, attitudes, behaviours, or experiences. Surveys are widely used for decision-making, data collection, and research in various fields, for example, social sciences, market research, and health care (Safdar et al. 2016), to name just a few. In criminology, victimisation surveys have been used for decades to learn about about people's experiences as victims of crime. These surveys offer a source of victimisation data in addition to police-recorded crime statistics (Hough and Maxfield 2007). They also offer significant additional data on crime (especially data otherwise not reported to the police, such as data on domestic violence), such as the frequency of which crimes are reported to the police, the fear of crime, and the employment of crime prevention measures and indicators of police trust. In order to address the issue of crimes that are not reported to the police, the first victimisation surveys were conducted in the 1960s (Heiskanen and Laaksonen 2021). During the coming years, victimisation surveys were carried out in almost every western country (Block 1984; Fattah 1981; Skogan 1976). The majority of this research used the United States' National Crime Survey as a model, where the primary objective was the gathering of information on the amount of crime that took place in different areas according to crime type (Dijk and Steinmetz 1983a, b).

A survey can be carried out in different ways, such as through post, face-to-face where an interviewer asks the questions, via e-mail, telephone calls, on the web, or personally by handing out paper questionnaires. There are also several strategies for reaching the target audience of a web-based survey. These may include reaching out to a random or representative population, extending mail invitations or advertisements, or using crowdsourcing platforms where respondents typically receive compensation for completing the survey. Thus, the survey method and distribution procedure can have an effect on the response rate, respondent answers, turnaround time, costs, sample characteristics, and data quality (Bachmann et al. 1996; Dillman 2011; Fang et al. 2021; Kelfve et al. 2020; Kwak and Radler 2002; Sproull 1986; Yun and Trumbo 2000). In the list below, we explore a range of survey methods, highlighting their respective strengths and weaknesses (Alderman and Salem 2010; Jones et al. 2013; Vaske 2011).

- *Face-to-face surveys* In this method, interviewers directly ask respondents questions. This enables the use of more complex question styles and follow-up questions, while also offering the chance to establish a connection with the participant, which could result in increased response rates. However, it may require a significant amount of time, money, and is at risk of being influenced by interviewer bias. Survey participants might also experience discomfort when talking about sensitive subjects in person.

- *Paper-based surveys* Participants receive questionnaires, which they fill out and return. This method offers flexibility to respondents and versatility as it can be used in various settings without any technical recourses. Nevertheless, the possibility of data entry mistakes exists when answers are inputted or converted into a digital form. It can also be expensive and time-consuming with limited reach.
- *Telephone surveys* These surveys involve interviewing people via telephone. They offer cost-effective and wide-reaching data collection and can be quick to perform as there is no need for travel. Yet, they could face challenges such as low response rates, limited sample representativeness, and potential interviewer effects or non-response bias.
- *Postal questionnaires* Participants receive questionnaires by mail and return them via post. This approach is also affordable and facilitates widespread distribution, while also giving the participant the flexibility to finish the survey at their own pace and convenience. Low response rates, possible delivery problems, and long turnaround times are obstacles because individuals require time to receive, fill out, and send back the survey materials via mail.
- *Web-based surveys* Surveys performed on the web are often cost-effective, as they do not require expenses for printing and postage. Additionally, it is a fast and effective technique that can be implemented easily and streamlines data collection procedures. The disadvantages could be that they miss groups that are not proficient in working with online platforms (e.g. older adults) or for different reasons cannot access the survey (e.g. in remote areas with poor internet access).
- *With active sampling* Researchers approach a random or representative population online to participate in surveys. Active sampling means that specific individuals or groups are selected, ensuring better sample representation (e.g. YouGov). They are also efficient, cost-effective and have a big reach.
- *Through mail invitations or advertisement* The survey is distributed through broad mail invitations or advertising to encourage people to fill it out online (on for example SurveyMonkey or Crowdsignal). This approach ensures high accessibility but could lead to self-selection bias and limited control over sample demographics. This method is assessed in the study.
- *Through crowdsourcing platforms* Crowdsourcing platforms are utilised to recruit respondents who are compensated for completing surveys (e.g. MTurk or Clickworker). This approach allows for inclusion of various participants and is also cost-efficient. The downsides are that the quality of data and the representation of the sample may differ, and concerns regarding the motivation and engagement of participants.

In this study we compare the results from a paper-based survey with a web-based survey through mail invitations or advertisement.

Research on the survey mode and the effect on responses

The literature is split between those who show evidence that web-based surveys could replace traditional paper ones with minor effects on response rates and lower costs (e.g. Hohwü et al. 2013; Kaplowitz et al. 2004) and those who argue that the survey mode can have a notable effect on the responses, sometimes higher, and sometimes lower response rates.

While the *response rate* is the percentage of *valid* responses received for each individual survey question and may fluctuate when respondents choose to skip certain questions and answer subsequent ones, *the completion rate* is the percentage of participants who answered all questions in the survey. Therefore, it may vary (or remain constant), as respondents progress through the survey. Response rates, in particular, are important because they directly affect the estimated prevalence rates on which public policies are based. In criminology, for example, Laaksonen and Heiskanen (2014) published a study in 2014 that explored the differences of using three different survey methods (web, telephone, and face-to-face) to collect information on victimisation and crime-related issues. They show that in comparison with the telephone and face-to-face modes, the web survey method consistently produced higher estimated prevalence rates for fear and property crimes. This shows that when respondents are given access to an online, self-administered platform, they may be more likely to disclose information about victimisation than they would do when using other modes. The authors also found that estimates of the occurrence of violence tend to be lower in telephone interviews. This pattern was associated with a feeling of greater privacy in modes where respondents answer questions independently. This is consistent with prior research and aligns with other studies which also found that most participants generally prefer computerised questionnaires over paper surveys or face-to-face interviews, as they tend to feel more comfortable answering questions about socially sensitive behaviours on a computer (Davis Jr et al. 1992; Davis Jr and Morse 1991; Turner et al. 1998; van den Berg and Cillessen 2013).

Studies in other fields can show different evidence. McCabe et al. (2006) found few significant differences between survey modes: their results suggest that web and mail surveys provide comparable estimates of alcohol use in a non-randomised mixed mode design. Patrick et al. (2022) found that while response rates and substance use estimates were not significantly affected, the mode of response was influenced by sociodemographic factors such as race, smoking habits, marital status, and education level. Reported substance use prevalence did not significantly differ according to survey mode after adjusting for sociodemographic characteristics.

Yun and Trumbo (2000) detected that there were a number of potentially important differences in response characteristics in a survey depending on whether it was carried out by post, e-mail, or on a website, but they found that these differences did not greatly influence their analyses. They concluded that the differences detected in the response groups indicate that using multi-mode survey techniques improved the representativeness of the sample without having

any bias on other results. Other studies found that paper surveys have lower non-response rates (when respondents skip or leave certain questions unanswered), but that respondents tend to give longer open-ended responses in web surveys due to ease of typing (Kwak and Radler 2002). Two recent studies show new evidence. Roberts et al. (2022) found that compared to mobile browser respondents, app respondents were less likely to drop out of the study, which indicates that there might be differences even within the modes of answering digital surveys. Haas et al. (2021) found no difference in respondents' perceived response burden between web surveys and paper surveys.

Some of these studies have reported greater response rates in favour of web surveys (Kelfve et al. 2020; McCabe 2004; McCabe et al. 2002; McMaster et al. 2017; Wygant and Lindorf 1999). Web surveys may enable respondents to participate more actively because they can be finished at their convenience and from any location with an internet connection, whereas paper surveys must be physically completed and returned, which can take more time and be less convenient. Other previous studies have identified greater response rates with paper surveys when compared with web surveys (Bason 2000; Kennedy et al. 2000; Kwak and Radler 2002; Messer and Dillman 2011; Shih and Xitao 2008). For example, Fang et al. (2021) compared a web-based survey with a traditional survey questionnaire (face-to-face questioning) in paediatrics to show that the web-based survey had a significantly lower response rate—the web-based survey had an effective rate of 70%, while the completeness rate of the traditional questionnaire survey was 86%. However, they also found that the output of the web-based survey was unaffected by the various data sources, which indicates strong internal consistency. Moreover, the response rate of various survey modes may also differ depending on the target group. Kelfve et al. (2020) found that while the web survey method resulted in a higher overall response rate, it revealed that certain demographics, including older individuals, particularly women, those who were not married, had lower levels of education, or were not employed, were less inclined to respond to web-based questionnaires.

Shih and Xitao (2008) performed a meta-analysis on 39 studies that compared response rates from web and mail surveys (paper) and found that 22 of them favoured the paper-based survey, 12 the web-based survey, and 5 that found no significant difference in response rate between the survey modes. We updated the review by adding studies after 2008 (Bason 2000; Fang et al. 2021; Hohwü et al. 2013; Kaplowitz et al. 2004; Kelfve et al. 2020; Kennedy et al. 2000; McCabe 2004; McCabe et al. 2006; McMaster et al. 2017), see Appendix 1 (Table 8) for details. Out of 47 studies that compared response rates between paper and web surveys, a majority (57%) found that the paper-based survey performed better than the web survey (32%). Only 11% found no significant difference between the two survey modes (Fig. 1).

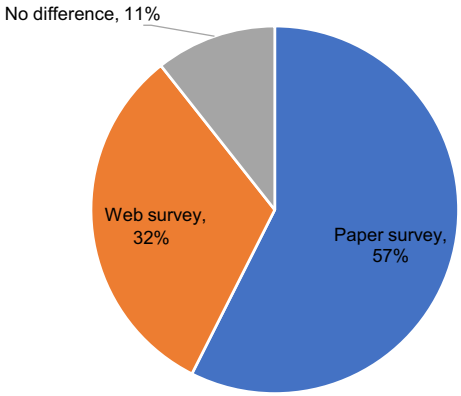

Fig. 1 Survey mode with higher response rate according to previous studies, $n = 47$. Source: Based on Shih and Xitao (2008) updated by authors

Impacts of order of alternatives on survey questions

The order of alternatives in multiple-choice questions is a well-known factor affecting how the respondents answer (Ferber 1952; Marks et al. 2016). This phenomenon may cause order bias in surveys and highlights the importance of how choices are presented in surveys. Previous research has discovered that the sequence of alternatives can significantly influence participant responses. Back in the 1950s, a study by Ferber (1952) investigated potential bias in sample surveys caused by the order of questions or alternatives. It examined how the order of occupations in a questionnaire affected respondents' credit ratings using two questionnaire forms (Form A and Form B), finding that respondents who received Form A were stricter in their ratings, assigning fewer "good" and more "poor" ratings compared to those who received Form B.

Another study investigated the effects of the order in which names are listed on peer nomination rosters in sociometric research, and found that peer nomination counts were significantly influenced by the order in which names appeared on the rosters (Marks et al. 2016). Earlier listed names received more nominations for specific sociometric criteria. According to the study, name order significantly affected affective and relational variables, such as friendship and acceptance, and accounted for more than 5% of their variance. Participants were more influenced by name order when there was less agreement among peers regarding the criteria, as shown by the stronger effects of name order for variables with lower internal reliability (Marks et al. 2016). Similarly, another study on peer nominations in middle-school settings found that long lists can introduce bias, with higher-ranked names receiving more nominations (Poulin and Dishion 2008). However, there have been studies that did not find any significant negative name-order effects (alternatives listed earlier receive more selections), contrary to previous research findings (Liu et al. 2024). The authors also suggested that the lack of significant name-order effects in their study does not definitively resolve the issue, particularly for longer rosters.

Research design

Research questions

Using the current strand of research on the area and the responses from our two surveys, we cast light on the following research questions:

(1) How does the response rate change as the survey progresses? And how does the completion rate differ?
(2) Does the survey mode affect the respondents' answers after we have checked for differences in the sample? If so, how?
(3) Does the order of the alternatives affect respondent answers when comparing two surveys (a paper survey that is fixed and an internet survey that is randomised). If so, how?

Data collection

In this study, we have used two survey methods to investigate the transit safety of travellers at railway stations in Sweden. We conducted a web-based survey from May to November 2022, while a traditional questionnaire survey was conducted in May–June 2022. Based on the methods and sources, the participants were divided into the following two groups: (a) web-based survey from a web source, (b) paper questionnaire survey.

The web-based survey was created using a web platform (Crowdsignal in Wordpress). The survey was directed at train travellers living in the municipalities of the study area where the 47 stations were located. It was distributed using email lists, social media, local Facebook groups, and webpages of the municipalities concerned.

In order to promote the survey, posters and cards were set up in a number of stations with a QR-code that could be accessed using a mobile phone directing the person to the web survey (Fig. 2). The researchers also participated in radio programmes promoting the research project and encouraging people to answer the survey. The survey was open from May 2022 to November 2022 following the approval by the Swedish Ethical Review Authority.

The traditional face-to-face survey was conducted by the investigators through face-to-face paper questionnaires at the stations and onboard the trains. Informed consent was obtained orally from the respondents before the investigation. The survey was conducted during May 2022 with a supplementary session in August 2022.

The demographics of the survey sample can vary depending on the type of survey, as demonstrated in earlier studies. Two matching sub-samples were created in order to account for variations in each sample's characteristics that could have an impact on the outcomes. These had a similar structure, and each had 500 responses. They were based on a set of background variables such as gender, sexual orientation, age, country of birth, income, disabilities, and station size. All these variables have demonstrated an impact on factors such as safety perception and victimisation to varying degrees in our analysis. For instance, women consistently reported higher

Fig. 2 Poster used for inviting passengers to answer the survey via the internet

levels of fear and experienced more victimisation, while men generally felt safer. Similar patterns were observed among younger individuals, those with disabilities, as well as those travelling from smaller stations. In Table 1, the sub-samples of each survey type are placed side by side with reference to these variables. There were no significant differences between the samples in these background variables according to chi-square tests.

Table 1 Description of the subsamples from each survey type, $N = 1000$

Variables	Paper $N = 500$ (in %)	Web $N = 500$ (in %)
Gender orientation		
Woman	62	64
Man	35	33
LGTBQI + /Non-binary/Other	3	3
Country of birth		
Swedish-born	88	90
Foreign-born	12	10
Age		
Young (under 30 years)	26	23
Middle-aged (30–59 yrs)	58	63
Old (60 years or more)	16	15
Income		
1–249 KSEK	20	16
250–499 KSEK	49	52
500–749 KSEK	22	23
750 + KSEK	9	8
Disability		
No disability	91	90
Minor disability	8	9
Major disability	1	1
Station size		
Small station	20	21
Medium-sized station	44	46
Large station	36	33

Methods of data comparison

Evaluating change in response rate during the progression of the surveys and their completion rates

For the response rate, the total number of valid responses was recorded for each question in both survey modes. These responses were then compared to the initial count, providing a basis for calculating the percentage change and revealing shifts in participant engagement. Positive changes indicated an increased response rate, while negative changes indicated a decrease in the response rate, suggesting challenges in comprehension or interest. The percentage change in the response rate could then be plotted on a graph for visual comparison. The completion rate was calculated by counting the number of completed surveys divided by the number of survey respondents.

Assessing the impact of the survey mode on respondents' answers

In order to assess whether the survey mode has any influence on the answers of the respondents, different categories of questions were created. We combined the answers within these categories (coded as 1 for a positive response and 0 for a negative response) to create summary scores, or indices, which could then be compared between the two survey types to assess the differences. The following indices were created for comparison in further analysis: Victim of crime, witness to crime, fear of crime, variables affecting safety, safety precautions, and recommendations. These are composite variables that summarise responses to a group of related questions or items. Each index represents a different category related to crime and safety, such as "Victim of crime", "Witness to crime", "Fear of crime", etc. As for example, "Victim of crime" includes victimisation experiences of various crime types listed in the survey (theft, robbery, violence, unlawful threat or hate crime, sexual harassment, and stalking). If the respondent checked a multiple of these boxes in the survey, the "Victim of crime" index would increase. The same procedure was repeated for all categories of questions (indices).

In order to measure how well the questions within the survey were related to each other, the Cronbach's alpha coefficient was calculated. Before creating these indices, the Cronbach's alpha coefficients were measured to ensure internal consistency. The Cronbach's alpha coefficient is used when evaluating a scale or group of related items meant to measure a specific construct or trait. It measures the degree to which the scale's items are correlated with one another, providing an estimate of how well the scale reflects the underlying construct. The Cronbach's alpha coefficient ranges from 0 to 1. The indices were compared using t-tests to explore differences in the responses between the two survey modes. T-tests are used to compare means between two groups to determine if there is a significant difference between them. Moreover, we also used chi-square analysis on variables related to crime and safety, for example, to examine whether there are significant variations in victimisation, fear or safety precautions taken by respondents based on the survey mode.

The effects of randomised alternative order on survey responses

To investigate the impact of the order of alternatives in multiple-choice questions (specifically the paper survey with fixed alternatives and the web-based survey with randomised alternatives), we examined the variation of ranking of answers based on three questions: (1) *Factors affecting safety* "Can you mark which of the following factors affect your safety at the station you normally travel from?" *(*Answers were composed of a set of 16 alternatives); (2) *Safety precautions* "Can you mark which of the following statements about safety/insecurity apply to you when you travel by train during the day or evening?" (Answers were composed of a set of 14 alternatives) and *Recommendations* "Can you mark which of the following could make your train journey safer?" (Answers were composed of a set of 16 alternatives).

In order to make the comparison between the two survey modes, we ranked the alternatives in order of magnitude, from the largest to the smallest, for each respective survey. Each alternative was then assigned a ranking number according to its

Table 2 Ranking of safety precautions from both survey modes

Paper survey (in %)		Paper ranking	Web survey (in %)	Web ranking
I am extra vigilant	60.7	1	88.2	1
I avoid certain people/groups	51.4	2	84.7	2
I place myself where I can be seen	32.5	3	63.0	3
I prefer to travel with someone else	32.1	4	51.0	5
I am in contact with someone on the phone	25.6	5	45.3	6
I seat myself close to another person	24.6	6	43.5	7
I try to look confident	21.0	7	57.8	4
I avoid certain stations	17.9	8	35.2	8
I avoid certain trains or routes	15.9	9	33.9	9
I take a detour to/from the station	11.5	10	33.0	10
I dress a certain way	10.9	11	25.2	12
I avoid wearing jewellery	7.1	12	25.8	11
I avoid carrying a purse	4.8	13	23.9	13
I carry a kind of weapon (e.g. pepper spray)	4.2	14	14.0	14

perceived significance by the participants (Table 2). Then the ranking lists of the two survey modes were compared using Spearman's rank correlation coefficient and Kendall's tau-b (τ_b) correlation coefficient.

Results

Change in response rate during the progression of the surveys and their completion rates

Important indicators of participant engagement and survey effectiveness are response rates and completion rates in surveys. In Fig. 3, the graph shows the change in response rates as both types of surveys were being completed, as well as their respective completion rates and how it affects the further progress of the respondents through the survey.

Starting with the response rate, a significant decline in the number of respondents was observed just after the first part of the web-based survey, with one-third dropping out after the first five questions (travel frequency, travel times, from which station they travel). In contrast, the paper survey saw a slight 8% decline during the same phase. About half of respondents completed the last question of the web-based survey, showing varying levels of participant engagement along the way (the average response rate for all questions was 60%). The response rates in the paper survey exhibit fluctuations, yet they generally remain consistently high, surpassing 90% for most questions (the average response rate for all questions was 93%). However, there is a notable exception in the question concerning the "age of respondents", where there is a significant drop of nearly 35% (see the thick blue line).

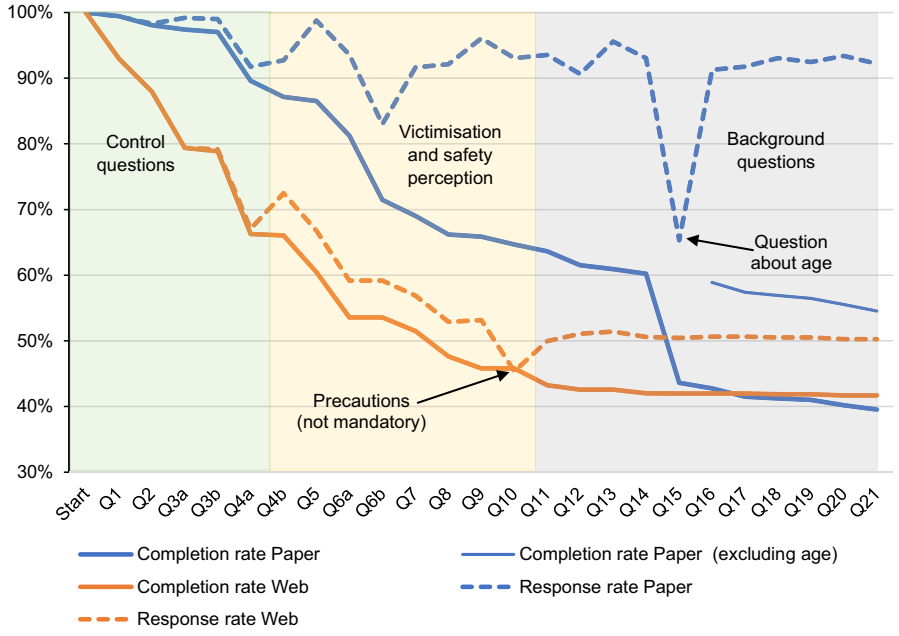

Fig. 3 Response rate for each question and the completion rate: Paper versus web survey

Regarding the completion rates for each of the individual surveys (where every question was answered), we see that the results are very similar for both survey modes. The paper survey reached an overall competition rate of 39%, while the web survey achieved a slightly higher completion rate of 42%. If we exclude this outlier variable (age of respondents), the completion rate of the paper survey increased substantially to 54%, see the thin blue line in Figure 3. Table 3 shows the drop by survey mode from the beginning to the end of the survey, with and without "age of respondents".

Impact of survey mode on respondents' answers

Tables 4 and 5 show the descriptive and reliability statistics of the indices in both surveys. The Cronbach's alpha coefficient is 0.76 which indicates *high internal consistency* among the items in the scale (here represented by the six indices), as

Table 3 Completed responses and percentage change from the initial count in each survey

	Participants at start	Participants at end	Percentage change
Paper survey	2180	862	−60.5
Paper survey excluding "age"	2180	1189	−45.5
Web survey	2713	1131	−58.3

Table 4 Descriptive statistics of the indices in both surveys

	Mean	Std. deviation	*n*
Victimisation	0.40	0.84	1000
Witness	1.00	1.51	1000
Fear of crime	3.11	2.54	1000
Factors affecting safety	4.11	3.11	1000
Precautions	5.65	5.20	1000
Recommendations	5.15	3.50	1000

Table 5 Reliability statistics of the indices

Cronbach's alpha	Cronbach's alpha based on standardised items	*n* of items (Indices)
0.76	0.79	6

Table 6 Comparison of mean responses and t-test results

Questions	Group means		*t*-test	
	Web: $n=500$	Paper: $n=500$	*t*	*p*
Victimisation	0.57	0.22	6.7	<0.001
Witness	1.40	0.59	8.8	<0.001
Fear of crime	4.43	1.84	18.9	<0.001
Factors affecting safety	4.68	3.64	5.3	<0.001
Safety precautions	8.16	3.87	13.9	<0.001
Recommendations	5.72	4.64	4.9	<0.001

indicated by DeVellis and Thorpe (2021). This means that people's responses tend to be consistent with each other regardless of survey modes; in other words, the indices measure the same construct in a similar and reliable way. The results from the comparison of the two surveys are listed below.

We can observe that there are significant differences in the responses between the two survey modes for all the categories of examined questions (Table 6). Respondents in the web survey reported higher levels across all categories of indices compared to the survey group using a paper questionnaire. They had been victimised more, witnessed more crimes, had greater fear of crime, had more factors affecting their safety, took more safety precautions, and requested more improvements in the form of recommendations.

The analysis revealed a significant disparity between the two groups regarding self-reported victimisation experiences. Participants in the web group reported a notably higher level of victimisation, with an average score of 0.57 compared to the paper group's average of 0.22. The *t*-test yielded a statistically significant result ($t=6.7$, $p<0.001$), indicating that the web group experienced higher victimisation

rates. Similar to the victimisation findings, participants in the web group reported significantly higher levels of witnessing incidents compared to the paper group. The web group's mean score was 1.40, while the paper group reported an average of 0.59. The *t*-test again demonstrated a highly significant difference ($t = 8.8$, $p < 0.001$).

The analysis of fear of crime produced one of the most pronounced disparities between the groups. The web group expressed significantly higher levels of fear, with an average score of 4.44, in contrast to the paper group's average of 1.84. This difference was highly statistically significant ($t = 18.9$, $p < 0.001$), indicating that respondents from the web group were more apprehensive about crime. Participants in the web group also reported higher scores on factors affecting safety, with a mean of 4.68 compared to the paper group's mean of 3.64. The *t*-test revealed a statistically significant difference ($t = 5.3$, $p < 0.001$), indicating that the web group perceived more factors affecting their safety.

A substantial difference emerged in responses related to precautions taken. The web group reported significantly higher precautionary measures, with a mean score of 8.16, whereas the paper group had an average of 3.87. Once again, this difference was highly significant ($t = 13.9$, $p < 0.001$), illustrating that respondents in the web group were more inclined to take precautions. Lastly, when it came to making recommendations related to safety and crime prevention, the web group scored higher on average (with a mean of 5.72) compared to the paper group (with a mean of 4.64). The *t*-test showed a statistically significant difference ($t = 4.9$, $p < 0.001$), indicating that the web group had more suggestions or ideas for improving safety.

To explore the differences in respondents' answers more thoroughly, we also conducted Chi-Square tests on 100 variables related to crime and safety. Remarkably, 81 out of these 100 variables showed significant differences. Across all these cases, the percentage were consistently higher for the web-based survey group. This further implies that individuals in the web-based survey group reported higher levels of victimisation and felt more unsafe compared to their counterparts who participated in the paper-based survey. These findings highlight notable distinctions in experiences and perceptions related to crime and safety between the two survey modes. The full list of the variables compared with Chi-Square tests can be found in Appendix 2.

The effects of randomised alternative order on survey responses

Examining the correlation between the rankings of the answers from paper and web survey rankings concerning factors affecting their revealed significant alignment, Spearman's rank correlation coefficient demonstrated a strong positive correlation ($n = 16$, $r = 0.88$, $p < 0.001$), while Kendall's tau_b correlation coefficient indicated a very strong correlation ($n = 16$, $\tau_b = 0.750$, $p < 0.001$).

Analysing how safety precautions were ranked by the paper and web survey groups revealed robust correlations. Both Spearman's rank correlation coefficient ($n = 14$, $r = 0.97$, $p < 0.001$) and Kendall's tau_b correlation coefficient ($n = 14$, $\tau_b = 0.91$, $p < 0.001$) demonstrated a very strong positive correlation. Finally, evaluating the ranking of recommendations from the paper and web survey groups also showed significant correlations. Spearman's rank correlation coefficient ($n = 16$,

Table 7 Correlations between paper and web survey group rankings for three categories

	Spearman's coefficient	p	Kendall's tau_b coefficient	p	*n*
Factors affecting safety	0.88	< 0.001	0.75	< 0.001	16
Safety precautions	0.97	< 0.001	0.91	< 0.001	14
Recommendations	0.77	< 0.001	0.91	< 0.001	16

$r = 0.92$, $p < 0.001$) and Kendall's tau_b correlation coefficient ($n = 16$, $\tau_b = 0.77$, $p < 0.001$) both indicated a very strong positive correlation. The results from all correlation analyses can be found in Table 7. The full ranking lists of the paper and web survey groups respectively can also be found in Appendix 3.

Despite this difference in the presentation of alternatives, answers from the two survey formats were highly correlated. This suggests that survey respondents in both survey groups were able to provide consistent and comparable answers regardless of whether the answer options were presented in a fixed or random order.

Discussion of the results

The results indicate the surveys' high internal consistency, which means that the indices measure the same construct in a similar and reliable way in both surveys. However, the study also reveals significant disparities in responses between web-based and paper-based survey formats across various dimensions related to transit safety in railway stations. In the web survey, respondents reported significantly higher levels of victimisation and fear than in the paper survey. These findings are consistent with prior research that found that participants tend to feel more comfortable answering questions about socially sensitive behaviours, victimisation, or perceptions of fear on a computer-based survey than on paper surveys (Davis Jr et al. 1992; Davis Jr and Morse 1991; Turner et al. 1998; van den Berg and Cillessen 2013). More interestingly, the greatest difference in reporting was found in the question about whether or not respondents take safety precautions, meaning what the respondents do to avoid risks and/or make them feel safer (indicated by alternatives showing respondents' place/time avoidance, their changes in behaviour such as travelling in a group). Respondents were also more openly outspoken about their safety perceptions (fear of crime while at the station or in different transit environments) in the web survey than in the paper version of the survey. The high number of significant differences in crime and safety related questions (81 out of 100 variables) between the survey types further emphasises the impact of the mode on respondents' answers after checking for sample characteristics. Social desirability could bias the answers in the paper-based survey, especially when anonymity is lower (Krumpal 2013). The web-based survey may also be subject to self-selection bias, which occurs when individuals choose whether to participate, leading to a sample that may not represent the broader population (Anderson et al. 2022; Bethlehem 2010; Khazaal et al. 2014). In this case it may be that people who have had particularly negative experiences or who are especially

fearful of train travel are more likely to participate in the survey. This could skew the results, making it seem like fear and victimisation are more prevalent than they actually are among train travellers as a whole.

The web-based survey experienced a notable decline in respondents, particularly in the initial section of the survey, with approximately one-third dropping out after the first five questions, while the face-to-face paper survey showed a more gradual decline during the same part of the survey and then followed a more stable pattern of responses. The paper survey generally maintained high response rates to all questions throughout the survey (93% average response rate), whereas the response rate of the web survey gradually decreased as respondents progressed (60% average response rate). People who are doing the paper questionnaire might feel the need to be polite and quickly finish the survey, possibly skipping some parts. However, online survey takers might tend to give longer, more detailed answers, but may also feel a sense of fatigue or frustration, leading them to suddenly stop participating. This finding goes against the initial idea that the act of writing the answer on paper makes respondents less willing to finish the paper.

The comparable completion rates between paper and web surveys, with only a slight difference (39% for the paper survey and 42% for the web survey), indicate the effectiveness of both survey modes in ensuring participants answered all questions. Notably, the exclusion of the outlier variable (age of respondents) significantly increased the paper survey's completion rate to 54%. This finding underscores the importance of identifying and addressing specific variables that may impact the engagement of participants. It is not certain why the variable 'age of respondents' was avoided by the respondents of the paper survey. One possible explanation is that the mode of asking the question might have had an impact on the response rate. Respondents were invited to write down their age in the paper survey (How old are you?) instead of choosing from possible alternatives among age brackets (Which age group are you?), as it was done in the web survey. Thus, changes in the format in the variable (from open questions to multiple choice questions) seemed to have an impact on the willingness of respondents to answer this question (people are less willing to write down and reveal their exact age than to mark an age group in the multiple-choice question. If the variable 'age of respondents' is excluded from the calculation, the completion rate of the paper survey turns out to be higher than the web survey. Such findings are in line with previous research such as Bason (2000), Shih and Xitao (2008), to name just a few.

Examining the impact of randomised order of alternatives in multiple-choice questions also provided interesting findings. Despite the different ranking (fixed vs. automatic randomised order), the answers from both survey formats were significantly highly correlated, see, for instance, another example from Liu et al. (2024). This suggests that respondents were consistent in their choices, regardless of the order in which the alternatives were presented in the web or face-to-face paper survey. This finding challenges the conventional concern of order bias in survey responses and highlights the adaptability of participants to different question formats. If the ranking order was different, it could make it challenging to compare the results across these survey modes and to decide for instance which interventions one should take to deal with the problems of crime and safety in transit environments.

However, the fact that the ranking order was highly significant for all three questions shows that safety experts and transit operators can single out these suggestions and make them a top priority for interventions.

As any study of this kind, this study is not free of limitations. Despite the fact we were able to select a comparable sample from the two samples, we have not included "frequency of use of railway system" as a criterion of selection, which may have implications. There might be a possibility that drops in the response rate might have occurred, in particular, in the web survey because the respondents do not frequently use the trains and stations. Another limitation is that we did not consider the fact that in one group the respondents were approached during the trip while in the other, they answered the survey in their homes or in some other environment. Thus, it is also possible that respondents who answered the survey on the platform were influenced by the presence of a person who "expects" the respondent to answer the survey. Moreover, although the order of response alternatives did not impact the pattern of responses, it is possible that, for example, posing the questions in another order could have influenced response patterns, which could be tested in future research.

Conclusions

This study sets out to assess the pattern of responses obtained by a web and a paper survey used to investigate the transit safety of travellers at railway stations in Sweden. Using statistical tests of different types, we showed that despite high internal consistency, significant disparities in responses between web-based and paper-based survey formats were found across various dimensions related to transit safety in railway stations. Web-based surveys reveal the fact that respondents were more open about their victimisation, fears, and precautions in comparison with those who answered the paper survey. There were also differences in the response and completion rate between the two survey modes; the paper survey did slightly better in both, but was not free of problems. Changes in the format in one variable (from open questions to multiple choice questions) seemed to have significantly affected responses in the paper survey, but not the order of the alternatives (from fixed to randomised alternatives), which is positive for the reliability and generalisability of the survey results. While the primary implications of this study's results are for researchers, safety practitioners can benefit from evidence regarding improved survey design and greater confidence in these findings. One recommendation is that mixed-mode survey administration, combining different approaches, can compensate for the weaknesses of each method and potentially provide a more solid ground for safety interventions.

Appendix 1

See Table 8.

Table 8 Survey mode with higher response rate according to previous studies (adapted table from Shih and Xitao (2008))

Reference	Higher response rate
Weible and Wallace (1998)	Paper survey
Jones and Pitt (1999)	Paper survey
Wygant and Lindorf (1999)	Web survey
Bason (2000)	Paper survey
Frey (2000)	Paper survey
Kennedy et al. (2000)	Paper survey
Cobanoglu et al. (2001)	Web survey
Klassen and Jacobs (2001)	Paper survey
Pealer et al. (2001)	No difference
Raziano et al. (2001)	Paper survey
Vehovar et al. (2001)	Paper survey
Kwak and Radler (2002)	Paper survey
Manfreda and Vehovar (2002)	Paper survey
McCabe et al. (2002)	Web survey
Miller et al. (2002)	Paper survey
Miller et al. (2002)	Paper survey
Shannon and Bradshaw (2002)	Paper survey
Truell et al. (2002)	No difference
Griffis et al. (2003)	Web survey
Hogarty et al. (2003)	Paper survey
Marshall et al. (2003)	No difference
Mertler (2002)	Paper survey
Sax et al. (2003)	Paper survey
Baxter et al. (2004)	Paper survey
Kaplowitz et al. (2004)	No difference
Laraque et al. (2004)	Paper survey
Leece et al. (2004)	Paper survey
McCabe (2004)	Web survey
Ritter et al. (2004)	Web survey
VanDen Kerkhof et al. (2004)	Paper survey
Bälter et al. (2005)	Paper survey
Im et al. (2005)	Web survey
James et al. (2005)	Paper survey
Khan et al. (2005)	Paper survey
Link and Mokdad (2005)	Paper survey
Northey Jr (2005)	Paper survey
Schillewaert and Meulemeester (2005)	Web survey
Cole (2005)	Web survey
Cole et al. (2006)	Web survey
Deutskens et al. (2006)	Web survey
Deutskens et al. (2006)	Web survey
McCabe et al. (2006)	Web survey
Rodriguez et al. (2006)	Paper survey

Table 8 (continued)

Reference	Higher response rate
Vitale et al. (2006)	Web survey
Hohwü et al. (2013)	No difference
McMaster et al. (2017)	Web survey
Kelfve et al. (2020)	Web survey
Fang et al. (2021)	Paper survey

Appendix 2

See Table 9.

Table 9 Chi-square analysis on safety-related variables in the paper and web-based surveys

Victimisation	Paper $N=500$ (%)	Web $N=500$ (%)	Chi-square	p
Victim to crime (inc. aggressive panhandling)	16.8	36.0	47.43	<0.001
Victim to crime	8.6	19.6	24.98	<0.001
Witness to crime	24.8	35.4	13.35	<0.001
Victim to theft	2.8	7.4	10.93	0.001
Victim to robbery	0.2	2.0	7.45	0.006
Victim to property crime	3.0	8.2	12.79	<0.001
Victim to violence	1.4	2.2	0.91	0.341
Victim to unlawful threat or hate crime	1.4	5.6	13.06	<0.001
Victim to violence or threat	2.0	6.4	12.03	0.001
Victim to sexual harassment	3.2	7.8	10.18	0.001
Victim to stalking	3.4	8.2	10.54	0.001
Victim to sexual crime	5.4	11.8	13.03	<0.001
Victim to aggressive panhandling	9.8	24.2	36.74	<0.001
Victimised on the train	4.8	10.6	11.83	0.001
Victimised in the station	3.6	14.8	37.54	<0.001
Victimised on the path to the station	5.2	16.2	31.66	<0.001
Safety perception	$N=498$	$N=500$		
Fear of crime	14.3	63.2	251.74	<0.001
Fear of crime (train)	6.2	25.4	68.84	<0.001
Fear of crime (station)	9.0	48.2	187.18	<0.001
Fear of crime (path to the station)	9.4	48.8	187.15	<0.001
Fear of theft	7.0	43.6	176.34	<0.001
Fear of robbery	5.4	39.2	164.06	<0.001
Fear of unlawful threat or hate crime	5.2	32.6	121.83	<0.001
Fear of violence	4.6	45.0	217.86	<0.001
Fear of sexual harassment	7.0	30.8	91.84	<0.001
Fear of stalking	6.0	32.2	110.47	<0.001

Table 9 (continued)

Safety perception	$N=498$	$N=500$		
Unsafe on the train (daytime)	1.0	2.4	2.90	0.088
Unsafe in the station (daytime)	1.4	5.4	11.69	0.001
Unsafe on the path to the station (daytime)	1.7	4.4	6.31	0.012
Unsafe on the train (night-time)	3.1	15.7	42.35	<0.001
Unsafe in the station (night-time)	7.3	25.2	53.48	<0.001
Unsafe on the path to the station (night-time)	8.5	24.5	42.67	<0.001
Unsafe on the platform	6.0	27.8	81.78	<0.001
Unsafe on the toilet	12.9	41.3	50.76	<0.001
Unsafe in the waiting room	13.1	41.0	68.92	<0.001
Unsafe in the bus terminal	14.4	43.4	69.62	<0.001
Unsafe in the parking lot	12.6	41.0	71.24	<0.001
Unsafe in the tunnel/overpass	30.4	64.8	98.72	<0.001
Factors affecting safety	$N=490$	$N=496$		
No shelter or weather protection	12.7	10.1	1.62	0.203
Poor illumination	36.1	39.9	1.51	0.219
No or too little staff	42.7	50.2	5.65	0.017
No or few other passengers	29.6	33.1	1.38	0.240
No emergency phone	9.4	13.1	3.41	0.065
Crowded	9.2	8.5	0.16	0.692
Lots of traffic and noise	5.1	4.6	0.12	0.734
Feelings of confinement/lack of overview	13.5	16.3	1.59	0.207
Graffiti/vandalism/litter	17.1	30.0	22.72	<0.001
Poor information (departures, signage, etc.)	16.9	16.1	0.12	0.732
Difficult to buy tickets	8.6	7.3	0.58	0.445
Underground passages or tunnels	29.2	52.0	53.26	<0.001
Poorly guarded (e.g. guards, surveillance cameras)	29.8	53.8	58.50	<0.001
Intoxicated/people under the influence	41.2	58.3	28.64	<0.001
People using or selling drugs	30.6	43.8	18.21	<0.001
Safety precautions	$N=496$	$N=457$		
Take any precaution	76.0	100.0	125.29	<0.001
Take any precaution (night-time)	74.8	99.6	126.28	<0.001
Take any precaution (daytime)	35.9	65.0	80.58	<0.001
Prefer to travel with someone else (daytime)	4.0	12.5	22.82	<0.001
Avoid certain trains or routes (daytime)	1.8	5.0	7.59	0.006
Avoid certain stations (daytime)	2.0	6.6	12.24	<0.001
Avoid certain people/groups of people (daytime)	21.4	44.0	55.69	<0.001
Seat myself where I can be seen (daytime)	8.9	23.6	38.66	<0.001
Seat myself close to another person (daytime)	4.0	9.8	12.65	<0.001
In contact with someone on the phone (daytime)	4.4	7.7	4.39	0.036
Extra vigilant (daytime)	10.1	25.2	37.80	<0.001
Dress a certain way(daytime)	3.6	7.9	8.03	0.005
Avoid carrying a purse (daytime)	2.8	12.0	30.06	<0.001

Table 9 (continued)

Safety precautions	$N=496$	$N=457$		
Avoid wearing handbag (daytime)	1.0	8.3	29.48	< 0.001
Carry some kind of weapon (e.g. pepper spray) (daytime)	1.6	5.5	10.59	0.001
Try to look confident (daytime)	8.5	29.3	68.70	< 0.001
Take a detour on the way to/from the station (daytime)	1.8	4.2	4.58	0.032
Take a detour on the way to/from the station (night-time)	11.1	32.2	63.26	< 0.001
Try to look confident (night-time)	20.2	56.2	132.13	< 0.001
Carry some kind of weapon (e.g. pepper spray) (night-time)	4.0	13.8	28.46	< 0.001
Avoid carrying a purse (night-time)	4.6	23.6	72.38	< 0.001
Avoid wearing jewellery (night-time)	6.5	25.6	66.13	< 0.001
Dress a certain way (night-time)	10.5	24.3	31.97	< 0.001
Extra vigilant (night-time)	60.3	87.5	90.31	< 0.001
In contact with someone on the phone (night-time)	25.2	44.0	37.28	< 0.001
Seat myself close to another person (night-time)	22.8	42.9	43.88	< 0.001
Seat myself where I can be seen (night-time)	31.0	61.3	87.59	< 0.001
Avoid certain people/groups of people (night-time)	51.0	84.0	117.00	< 0.001
Avoid certain stations (night-time)	17.1	34.6	38.07	< 0.001
Avoids certain trains or routes (night-time)	15.3	33.7	43.86	< 0.001
Prefer to travel with someone else (night-time)	31.3	50.5	36.75	< 0.001
Recommendations	494	500		
More staff at the station	49.4	57.2	6.09	0.014
Better maintenance	23.5	37.8	23.95	< 0.001
Better illumination	36.6	49.8	17.53	< 0.001
Digital timetable with real-time information at all stations	22.9	22.2	0.07	0.799
Better information about where trains and buses depart/arrive	20.2	17.6	1.13	0.287
Better information about where and how to buy tickets	7.7	8.4	0.17	0.682
Higher frequency of service	25.1	28.4	1.38	0.240
Fewer changes during the trip	15.4	15.4	0.00	0.995
A single phone number to call for problems	22.9	21.6	0.23	0.629
A “help button” to be able to get help at the station	33.6	31.4	0.55	0.458
A “help button” to be able to get help on the train	34.4	30.2	2.02	0.156
A safety app on the phone report problems	23.1	29.0	4.53	0.033
More police/guards patrolling the station	36.0	62.2	68.08	< 0.001
Train host on board the train	37.0	47.2	10.51	0.001
Surveillance cameras (CCTV) on the train	33.6	51.0	30.80	< 0.001
Surveillance cameras (CCTV) at the station	42.1	62.2	40.22	< 0.001

Appendix 3

See Tables 10, 11 and 12.

Table 10 Ranking of factors affecting people's safety in the paper and web-based survey

Factors affecting safety	Paper ranking	Web ranking	Ranking difference
No or too little staff	1	4	−3
Intoxicated/people under the influence	2	1	1
Poor illumination	3	6	−3
Isolated/desolated	4	8	−4
People using or selling drugs	5	5	0
Poorly guarded (e.g. guards, surveillance cameras)	6	2	4
No or few other passengers	7	7	0
Underground passages or tunnels	8	3	5
Graffiti/vandalism/litter	9	9	0
Poor information (departures, signage, etc.)	10	11	−1
Feelings of confinement/lack of overview	11	10	1
No shelter or weather protection	12	13	−1
No emergency phone	13	12	1
Crowded	14	14	0
Difficult to buy tickets	15	15	0
Lots of traffic and noise	16	16	0

Table 11 Ranking of precautions in the paper and web-based survey

Precautions	Paper ranking	Web ranking	Ranking difference
Extra vigilant	1	1	0
Avoid certain people/groups of people	2	2	0
Seat myself where I can be seen	3	3	0
Prefer to travel with someone else	4	5	−1
In contact with someone on the phone	5	6	−1
Seat myself close to another person	6	7	−1
Try to look confident	7	4	3
Avoid certain stations	8	8	0
Avoid certain trains or routes	9	9	0
Take a detour on the way to/from the station	10	10	0
Dress a certain way	11	12	−1
Avoid wearing jewellery	12	11	1
Avoid carrying a purse	13	13	0
Carry some kind of weapon (e.g. pepper spray)	14	14	0

Table 12 Ranking of recommendations in the paper and web-based survey

Recommendations	Paper ranking	Web Ranking	Ranking difference
More staff at the station	1	3	−2
Surveillance cameras (CCTV) at the station	2	1	1
Train host on board the train	3	6	−3
Better illumination	4	5	−1
More police/guards patrolling the station	5	2	3
A "help button" to be able to get help at the station	6	9	−3
Surveillance cameras (CCTV) on the train	7	4	3
A “help button” to be able to get help on the train	8	8	0
Higher frequency of service	9	11	−2
Better maintenance (cleaning, graffiti removal, broken glass, bush clearing)	10	7	3
A safety app on mobile to report problems	11	10	1
A single phone number to call for problems	12	13	−1
Digital timetable with real-time information at all stations	13	12	1
Better information about where trains and buses depart/arrive	14	14	0
Fewer changes during the trip	15	15	0
Better information about where and how to buy tickets	16	16	0

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