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Passengers' Perceptions of Railway Safety

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Abstract

The aim of the study was to identify the passengers' perceptions of railway safety, with emphasis on the internal safety and potential safety improvements. Train passengers (n=243) in Sweden were surveyed and data were analyzed with descriptive and bi-variate statistics. Results showed that only 40% judged the internal train safety as safe. Closed luggage racks and more space for luggage were the most acceptable changes. Both regarding internal safety and acceptable safety changes there were significant differences between high- and low-frequency travelers, with more seasoned travelers less worried about safety and less excepting of additional safety features and costs. The conclusion was that high-frequency and low-frequency travelers differ in their perceptions of safety and that acceptability of safety features followed the perceived effects on comfort.

Keywords: *accident, crash, injury object, prevention, wounds/injuries*

1. Introduction

The use of rail transport is steadily increasing meanwhile train speeds are escalating. These factors in combination with failing crash avoidance systems (1, 2) result in an increasing frequency of crashes of such severity that they can be classified as disasters (≥ 10 killed and/or ≥ 100 non-fatally injured)(3). As crashes in high speeds increase the risk for injuries and mortality railway safety has become an important contemporary issue.

In Sweden there have been few severe train crashes during the past few decades, but its railway infrastructure is alarmingly worn and overburdened (4, 5), which may be one reason for the increasing number of mishaps reported in the past few years (6-8). In the train crashes in Sweden; in Nosaby, 2004 and in Kimstad, 2010, passengers were injured when they were thrown against various structures, into each other, and when hit by loose furniture and luggage (9, 10). The consequences of the interior design and the prominence of improvements has also been illustrated by others (11-16). Despite these consequences, injury reducing improvements concerning internal carriage design have been minor. Although improvements have been made in train construction and crashworthiness (16-20), developments and implementation of safe interior design lag behind.

Certainly funding to finance safety improvements are constrained in the railway sector (21) as well as elsewhere. In relation to rail transport this entails two major problems: the challenge of improving safety in an already very safe system (22), and, the financial aspects (23) and willingness-to-pay for somewhat increased safety by passengers (21). These issues may be even more compounded when one moves on to internal safety measures, which are designed to limit the amount and severity of injuries if a crash occurs. Railway agencies commonly argument that increased safety measures would risk

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diminishing the perceived safety, reduce comfort and increase cost, all issues which could decrease the number of passengers. It is thus of interest to discern the passengers' viewpoints on railway safety in order to support decision making regarding the prioritization of investments and developments in the sector.

Therefore, the purpose of this pilot study was to explore passengers´ perceptions of railway safety with emphasis on internal safety and thinkable safety measures. The main issues addressed in this paper are: a) perceptions of safety, b) factors affecting safety and, and c) acceptance of safety measure implementation and costs.

2. Materials and Methods

2.1. Sample

A total number of 243 passengers (ages 18-79), at four train routes covering urban and rural areas in Sweden, agreed to answer the survey. Of those asked to participate in the study 119 declined. Criteria for inclusion in the study were that the respondents were at least 18 years of age and capable of independently answering the survey in Swedish. The general response rate was 67% but there were also partial losses to some of the survey questions, which were left unanswered. Of the respondents 55% were female, 44 % male and 1% did not answer the question of sex.

2.2. Data Collection

Data for this pilot study were collected by a purpose-designed survey in Swedish which was distributed by one of the authors, at four train routes covering urban and rural areas in Sweden, between July and August 2015. The design and layout of the survey followed the instructions by Peterson (24) and a consulting statistician. Questions regarding safety measures were based on prior studies of injury objects and possible injury mitigating actions, conducted by the authors (9-12) as well as the work of Ilkjær & Lind (25), Fothergill (13) and Cugnoni *et al.*, (15).

To discern the passengers' assessments of safety they were asked to that extent they thought train travel was safe, what they thought of the internal safety and to what degree they thought the internal safety should be increased. All answers were given on a five point uni-polar scale. Next, the respondents were asked what factors they considered as detrimental for the internal safety, with the possibility to tick several of the responses (loose luggage/ too few spaces for larger luggage/ absence of seatbelts/ standing travelers/ tables/ other…). Then, they were asked to tick which of the above changes were acceptable, if they were willing to pay a higher price and how much extra they would be willing to pay. Responses to willingness to pay was given on a five-point uni-polar scale and how much extra was replied in increased percent of current ticket prices (nothing/ 1-5%/ 6-10%/ 11-15%/ 16-20%/ over 30%). Lastly, the passengers were allowed to provide further comments regarding train safety.

2.3. Variables and Analysis

Extracted data included the objective parameters sex, age and travel habit as well as subjective assessments of safety, factors perceived to decrease internal safety, and what measures would be accepted in terms of effects on comfort and costs.

The respondents answers regarding travel habit were classified as "daily" (11%), "a few times a week" (12%), "a few times each month" (25%), and "more rarely" (51%). One respondent did not answer the travel habit question. Due to the subjectivity in the answers we chose to compare groups with a high difference in travel habit. Thus the two groups of respondents that travelled most frequently were pooled together and denoted as the "high-frequency travelers" (n=65). Those that travelled by train more rarely than a few times each month were denoted as "low-frequency travelers" (n=125). In the results

section the group of average frequency travelers were therefore only presented with general results of travelers, not in the comparisons.

A Chi-square test (23, 24) was used to determine any differences between the high-frequency travelers and the low-frequency travelers. A p-value<0.05 was considered as a significant difference between the groups (α=0.05) and Cramer´s V was used for symmetric measures. Microsoft Excel 2013 and STATA Statistical software release 13 (College Station, TX, USA; StataCorp LP 2013) were used for data preparation, cross tabulation and Chi-Square tests.

2.4 Methodological considerations

Certain important limitations need to be considered. One limitation of the study was that the number of respondents were relatively small. Additionally, the routes were respondents were sought for only included southern Sweden, which implies that the national representativeness is uncertain. Furthermore, the routes were not differentiated in the analysis, thus potential differences between them were not explored.

In terms of the questions in the survey these might on the one hand be considered narrow, as security issues like criminality in relation to train travelling were not included. On the other hand the line of questioning may be considered somewhat leading, in order to ascertain the respondents acceptance of specific safety measures. This pilot study allowed for further improvement of the survey, for the coming large scale study.

3. Results

3.1. Assessment of Safety

The train travelers (n=243) had a general feeling of safety when travelling; 73% (n=177) thought it was very or extremely safe to travel by train. Regarding the train carriages' internal safety only 40% (n=97) of the train travelers thought it was very or extremely safe. A comparison between high- and low-frequency travelers revealed a significant difference, where the inner safety was graded more positively by higher percentages of high-frequency travelers (p<0.05). Train travelers generally thought that the internal safety only needed to be increased to a small (n=81, 33%) or a moderate extent (n=83, 34%).

3.2. Factors Affecting Safety and Comfort

Regarding factors which the travelers thought were detrimental to internal safety 61% (n=149) judged loose luggage and 47% (n=113) thought too few spaces for luggage and trolleys was a problem. Quite a few also judged that standing travelers (n=80, 33%) and absence of seat belts (n=52, 21%) negatively influenced safety. Few considered presence of tables (n=8, 3%) and travelling forward facing (n=11, 5%) as something that jeopardized safety Figure 1.

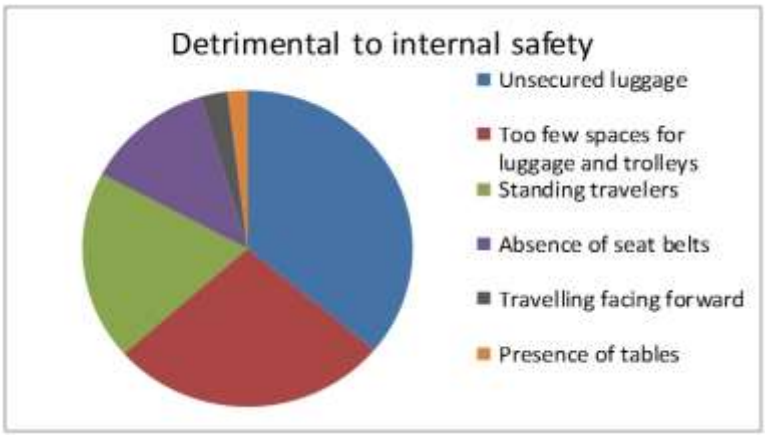

Figure 1. Detrimental to Internal Safety

In terms of significant differences between high- and low- frequency travelers those were only seen connected to loose luggage and seat belts, where these were perceived to be less of a problem by more seasoned travelers. Similarly, a significantly smaller percentage of high-frequency travelers considered closed luggage racks and seat belts as acceptable safety measures ($p<0.05$). Still, closed luggage racks were generally the most acceptable change (n=154, 63%) that could be done in order to increase the internal safety. Bigger, or more, spaces for luggage was also considered an acceptable change by a majority of passengers (n=129, 53%). The smallest percentage of travelers (n=20, 8%) thought travelling backward facing was an acceptable change. A medium percentage of travelers thought fold-down tables at all seats (n=53, 22%), seat belts (n=67, 28%) and seating for all travelers (n=92, 38%) was tolerable (Figure 2). In all cases perceptions of acceptability followed the perceived effects on comfort by implementing the safety measure. Over 70% thought more seats (n=184, 76%), sealable luggage racks (n=152, 73%) and more space dedicated for larger luggage and strollers (n=173, 71%) would be positive or very positive for comfort. Meanwhile the smallest percentage were supportive of introducing seat belts and solely backward facing seating, with 30% (n=73) and 11% (n=27) respectively grading these features as positive or very positive for comfort. Although this was not really a commentary question over 20 responders still noted how rearwards facing seats led them or others to be car-sick.

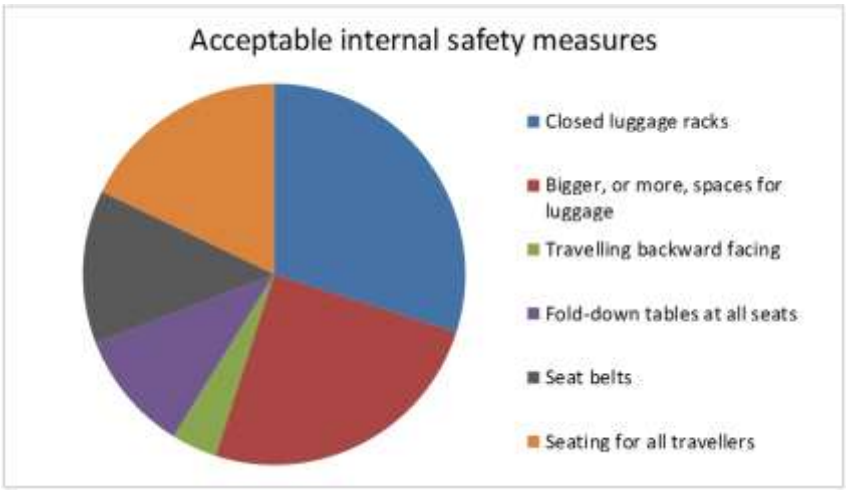

Figure 2. Acceptable Internal Safety Measures

3.3. Safety Implementation Costs

With respect to willingness to pay a higher fare 21% (n=51) of travelers reported not being at all willing and 37% (n=90) not particularly willing to pay an increased fare. Meanwhile 2% were extremely willing and 7% rather willing to pay more for increased safety. A significant difference in willingness could be seen with those who traveled less frequently more willing to pay an increased fare ($p<0.05$). If one compares reported willingness to pay a higher fare with percentage increase per trip for safety improvements approximately one third (32%, n=79) were willing to pay 6% or higher per trip and roughly another third (30%, n=72) were willing to pay a 1-5% increase. Again, low-frequency travelers were significantly more willing to pay a higher fee ($p<0.05$).

3.4. Additional Thoughts on Safety

In the comments section of the questionnaire several additional issues for safety were mentioned such as too few things to hold on to when standing, as well as important aspects for emergencies such as being able to hear the speakers in all of the trains' spaces, better information on escape routes and placement of first aid equipment. Moreover, several aspects for general safety and security were highlighted such as improved rail maintenance, (to lessen the risk of a crash), a need to see ones' luggage (to lessen risk of theft), and need for guards at night to protect passengers and personnel (from threats caused by drunk or intimidating passengers).

4. Discussion

Some of the findings in this pilot study are worthy of further discussion regarding the most acceptable changes to improve interior safety and how those features may be designed. While many of the passengers seemed to think the internal safety left one wanting, fewer thought it needed to be increased. When questioning why this may be the case we saw that several responders appeared to consider the possible trade-offs for making changes. On one hand other improvements for train travelers may be perceived as more pressing, but review of the comments also showed that passengers were concerned for example that increased space for luggage would imply less space for people and that was not desirable. Perceptions of acceptability were also significantly correlated with perceived effects on comfort. Three internal safety issues were deemed as problematic and amending those problems were the most acceptable and beneficial for comfort: luggage compartment design, luggage compartment availability and size, and, seating availability. We will present some design alternatives, in relation to these features, that could be of interest for future investments (but there are likely many different solutions so these will only serve as examples). Some alternatives may also be more applicable for implementation in trains for regional, longer journeys, rather than urban transit.

As many respondents thought loose luggage storage over-head had a negative impact on internal safety, one solution close at hand would be sealable containers with hatches, similar to those used in airplanes, but with a non-lacerative, see-through bottom Figure 3.

Figure 3. Sealable, Transparent Compartments for Hand Luggage

In the comments section of the survey some respondents wrote of the need to see one's luggage. Increasing visibility could decrease the risk of losing one's luggage due to both theft and forgetfulness. Meanwhile closing those spaces would lessen the risk of passengers being hit by loose luggage during bumpy rides and in the event of a crash. In relation to this many passengers also stressed their need to store larger items, which otherwise ended up clogging the aisles, posing risks of hindering evacuation and severely injuring passengers. Larger storage containers with hatches placed on rails that could be pulled up and down may be one alternative Figure 4.

Figure 4 & 5. Storage Compartments for Main Luggage and Example of Additional Seating under which Hand Luggage can be Stored

Even if one could not lock these storage spaces technical solutions like bar scans connected to the users smart phones could be used to notify if the hatch is opened. Seating for all passengers was the third most accepted safety feature. Dependent on the design it could also be adapted to allow for luggage storage underneath and a fold-out table in the back-rest Figure 5, with a collapsible honey-comb structure as suggested by Severson and Parent (28). With regard to seat belts about one in five thought the absence of seatbelts had a negative impact on safety and around slightly more were positive towards adding seat belts. Still those numbers are quite low. Another option to lessen the distance and thus force the passengers can be subjected to in the event of a crash could be to have smaller, see-through compartments instead of long rows of seats.

Moving on to particular interest to follow up in the large scale survey the significant differences shown between high-frequency and low frequency travelers regarding perceptions of safety and acceptable safety measures may be considered the most important. It appeared that safety was not perceived of as an issue for more seasoned travelers, thus the implementation of further safety measures and corresponding costs were not deemed as necessary and acceptable as by low-frequency travelers. These findings are not surprising itself as those who have a history of frequent trips without any incidents are likely to assume that everything will continue in the same manner. As they travel more they are also more affected by a change in pricing and thus less willing to accept implementation of safety features and corresponding costs. Depending on the

proportion of high-frequency to low-frequency travelers at each route this would imply a difference in ease to implement changes dependent on the type of train route and travelers, unless the railway agency is big enough to balance out increased costs on a large system.

5. Conclusions

Safe storage of luggage was perceived by passengers as the most pressing problem and related safety features were the most acceptable. However, high-frequency and low-frequency travelers differed in their perceptions of safety and acceptability of safety features followed the perceived effects on comfort.

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