

# Use of Classic Risk Analysis in Usability Engineering Work with Trams and Elderly

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*In the work with usability for the traffic environment, safety aspects are crucial, especially for the elderly population. This paper presents the use of a classical risk analysis method, Fault Tree Analysis (FTA), when analysing usability aspects in two case studies regarding trams and elderly users. In these studies, the FTA-method was used as an analysis tool for empirical collected data from observations and interviews. The method worked well for formation of data as well as for showing connections and relations between data. To conclude, the use of a classical risk analysis method has shown to give adequate results to usability engineering design.*

## **1 Introduction**

When working with usability engineering in traffic environments, safety aspects are crucial, especially for the elderly population. In the aging processes, the human's physical and perceptive functions get impaired to some extent, for example the visual and audible capacities, the reaction time, and balance. These impairments can lead to a higher degree of exposure to hazards for elderly pedestrians in public transportations.

When working with risk and safety in technical systems, different risk analysis methods are used to analyse hazards and their consequences. These methods also have a possibility to contribute to work with safety aspects within the field of usability engineering.

## **2 Scope**

The scope of this paper is to present the use of a classical risk analysis method, Fault Tree Analysis (FTA), when analysing usability aspects in two case studies regarding trams and elderly users.

## **3 Frame of reference**

### *3.1 Elderly in the traffic environment*

Several physical and mental abilities decrease by age (Hellberg, 2004). For example, the perceptive functions are to some extent reduced, i.e. the skill to take in and interpret information from the surrounding world. Some physical functions, such as visual and audible capacity, reaction time and balance (muscular coordination) are also diminished. These skills play an important role when staying in the traffic environment. However, other abilities are stable or increase to some extent by age, such as knowledge, skill

based behaviour and experience. These abilities can to some degree compensate for deteriorated physical functions.

Older people have in general poorer physical and mental possibilities to avoid external objects or situations in the traffic environment, which can be one part of the circumstances leading to an incident or accident. Though, older people often take measures to decrease the risk to a greater extent than younger people, as a result of awareness and earlier experience. Such measures could be planning their trips in advance, with plenty of time available to reach their final destination without hurry and stress, or avoiding rush hours.

### 3.2 Risk and risk analysis methods

In nearly all situations, there is some kind of hazard involved that can harm people, and injuries often occur due to a sequence (chain) of events. Risk analysis is a methodology for investigation of how a sequence of events can lead to accidents, with judging the risk for occurrence.

Usually, risk is defined as the probability of a hazard leading to harm, in combination with the severity of the harm, when a human is exposed for the hazard (ISO, 2000). A risk is thus consisting of two components; probability and consequence. To reduce the risk in a situation, either the probability for harm or the consequence can be minimized or both.

All work with risk and safety is aimed at avoiding harm to humans, animals, artefacts and the environment. Central to such work is the concept of hazard. Usually hazard is defined as a potential source of harm.

A hazard gives rise to a risk through the harm it can create. The risk itself depends on the characteristics of this harm. The factors usually taken into account are the probability that a hazard will lead to harm and what injury occurs to humans, animals, artefacts or the environment when these are exposed to the hazard.

- Risk is “... *is a measure of the probability and the severity of a negative effect to environment/property, or to health*”(Dhillon, 2003)
- Risk analysis “... *is the utilization of current available information to determine from hazards the risk to individuals or groups, equipment/property or the environment. Usually, risk analysis is composed of a number of steps: scope definition, hazard identification and risk estimation*”.(Dhillon, 2003).

For estimating the risk itself, a common method is Fault Tree Analysis (FTA) (Stricoff, 1996). FTA considers an event that may cause damage (called a top event) and describes what must happen before the event can occur. For example, a car parked on a slope can not begin to roll unless, among other things, both the hand-brake and the gears are released (Figure 1). A fault tree is then created by the use of AND-gates and OR-gates, depending of the causal relation between the events.

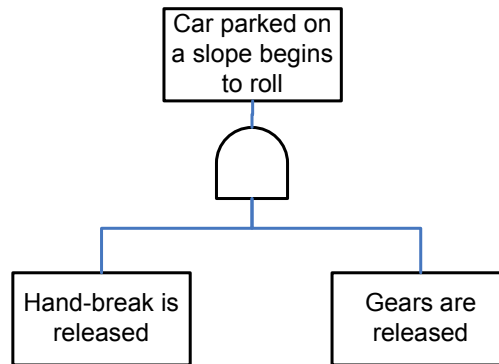


Figure 1, Example of a fault tree with an AND-gate

#### 4 Case study – falls inside trams

In the first case study (Engelbrektsson et al., 2006; Appelfeldt and Nätterlund, 2007), an analysis was made concerning why people lost balance and fall over inside trams, which is a problem that particularly concerns elderly. The FTA-method was applied to organise and structure all the factors that affect a passenger in a tram (Figure 2). The risk analysis showed a sequence of events that need to occur after a person has entered the tram until the person is hurt by falling over. First, the passenger has to be exposed to a disturbance, e.g. movements of the tram; secondly the passenger has to loose balance. Thirdly, the passenger has to start falling and finally get hurt by the impact to obstacles or to the tram floor. If this chain of events is broken at any place, the passenger will not come to any harm. Based on the result from the analysis, it was possible to elicit and evaluate counter measures that could prevent falling accidents inside trams, e.g. placement of the seats. In addition, the FTA-structure made it easier for the developers to understand measures that could prevent an accident early in the event chain. To prevent accidents is especially important for elderly since it increases the level of experienced safety, which is crucial for this group of users in order to get the courage to use public transportations in the first place.

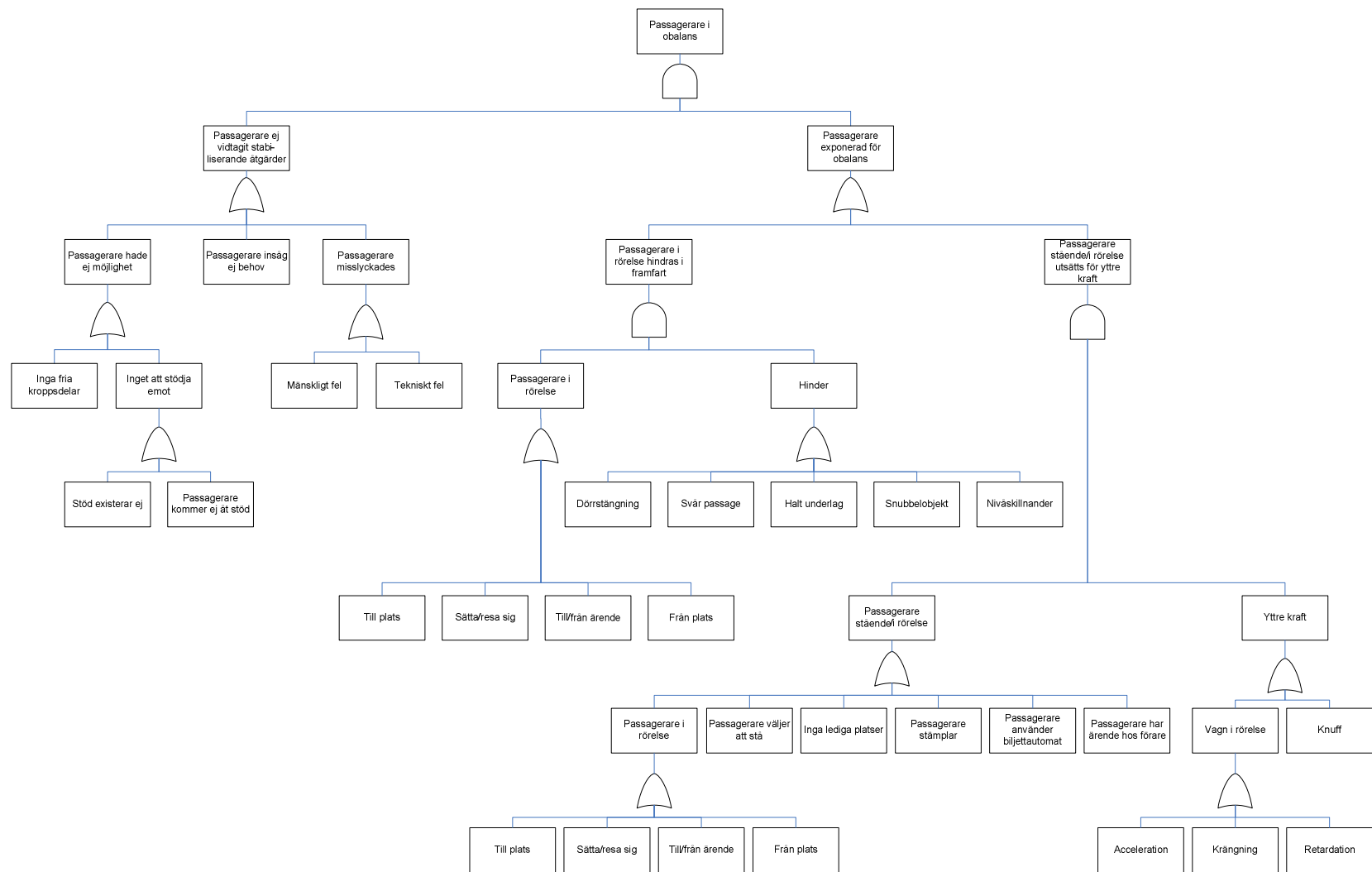


Figure 2, Fault Tree, describing factors that can contribute to falls inside trams (in Swedish)

## 5 Case study – tram crossings

In the second case study (Eriksson et al., 2007), an analysis was made to examine why pedestrians, especially elderly, get into near contact with the tram when passing the tram track at crossings. The FTA-method was used to organise and structure the factors that have an affect of pedestrians' behaviour at tram crossings (Figure 3). The result from the analysis showed that there were three main reasons way contact occurs. Either the pedestrians had not noticed that they had entered a track area, or the pedestrians had noticed that they were on a track area but not observed the incoming tram. Finally, the pedestrians had noticed the tram but miscalculated the situation, e.g. the velocity of the tram. Based on the results, counter measures could be elicited and evaluated, e.g. markings on the ground or warning signs at the tram crossing.

An important factor, to avoid direct contact between the pedestrian and the tram, is the pedestrian's ability to interpret available information correctly. All pedestrians, but especially elderly who already may have reduced cognitive skills, should benefit much if the information around the tram crossings was more than clear and unambiguous. This can be made through call for attention from several senses simultaneously, since physical impairment of one or more sense organs are usual among elderly.

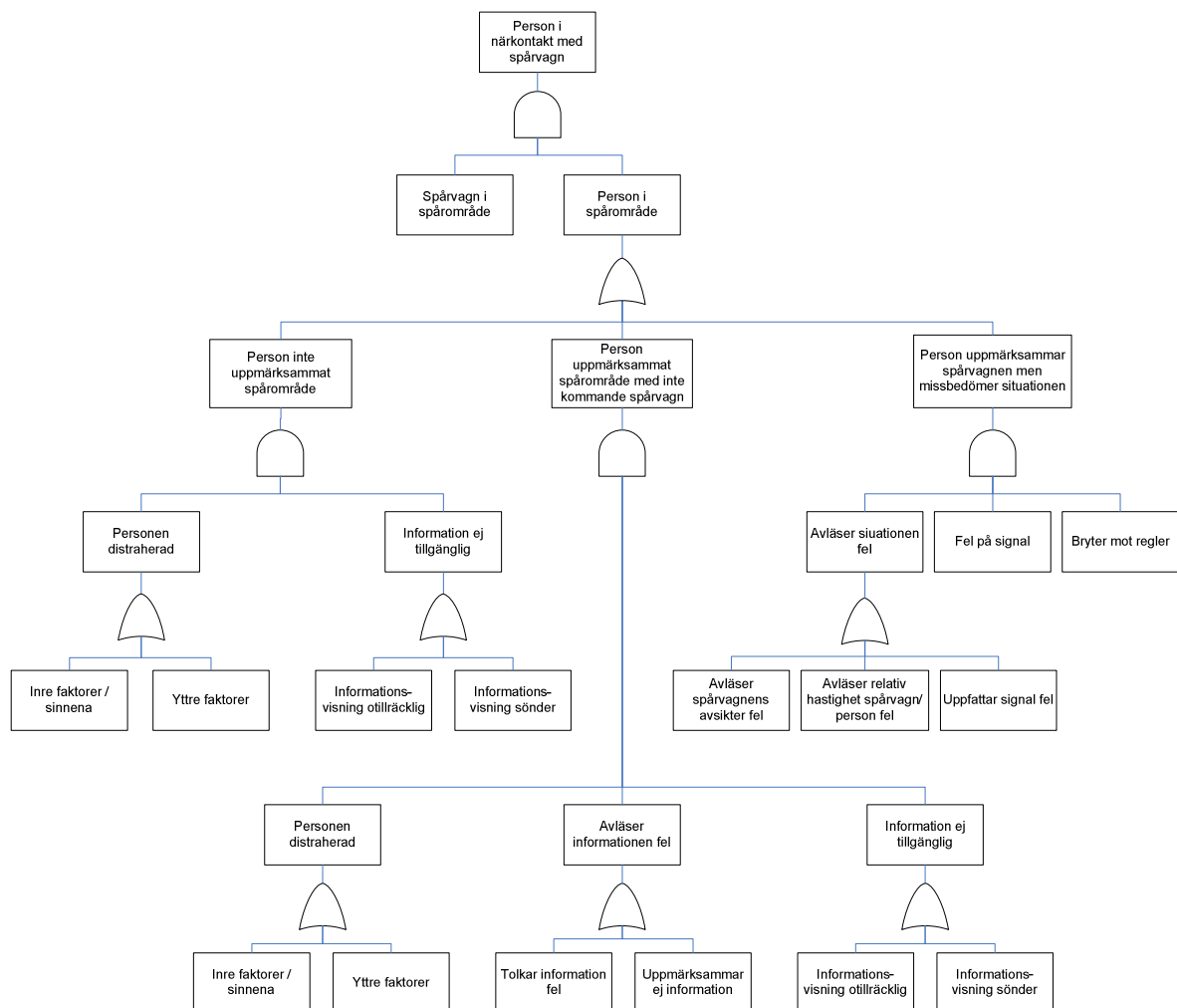


Figure 3, Fault Tree, describing factors that can contribute to accidents at tram crossings (in Swedish)

## 6 Discussion and conclusions

In the two case studies presented in this paper, the FTA-method had served as an analysis tool for empirical collected data from observations and interviews. The method worked well for structuring and illustrating connections and their relations, based on empirical data collection.

There was no difference in the structure of the FTA diagrams for elderly and younger pedestrians respectively. But when the risk should be estimated for the different events, elderly pedestrians were estimated to have higher risks; i.e. both probability and consequences were higher than for younger users.

To conclude, the use of a classical risk analysis method has shown to give adequate results to usability engineering design. As well as it is important to bring in human factors knowledge into classical technical risk analysis, usability engineering can gain benefits from methods from the area of traditional risk analysis.

## 7 References

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