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A fuzzy reasoning system for evaluating the efficiency of cabin baggage screening at airports

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A B S T R A C T

The growing threat of unlawful interference and terrorist acts has led to widespread implementation of screening systems for checking people and baggage at airports. Introducing limits regarding objects permitted to be transported and screening procedures themselves have decreased the comfort of travelling and reduced the capacity of terminals. It is therefore important to examine the efficiency of screening, whether carried out under regular circumstances or in a situation where threat level is high. The purpose of this study is to develop an effective method and calculation tool making it possible to quickly and exactly determine the effectiveness of cabin baggage screening, depending on the equipment available, the choice of screening staff, and the organisational solutions applied. What is more, the human factor is of great significance as far as cabin baggage screening is concerned. It introduces a certain amount of subjectivity, imprecision, and incompleteness of description. Due to this, fuzzy reasoning solutions have been employed. The results indicate that it is possible for the efficiency of cabin baggage screening to vary significantly at various screening checkpoints (SC), even within one airport. It is also demonstrated that it is possible to actually manage the level of screening efficiency, also in a situation where the risk of an attack is greater than usual. One should avoid taking global decisions and, instead, focus on assessing screening at particular SCs and take steps on the basis of the results of such an assessment. Results obtained with the use of a computer tool under the name of COBAFAS demonstrate that it is then possible to improve the efficiency of screening without hindering the capacity of the airport at the same time.

1. Introduction

Cabin baggage (also referred to as hand baggage) screening is one of the basic and most important elements of civil aviation protection against unlawful interference (ICAO, 2010). Whether or not prohibited articles and dangerous articles which could be used for a terrorist attack on board of an aircraft are detected depends on the thoroughness of such screening. In this context, the security of passengers travelling by air depends on the skills of security screening operators (SSO) called simply screeners, their psycho-physical ability, and the level of their training. To ensure that their work remains as effective as possible, SSO undergo continuous training and testing organised by competent authorities who sometimes even simulate threats.

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1.1. Hand baggage screening process

Security screening process is described in detail in European Union regulations and in domestic legal regulations which define certain minimum standards guaranteeing sufficient protection of passengers (European Commission, 2010a). While screening baggage, the security screening operators (SSO) have certain tools for making their work more effective at their disposal. According to the provisions of the law currently in force, hand baggage security screening may be carried out:

– using a roentgen device for scanning baggage,
– by means of manual control,
– using an explosives detection system (EDS),
– using dogs for detecting explosives,
– using devices for detecting trace amounts of explosives (ETD).

In practice, cabin baggage security screening usually comprises two stages:

– screening the interior of baggage using an X-ray device,
– manual inspection – resorted to whenever SSO has doubts as to the contents of the baggage and applied randomly to a certain percentage of bags defined by the law – if the X-ray device is not equipped with a Threat Image Projection system (TIP).

If the screener is not able to determine whether or not a given piece of cabin baggage contains prohibited articles, such baggage is rejected or screening is repeated until it is concluded that security requirements have been met. The list of prohibited articles is quite extensive and by no means exhaustive. In practical terms, this means that SSO has the right to refuse a passenger to transport in his/her bag articles or substances which SSO believes could be used for committing an act of unlawful interference. As far as security screening is concerned, two situations with substantial impact on the safety of aviation operations are possible and we take those into account in this study.

The first situation is when a passenger, oblivious of the regulations in force, attempts to transport statutorily forbidden articles in his or her cabin baggage. If this is the case, articles forbidden to be transported in cabin baggage (provided that they are not forbidden to be transported in checked baggage) can be (MoTCaME, 2012):

– placed in the hold baggage during check-in,
– marked by the aviation carrier as hold baggage and sent to the baggage hold during security screening,
– stored at the airport for a fee in a room especially meant for the purpose, to be received at a later date,
– after the removal thereof from cabin baggage, placed in a special container and destroyed at the expense of the aviation carrier or the airport operator.

The other situation, much less common, constitutes a serious threat to all who are near the security checkpoint – this is when a dangerous article such as a weapon or explosive material is detected. SSO has to act decisively and smoothly remove the threat. A very important part of steps to be taken in such a situation is familiarity with procedures and systematic practice – this makes it possible for all security screening operators to cooperate efficiently in the face of danger. An important part of the entire process is played by the TIP system installed in X-ray devices – it combines the image of the baggage being scanned with a virtual image of forbidden articles. The SSO then has to detect such virtual forbidden articles and press the relevant button. On the one hand, it is a tool for employees work assessment and, on the other hand, it makes it possible for the employee to get familiar with images of prohibited or dangerous articles, more or less cunningly hidden in the baggage, and, consequently, to improve his or her skills and knowledge and the efficiency of tasks performed.

During cabin baggage screening, particular attention should be paid to manual inspection, consisting in searching through the entire contents of baggage in order to make sure that it contains no prohibited articles. It should be performed whenever SSO has doubts as to the contents of baggage. Rule of thumb is that all doubts are decided not in favour of the passenger. If an image of an article which SSO is not able to recognise appears in the image of the screened piece of baggage, SSO has the right to and is obliged to carry out a thorough manual inspection of such piece of baggage. This is not always convenient for the passenger, especially for passengers with low awareness of security, but it is necessary and very important in view of ensuring the security of civil aviation. In this study, we will discuss both manual inspection performed as a result of the above-indicated sequence of events and manual inspection performed at random when the law requires so.

In practice, there have been many instances of people trying to hide articles which could be used for committing an act of unlawful interference in especially prepared concealed compartments of cabin baggage. Consequently, the screening of cabin baggage is one of the most important elements of airport security system. The safety of passengers and the overall evaluation of the security of a given airport depend on its efficiency. In our study, we present a fuzzy model and a fuzzy reasoning system making it possible to assess the efficiency of cabin baggage screening in quantitative terms.

The implementation of an efficient method for assessing the effectiveness of baggage screening performed by the screeners into the daily work will allow for a better management of the civil aviation security. International regulations describe only certain boundary conditions that must be met. However, there are many ways to practically change the control system