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ECONOMIC ASPECTS OF AIRPORT SECURITY SYSTEMS (BEHAVIORAL ANALYSIS)

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Abstract

The article presents different economic aspects of the implementation of non-verbal analysis programs and makes recommendations for their introduction in airport security, it outlines the opportunities for financial investment and the important issues to be taken into consideration. The aim of the research is to outline the importance of behavioral analysis in the field of airport infrastructure. The problematic area of this subject is provoked by the continuous increase of the risks and threats to the airport infrastructure and the necessity of modern and innovative methods to overcome them. In recent years, the non-verbal analyses have become more and more important for the economic, social and political relations, as well as for different aspects of security.

Key words: airport security; security; behavioral analysis; economical

JEL: M14, L20

Introduction

Being exposed to numerous and various threats to its security, the contemporary airport infrastructure needs an invigorate protection and stronger defense mechanisms. The instruments of the behavioral analysis provide an advanced and innovative opportunity for a solution to this problematic challenge. More and more countries have already focused their attention on the programs for observation of individuals aiming at the detection of suspicious behavior. With regards to that, we discuss in our article the importance of the introduction of behavioral analysis programs in the security system of airports, the economic aspects of their implementation and the good practices of the USA and Israel in that field.

Various American and Israeli systems based on the behavioral analysis are presented in the article – Project Hostile Intent, Screening Passengers by Observation Technique, Future Attribute Screening Technology and COGITO including their working mechanisms and elaborating technology. Furthermore,

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the research of the specialists in the field, particularly Albert Mehrabian, Peter Clayton and Paul Ekman, are also introduced.

The importance of the airport security

Airport infrastructure as a location with a concentration of numerous logistical elements and masses of people, as well as their connection to other public and private services is of significant importance to the national security of a particular country. Being part of a transportation system, and through that to the critical infrastructure, requires enhanced protection due to the magnitude of the potential consequences in an event of destruction or malicious attack.

The aviation is one of the largest industries in the world, realizing a significant net value on organized passenger and commodity traffic and the production and development of special technologies in that field. Over the past 10 years, the number of air passengers has almost doubled, reaching its peak of 4.233 billion in 2018 (International Civil Aviation Organization). A similar upward trend is observed in a financial revenue. The peak was reached in 2019 at an amount of $612 billion (Mazareanu, 2020). This trend clearly imposes the need for improved security and safety in the aviation sector and the airport infrastructure.

The safe and unhindered access to aviation services guarantees one of the fundamental human freedoms and rights - that of the free movement of each individual. It was specified in the European Convention of Human Rights (formally the Convention for the Protection of Human Rights and Fundamental Freedoms) and became one of the first fundamental rights and freedoms specific to European Union citizens (European Convention of Human Rights, Protocol 4, Article 2), inscribed in the Maastricht Treaty in 1992 (Maastricht Treaty, Article 3) and later in the Charter of Fundamental Rights of the European Union (Charter of Fundamental Rights of the European Union, Title 5, Article 45).

The airport[1] itself is a complex structure, including different facilities, supply areas, communication and information systems, security systems, coordination and control centers, personnel, documentary databases, service zones, access control systems and video surveillance. Inevitably, thousands of people per day have access to these structures – specialists working in its territory, members of the personnel, passengers, visitors, services and equipment providers, etc.

As a result of insufficient or untimely adequate protection of the airport infrastructure, various aspects would be negatively affected – economic, political, social, as well as public health and safety. Besides the potential number of casualties or injured people and the economic losses the airport and aviation might suffer from the destruction of its infrastructure, social consequences are also critical for the reputation of any given airport system. They may result in a decrease in the public confidence in the aviation, physical suffering and disruption

of the daily life of the population. For this reason, ensuring the security of this element of the critical infrastructure is a priority for the governments, the private and non-government bodies.

Why behavioral analysis?

Body language is an external reflection of an individual's emotional state and is a base for the performance of behavioral analysis[2]. Every single gesture and body movement could be a valuable indicator of a person's emotions at a particular moment.

Albert Mehrabian, a professor of psychology, who became a pioneer in the study of body language in the 1950s, concluded that out of the total impact a message has, about 7 % is verbal (only through words), 38 % is vocal (including intonation, pitch or other sound characteristics) and 55 % is nonverbal. In addition to that, research in that field shows that nonverbal communication has a nearly five-time stronger influence and effect than the verbal one (Пийз, 2014).

The ability of interpretation of elusive and covert gestures might be a crucial factor in ensuring the safety and security of an airport. In order to achieve that, it is necessary for properly and timely performed behavioral analyses to be performed, as well as, profiling techniques implemented.

For airport infrastructure security, it is of significant importance to define "hostile passenger". This would be a passenger who with their behavior presents indications that he or she is a potential threat to the airport's critical infrastructure. In general, those passengers could not only be persons who intend to commit a malicious act and consequently, cause damages, but also individuals who show aggressive behavior towards other people in the airport's territory.

A precise and cautious approach should be applied in order to identify an individual as a "hostile passenger" based on his or her nonverbal communication. The key to the behavioral analyses in this sphere is the ability to outline and realize what a person's emotional state is and more importantly what the circumstances leading to that particular behavior are.

The behavioral indicators of the lie, for example, are usually associated with more constrained body, visibly expressed when the person is sitting and standing, as well as excessive movement of the hands or frequently touching the face. Such signs are even more indicative when they are combined with one another.

When a person lies or tries to hide his true emotions and intentions, the autonomic nervous system activates all possible uncontrollable signals such as trembling of the facial muscles, dilation or contraction of the pupils, averting of the sight, nervousness, blushing, sweating of the palms, etc.

However, when it comes to an airport, the behavioral analysis is not so simple and obvious. Knowing the international etiquette in recognizing the non-verbal

signs on the territory of the airport is crucial for the correct and adequate reading of the body language indicators. For the temperamental French people, for example, gesturing is quite common and should not always be interpreted as a signal of irregularity or danger. Hungarians, on the other hand, are not as friendly in their demeanor as Italians and prefer to keep their private zone out of physical contact. Therefore, they stand at a certain distance from each other, but this is again, not a sign of suspicious behavior. The situation is similar with the Canadians, who are also not keen on excessive gesturing (Клейтън, 2004).

Paul Ekman, psychologist and pioneer in the study of emotions, an analyst of lies and detection of deceptive behavior, conducts numerous experiments and researches in that field. He concluded that the most commonly used devices such as "psychological stress assessor", "voice analyzer", "voice stress analyzer", "psychological stress analyzer", "voice stress monitoring" and others are not very effective because they capture the stress level, not the lie itself.

These types of devices are almost impossible to distinguish the fear of a guilty person of being exposed from the one of an innocent person for not being able to convince the authorities that he or she is blameless. The signs of fear in both the above cases are the same. That is why these devices fail to identify liars who do not experience negative emotions and misleadingly identify as liars people who are simply stressed or upset.

His research and conclusions in that sphere clearly show the disadvantages in the functioning of the existing devices for detecting malicious behavior and the need of introduction of modern and improved tools and mechanisms for the behavioral analyses of suspicious individuals. He developed several technologies to perform this, claiming they are more effective and helpful:

- **Micro-expression recognition simulator**

Micro-expressions are facial expressions with a very short duration of about a quarter to half a second and because of that are extremely difficult to be fully noticed and adequately analyzed. They might appear in an attempt to deliberately conceal feelings and emotions or unconsciously as a defense mechanism. Based on that, Ekman created the ***Micro Expression Training Tool***, which includes modules for comparison of contrasting emotions having positive effect in trainings and improvements in the analysis of nonverbal behavior.

- **Hidden expression recognition simulator**

Hidden expressions are light facial expressions that appear when the emotion is extremely strong, but the person is trying to hide it and because of that only fragments of the whole facial expression appear. Ekman developed a simulator to recognize these hinted expressions in order to improve people's ability to identify the micro-signals - ***The Subtle Expression Training Tool***. According to him, in

analyzing hidden expressions, it is extremely important to first determine what kind of emotion it is and whether it is weak, strong or suppressed.

- **Detection of dangerous behavior**

Ekman conducted numerous experiments demonstrating that there are six basic emotions (anger, disgust, fear, happiness, sadness and surprise) that are universal to all individuals irrespective of gender, ethnicity and culture. He presented a group of police officers from different countries images showing part of those facial emotions. 85 % of the interviewed recognize the expression of the attacker in one of the provided photos, seconds before the aggressive act appears. The result was the same among police officers of different nationalities. That leads to the need of creation of a simulator for recognizing dangerous behavior - ***Dangerous Demeanor Detector*** (Екман, 2011).

The increased attention and research in the field of behavioral analysis has led to the conclusion that non-verbal communication may be the key in identifying suspicious, criminal or hostile behavior. The development of various surveillance programs and systems would facilitate the prevention of crime and aggression acts on the airport's territory. Consequently, this would increase the safety levels of the airport infrastructure and improve the security systems.

In order to identify the impact of behavioral analyses programs and their role in providing airport protection and security, the good practice of the United States and Israel in this area will be presented.

United States actions in applying behavioral analysis programs

Following the terrorist attacks from September 11th, the United States began to develop surveillance and screening programs for passengers to identify suspicious or hostile behavior. The process was initiated with the development of the American project for the detection of hostile behavior ***Project Hostile Intent*** to the Department for Analysis of Human Factors at the Homeland Security. It aims to identify hostile behavior in real time using non-invasive sensors. The goal of the program is to create a prototype technology that would improve today's so-called "screening" monitoring methods and through that to outline which passenger is suspicious.

The project operates on two levels. The first includes patterns of hostile and deceptive behavior, exploring non-verbal and verbal signs. They could be determined by various experiments based on a variety of conducted interviews with individuals or scenarios affecting the screening. The second level needs non-invasive sensors and algorithms that will automatically detect and enter the input indicator in the models of the first level.

According to Larry Willis, program manager of the project, the results are optimistic because this technology has the potential to modernize screening and the process of interviewing passengers, helping border controls and critical infrastructure in general (Homeland security, 2009).

After the 9/11 attacks ***Screening Passengers by Observation Technique – SPOT*** was introduced at Boston airport**,** based on the monitoring of passengers by observation technique. Subsequently, it was introduced in dozens of other airports, as specialists observe the passengers for the appearance of suspicious indicators on a list of 30 signs, each of which has a degree determined by a number. If an individual collects a certain number of points, he became subject of questioning by the security authorities.

According to Paul Ekman who is a consultant on the program, finding the reason for covering the passengers' real emotions was essential for its success. He explains that more than 80 % of people who are interrogated are quickly excluded from the risk list because the reasons for their hidden emotions are usually innocent and banal (for example, tiredness from the working day, anxiety about a delay in the upcoming flight, grief over the loss of a relative or others). If the suspicions still remain, then a specially trained expert in this field would interrogate them. SPOT specialized groups have found more than 100 people trying to smuggle drugs, using false documents or committing crimes different from terrorist attacks.

On the other hand, the program is facing some criticism mainly related to the fact that it could violate human rights, as it may make decisions that are not based on clear criteria but on racial ones. However, the management claims that while the technology is based on human behavior, it does not do racial profiling. (Karp and Meckler, 2006)

Another program, introduced after Project Hostile Intent is ***Future Attribute Screening Technology (FAST)***. Its goal is to improve the ability to promptly and objectively analyze the behavior of individuals and detect dangerous and hostile ones. FAST combines behavioral and psychological sciences, theories for the detection of forensic behavior and sensory technologies.

The system is gender, culture and age neutral and does not use "profiling" techniques, nor does it collect personal data and sensitive information about individuals. Instead, it uses contactless sensors (as opposed to a lie detector) to analyze the psychological and behavioral signs of body language such as body movements that the individual unconsciously makes. The analysis of the collected data and information is performed in real time in order to make a references from the system for conducting an additional screening check.

FAST examines 3 main behavioral indicators - physical signs, non-verbal gestures and paralinguistic symbols, including intonation, timbre, even stuttering

or trembling of the voice. To identify these elements, various sensors have been created:

- Cardiovascular and respiratory sensor to measure heart rate, respiratory rate and the presence of arrhythmia;
- A device for the detection of eye movement using a camera and software to track the position of the sight, including the size of the pupils;
- Cameras for monitoring the changes in facial expression and body movements;
- High-resolution recordings that allow the analysis of captured facial expressions and changes, as well as non-verbal signs in the process of examining the individuals.

Currently, the information used and collected from the individuals is related to demographic data (age, gender, place of residence and ethnicity), medical information and data on the physical condition of individuals (cardiovascular data, visual disturbances, treatment of emotional or mental disorders) and medication or taken caffeine, tobacco, alcohol or other specific substances during the last 7 days.

Demographic data, on one hand, is examined in order to identify whether the technology has discrepancies in results between different demographic groups. Although the program has a neutral status with regard to these data, studies are still being carried out in this direction. Medical information, on the other hand, is used to help analysts assess whether different substances and medications do not affect the test result and mislead it (caffeine and nicotine, for example, can increase the heart rate) (Teufel III, 2008).

It should also be noted that the introduction of FAST minimizes the inconveniences for the examined individuals that occur in current screening practices like fingerprint analysis, inspection of shoes, random checks, etc. The technology provides a discrete and simplified method of checking that allows individuals to be more flexible and move freely during that time.

Israel's COGITO system

The Israeli company Suspect Detection Systems Ltd (SDS) develops and introduces systems for the detection of suspicious behavior and is a leader in counter-terrorism and crime prevention. In the center of the company's programs is Israel's experience in the struggle with suicide bombers.

The company develops and maintains the COGITO system - a technologically designed solution to identify suspicious behavior which is aimed at causing damage. The system could be used to capture an "internal threat" such as the

malicious conduct of an employee of a government body or enterprise, as well as in police interrogations and border checks.

COGITO is a major technological discovery that might assist international aviation and national security in the fight against terrorism, which is evolving increasingly, becoming more complex and dangerous. The COGITO technology is used in airports and border crossing screenings – including detection of terrorists, illegal immigrants, smugglers, as well as conducting secondary screening of suspicious individuals.

The essence of the COGITO technology is in the software ("expert system") that supports the "investigative module" of the program, combining it with the "decision-making" algorithms. The concept of the system is built on several assumptions:

- **Intent vs. Means**

The COGITO concept focuses on identifying malicious or terrorist intentions, not on the means and resources of its execution (e.g. the use of explosives, weapons or special equipment). As the 9/11 attacks and other similar ones show, terrorists do not always possess and use weapons or devices in conducting the attack.

- **Stimulation of psychophysical reactions**

The COGITO method is based on stimulation of the examined individuals with specific provoking indicators related to terrorism, using the "direct contact, interaction and conscious" approach. The system shows that certain words or sentences may influence a terrorist to exhibit psychophysical reactions that are different from those of non-terrorists who are asked the same questions.

The modern methods such as visual identification of signs of nervousness (e.g. sweating, dilated pupils and nervous body language) alone are not enough and can potentially be misleading. The reasons for that are based on the following facts:

– Terrorists could be trained not to show visual excitement or behavioral signs that might attract attention to them;
– Terrorists may have used sedative medicaments which could relax their psycho-physical behavior. Only a precise sensor might identify the usage of such substances by tracking their behavior towards various stimulations;
– There is no scientifically proven evidence that a terrorist would show higher levels of anxiety and tension than a regular passenger. This is caused by the fact that an ordinary passenger may feel tension and show a multitude of signs of nervousness caused by the upcoming flight;

– Every well-trained terrorist would take into account the existence of visual monitoring systems to detect atypical behavioral signs and would control his body language and emotions.

- **Technology for field usage**

The COGITO method is based on the introduced and effectively proven psycho-physical sensors /GSR and BVP/, which are already applied in that field. These sensors are widely spread among most security agencies in the world, the Central Intelligence Agency and the Federal Bureau of Investigation. The flexibility of the method allows the introduction of additional sensors to achieve better efficiency. COGITO is used in 15 countries and assists law enforcement aiming at catching terrorists and preventing potential crimes.

- **Low levels of false alarms**

The system achieves a value of less than 4 % false result. This is because of the COGITO specification - usage of a "guilt test" rather than the standard and popular "control questions".

- **Guilty knowledge test**

This method allows investigators to identify the potential perpetrators of a criminal act. This is achieved by questions on the basis of information that is known only to the true perpetrator, not to the mass audience. This theory is based on the assumption that when an individual is emotionally burdened with a feeling of guilt or fear (known only to him and the investigator), his reaction to a certain stimulation directed at the particular criminal act would be different from that of an innocent person.

- **Algorithm for Signal Analysis Input**

The input of information is collected and analyzed by an expert system based algorithm. The COGITO experts transformed the numerous existing polygraph tests into 4 developed algorithms in order to analyze specifically defined 12 different parameters.

- **Storage data system**

It is designed to manage and control all test positions in a given location, i.e. at one airport. It also serves as a central area that preserves the history of all tests and passenger profiles (Suspect Detection Systems, 2020).

Economic aspects of the implementation of behavioral analysis systems at the airport infrastructure

The airport as a form of a business organization should pay attention to the management of security culture, including the development and maintenance thereof, considering that security-related culture provides the basis of the business organizations' security, protection and achievement of its interests (Poudin, 2018).

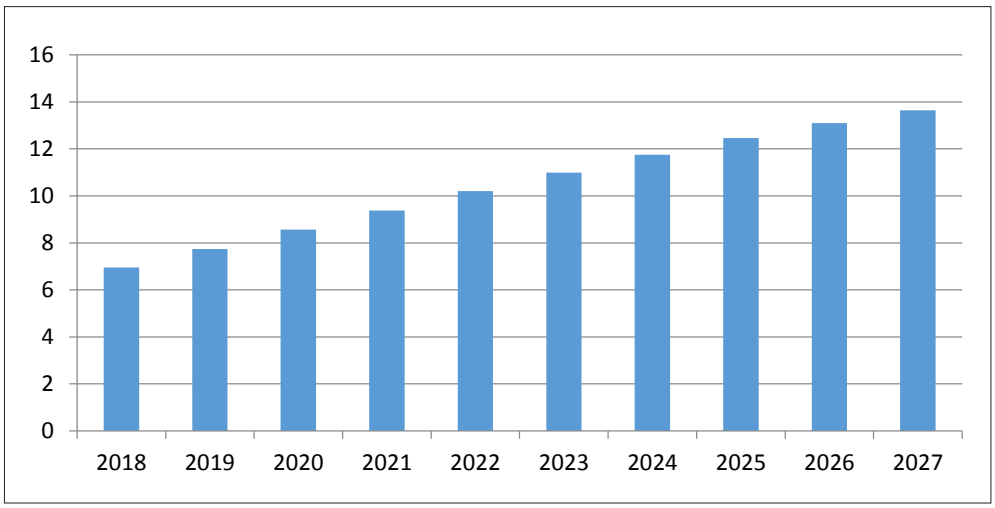
The case when enhanced security measures are taken as a result of a threat or critical situation is not rare. Many examples can be given of terrorist attacks that take place precisely because of a weakness in the security system. A proactive security policy that identifies and analyses potential threats and therefore directs resources to prevent them from occurring would be of significant advantage to the airport security.

Certain economic aspects should be taken into account when it comes to the implementation of such programs. On one hand, there are the number of casualties and financial losses occurring due to a terrorist attack or a criminal act. That would have negative consequences on various aspects and levels concerning the economy of a country. On a micro level the disadvantages could be for the airport at which it occurs, resulting in destroyed infrastructure, financial losses, bad reputation and others. This might also lead to political or economic issues on macro and national level as well.

An example of a negative economic result of such a malicious act is the terrorist attack of September 11th. That event took the life of nearly 3 000 people (Al-Qaeda-terrorist attacks by death roll, 2011) and had an immediate negative effect on the country's economy. The day after the attack the market faced a 7.1 % downsizing. The New York economy itself lost 143 000 jobs in a month and $2.8 billion wages in the first three months. Not surprisingly, air transportation and finance suffered the heaviest loss, which accounted for 60 % of lost job positions (Editors, History.com, 2019).

In the aftermath of the attacks, the U.S government grounded the commercial fleet for three days which led to 31.6 % reduction in the travel volume of September 2001 compared to the same period back in 2000 and that resulted in massive industry losses. There are findings showing that till the end of 2002 the domestic air travel was 12 % lower than it would have been if a terrorist attack never had occurred (Clark, McGibany, Myers, 2009).

On the other hand, the introduction of such a type of behavioral analysis systems might severely reduce those damages but at a significant financial cost. As the following graph shows, there is a trend towards increase in the global security screening market which consists of technologies and programs for monitoring and screening of different public areas and transportation systems, including airports.



Source: Statista

Figure 1: Global Security Screening Market Size from 2018 to 2027

In many cases the service airlines are private which would make it difficult to define a mechanism for determining the source of such significant investment. That is why the involvement of a maximum number of airlines in the funding is recommendable. Increased security would lead to a better safety, resulting in more satisfied passengers and therefore revenues for airlines. Consequently, an investment in security now leads to financial receivables and a better trade and marketing reputation in the future.

Another opportunity for investment would be the governments' participation. As was the case with the United States, the initiative for the implementation of behavioral analysis systems might come from the government's bodies and national security funds. The combination of private and public sector investments for the introduction of such programs is also an option, depending on the political and economic system of the particular country.

Another important financial aspect is the training of the airport's employees in recognition of non-verbal signs and applying behavioral analysis systems. Although the role of integrated surveillance programs is significant, it is essential that security professionals are trained to correctly and timely recognize suspicious behavioral indicators.

The signs that a passenger with deceptive behavior shows, could be keys in preventing the commitment of a crime or terrorist act, as long as they are properly and competently analyzed. In many cases the staff compromises the security unintentionally. Some members of the staff make mistakes which could financially harm the organization due to insufficient experience and poor training

(Poudin, 2019). That leads to the idea that the training of employees engaged with the airport security would reduce the level of threats and improve the safety on its territory. With regards to that, more specialized trainings and additional educational qualifications might be needed. That would require certain financial and time investments which should be set as goals in advance for the future periods.

However, it should be taken into account that the training and preparation of specialists in that field hides its risks. In numerous countries, the so-called "human capital flight" is commonly observed, which is a serious threat for the airport infrastructure in the form of loss of qualified and prepared professionals in behavioral analysis.

Last but not least, the importance of the protection of personal and sensible information is another important issue. Recently, the European Union introduced the General Data Protection Regulation (GDPR) policy which attracts serious attention on the protection of such data.

Failure to comply with the regulative or to make it familiar to the passengers that such personal data is collected for, would have serious social and legal consequences, which might also lead to economic implications. The establishment and implementation of such monitoring systems, especially on the territory of a country which has adopted and implemented such data protection policies, should be very careful and precise.

Conclusion

Behavioral analyses might have an important role in ensuring airport security through passenger non-verbal monitoring programs. They detect potentially dangerous and suspicious individuals and prevent critical situations that damage the security of the airport infrastructure.

Despite the current application of various security programs, the implementation of surveillance systems in airports would play a key role in protecting the security of their infrastructure and would lead to modern improvements in this area.

Although the behavioral analysis is becoming more and more popular nowadays, there is still a serious need of additional research in that field, in order to determine which program would be the most efficient for the purposes of a particular airport and country. An in-depth analysis of the economic aspects of the implementation of behavioral programs should be carried out in order to outline the financial benefits and costs for the establishment of such an integrated security system.

Notes

[1] The notion "airport" is used as a complex term including different facilities, areas, systems and zones on its territory.

[2] The notion "behavioral analysis" is used to explain every kind of analysis performed on the basis of non-verbal or body language signs that indicate individual's feelings, emotions and intensions.

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