3

A Multi-Faceted Assessment of the Applications of Full Body Scanners at Airports

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1. Introduction

Performed research indicates that the number of passengers travelling by air is increasing. Likewise, the percentage of global air cargo is growing. For safeguarding established safety levels, the International Civil Aviation Organization, ICAO, in conjunction with national Civil Aviation Authorities has introduced over the years a number of rules and frameworks that aviation companies and airports need to adhere to. Indeed, it can be argued that although ICAO's main scope is to regulate international air travel, the means and methods implied to achieve safety levels in the aviation sector remains at the corresponding Civil Aviation Authorities and the associated airport management.

An escalating number of violations of security measures over the years have led some airport authorities to impose stricter aviation-specific security techniques, suggesting that current legal, and/or technology-related frameworks ought to be further optimised. In doing so, the quest for establishing higher quality and safety levels in the aviation sector has resulted in the development, marketing and operation of Whole Body Imaging, WBI technologies. Although regarded by airport authorities as a means of either supplementing already existing security checks, or even to replace metal, or/and explosive detectors, initial research indicates that public reaction is split, as it considers issues such as religious beliefs, health-related and ethical issues.

The preliminary study carried out so far indicates–primarily-the application of two different strategies per se. FAA requires the use of Full Body Scanners, FBS, at American airports. Within the European Union however, the use of FBS is not yet regulated, as it awaits the outcomes of an impact assessment review.

This work will acknowledge the current operating legal framework and will elaborate on contemporary implied practices, which will address the areas of quality/benchmarking, safety and security and will consider the time value of money taking into account the acquisition of such scanning machines. A potential sector-wide operation of Full Body Scanners, FBS may equally have an effect on associated flight operations and slot management.

Based on real-life case-studies, this research will address basic operating principles of FBS and will suggest best benchmarking practices within an applied Quality Management environment.

In view of the above, the aim of this study will be to suggest alternative means of checking methods, whilst maintaining set quality levels and enhancing benchmarking tools.

In doing so, this work will address the following objectives:

- to study current Legislation on safety matters in the aviation area
- to perform an in-depth analysis of the operating characteristics of the various types of FBS already in use
- to elaborate on a variety of potential drawbacks resulting thereof
- to develop questionnaires
- to review current quality levels regarding overall airport performance and handling-specific percentages
- to appraise benchmarking tools
- to conduct comparative analyses between airports already using WBI technology and airports that apply traditional means of checking points
- to validate alternative means of passenger checking
- to propose a viable and sustainable alternative

1.1 Initial hypotheses pertaining to safety levels in relation to quality

Initial research carried-out indicates that a wide-spread application of Full Body Scanners, FBS falls short. This may be attributable to the following reasons:

- their effectiveness has not yet been proven. This entails the capability of the scanning machine to effectively detect hidden ammunition on human body parts, whilst subjecting the scanned person to the least amount of radiation
- they are not regarded as being the panacea to airport and flight-specific safety.

It is the authors' view that both potential causes mentioned above should be viewed taking into consideration the "time value of money"-principle into account. This is defined as the amount of interest earned on an initial investment within a set time period. However, this term deduces a lean investment and a seamless payback period, not necessarily considering long-term "what-if" scenarios. The latter may include long-term radiation level exposure and its effects on travelers, in particular frequent flyers.

This study will emphasise the need for a multi-faceted assessment of the application of FBS at airports and major transportation hubs-such as international railway terminus-considering potential drawbacks on the long-term. In addition to this, it will suggest alternative scanning methods that will be able to effectively detect dangerous objects, whilst minimising the radiation dosage emitted. It is worth mentioning at this point that the latter forms part of current on-going research.

2. Literature review and methodology

Safety and security are amongst the most widely coined clauses in any airline's Mission Statement. Safety is defined as "*…freedom from danger, risk, or injury*", whereas security is described as "*…freedom from risk, or danger; safety; anything that gives or assures safety; one who undertakes to fulfill the obligation of another; surety*" [1]. The latter of the term forms part of an airline ticket and is seen as a legal term of a contract agreed and signed between the passenger and the air carrier. Their mutual acceptance of this contract detailing potential claims and law suits in the event that either party may have failed to provide the service as stated in the Warsaw Convention of 1929 [2]. It is worth mentioning at this point that the latter was subject to two revisions, namely the Hague amendment of 1955 and that of Montreal in 1999.

Research performed by Topouris *et al*, (2011), has shown that global air travel exhibits a continuous growth in passenger numbers and cargo. This in turn, necessitated -amongst others-the introduction and development of safety procedures and built-in safety devices, such as metal detectors.

The Ontario Privacy Commissioner IPC, in collaboration with the Dutch Data Protection Authority established in 1995 the term Privacy Enhancing Technologies, PETs. This refers to "…coherent systems of information and communication technologies that strengthen the protection of privacy information systems by preventing the unnecessary or unlawful collection, use and disclosure of personal data, or by offering tools to enhance an individual's control over his/her data."[4].

The events of September 11th, 2001, led the Research, Engineering and Development Advisory Committee of the Federal Aviation Administration, FAA (2002), to introduce a number of approaches in order to minimise potential security threats. Among the suggestions launched, the Advisory Subcommittee proposed the adaptation of the following short-term means:

- hardening the cockpit door
- initiating integrated airport-wide security test beds
- further improving human performance
- demonstrating technology to screen people, and
- triage procedures for screening people and their belongings

Screening technology as proposed by the Advisory Subcommittee translates to Whole Body Imaging, WBI, technology. This refers to basically two different types of apparatuses, namely:

- Millimeter-Wave, and
- Backscatter x-ray

The FBS listed above, use an array of algorithms so as to provide the security controller with a detailed view of any illegal items carried by the traveler, while aiming at safeguarding personal data.

In the long-term, it is stated that the FAA would need to tackle the aviation security issue as a generic system and develop henceforth a number of technologies and techniques, capable of integrating potential threat information. It is the authors' view that this scenario would require continuous investigation. The latter ought to consider cutting-edge technology, processes and procedures alike, so as to cater for potential unauthorized "system-entries". Indeed, it can be argued that potential "loopholes" within the aviations' generic system are subject to misconduct.

The Transportation Security Administration, TSA, commenced the deployment of WBI technologies and procedures at airports. Opponents of the latter argue that it violates fundamental human rights.

However, the Securing Aircraft From Explosives Responsibly: Advanced Imaging Recognition Act, S.A.F.E.R A.I.R Act, actually imposes the positioning of WBI apparatuses at airports by 2013.

Performed research reveals that the number of FBS at airports is increasing. The United States are pioneering in this area, followed by the United Kingdom, Holland and Germany to name but a few. Bart (2011), states that "…system-wide there are more than 750 screening checkpoints and over 2.000 screening lanes across 450 airports in the USA, with TSA's goal being the installation of 1.800 units by the end of 2014."

It is worth mentioning at this point that the legal framework addressing the deployment of FBS has not been finalised yet.

The European Directive No 2320/2002 sets the platform for passengers and cabin baggage screening placing the emphasis on metal detectors. However, the European Resolution (2008) 0521 of October 23rd, 2008 states that:

"…essential information is still lacking and asks the Commission, before the expiry of the three-month deadline, to:

- carry out an impact assessment relating to fundamental rights;
- consult the EDPS, the Article 29 Working Party and the FRA;
- carry out a scientific and medical assessment of the possible health impact of such technologies;
- carry out an economic, commercial and cost-benefit impact assessment;

2. Believes that this draft measure could exceed the implementing powers provided for in the basic instrument, as the measures in question cannot be considered mere technical measures relating to aviation security, but have a serious impact on the fundamental rights of citizens;…"

Preliminary research reveals that WBI technology may have long-term effects primarily on the health of passengers going through these devices. This is a focal point that is acknowledged by the EC. The latter awaits the outcome of current on-going research. The data gathered will serve as a platform in order to establish an EU-wide legal framework addressing effective and efficient security measures at airports. It is the authors' view that the long-term effects of the widespread use of FBS ought to be further researched.

Another noteworthy point is the potential infringement of fundamental human rights, considering the fact that aforementioned Resolution calls for "strong and adequate safeguards" to "protect the right to personal dignity". Finally, the Resolution stresses the fact that the impact of a wide-area deployment of FBS devices ought to protect and cater for an unlawful processing of personal data. Indeed, the latter part of the sentence is addressed by the Obscene Publications Act 1959 of the United Kingdom. To accommodate for any unlawful processing of personal data, the Obscene Publications Act introduces the term "test of obscenity".

It is the authors' view-based on preliminary research performed- that advise was not sought for at the European Data Protection Supervisor (EDPS), as required by Article 28(2) of Regulation (EC) No 45/2001. In addition to this further research ought to be carried-out, so as to include feedback from a variety of agencies such as the Fundamental Rights Agency, FRA.

EU Commission Regulation 185/2010 acknowledges that: "… methods, including technologies, for detection of liquid explosives will develop over time. In line with technological developments and operation experiences both at Community and global level, the Commission will make proposals, whenever appropriate, to revise the technological and operation provisions on the screening of liquids, aerosols and gels". This is in par with the European Directive 95/46/EC concerning "…the protection of individuals with regard to the processing of personal data and on the free movement of such data". However, the Directive 95/46/EC coins the term of "necessary measure", allowing airport security to perform a detailed check, if the person is a suspect.

Owing to the multiple of applicable Laws, Regulations and the novelty of the area, this work is aimed at providing all potential users of WBI technologies with a fundamental platform, taking into consideration legal/ethical, technological, quality and health-related issues.

Initial research includes the study of a number of International, European and National Laws and Regulations, which revealed that the deployment of WBI technologies and apparatuses is distinctly split between opponents and proponents. The opponents primarily represent the EU, whereas the latter stand for the United States of America.

However, it is noteworthy to mention that within the EU, Member-States have decided to address aviation security by different means. As such, the United Kingdom has decided to implement FBS at all UK airports by the end of 2010, whereas in Germany, only Fühlsbüttel Airport in Hamburg is deploying such a scanner, albeit on a voluntary basis. Performed research has shown that backscatter x-ray scanners are illegal for use at German airports, with current research focusing on millimeter-wave scanners.

In order to provide a detailed view concerning public perception of a potential EU-wide deployment of FBS questionnaires were developed. These were targeted at random to travelling passengers from a number of Greek airports. The outcome thereof will be discussed as of chapter 3 on.

When searching for the corresponding legal framework, in particular the one dealing with "Health and Safety at Work", it was found that this subject area was not addressed. In view of the above, on-going research will focus on developing alternative WBI means, emphasising on effectiveness and efficiency, while minimising the emitted radiation.

3. Results

As already mentioned in chapter 2, the Obscene Publications Act 1959, OPA, of the United Kingdom sets the platform for safeguarding unlawful distribution of personal data. To this extend, it equally includes sections of the Broadcasting Act 1990 concerning the terms "programme" and "programme service". As such, the OPA introduces the so-called "test of obscenity" whereby *"…the effect of any one of its items is, if taken as a whole, such as to tend to deprave and corrupt persons who are likely, having regard to all relevant circumstances, to read, see or hear the matter contained or embodied in it.*

In this Act "article" means any description of article containing or embodying matter to be read or looked at or both, any sound record, and any film or other record of a picture or pictures.

For the purposes of this Act a person publishes an article who—(a) distributes, circulates, sells, lets on hire, gives, or lends it, or who offers it for sale or for letting on hire; or(b)in the case of an article containing or embodying matter to be looked at or a record, shows, plays or projects it [or, where the matter is data stored electronically, transmits that data.]

For the purposes of this Act a person also publishes an article to the extent that any matter recorded on it is included by him in a programme included in a programme service.

Where the inclusion of any matter in a programme so included would, if that matter were recorded matter, constitute the publication of an obscene article for the purposes of this Act by virtue of subsection (4) above, this Act shall have effect in relation to the inclusion of that matter in that programme as if it were recorded matter."

It is the authors' view that this Act should serve as the legal cornerstone regarding the lawful and legal handling of personal data, in association with the use of FBS. The latter is the outcome of further research by leading industries aimed at enhancing security checks at airports. As already mentioned in chapter 2, there are two different WBI apparatuses currently in use:

- Millimeter Wave, and
- Backscatter X-ray

Millimeter wave utilises non-ionising radio frequency energy in the corresponding mm-wave spectrum, so as to produce a 3D-picture of the object under study. Figure 1 shows the operating principle of such a device.

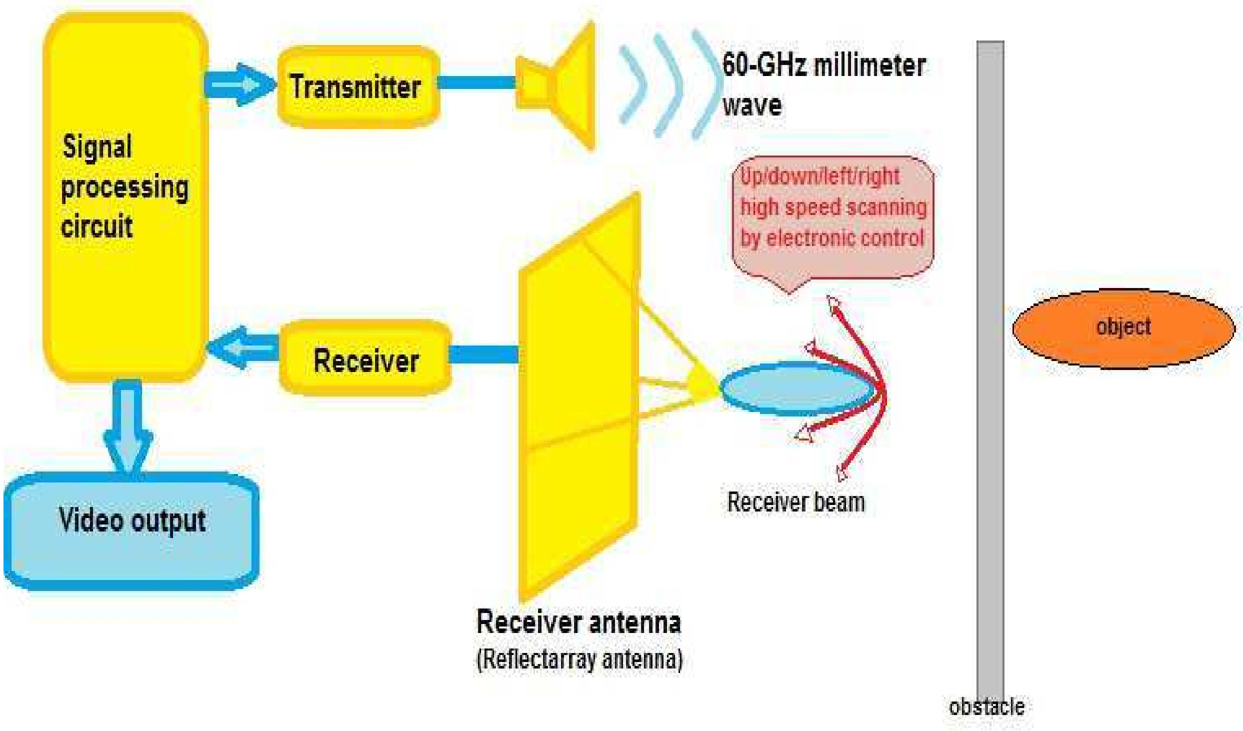

Fig. 1. Operating principle of a Millimeter wave device

The image is displayed on a remote monitor, subject to further analysis.

Backscatter X-ray devices use a narrow, low-energy x-ray beam that scans the surface under study at a certain speed. Their operating principle is depicted in figure 2.

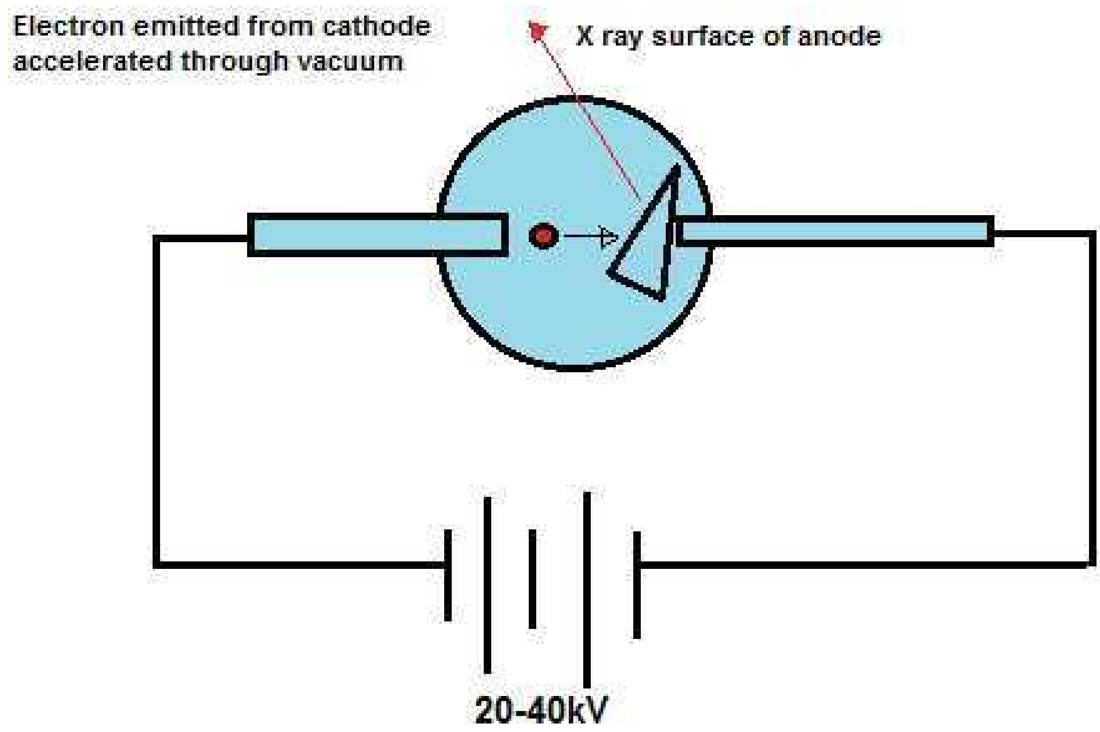

Fig. 2. Operating principle of a Backscatter X-Ray device

It thereafter generates a picture of the object that is projected onto a remote monitor for further analysis.

Preliminary analysis shows that the radiation dosage of the backscatter x-ray scanners is:

H= E / wT = (0.0001 / 0.01) mSv per scan = 0.01 mSv per scan.

Supposing that the entire dose used in order to calculate the effective dose (E) is the skin, and the "manufacturer's worst case" estimate of E = 0.0001 mSv per scan, then the worst case equivalent dose (H) to the skin is as calculated above 0.01 mSv per scan.

Table 1 shows various radiation levels from a number of human activities.

It is worth mentioning at this point that performed research showed the legal ban of all backscatter x-ray devices in the Federal Republic of Germany. Further studies aim at optimising millimeter x-ray scanners, as the apparatus at Hamburg’s Fühlsbüttel Airport was put out of operation. The latter was due to experienced bottlenecks, both in terms of overall passenger handling delay, as well as the number of complaints received by travelers.

Examples	mSv
Eating one banana	0.0001 mSv / banana
Sleeping next to a human for 8 hours	0.0005 mSv / night
Dental x-rays	0.005 mSv / visit
Backscatter X-ray	0.01 mSv/scan
Mammogram	3 mSv / visit
Chest CT scan	6-18 mSv / scan
Living near a nuclear power plant	0.0001-0.01 mSv / year
Living in San Diego (radiation from the sky)	0.24 mSv / year
Living in San Diego (radiation from the ground)	0.28 mSv / year
From your own body	0.40 mSv / year
Airplane trip	0.01 mSv / 1000 miles flown
Smoking a pack and a half a day	13-60 mSv / year
Start of level known to cause cancer	100 mSv / year
Standing in the middle of the Fukushima Daiichi nuclear power plant	100 to 400 mSv

Table 1. Radiation levels from a number of human activities

Indeed, a study by the German Radiation Protection Registry revealed some statistical data based on a study concerning the flight hours of pilots and crew members during the 5-year period 2004-2009 [14]. Authors Frasch G., Kammerer L., *et al* (2011) found that the average effective dosage of 2.35mSv per flight crew in the year 2009 was 20% higher as opposed to 2004. They justified this as being the result of “the cosmic radiation due to the altitude”. Indeed, epidemiological studies point to increased health risks of flight personnel. However, an explicit correlation between altitude radiation and carcinosis is subject to further scientific research. It is therefore suggested that flight crew adhere to safety standards and optimise flight and route planning, so as to avoid high radiation areas.

In order to gauge public concern and evaluate the reactions concerning a potential use of FBS on European Airports and Transportation hubs, a questionnaire was developed and the opinion of a random sample of 50 travellers asked. The questions raised dealt with airport security matters. In particular, the query focused on how a potential introduction of FBS may affect their lives. The outcomes are shown in the following pie-charts below:

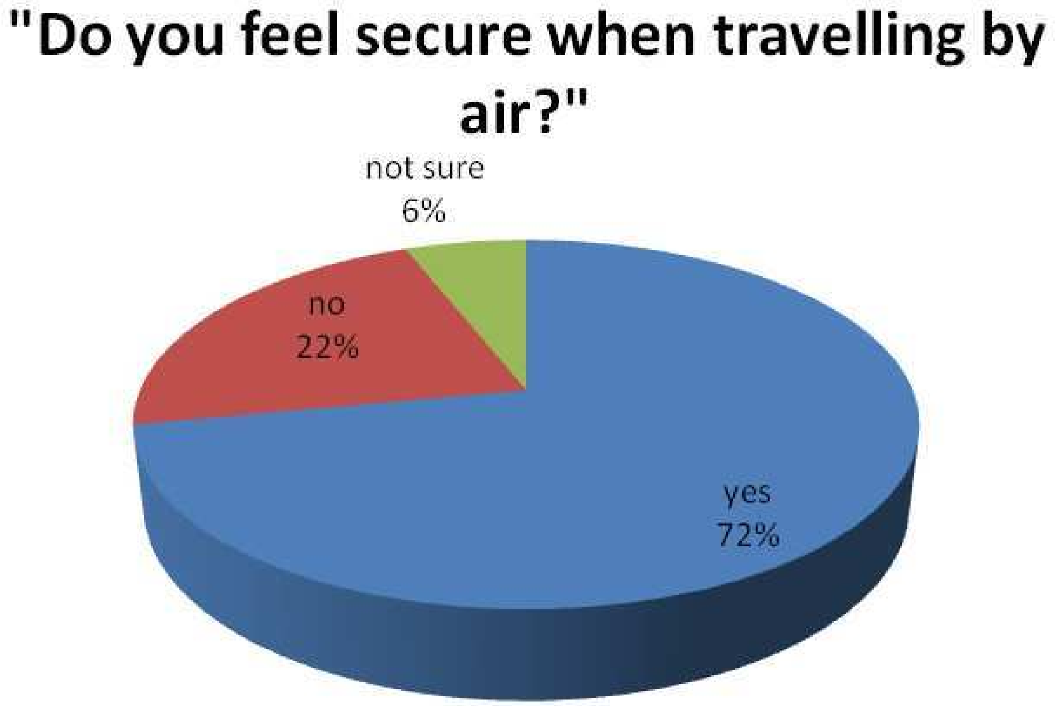

Fig. 3. Passenger replies concerning air travel

When passengers were confronted with the question, if they felt secure when travelling by air, 72% responded that they did. Only a 22% was feeling insecure. The latter may be subject to further research. Likewise, airports were regarded as inducing a feeling of security to 74% of passengers, as opposed to 4% who felt not secure. By comparing these two pie-charts one may observe that the positive responses do not show any significant variation.

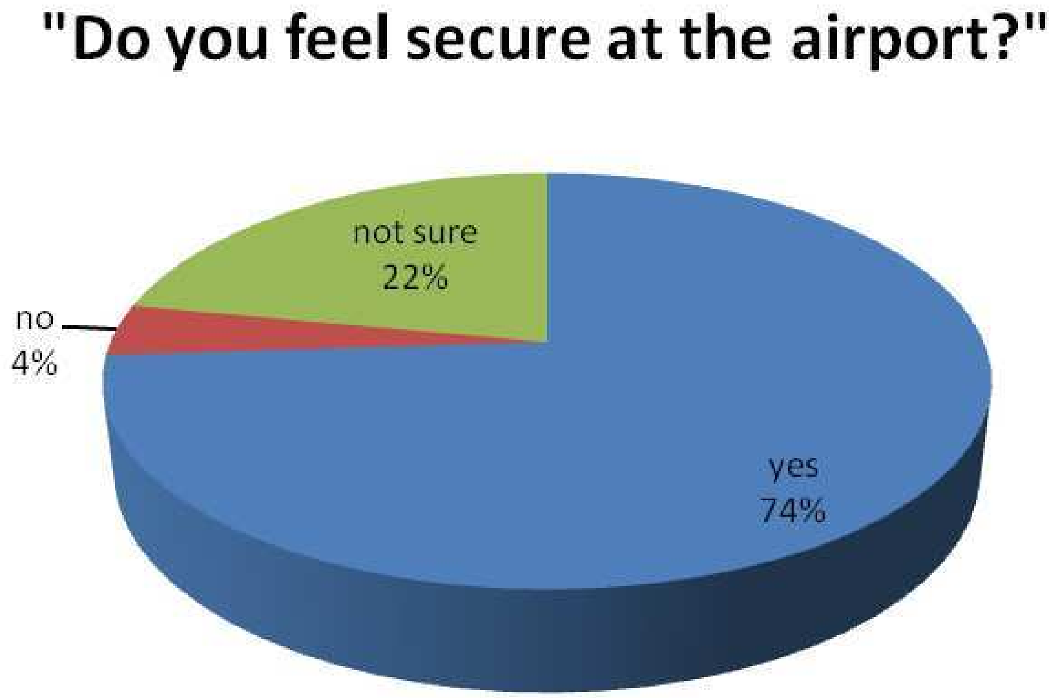

Fig. 4. Customer outcome regarding airport-related security

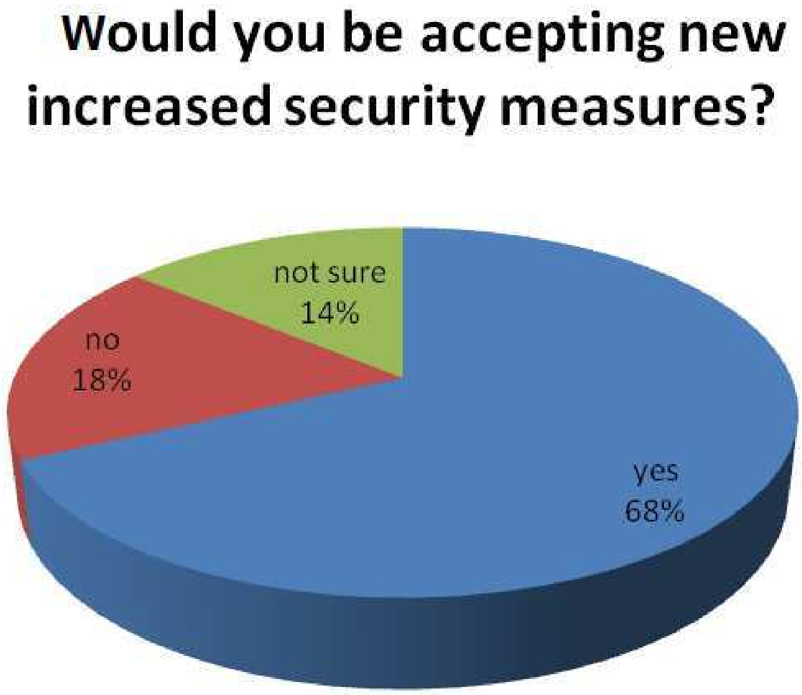

Fig. 5. Traveler results pertaining to security measures

68% of passengers travelling by air would accept new increased security measures. The outcome of the latter contradicts previous results, which underlie the fact that on average 73% of travelers feel both secure at the airport and on the aircraft.

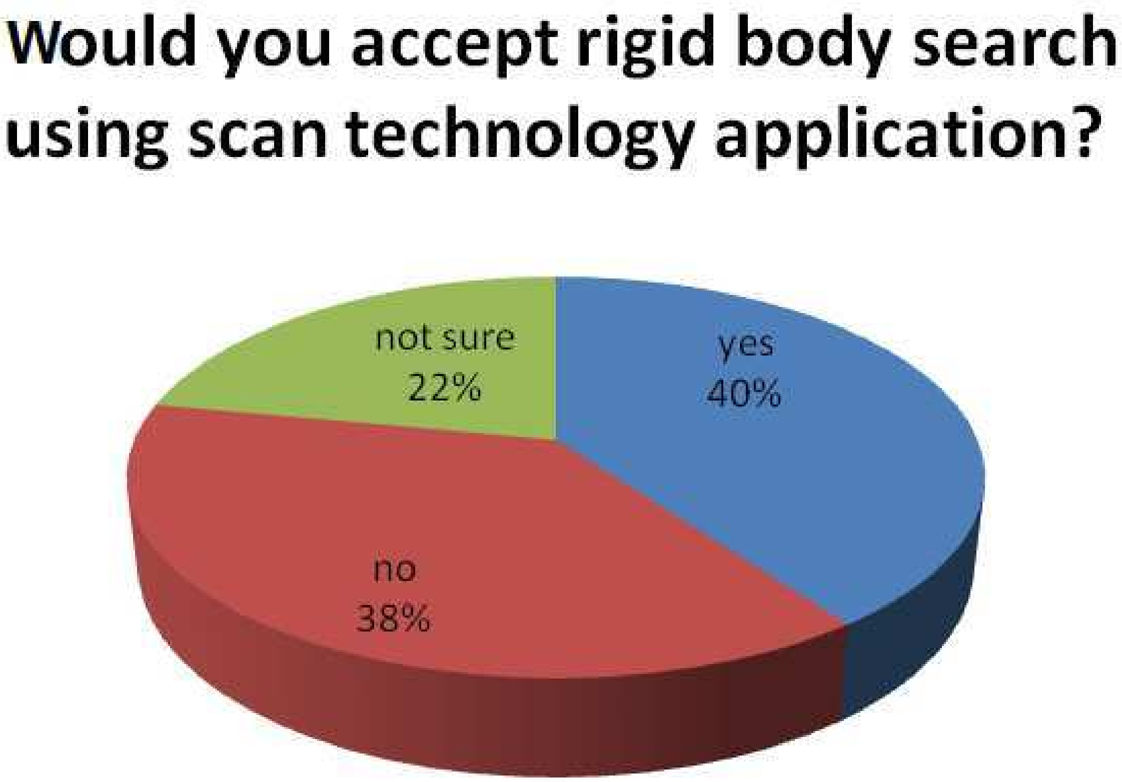

Fig. 6. Proponents vs. opponents of scan technology at airports

When further narrowing the question pertaining to the type of security device used, the responses show an approximate equal split. 40% of travellers would accept WBI technology, while 38% would not accept FBS. The remaining 22% of people quoting "not sure" needs further investigation as to the potential causes of their reply, past experience, social, moral and ethical beliefs to name but a few. The results thus far hand-shake with the initial hypotheses and indicate that:

- the majority of passengers would accept increased security measures, and
- that the deployment of FBS is not regarded as being the panacea to airport and flight-specific security
- a considerable percentage of people ranging between (14-22)% were not certain concerning increased security measures and the use of rigid body scan technology at airports, so as to enhance an overall security feeling

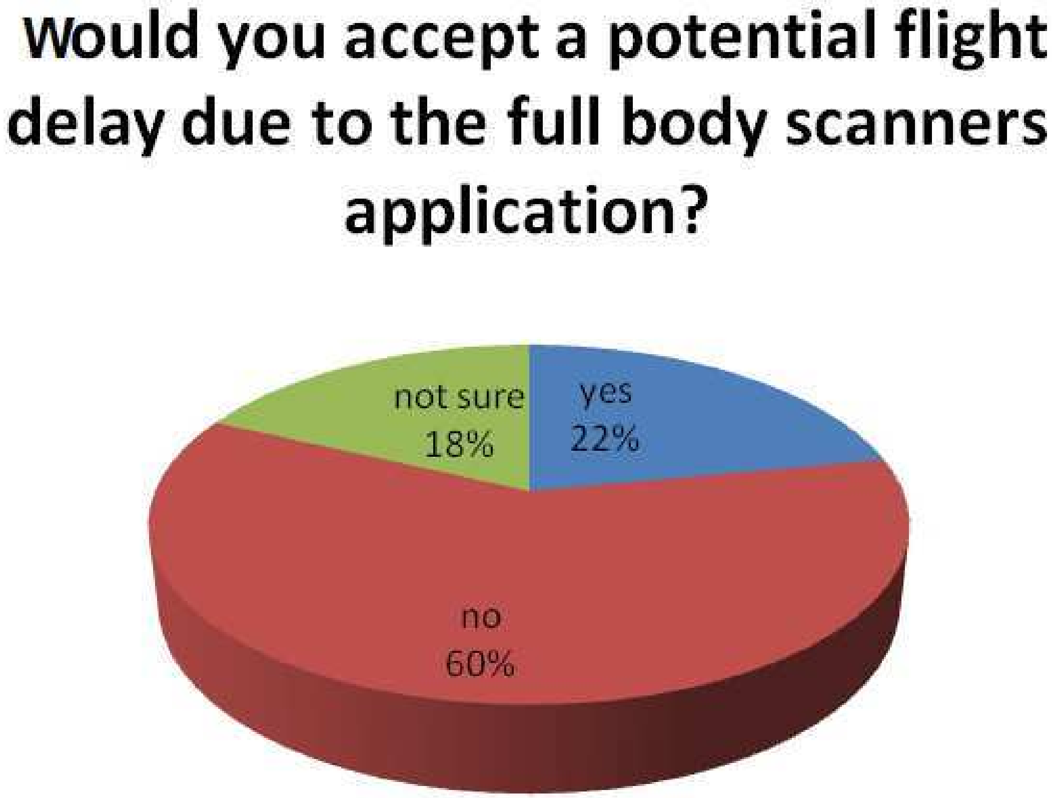

Fig. 7. Potential operational impact of FBS on slots

The pie-chart shown above suggests the following:

- 60% of passengers would not accept a delay in the slot-management of their flight, albeit having passed a full body scan. This empowers initial hypotheses concerning the development of optimised benchmarking tools and techniques. The latter would be the outcome of probable bottlenecks in passenger handling. It is the authors' view that this may also be the cause of past passenger-specific experience regarding the usefulness of FBS at countries already deploying them
- 22% of travelers would accept a likely delay of their flight in lieu of a full body scan
- 18% of responses were "not sure" about their acceptance of WBI apparatus

Based on the findings of the questionnaire, passengers do indeed opt for air travel as it is a fast, safe and effective transportation means. In their view, air travel has become cheaper. Modern airplanes manage to cover long distances by offering an improved level of comfort.

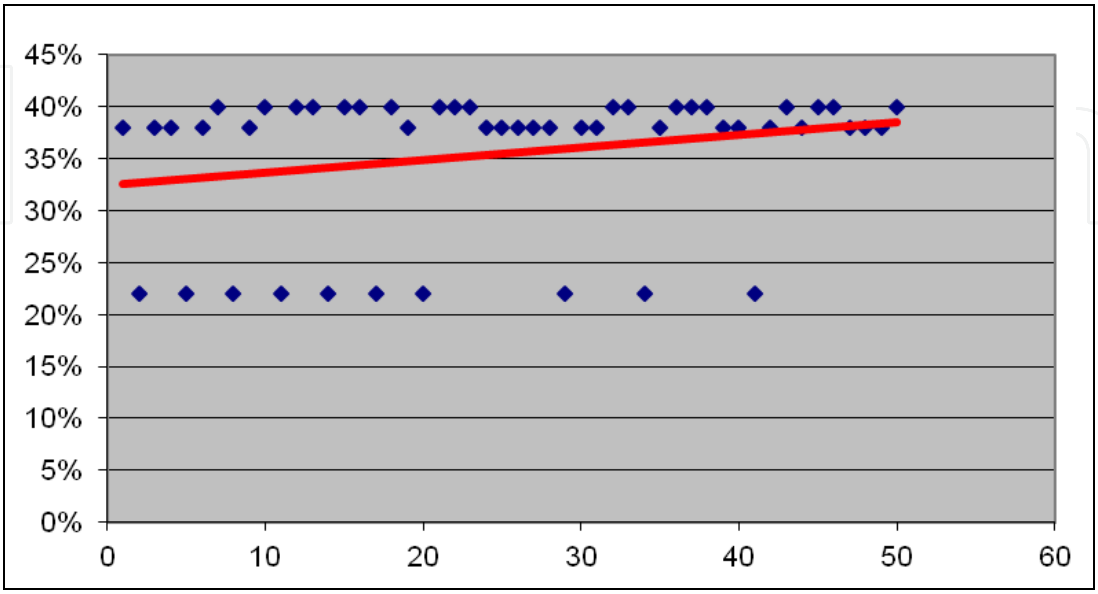

Diagram 1. Trend-analysis based on the sample of 50 passengers

4. Analysis

Initial research shows that airport authorities aim at satisfying passenger needs between (95-99)% of all times. In order for a statistical process to be regarded as being within set tolerances, the term Capability Index is introduced. Bergman and Klefsjö (1994) define capability as *"…the ability of a process to produce units with dimensions within the tolerance limits…"*.

Capability Indices, Cp_ks, are a simple and widely used quality technique tool (Kounis, 2010). They measure the dispersion of a process in relation to the range of the set tolerance interval, by including the Upper Specification Limit, USL, and the Lower Specification Limit, LSL. Capability Indices may equally be applied to evaluate a process, or design. The higher a Cp_k value is, the lesser the amount of rejects. However, although a Cp_k shows a small variation, it is not always centered around the target value (Kounis *et al*, 2000).

As Cp_ks, were not readily available by airport authorities, or required detailed evaluation, a sample size of 50 was deemed appropriate. Indeed, research performed by Kounis *et al* (2000) have argued that a random sample of less than 50, may lead to making the resulting capability index Cp_k unacceptable. However, the authors suggest than in cases such as inadequate funding, or inhabitive volumes, Extreme Value Statistics, EVS, may be regarded as an alternative method to capability indices, since it focuses on the behaviour of the tails of the distribution. Indeed, the authors argue that EVS "…are capable of describing these situations asymptotically."

Diagram 1 shows a trend analysis of the received outcomes to the question concerning the acceptance of scan technology apparatuses.

It primarily highlights two different areas:

- the clear split between the people who are "not sure about accepting" such a technology, representing 22% of the sample, and
- a near 50:50 division of respondents standing for the acceptance of such a technology, as opposed to the ones not accepting it

The outcomes received thus far indicate that further research ought to be carried-out, as the application of WBI technologies affects a multitude of transport-related areas and entities. In addition to the technology implied, the results suggest a refinement of the corresponding legal framework, so as to:

- foster security measures at transportation hubs
- cater for cumulative radiation levels
- consider passenger demographics

With regards to increasing security measures at transportation hubs (airports and railway terminus), the "CRS Report for Congress" of May 26th, 2005, acknowledges an "*…inherently vulnerable*" state of passenger rail systems world-wide; the latter resulting from the Madrid 2004 rail events.

For an organisation to develop a thread-based risk management, Roper (1999), conceptualises it by means of the following equation:

$$\text{Vulnerability} + \text{Threat} + \text{Criticality} = \text{Risk}$$

As such, "vulnerability" is defined as a system's open, unprotected and exposed boundaries and/or areas to potential attacks.

Likewise, "threat" refers to the potential likelihood of an attack on a system, whereas "criticality" associates the potential consequences of an attack to the system's behaviour and performance.

5. Discussion

The outcomes of this preliminary study and basic Extreme Value Statistics, EVS concepts suggest that the introduction of more effective security means is indeed condoned by travellers. However, public perception is split when it comes to FBS, as they are deemed to either infringe, yet even violate basic human privacy rights, or to inadvertently cause health-related diseases.

The latter would have to form an area of on-going further research. It is the authors' view that no explicit scientific outcomes may be formulated, as the following factors ought to be taken into consideration:

- amount of cosmic radiation, acknowledging global warming
- travel frequency of passengers
- selected routes and associated level of cosmic radiation
- travellers' demographics and related health condition
- effect of other radiation-emitting sources on human health

It is worth mentioning at this point that long-term effects ought to be studied and various external and interrelating parameters be taken into consideration.

On the other hand, research is currently focused on the development of so-called Sound Amplification by Stimulated Emission of Radiation, SASER, or sound laser. A saser is in effect a photon laser that produces a highly consistent beam of ultrasound. One might argue that a saser is a slightly modified version of a laser; the former forcing sound waves to travel at THz frequencies, albeit on a nano scale. The basic operating principle is the employment of phonons to produce sound waves. Rather than emitting waves and forcing them to pass through an optical cavity-as is the case with a laser- a saser-produced wave travels via a superlattice structure. The latter consists of 50 ultra-thin and alternating layers of gallium arsenide and aluminium arsenide. Once the phonons are inside said superlattice, they rebound, multiply and escape in the form of an ultra-high frequency beam.

The University of Nottingham has pioneered in this area (http://www.rexresearch.com/kentsaser/kentsaser.htm). Kent *et al* argue that saser could find potential application in the manufacture of computers resulting in higher execution times.

Experiments also focus on understanding and assessing the behaviour of saser technology in spectral distribution. In particular, the detection of phonons in R_1 luminescence is studied so as to draw practical applications [IOP Science] (http://iopscience.iop.org).

Another application of saser technology is to suppress the quantum noise that drowns out very faint signals in ordinary conductors [New Scientist]. The aim of on-going research is to try and reduce potential noise levels in electronic devices, so as to track down weak signals.

This paper acknowledges current research work and aims at developing a device capable of producing sound waves. These would retract once a surface or an object is been hit. Using a suitable interface, the projection of said object could be facilitated. Likewise, areas of high density could be shown by means of peaks on an oscilloscope. The hypothetical apparatus making use of saser technology is shown in figure 3.

It is the authors' view that the proposed device be simple and easy-to-use. In addition to the above, it ought to be capable of identifying and showing dangerous materials and/or tools, whilst protecting human health and personal data. The latter should be stored in means that would serve a dual purpose:

- be fail-safe, and
- prevent a potential violation by other users, or third parties

In order to enhance flight security suggested imaging apparatuses might be linked on a European-wide area, providing the outcomes of further research sectors are satisfying. This however, necessitates either amendments to current legislation, and/or the development of new EU-wide Laws. The latter ought therefore to be based on "best practice"-principles. Additional ethical and religious matters ought to be accounted for in a potential EU-wide legal framework.

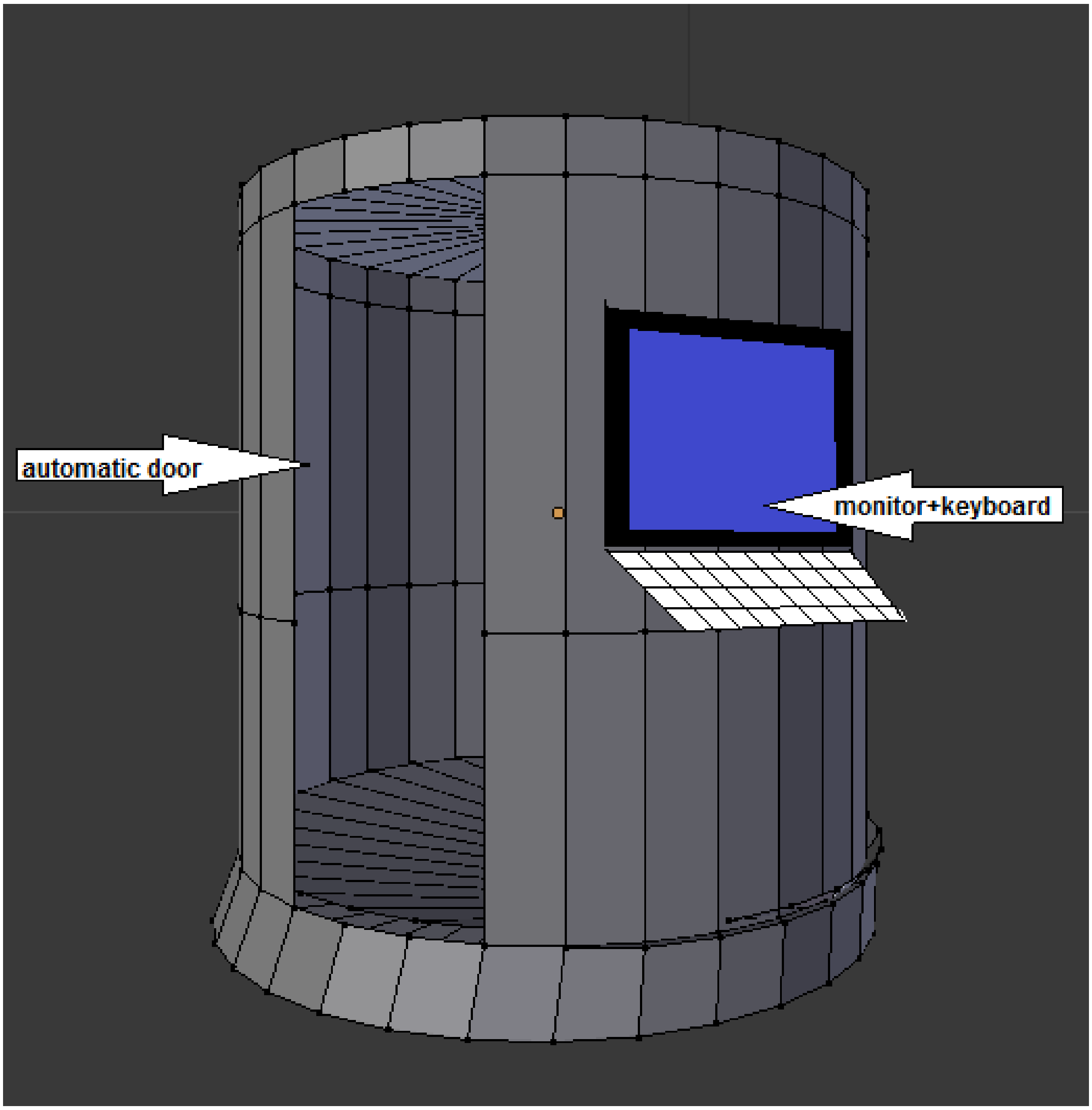

Fig. 8. Hypothetical scanning device based on saser technology

Finally, real-life data from airports already using FBS as opposed to the ones not applying such practices ought to be performed, so as to eliminate bottlenecks and optimise benchmarking techniques. The latter ought to consider the reasoning of airport authorities that have rejected the use of body scanners, based on "not satisfying outcomes", as postulated by their users.

Further research ought to account for the cumulative radiation levels for travellers as well as flight crew, in relation to the frequency at which these are subjected to WBI apparatuses. The outcome thereof would be compared to the percentage that would show potential health-related problems over a long-term period.

6. Conclusions and further work

This work has considered current legislative matters pertaining to safety and security levels in the aviation sector. It identified open-ended issues that require further research, both in the legal, as well as the technological area. To this end, it introduced basic operating principles of millimetre and backscatter x-ray scanners, detailing their characteristics and associated drawbacks.

Performed research indicates that the perception is not unanimous. A number of countries are aiming at a sector-wide deployment of WBI apparatuses, whilst other states either seek to develop alternative means, and/or to improve on already existing ones. This trend is equally mirrored by the preliminary outcomes of the questionnaire from a sample of travellers.

Up-to-date investigations concerning alternative means of passenger checking are likewise introduced and discussed. As such, owing to the novelty and the scientific wideness of this particular area it is the authors' view that further research ought to be conducted in areas such as benchmarking/quality and its effects on an airport's overall performance. In addition to the above, further work ought to be focused on grouping of potentially dangerous articles based on their physical and/or chemical properties, so as to develop effective scanning apparatuses.

In view of the above and acknowledging the fact that the FBS positioned at Hamburg's Fühlsbüttel Airport was taken out of operation, this study is serving as the platform for optimising security means at transportation hubs. Potential operating bottlenecks-as experienced by airport authorities already using WBI technologies- will be appraised and evaluated. The outcomes thereof will form the building platform of benchmarking models to optimise passenger handling.

It is also worth mentioning at this point that no specific and accurate measures can be derived thereof, as the time interval concerning the application of FBS in relation to the potential risk of carcinogenesis, is small and yet-to-be defined. The latter would include a diverse field of further potential influencing parameters as already outlined in the study of the German Agency for Radiation Protection. In particular, a clear split of environment-specific radiation as opposed to security-imposed radiation ought to be defined and boundaries established. For introducing a humanly-safe and secure apparatus, the effect of radiation on demographic groups ought to be further elaborated on. The latter forms part of further and continuous research aimed at identifying probable causes and interrelations.

7. References

Bart E., "Changes in Airport Passenger Screening Technologies and Procedures: Frequently Asked Questions", in *Congressional Research Service*, 7-5700, R41502, January 26th, 2011

Bergman B., Klefsjö B., „Quality: from Customer Needs to Customer Staisfaction", McGraw-Hill, 1994

Broadcasting Act 1990

Cavoukian A, "Whole Body Imaging in Airport Scanners: Activate Privacy Filters to Achieve Security *and* Privacy", in *Information and Privacy Commissioner of Ontario,* March 2009

Convention For The Unification Of Certain Rules Relating To International Carriage By Air, Signed At Warsaw On 12 October 1929 (revised at the Hague in 1955 and Montreal in 1999)

EU Commission Regulation 185/2010

European Directive 95/46/EC

European Directive No 2320/2002

European Resolution 0521 of October 23rd, 2008

Federal Aviation Administration, FAA, Research, Engineering and Development Advisory Committee, *Report of the Subcommittee*, February 2002

Frasch G., Kammerer L., Karofsky R., Schlosser A., Spiesl J., Stegemann R., „Die berufliche Strahlenexposition des fliegenden Personals in Deutschland 2004-2009", in *Bericht des Strahlenschutzregisters, Fachbereich Strahlenschutz und Gesundheit*, Salzgitter, August 2011, urn:nbn:de:0221-201108016029

IOP Science http://iopscience.iop.org

Kounis A.B., McAndrew I.R., O'Sullivan J.M., „Determining capability indices with small samples", in *Advances in Manufacturing Technology XIV*, 16th National Conference on Manufacturing Research, 5-7 September 2000

Kounis, L. D., McAndrew I.R., O' Sullivan J., M: *Modelling of parametric relationships in jet fans,* 3rdInternational Conference on Quality, Reliability and Maintenance, QRM 2000, pp.223-226, Ed: G. J. McNulty, University of Oxford, Oxford, United Kingdom, 30-31 March 2000

L.D. Kounis: Robustness and Capability Indices in the optimisation of an Airline's fleet. Bridging contradicting outcomes, in "Enterprise Networks and Logistics for Agile Manufacturing", pp. 359-397, Ed. Lihui Wang and S.C. Lenny Koh, Springer Publ., September 2010, ISBN 978-1-84996-243-8

New Scientist Journal reference: *Physical Review B*, in press

Obscene Publications Act 1959, United Kingdom

Peterman Randall D.: *Passenger Rail Security :Overview of Issues,* CRS Report for Congress, Updated May 26th, 2005, Congressional Research Service, The Library of Congress

Regulation (EC) No 45/2001, Article 28(2)

Roper Carl, A. *Risk Management for Security Professionals,* Butterworth-Heinemann, 1999

S.A.F.E.R A.I.R Act, Transportation and public works. 111th Congress, 2009-2010

The Heritage Illustrated Dictionary of the English Language, International Edition, Vol. II, Houghton Mifflin Company, 1979

Topouris S., Xenos-Kokoletsis A., Kounis L.D., "A feasibility study pertaining to the accommodation of the A380 at Athens International Airport", Paper ID2288, November 11-13, 2011 Zhengzhou, China

University of Nottingham Ref: http://www.rexresearch.com/kentsaser/kentsaser.htm

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Laser scanning technology plays an important role in the science and engineering arena. The aim of the scanning is usually to create a digital version of the object surface. Multiple scanning is sometimes performed via multiple cameras to obtain all slides of the scene under study. Usually, optical tests are used to elucidate the power of laser scanning technology in the modern industry and in the research laboratories. This book describes the recent contributions reported by laser scanning technology in different areas around the world. The main topics of laser scanning described in this volume include full body scanning, traffic management, 3D survey process, bridge monitoring, tracking of scanning, human sensing, three-dimensional modelling, glacier monitoring and digitizing heritage monuments.

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