

## AIRPORT REDESIGN FOR SAFETY AND SECURITY: CASE STUDIES OF THREE SCOTTISH AIRPORTS

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**ABSTRACT.** This research study set to develop KPIs for airport safety and security using a case study and ethnographic approach to research, the focus was on the role of Facilities Management (FM) in improving safety and security at the airport. The study centred on the management and staff of the case study airport and experts in the field of facilities management and aviation. The methodology for this study is a case study of three Scottish airports, owned and operated by the BAA Scotland (Glasgow, Edinburgh and Aberdeen international airports). Data was collected from Civil Aviation Agency, analysed and presented in the study. The study developed a three 'AAA' model (Airport – Aircraft – Airport) and a 3 stage approach to the research process. Evidence in this paper supports the conclusion that planning for airport safety and security are airport specific because no two airports are exactly the same, they differ in their; sizes, mode of operations, passenger type and flight destinations.

**KEYWORDS:** Airport; Aircraft; Safety and security; Performance indicators; Facilities management

### 1. INTRODUCTION

Airports are safer today than they were in the past. Blakey (2005) appearing before the US Senate Commerce subcommittee on aviation safety issues said that “three year average commercial accident rate is 0.017 accidents per 100,000 departures” meaning accident rate is the equivalent of one fatal accident for every 15 million passenger carrying flights. In today’s world intelligence, security partnering and information sharing has help to reduce incidents and accidents at the airports take

the Germany plot on the 5<sup>th</sup> September 2007 by Islamic militants against America target in Germany the threat was real, massive and imminent. A CNN source said the detonator was sophisticated, like the ones used in military device hard to come by, very precise kind of high-tech and can inflict more casualties than lower-grade detonators.

This paper examines how baggage and passengers are processed through the airport for their on-ward journeys, the health and safety perspective of manual handling, and work

place injuries and reportable injuries. Movement in and out of the case study airports was examined. A passenger profiling at each of the airports was carried out by the researcher to see first hand the experiences of each passenger on the day of travel and also to have a fair and proper evaluation of performance and performance related issues in the case study airports in terms of airport facilities.

The research methodology examines the process undertaken by the researcher in developing the key performance indicators from beginning to completion of the final KPI list. The study developed a three 'AAA' model (Airport – Aircraft – Airport) and a 3 stage approach to the research process; which involved a review of the IATA level of service standard, followed by a review of the CAA incidents and then a review of the airport operational procedures and practices. The airport was fully examined including departures and arrivals, covering a complete journey circle from airport to aircraft and from aircraft back to airport.

The level of service was examined and related to airport capacity and their influence on the design of the airport and the facilities provided by airports. Attempts were made to relate the case study airports to the IATA space standards and examine how the level of service is determined at each facility in the airport. The dwelling time of each passenger can be estimated from information available and this has a huge implication for both the designers of airport as a facility and the managers of the airport in planning for facility usage and human resource implications. Also discussed is the CAA data; analysis and presentation. Here the CAA data was presented in tables, originally data was collated in MS Excel and statistical tools (Chi-square) was used to test for independence of incident. Where  $H^0$  = incidences are independent, and  $H^1$  = incidences are dependent.

The philosophy of performance measurement was also a key focus of the research

study; this study differs from previous studies, as it concentrates on looking at how FM impacts upon airport performance in relation to safety and security. The rationale behind the focus on Scottish airports was the logistics to accessing key people at each airport and collecting relevant data in conjunction with the belief that to some extent operating procedures will be similar across the world in terms of the security and safety function. A more international perspective is perhaps an additional research activity for the future and is outside the scope of the current project.

## 2. LITERATURE REVIEW

Airports take proactive measures to solve operational vulnerabilities through procedures, awareness, airport infrastructure, education, enlightenment, training and technology. Airport safety requires a coordinated approach between the various interest groups and the government as well as the stakeholders and workers. Facilities Management uses a wide range of measures in performance measurement from traditional financial accounting measures to indicators of managerial behaviour as well as different other measures of effectiveness (Amaratunga and Baldry, 2003). Measurement is still one of the critical aspects of today's management, just as it has been in the past being a key aspect of scientific development since the seventeenth century. The concept of performance measurement has been embraced by facilities managers and project managers, who increasingly use it as a benchmark against which effectiveness can be measured, and a basis for which improvement can be determined (Enoma and Allen, 2007).

Crisis management scholars have developed several models of crisis management all offering different explanations of crisis with no real convention on how to deal with crisis, however no particular model has been tested empirically in the context of terrorism and or-

organisational response to crisis (Paraskevas and Arendell, 2007). Quarantelli (1986) observed that crisis management of disaster does not follow automatically from disaster planning but from activities of emergency organisations and identified areas of problems in disaster management to be communication process, the exercise of authority, and the development of coordination. However prior planning can limit the extent of management difficulties and the effect of the disaster but can not eliminate the occurrence completely (Smith, 1990). In crisis management risk assessment and contingency planning are vital tools for effective control strategy and at the same time identifying specific element that has to be in place at each stage of the disaster lifecycle. Faulkner and Vikulov (2001) in their framework on crises ranging from employee strikes, terrorism and economic recession introduced broader strategic issues like environmental scanning, strategic choice and control, resource management and organisational learning. But this very generic framework will be of limited use to those studies wishing to develop anti terrorist strategies aimed at preventing terrorist attack on our institutions.

The role of Facilities Management (FM) in the delivery of safety and security within the airport will depend upon the ability to identify, communicate, and manage opportunities and threats to help support the airport business objectives at the earliest possible time. This involve a more holistic view for the FM function as reflected by strategic facilities management and the ability to address its requirements at an early stage of the development process, where considerations is given to FM can be as early as the design stage. This will entail major developmental shift of airport as construction projects to FM services provision. This orientation makes the development of the scheme one of designing for FM. In airport redesign for safety and security, all airport facilities are examined for their support/contributions to the

overall business objective of the airport at the same time looking at how they fit to regulatory framework of the authorities. FM has a major role to play in ensuring safety and security at the airport.

### **3. AIRPORT SUPPORT FACILITIES**

Airport support facilities are needed to achieve efficient and effective airport system, to facilitate flight operations, airport maintenance and airport administration as well as the maintenance of aircraft and other airlines related services. Mainly airline support services, on site air support functions are necessary for the normal operations of the airport.

Aircraft maintenance facilities are a major support facility, made up of hangars ranging in height and number depending on the airport and the planes that it serves, the hangars can range from 28 m to 39 meters above grade, this facility is usually for line maintenance with heavy maintenance procedures been undertaking not so often. You also have the ground handling equipment maintenance; airlines and their agents operate, maintain and store different types of ground handling equipment, design for use in the apron areas of the airport.

Fuelling facilities, part of the airport support facility most airport have fuel depot where most of the arriving and departing aircraft are refuelled, while most of the aircraft are refuelled by using trucks others can be refuelled using permanent hydrant.

Aircraft kitchen and cleaning services are responsible for all kitchens' prepared and packed meals for in-flight service and at the same time responsible for cleaning the aircraft making sure the aircraft is clean before passengers are allowed into the aircraft for their onward journey. Most of these facilities are located near the airside and would not have restricted but controlled access to the apron in the airport terminal to carry out their functions.

There is also the aircraft waste facility; this facility has the capacity for processing aircraft sewage, normally sewage truck with tanks makes way to the waiting aircraft in the apron and extract all the sewage from the aircraft for onward processing at the waste facility or for disposal at the local council sanitary sewage, this particular facility can be located near the airport or located outside because there are specialized vehicles for processing waste.

Airports provide facilities to help aircraft movement, cargo and the processing of passengers. Some of the facilities have been discussed above others are; Emergency response and coordination, policing and security, airport airfield maintenance, administrative and support staff accommodation. Emergency response and coordination are responsible for any emergency on airport property and aircraft crash and rescue; they are responsible for hysteria control when there is an accident of any nature, their responsibility stresses beyond call to duty it also entail coordination of the activities of the rescue team and setting up support for both victims and their relations or love ones, counselling and information dissemination. You also have the fire service in case of any fire within airport properties and aircraft. In cases of emergency the government emergency services will always help and it is the responsibility of the in house response team to coordinate and control the services of the outside emergency teams.

Scottish and borders police with special branch provide airport policing in our case study airports, with each of the airport having their own security team (BAA SECURITY) they make up a third of the airport workers, they are responsible for the airport security, they physically man all the security post and carry on security patrol on the perimeter fence of the airport, they are also responsible for the security screening of passenger and their belongings. They work in close cooperation with the police, special branch and all the control

authorities in effecting security and policing for the airport.

Airfield maintenance a very important support services, they provide and maintain lighting for the airport and airfield making sure safe and orderly movement of aircraft both in the air and on ground. Flood lighting and road security display lighting provide safe and secure environment for support services and other airport workers. They also maintain the airfield pavement performing the all important function of preventing aircraft accident and enhance resurfacing of the airfield for aircraft operation.

A review of airport FM facilities will be incomplete without consideration of the design implication of the facilities on safety and security this leads to the discussion of dwell time.

#### 4. DWELL TIME

The concept of "dwell time" refers to the amount of time passengers spend in a particular location. It is a very important concept in planning and design for a facility in the airport. For example if during the peak period at Edinburgh airport, 1200 passengers are processed per hour and each passenger has a dwell time of thirty minutes, so the maximum number of passengers in the lobby at any given time will be  $1200 \times \frac{1}{2} = 600$ . So in planning for space you need to provide space for 600 passengers not 1200 passengers. In the design, the typical peak hour passenger number is often used which will mean provision is made for two times the capacity, this is often a mistake which makes the dwell time concept very relevant in space planning and design.

Our case study airports were developed for a specific set of conditions which relate to how long a typical domestic or international passenger spends in the terminal building, the percentage of that time that is spent in the check-in, ticket lobby or ticket counter, the percentage spent in security, percentage

spent in customs procedures the group guideline recommend a total of 24.2 square meters per typical peak hour passenger for domestic passenger and 39.2 square meters per typical peak hour passenger for international passenger. And there was an allocation of one square meter for the ticket lobby, 3.3 square meters to customs and 3.8 square meters allotted for security. For an effective and efficient performing airport the design process for airport terminal need to focus seriously on the dwell time of the users of the airport, meaning the actual time spent on the airport by the passenger is important.

An example of this shows much of the dwell time behaviour can be linked with the people or the passengers. For example the travelling Irish passengers behave in a completely different manner from the Scottish passenger, in respect of their dwell time at the case study airports. The observation was easy because during the 6 nation rugby tournament all sets of fans from England, Italy, France, Wales, Ireland and Scotland the six nations in the tournament were observed for their dwell time behaviour over the duration of the tournament at Edinburgh airport.

## 5. THE AIRPORT-AIRCRAFT-AIRPORT AAA MODEL AND 3 STAGE APPROACH

This aspect outlines the development of the research project from inception to completion in developing the key performance indicators (KPIs) for airport safety and security. A series of processes were adopted in conducting the research, before arriving at the final KPI list. The stages are:

1. Review of International Air Transport Association (IATA) standards.
2. Review of Civil Aviation Authority (CAA) incidents.
3. Review of the operational practices (work placement, interview, workshop).

The research used AAA approach (Airport-Aircraft-Airport) in arriving at the KPI for airport safety and security. Questions were design to elicit answers in two broad areas:

- Airport.
- Aircraft.

Airport examined movement in and out of the airport; airport access, airport passengers terminal, movement of baggages, capacity of airport building, design concept, level of service, IATA space standard, passenger dwelling time, flow standards, airport master plan, support facilities, emergency services, apron, runway/ taxiway, cargo terminal, check-in area, signage. Security, retain space, car parks, apron layout, offices, information service, baggage hall.

Aircraft relate to all other activities outside of the aerodrome, but within the aircraft, before take off and during flight, to landing and discharging of passengers. The research focuses on airport facilities; trying to determine their performance and ways of improving their efficiency and effectiveness.

### 5.1. Review of standards (IATA Level of service)

Airport terminals are for mass transport, with huge numbers of passengers, visitors and workers expected to stay at the arrival and departure halls. Security is a major issue everybody going through the airport is subject to some form of screening or searching from people to baggage and from airside to landside. As you move from non-secured to secured zones movement of people and their belongings have to go through the x-ray machines, metal detector and security checks points. Apart from the outside world where there is complete freedom, at the airport you move through different levels of securities as you move from one zone to the other. There are two major zones for security purpose:

- Restricted zone (RZ).
- Controlled area (CA).

You also have:

- Airside.
- Landside.

The level of service offered at the airport terminals represents the quality and condition of service as experienced by the passenger in one or more of the airport facilities like baggage reclaim, check-in, security, boarding cards, waiting/circulating and dwelling. And can be measured in waiting time, processing time, dwelling time, walking time. Most airport set service level target these are very important because of the implications on the airport in terms of cost and economics as well as image to the public, no airport would like to be known for its long winding queues or long delay in processing passengers through on the day of travelling. This issue is so important that IATA has an acceptable standard expected of any airport. IATA airport development manual specifies, six (6) categories from A = excellent through C = good to F = unacceptable. The Table 1 shows Level of Service (LOS).

Flows and Delays refer to movement of passengers and their carts through the airport. Comfort is the feeling of the passengers resulting from flows and delays in the processing.

The old version of airport development manual 8<sup>th</sup> edition along with the new version of the manual the 9<sup>th</sup> edition were presented by (De Neufville, 1990; De Neufville and Odoni, 2002) in four main areas. All further

discussions of LOS in this paper will be based on these four areas which IATA standard also provides:

1. Check-in Area.
2. Baggage claim Area.
3. Passport/Hold.
4. Wait/circulate.

Both old and new versions are measured in square meter per passenger for level of service, the main difference between the old and the new versions is that the new versions makes provision for carts/ bags along side passengers while old version considers passengers only for level of service provision.

### 5.1.1. IATA LOS Space standard

Table 2, is the old version of IATA LOS in square metre per person. The A to E and F represent the level of service, from excellent to inadequate and unacceptable, F was not reflected on the table because it is unacceptable at all times, whether peak or rush or crush periods. The new version created more space as required for movement with bags and carts. The next stage presents the IATA space standards for each of the key areas highlighted above. With some areas requiring more space for carts and bags than other areas, areas like after check-in desk and some times no more carry on luggage or hand bags, so the space specification would actually vary depending on

**Table 1.** IATA level of services standards specified for airports

LOS	FLAWS	DELAYS	COMFORT
A – Excellent	Free	None	Excellent
B – High	Stable	Very few	High
C – Good	Stable	Acceptable	Good
D – Adequate	Unstable	Passable	Adequate
E – Inadequate	Unstable	Unacceptable	Inadequate
F – Unacceptable	System breakdown	System breakdown	Unacceptable

\* Airport Manager must specify level of service;

\*\* Standard acceptable minimum LOS be level C and Level D for rout/crush periods.

**Table 2.** IATA level of service Space standards in square metres

Area	A	B	C	D	E
Wait/circulate	2.7	2.3	1.9	1.5	1.0
Bag claim	2.0	1.8	1.6	1.4	1.2
Check-in queue	1.8	1.6	1.4	1.2	1.0
Hold-room/inspection	1.4	1.2	1.0	0.8	0.6

the area of the airport or aerodrome you are in. Innes and Doucet (1990) demonstrated the importance of level of service in airport choice decision making, they believe that passengers prefer fast and quick service which they referred to as Jet service and concluded that passengers will go any distance to acquire the kind of service they require.

**5.1.2. IATA standards: Check-in area**

The check-in area is where the journey starts from at the airport, it begins when a passenger submit it's self and belongings for check-in, to obtain boarding pass/card and process himself for the onward journey and ends when he leaves the ticketing counter after putting his luggage on hold. Average processing time will depend on a lot of factors; like the number of passengers at check-in, numbers of counters open for service, numbers of staff at the counters, airline operating policies. The capacity of checking area can be calculated by estimating the average service time and this can be done by calculating the numbers of passengers in the terminal hold area and multiplying by size of the area.

Table 3, presents the old edition of the IATA LOS manual for airports in the check-in area, they are measured in square meter per passenger. The next Table 4 is the new edition of IATA LOS manual; here provision is made for carts and bags, whether there are few or more or high or heavy. Passengers with heavy bags/carts are given more provision in terms of square meter per passenger, and the ones with few get the least.

**Table 3.** IATA LOS in Check-in area

Square metre per passenger for level of service				
A	B	C	D	E
1.8	1.6	1.4	1.2	1.0

**Table 4.** IATA LOS in Check-in area

Row width	Carts bags	Square metre per passenger for level of service				
		A	B	C	D	E
1.2 m	Few	1.7	1.4	1.2	1.1	0.9
	More	1.8	1.5	1.3	1.2	1.1
1.4 m	High	2.3	1.9	1.7	1.6	1.5
	Heavy	2.6	2.3	2.0	1.9	1.8

**5.1.3. IATA standards: Baggage claim area**

The baggage claim area usually refers to incoming passengers. After disembarking from the aircraft through the gates to the terminal building; the number of passengers waiting in the baggage reclaim facility will depend on a number of factors, the rate of arrival, the luggage process rate and the number of aircraft arriving at the time and when larger aircraft with full passenger capacity arrive the demand for this service will be greater than when smaller planes with fewer passenger arrive and also the number of baggage reclaim belt or facility at the airport. We can estimate the average time a passenger spend in the reclaim area by calculating the number of passenger in the reclaim area and the size of the reclaim area and the speed of processing reclaim. In most cases, it is the number of passengers in the area that is more relevant than the number of bags in trying to estimate the average time a passenger has to wait for bags. Mathematical models like queuing theory can be used to estimate the numbers of passenger in the baggage claim area.

**Table 5.** IATA LOS in Baggage claim area

Square metre per passenger for level of service					
A	B	C	D	E	F
2.0	1.8	1.6	1.4	1.4	0

**Table 6.** IATA LOS in Baggage claim area

Square metre per passenger for level of service					
A	B	C	D	E	F
2.6	2.0	1.7	1.3	1.0	0

Table 5, is the old edition of the manual in the baggage claim area while. Table 6 is the new edition, the main difference between Tables 5 and 6 is that Table 6 assumes that about 40% of airport users use carts or bags and gives more range for A, excellent LOS and less for E inadequate LOS and zero for F (unacceptable at all times).

#### 5.1.4. IATA Standard: Passport/Hold

Passport controls are required for passengers departing for and arriving from international flight, there are customs and immigration formalities at every airport where passengers comply with the laws of the country. But the passenger holding area refer to all areas where the passenger wait for flight for departure and areas where they wait before they collect there luggage's from arrival, it includes facilities like baggage reclaim, transit lounge, airport control lounge, lobbies. Usually for a departing passenger the control activities are carried out at the check-in desk and security operations area, before proceeding to the departure lounge where the airline does the final check and escort the passenger through the piers to the waiting aircraft. But for the arriving passenger the situation is slightly different, the arriving passenger comes through the gates straight to immigration control, they will be processed according to nationality, citizens have there own lines as different

**Table 7.** IATA LOS in Passport/Hold areas

Square metre per passenger for level of service				
A	B	C	D	E
1.4	1.2	1.0	0.8	0.6

**Table 8.** IATA LOS in Hold areas

Maximum occupancy rate (% of capacity)				
A	B	C	D	E
40	50	65	80	95

from other nationals, you are then subject to these immigration control and custom control before going to the baggage reclaim for you bags after which you may be subject to further checks depending on what you are carrying and where you are arriving from. Here the average waiting time depends on the number of passengers on queue the number of control officers at work and speed at which it takes to process each passenger and the size of the control area.

Table 7 presents the old edition of LOS in Passport/Hold areas and are measured in square meter per passenger while Table 8 is the new edition of the LOS in the Hold areas the belief is that at the passport desk you only have your carry-on luggage. This new edition assumes 1.7 square metre per passenger sitting and 1.2 square metre per passenger standing. LOS is defined in terms of % of Space use in the Hold area. The meaning is that for an excellent LOS the maximum occupancy rate expressed in % of capacity should be 40% and 95% for inadequate LOS.

#### 5.1.5. IATA Standard: Wait/Circulate

Waiting areas are those parts of the airport where people are allowed to shop, eat and relax before or after their journeys; this would include all the shops, restaurants, bars, cafes, areas where circulation takes place after check-in, some of these areas are opened to the



general public not only the travelling passenger, so that a passenger can spend some time with their loved ones before proceeding on a trip. The amount of time spent by a passenger to move from the entrance to the gate of the aircraft will depend on the time spent in waiting and the time spent in the service of the facilities he goes through on the day of travel, and the time he takes to move from one facility to the other. On a general note the space standard allows for planning and design of the processing facilities, it also allows for the allocation of resources, it determines the efficient use of space, time and resources.

**Table 9.** IATA LOS in Wait/Circulation areas

Square metre per passenger for level of service				
A	B	C	D	E
2.7	2.3	1.9	1.5	1.0

Table 9 is the old version of the IATA in Waiting/Circulation areas, LOS is expressed in square meter per passenger and Table 10 is the new versions of IATA LOS in Wait/Circulation areas this edition takes into consideration the passenger’s location and the likely of carts and bags and makes reference to the speed per second and space per passenger.

**Table 10.** IATA LOS in Wait/Circulation areas

Location	Carts	Space square metre per passenger	Speed metre per seconds
Airside	None	1.5	1.3
After check-in	Few	1.8	1.1
Departure area	Many	2.3	0.9

**5.2. Review of CAA incidents**

In carrying out this research a case study approach was adopted for the research project and data was collected from the Civil Aviation Agency (CAA) Safety Regulation Group Safety Investigation and Data Department (SIDD).

The CAA database contains information on incidents, which was extracted, analysed and presented. These records were retrieved from UK CAA mandatory Occurrence Reporting (MOR) systems. Information was on all May-day/emergency calls made by passenger aircraft flying across Scotland from the period January 2000 to January 2007, and tested by Enoma and Allen (2007).

Das (1983), Yin (1994), Kaplan and Norton (2001), Wiggins and Tymms (2001), Adey (2004) and Beatham et al. (2004) have all contributed to the issue of performance measurement, safety and security as well as key performance indicators.

In reviewing the CAA incidents the variables used for the Key Performance Indicators for airport safety and security were used to analyse the CAA database, from incident report on aircraft emergency calls made across Scotland.

1. Airport facility failure.
2. Fire incidence.
3. Evacuation.
4. Hysteria control.
5. Others.

Statistics was used to establish relationship amongst variables in order to explain, predict and control their occurrences. The relationship is co-relational and not causal. There are two data sets or variables to investigate and confirm if a relationship exists between them and the nature or magnitude of the relationship. Chi square statistics is used to test for dependence of the variables and the airports. The argument here is whether the hypothesis of independence between the data set and the airport is tenable? Chi-square was used in the process of analysis; it is a process of statistical elaboration in trying to establish a relationship between the hypothesis and the variables used in the study. This is a theory guided process in an attempt to explain the causal relationship that exists between the variables and the case study.

Chi square test consists of calculating expected result under the hypothesis of independence and comparing it with the observed result, in this study, the observed result are collected from the CAA database on emergency calls made across Scotland over the period January 2000 to January 2007. The results are presented in Table 11. The competing hypothesis under test in this problem may be stated as follows:

$H_0$  = incidences reported by CAA are independent on the airports.

$H_1$  = incidences reported by CAA are dependent on the airports.

The test statistics used to make the comparison is the Chi square Statistics:

$$\chi^2 = \sum \frac{(\text{Expected} - \text{Observed})^2}{\text{Expected}} \quad (1)$$

Number of the Degree of Freedom is usually determined in order to apply the  $\chi^2$  test.

The degree of freedom is (r-1) (c-1), thus in this study the degree of freedom is (3-1) (5-1) =  $2 \times 4 = 8$ .

The decision rule is

$$\chi_{\text{calculated}}^2 > \chi_{\text{tabulated}}^2, \text{ reject } H_0, \quad (2)$$

$$\text{If } \chi_{\text{calculated}}^2 \leq \chi_{\text{tabulated}}^2, \text{ accept } H_1 \quad (3)$$

Then we find the critical value at  $\chi_{0.05}^2$  that is at 95% confidence interval, given a degree

of freedom of 8 then we have the result stated below.

Chi-square calculated $\chi^2$	25.71
Chi-square tabulated @ 95%	15.51
Chi-square tabulated @ 99%	20.09

**DECISION RULE**

$$\chi_{\text{calculated}}^2 > \chi_{\text{tabulated}}^2, \text{ Reject } H^0 \text{ and accept } H^1 \quad (4)$$

Chi-square calculated was greater than Chi-square tabulated at both 95% and 99% confidence interval. So we accept that the incidents are dependent on the airport.

**5.3. Review of operational practice**

The methodology employed in data collection was triangulation a mixed methodology, involving the use of questionnaires, structured interviews and workshop. It was largely exploratory as well as qualitative in nature, rich in content and voluminous.

It was also necessary to reduce this large volume of data into useable literature, to further support the research subject. The study main aim was to develop and test a set of Key performance indicators for airport safety and security. While at the same time, attest to the fact that FM had a role in improving airport facilities.

Hypothesis was not developed since it was not the intention of the study, to formulate

**Table 11.** Observation data: emergency calls made by commercial aircraft in 3 Scottish airports

Factors	Glasgow	Edinburgh	Aberdeen	Total
Facility failure	29	25	35	89
Fire incident	6	7	2	15
Evacuation	3	6	0	9
Hysteria control	18	10	1	29
Others	11	6	4	21
Total	67	54	42	163

Source: CAA database.

theories and test them. However in applying statistical tool of Chi-square in the process of analysis, it became necessary to use hypothesis to accept or reject our data. The data collected from CAA data base was presented and analysed using statistics to support the analysis; tables, graphs, charts and calculations were used to further elucidate. In reality, interview transcripts are normally analyse by reading through and in this research they were analysed by reading through to highlight common areas in response and compared with other responses in the case studies.

Table 12 gives an indication of the passenger flow in one of the case study airports, most journeys are either leisure related or business related, at Edinburgh airport about 53% are leisure users while business accounts for the remaining 47%.

Work placement at Edinburgh international airport provided opportunity for the researcher to observe the operational procedure at one of the case study airport without the workers/staff knowing that such a study was going on. But in trying to measure all areas of performance there was the need to profile the behaviour pattern of passengers going through each of the case study airport and also those arriving into each of the case study airport. The very essence of the profiling was not only to measure performance but also to see if they were in compliance with the IATA standard and if it had any design implication for each

of the case study airports. Also to see for the study the FM practices in each of the airports.

The interviews provided further incite into the FM practices in each of the case study airports, being the very first contact with the case study airports; it provided the researcher with a lot of information with regards to the design, passengers handled, the dwell time, the airport capacity and the various facilities present in each of the airports. Then further visits during the passenger profiling provided more answers to things that were not so very clear at the initial visit. The interview with the facilities managers gave all the needed information on the airport facilities and how they are used to create value for the airport. Security was seen as the primary duty of every airport worker, for example the Facility manager for Glasgow airport sees himself first as a security officer of Glasgow international before his function as the airport’s facility manager.

The workshop further interaction with the airport officers, the questions asked provided further information into the operational procedures, the question on priority was meant to give the operational procedure in case of an emergency a kind of contingency plan i.e. The operational procedures adopted during the occurrence of any incidence relating to the KPIs in the list. Measure of success was the KPIs itself, its gives information on the efficiency and effectiveness and the resources available for dealing with the issues. Target was a kind

**Table 12.** Edinburgh passenger traffic for the year 2002–2006

Year	Annual domestic passengers (millions)	Annual international passengers (millions)	Annual total passenger (millions)
2002	4.93	1.98	6.91
2003	5.40	2.08	7.48
2004	5.84	2.15	7.99
2005	6.13	2.31	8.44
2006	5.88	2.73	8.61

Source: BAA Edinburgh.

of benchmark for improvement, an indicator of how well the airports are doing with the resources available to them. In addition it is envisaged that once an approved list of KPIs has been developed further research will be undertaken with the airport teams to identify the impact of each on the airport facilities, and if it does have a design implications for the airport facilities. From these set of interviews a final set of KPIs was then reached which will be validated by expert opinion.

## 6. CONCLUSION

The study set out to look at how to implement safety and security at the airports, it developed performance measurement for airport safety and security, a three (A) model was developed for the research and the model employed a 3 stage approach in the research process, a detail examination of the case study airports involved passenger profiling in both arrivals and departures.

The data collected from CAA data base had to be presented in excel and analysed using statistics to support the analysis; tables, graphs, charts and calculations were used to further elucidate. In reality, interview transcripts are normally analyse by reading through and in this research they were analysed by reading through to highlight common areas in response and compared with other responses in the case studies. The implication of this is that as we analyse the trends and the variables in the case study airports, it is sufficient to say that the airports handles different classes of passengers and travels and that support our findings that planning for safety and security has to be airport specific as it has to take into account the needs of the different users. The result of our analysis shows that the incidents are dependent on the airport meaning that in planning for safety and security the plan has to be airport specific.

In planning for airport safety and security, a complete redesign of the airport using the IATA standard of level of service specification is necessary not only to provide excellent level of service to airport users but to be sure of effectiveness in the use of space and other related resources, a one directional movement is recommended for flow in and around the airport so that counter traffic can easily be sported, and those in breach easily identified.

Facilities Management process considers risk management in airports in the delivery of airport services, particularly in the area of airport safety and security. Lessons from past incidents helped in formulating new processes the various hijacking in the past form the basis of the present day security at the airport in 1985; Indian jet was lost off Cork through a bomb in an unaccompanied suitcase. In Lockerbie 21<sup>st</sup> December 1988, an unaccompanied suitcase carrying a Toshiba radio/cassette player bomb was put on board a Pan American flight bound for New York the result was loss of 270 lives 259 on board and 11 on ground. The best defence against all this incident is a good security measures to prevent unauthorised access to aircraft any where in the airport. Serious security checks to stop anybody staff and passengers from slipping anything on board aircraft. Efforts must be made to stop the terrorist before they get to the aircraft. The various incidents in the past have so far informed the following action.

- Airports are equipped with highly sophisticated devices that can detect explosives, powerful x-ray that can scan radio, laptops and video against makers' manual in-case of (Lockerbie Bomb).
- Passenger/Baggage reconciliation if the bar code tag cannot be matched to a passenger on the computer the bag doesn't fly.
- Security consciousness passengers are themselves checked by security officers and CCTV for names know to the immigration service.

- Currently there are studies, research into ways of making commercial aircraft harden to resist bomb attack.
- Armoured Luggage containers.
- Padded walls to channel the blast.
- Future aircraft will be resistant to terror attack in built like military planes are able to resist some amount of battle damage.

Airport safety and security is all about risk management. The two components that contribute to risk analysis are likelihood and hazard. The ideal risk model is one that can be applied to a number of different threat scenarios at any time. The process should be flexible and simple enough to allow decision makers allocate resources that can shield the wildest array of threats, vulnerabilities and consequences. In the process of developing risk models different teams should look at similar risk scenarios from slightly different perspective to avoid going off in the wrong direction. A workshop situation with different groups or teams expressing their views on various risk scenarios based on experience or perceived opinion either learned or acquired.

Airport design, facilities Management and airport safety and security are all important in providing aviation industry and the travelling public with safe and secured air transport system. Airport are designed to serve the public, what separates one airport design from the other depends upon the types of services it provides, the size of aircraft it serves, and the length of the runways with its complementary terminal facilities, these are all supported by this research whose result suggest that incidents are airport specific meaning that in planning for airport safety and security; there is the need to take into consideration the type of business mainly done in the airport, the users of that airport and the facilities available for use in that airport. Airport design influences airport capacity, level of service standards, dwell time, safety and efficiency of operations

on the ground and in the air. FM influences the design and management of airports.

Findings. It is recommended to redesign the airport to effect safety and security whilst working with IATA level of service standard for excellent service; dwell time calculation is an important factor in providing level of services that are comfortable and useful in airport operations.

Research limitations/implications - the multiple case studies focused on only three Scottish airports and were examined and analysed by KPIs developed for airport safety and security (Enoma and Allen, 2007). CAA database also provided a useful test case, IATA LOS specification provides the guide in airport redesign.

Originality/value - this paper the redesign of for airport safety and security, used a set of raw data collated by the CAA and IATA LOS specification.

## REFERENCES

- Adey, P. (2004) Secured and sorted mobilities: examples from the airport, *Surveillance & Society*, 1(4), pp. 500–519.
- Amaratunga, D. and Baldry, D. (2003) A conceptual framework to measure facilities management performance, *Property Management*, 21(2), pp. 171–189.
- Blakey, M.C. (2005) Aviation safety issues. In: Committee, SC, Ed., New York: US Congress, Administrator of the federal aviation.
- Das, T.H. (1983) Qualitative research in organisational behaviour, *Journal of Management Studies*, 20(3), pp. 301–314.
- De Neufville, R. (1990) *Applied Systems Analysis: Engineering Planning and Technology Management*. McGraw-Hill.
- De Neufville, R. and Odoni, A. (2002) *Airport Systems: Planning, Design, and Management*. McGraw-Hill Professional.
- Enoma, A. and Allen, S. (2007) Developing key performance indicators for airport safety and security, *Facilities*, 25(7/8), pp. 296–315.

- Faulkner, B. and Vikulov, S. (2001) Katherine, washed out one day, back on track the next: a post-mortem of a tourism disaster, *Tourism Management*, 22(4), pp. 331–344.
- Innes, J.D. and Doucet, D.H. (1990) Effects of access distance and level of service on airport choice, *Journal of Transportation Engineering-ASCE*, 116(4), pp. 507–516.
- Kaplan, R.S. and Norton, D.P. (2001) Transforming the balanced scorecard from performance measurement to strategic management: Part I, *Accounting Horizons*, 15(1), pp. 87–104.
- Paraskevas, A. and Arendell, B. (2007) A strategic framework for terrorism prevention and mitigation in tourism destinations, *Tourism Management*, 28(6), 1560–1573.
- Quarantelli, E.L. (1986) Disaster crisis management: The need for planning, training, and policy on emergency preparedness. In: Logan, M.E. (Ed.) *Canada Today & Tomorrow*, Ottawa, Canada: Emergency Planning Canada, 1986, pp. 80–86.
- Beatham, S., Anumba, C., Thorpe, T. and Hedges, I. (2004) KPIs: a critical appraisal of their use in construction, *Benchmarking: An International Journal*, 11(1), pp. 93–117.
- Smith, D. (1990) Beyond contingency planning: towards a model of crisis management, *Organization & Environment*, 4(4), 263–275.
- Wiggins, A. and Tymms, P. (2001) Evidence-Based policies: The Effect of Key Performance Indicators. *Proceedings of the Third International, Inter-disciplinary Conference on Evidence-Based Policies and Indicator Systems*, Durham, UK, July 2001. Durham University, pp. 292–300.
- Yin, R.K. (1994) *Case study research: design and methods*. Thousand Oaks: Sage Publications.

## SANTRAUKA

### ORO UOSTO PERTVARKYMAS SIEKIANT SAUGUMO IR APSAUGOS: TRIJŲ ŠKOTIJOS ORO UOSTŲ ATVEJO TYRIMAI

Aghahowa ENOMA, Stephen ALLEN, Anthony ENOMA

Šiuo tyrimu siekta sukurti oro uosto saugumą ir apsaugą užtikrinančius pagrindinius veiklos rodiklius (KPI), pasitelkus atvejo tyrimą ir etnografinį požiūrį į tyrimą. Daugiausia dėmesio skirta pastatų ūkio valdymo reikšmei, didinant oro uosto saugumą ir apsaugą. Tyrimo centre – atvejui tirti pasirinktų oro uostų vadovai ir darbuotojai bei pastatų ūkio valdymo ir aviacijos sričių ekspertai. Šiam tyrimui pasirinkta metodika – tai trijų Škotijos oro uostų, priklausančių ir valdomų BAA Scotland (Glazgo, Edinburgo ir Aberdyno tarptautiniai oro uostai), atvejo tyrimas. Iš Civilinės aviacijos agentūros surinkti duomenys buvo išanalizuoti ir yra pateikiami tyrime. Tyrimo metu sukurtas trijų O modelis (oro uostas – orlaivis – oro uostas; angl. Airport-Aircraft-Airport, t. y. trijų A modelis) ir trižingsnis požiūris į tyrimo procesą. Iš šiame darbe pateiktų įrodymų kyla išvada, kad kiekvienas oro uostas saugumą ir apsaugą planuos kitaip, nes nėra dviejų visiškai vienodų oro uostų: skiriasi jų dydis, valdymo būdas, keleiviai ir skrydžių paskirties punktai.