ETM
ENGINEERING & TECHNOLOGY MANAGEMENT

Benefit-Cost Ratio Analysis: Life Safety and Airport Infrastructure Risk Reduction using Counter Terrorism Measures

Course Title: **Advanced Engineering Economics**
Course Number: **ETM535/635**
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Term: **Fall**
Year: **2013**
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ETM OFFICE USE ONLY
Report No.:
Type: Student Project
Note:

BENEFIT-COST RATIO ANALYSIS: LIFE SAFETY AND AIRPORT INFRASTRUCTURE RISK REDUCTION USING COUNTER TERRORISM MEASURES

ETM 535 Advanced Engineering Economics

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Fall 2013

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1. Abstract

Post September11, 2001 there has been an increased awareness of terrorism globally and as a result nations have increased spending in regards to combating terrorism. Since 2002, the United States Department of Homeland Security has seen an average annual increase of 6.85% in its budget [1, 2]. Arguments stating that majority of the money and effort spent since 2002 has been wasted have been presented [3]. Specifically looking at the aviation security subset, recognition that the various aviation security infrastructure projects must "*be installed in and function as part of operating airports, which, throughout the entire process, must be continue to handle ongoing operational requirements in a competitive and cost-effective manner to the satisfaction and safety*" [4] of involved stakeholders, is a tremendously complex task; whose risks, not properly planned for, can be a cause of project slip. Solution providers must consider this dynamic environment in addition to any internal causes of risks that could affect the project outcome if project success in terms of positive financial performance is to be had. This paper will examine this volatile operating environment in an attempt to provide a quantification method to assess the benefits in the manufacturing, deployment and service of life safety systems in the aviation field. Specifically, a case study in which a cost benefit analysis is conducted from the perspective of the Transportation Security Administration in conjunction with Denver International Airport, of the dynamics surrounding explosive detection equipment that scan checked baggage will be conducted to analyze the effects of the involved risks on the economics of deploying infrastructure pieces in this environment. Correlations between this type of infrastructure construction project and others will be made in an attempt to draw upon proven project management strategies to combat risk and increase profits.

2. Literature Review

The advanced security postures taken by governments around the world are due in part to a handful of spectacularly disastrous events that have warranted the increased security. The bombing of Pan AM Flight 103 over Lockerbie, Scotland in 1988, TWA Flight 800 in 1996, and the events of September 11, 2001 in which the World Trade Center and the Pentagon were attacked by hijacked planes. The first event prompted the US Government to enact a law in 1990, requiring the Federal Aviation Administration to install explosive detection equipment. Due to the inability of the government and the US airline industry to agree on standards, the infrastructure remained uninstalled until 1996. The explosion of TWA flight 800 prompted the US government to revisit the explosive detection standards and as a result, Congress mandated 100% checked baggage screening by 2013. The events of 9/11 prompted the government to accelerate that timeline to December 31, 2002 and created the Transportation Security Administration through Public Law 107-71, the Aviation and Transportation Security Act [5,6,7,8,9,10,11,12,13,14,15].

The aforementioned events forced airports across the United States to install the required explosive detection equipment. A fraction of the United States airports had the required detection equipment prior to 9/11, resulting in a massive construction push to meet the imposed deadline [5]. Existing airports required occupied retrofitting of the existing infrastructure during live operations as the public/airline industry would not stand for massive delays for construction, while new airports would be built with the required infrastructure. The haste in which Congress and the involved companies handled the installation of the explosive detection equipment resulted in massive waste of taxpayers' funds [17].

A common definition of cost-effectiveness of enacted counter-terrorism measures is in terms of cost spent on risk reduction per life saved against an applied terrorist threat [14, 16]. Starting with these considerations, our research begins.

M. G. Stewart and J. Mueller in [11] state, " Several risk-based approaches to cost-benefit analysis that consider economic and life-safety criteria for the protection of buildings, bridges and other built infrastructure have been developed, with cost-effectiveness contingent on the likelihood, cost, and effectiveness of security/protective measures and consequence of terrorist attacks on such infrastructure. Following this approach, Stewart and Mueller conducted an assessment of increased United States federal homeland security expenditure since the 9/11 attacks and of expected lives saved as a result of such expenditure. The cost-benefit analysis suggests that the annual cost per life saved ranges from $64 million to $600 million, greatly in excess of the regulatory safety goal of $1-$10 million per life saved. This means that $300 billion spent by the United States government to protect the American homeland from terrorism since 2001 fails a cost-benefit analysis. These findings focus on the total homeland security budget. This is not to say, however, that every specific security measure fails to be cost-effective. There may be some that are."

3. Background

Our group set out to develop a comprehensive model that took into consideration "total" airport infrastructure pieces to include (the airport itself, explosive detection equipment, aircraft, people, emergency responders, emergency response vehicles) to develop a cost benefit analysis that looked at the situation from a system perspective as opposed to one of the individual elements. We pose that, given a total "system" perspective as we have described, a favorable cost-benefit analysis could be had. Aviation system is protected by a layered security strategy that is sometimes, but not always, effective. Multiple types of security technologies and other measures provide several lines of defense that must be breached for an attack to be successful; however, no security measure is 100% effective. Risk reduction (ΔR) is influenced by human factors, reliability of security gateways, and the possibility of terrorists to find ways to retaliate against the current security system [18].

4. Problem Statement

In addition to national security, commercial aviation plays a central role in the economy, and attacks on planes and airports have been targeted by terrorists. The threat of terrorist attack on aviation has made homeland security invest heavily in counter-terrorism measures, but it is difficult to determine if the benefits outweigh their costs. This paper attempts to quantify the benefits and the costs in using the security and risk mitigation measures in airports.

5. Project Scope

This paper focuses on the checked Baggage Screening equipment of the airport security system. The paper studied the issue from the Transportation Security Administration (TSA) perspective. The project model includes installation and operation costs of the checked baggage scanners. For the benefits; cost of life, aircraft and building are considered but does not include other infrastructure inside the airport. The research utilizes available data from Denver International Airport. For the purpose of the study, a time window of 10 years is chosen as the end of life-cycle of the equipment. Carry-on checked baggage scanners are not included in the scope of the study.

6. Research Framework

Installation and operation of the baggage scanners is the responsibility of TSA for the safety and security of the public. TSA receives funds for the installation and operations of the baggage scanners from the federal government. These funds are tax dollars which makes the public, the owner of the project. Baggage scanning equipment involves significant investment in terms of leading edge technology and the quantity needed. In addition, we have to look constantly at upgrading this infrastructure to ensure it can keep up with the latest and greatest vulnerabilities that terrorists look to exploit. Even though these projects do not result in a direct monetary return on investments, they are of benefit to the public relating to safety and protection from terrorist attacks. So, we have identified the Benefit - Cost (B-C) ratio analysis as an ideal mechanism to quantify the effective usage of our tax dollars investment in this element of the aviation industry.

7. Methodology

To calculate the costs involved, we have chosen the Equivalent Uniform Annual Cost (EUAC) as the basic standard in the analysis.

a. EUAC

EUAC is a uniform annual series of costs involved in a project for the project duration. This is equivalent to the discounted cash outflows at the Minimum Attractive Rate of Return (MARR). EUAC is equivalent to the Annual worth (AW) of the project when there are no revenues (cash inflows) involved.

The formulation for EUAC is as follows:

$EUAC = I(A/P, i\%, N) + E$

Where, I = Initial Investment

i = MARR

N = Project Duration

E = Annual Expenses

b. Benefit-Cost Ratio

Benefit-Cost ratio is commonly used in the evaluation of the public and nonprofit projects where monetary return on investments is not expected but instead some benefits are realized. In the benefit cost analysis, the benefits are quantified and compared with equivalent costs involved.

The formulation for Benefit Cost (B-C) ratio is as follows

B-C ratio = (AW (Benefits) – AW (Disbenefits))/(AW(Investment)+AW(O&M costs))

If the B-C ratio of the project is greater than 1, then the project is acceptable.

c. Benefit

A quantification approach for benefits of safeguards from various types of terrorist attack risks has been published in previous studies [19]. We have identified some modifications in order to address the specific application to checked baggage screening systems and enable the quantification of the life safety risk scenarios involved. With that in mind, we have proposed the following parameters and the formula to calculate the benefits with deploying a checked baggage screening system.

i. Parameters

P_{attack} = Probability of a terrorist attack happening.

$P_{(intensity\ of\ threat|attack)}$ = Probability of a high or medium or low intensity of attack given that attack happens.

$P_{(originated\ in\ BG|\ intensity\ of\ threat)}$ = Probability of the attack originated in Baggage Screening Department given the intensity of the threat.

$R_{due\ to\ security\ measure}$ = Reduction of the risk due to the security measures

$P_{loss\ of\ life}$ = Probability of a terrorist attack happening

$C_{loss\ of\ life}$ = Cost of loss of life if the threat happens

$P_{loss\ of\ aircraft}$ = Probability of a terrorist attack happening

$C_{loss\ of\ aircraft}$ = Cost of loss of aircraft if the threat happens

$P_{loss\ of\ property}$ = Probability of a terrorist attack happening

$C_{loss\ of\ property}$ = Cost of loss of property if the threat happens.

ii. Formula

Total Benefit: $E_b = P_{attack} * ((P_{(intensity\ of\ threat|attack)} * P_{(originated\ in\ BG|\ intensity\ of\ threat)}) * R_{due\ to\ security\ measure}) * ((P_{loss\ of\ life} * C_{loss\ of\ life}) + (P_{loss\ of\ aircraft} * C_{loss\ of\ aircraft}) + (P_{loss\ of\ property} * C_{loss\ of\ property}))$

d. Cost

A quantification approach for costs for baggage screening systems has been published from previous studies [7]. We have identified some modifications required to the approach in order to address the specific application to checked baggage screening system (e.g. first vs. second vs. Explosive Ordinance Disposal teams) usage modes. With that in mind, we have proposed the following parameters and the formula required to calculate the cost aspects of the checked baggage screening systems. With that, we have proposed the following parameters and the formula to calculate the costs in deploying and maintaining a checked baggage screening system.

i. Parameters

Probability parameters

$P_{FA} = P_{A|NT}$ = probability of falsely indicating a threat by the device recoverable with re-screen

$P_{FA\_MIN} = P_{A\_MIN|NT}$ = probability of falsely indicating a threat by the device recoverable with single re-screen

$P_{FA\_MAX} = P_{A\_MAX|NT}$ = probability of falsely indicating a threat by the device recoverable with double re-screen = $P_{FA} - P_{FA\_MIN}$

$P_{TC} = P_{NA|NT} = 1 - P_{FA}$ = probability of correctly indicating a non-threat by the device

$P_{TA} = P_{A|T}$ = probability of correctly detecting a threat by the device

$P_{FC} = P_{NA|T} = 1 - P_{TA}$ = probability of not detecting a threat by the device

P_T = probability that a checked bag contains a threat

Cost Parameters

C_{FA_MIN} = cost of falsely indicating a threat recoverable with single re-screen

C_{FA_MAX} = cost of falsely indicating a threat recoverable with double re-screen

C_{FC} = cost of not detecting a threat

C_{TA} = cost of correctly detecting a threat

C_{TC} = cost of correctly indicating a non-threat

C_F = purchase price and installation cost (fixed) of a baggage screening security device

C_O = annual maintenance costs (operational) for a baggage screening security device

C_I = cost of operating a baggage screening security device, per checked bag inspected

B = No. of bags screened per year

ii. Formula

Total Cost: $E_C = AW(C_F) + C_o + C_I*B + ((P_{FA\_MIN}*C_{FA\_MIN})+(P_{FA\_MAX}*C_{FA\_MAX}))*(1-P_T)*B + P_{FC}*C_{FC}*P_T*B + C_{TA}*(1-P_{FC})*P_T*B + C_{TC}*(1-P_{FA})*(1-P_T)*B$

8. Analysis

a. Aircraft and Passenger data

We obtained basic statistics from public domain for Denver International Airport in the US as shown in Table 1.

YEAR	DOMESTIC	INTERNATIONAL	TOTAL	DOMESTIC	INTERNATIONAL	TOTAL
2002	**15,905,103**	**505,279**	**16,410,382**	**190,251**	**5,090**	**195,341**
2003	**17,279,336**	**579,241**	**17,858,577**	**224,495**	**6,486**	**230,981**
2004	**19,588,737**	**669,121**	**20,257,858**	**254,044**	**6,765**	**260,809**
2005	**19,924,942**	**763,950**	**20,688,892**	**254,099**	**7,521**	**261,620**
2006	**21,838,797**	**939,239**	**22,778,036**	**271,108**	**9,449**	**280,557**
2007	**22,998,300**	**1,066,557**	**24,064,857**	**280,565**	**11,714**	**292,279**
2008	**23,164,762**	**1,084,754**	**24,249,516**	**284,120**	**11,292**	**295,412**
2009	**23,006,550**	**942,026**	**23,948,576**	**279,742**	**11,468**	**291,210**
2010	**24,268,277**	**955,656**	**25,223,933**	**290,411**	**11,806**	**302,217**
2011	**24,757,626**	**876,889**	**25,634,515**	**290,652**	**10,891**	**301,543**
2012	**24,906,331**	**869,908**	**25,776,239**	**283,863**	**10,404**	**294,267**
	Note: All numbers are for scheduled services.					
	SOURCE: Bureau of Transportation Statistics T-100 Market data.					

Table 1. 10 year data on passengers and flights from one airport in the US

The information on flights and passenger volume, derived from Table 1 and converted to the graph shown in Figure 1, indicates a steady increase in air travel. This correspondingly also increases the probability of terrorist attack using checked baggage, not only in terms of the volume of attempts, but also in terms of the vulnerabilities that the terrorists will try to exploit. This speaks to the criticality of doing such a B-C analysis and making an ideal choice to ensure safety of travelers.

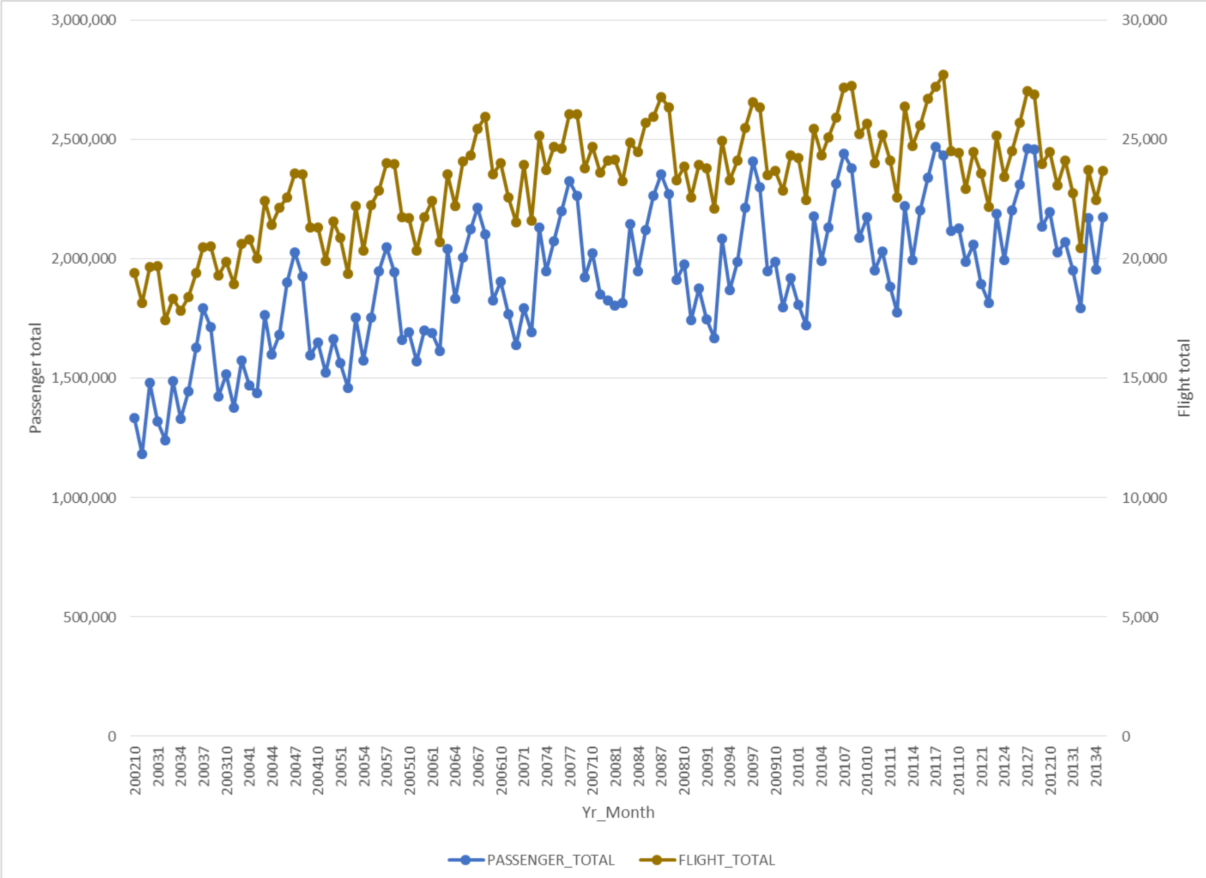

Figure 1. Flight and Passenger Volume

b. Probabilities and Assumptions

Due to the sensitivity of much of the information, we combed through information from public domain, historical and referenced data to come up with data to apply in the calculation of the B-C ratio formula specified in Section 7. The data assumptions used in the formula calculations fall into three categories, historical, referenced, and assumed.

i. Historical

This category of assumed data is based upon historical data. The variables in this category are:

1. $P_{(\text{originated in BG}|\text{ intensity of threat})}$): Probability of a the threat having originated in baggage given a high-intensity of threat

a. 6 high intensity terrorist attacks on airplanes over 25 years, namely, the bombing of Pan AM Flight 103 over Lockerbie, Scotland in 1988, TWA Flight 800 in 1996, and the events of September 11, 2001 in involved 4 hijacked planes have been considered.

b. Only 2 of these originated in checked baggage

c. $P_{(\text{originated in BG}|\text{ intensity of threat})} = 2 \div 6 = 0.3333$

2. $P_{\text{loss of life}}$: Probability of loss of life in a high intensity of threat

   a. 6 high intensity terrorist attacks on airplanes over 25 years, namely, the bombing of Pan AM Flight 103 over Lockerbie, Scotland in 1988, TWA Flight 800 in 1996, and the events of September 11, 2001 in involved 4 hijacked planes have been considered.

   b. All 6 of these resulted in a complete loss of life

   c. $P_{\text{loss of life}} = 1$

3. $P_{\text{loss of aircraft}}$:

   a. 6 high intensity terrorist attacks on airplanes over 25 years, namely, the bombing of Pan AM Flight 103 over Lockerbie, Scotland in 1988, TWA Flight 800 in 1996, and the events of September 11, 2001 in involved 4 hijacked planes have been considered.

   b. All 6 of these resulted in a complete loss of life

   c. $P_{\text{loss of aircraft}} = 1$

4. $P_{\text{loss of property}}$:

   a. 6 high intensity terrorist attacks on airplanes over 25 years, namely, the bombing of Pan AM Flight 103 over Lockerbie, Scotland in 1988, TWA Flight 800 in 1996, and the events of September 11, 2001 in involved 4 hijacked planes have been considered.

   b. Only 1 of these resulted in a loss of airport property

   c. $P_{\text{loss of property}} = 1 \div 6 = 0.1667$

ii. Referenced

This category of assumed data is based upon data available in some of the reference papers. The variables in this category are:

1. $P_{(\text{intensity of threat}|\text{attack})}$: This is the probability of a high or medium or low intensity of attack given that attack happens. 0.1 has been found as a good value to use for this variable [19].
2. P_{FA}: $P_{A|NT}$ This is the probability of falsely indicating a threat by the device recoverable with re-screen. 0.125 has been found as a good value to use for this variable [7].

iii. Assumed

This category of assumed data is based upon the team's judgment. The variables in this category are:

1. P_{attack}: This is the probability of a terrorist attack happening. We have set this to 10^{-5}.
2. P_{TA}: This is the probability of correctly detecting a threat by the device. An assumption of the baggage screening equipment used in the model will correctly detect a threat is set to 95%.
3. P_{T}: This is the probability that a checked bag contains a threat; this is assumed and set to $5.0005*10^{-9}$.
4. P_{FA_MIN}: This is probability of falsely indicating a threat by the device recoverable with single re-screen. 70% of the screened baggage is expected sent through for a re-screen.
5. Single rescreening time: This is assumed to take 40 seconds.
6. Double rescreening time: This is assumed to take 600 seconds.
7. Threat disposal time: This is assumed to take 86400 seconds.
8. Screening equipment personnel salary: This is assumed to be $12/hour.
9. EOD personnel salary: This is assumed to be $1553/hour.
10. Cost of life: $3 Million is assumed as the cost of a single life.
11. Cost of an aircraft: Cost of an aircraft is assumed to be $352M.
12. Cost of an airport: Cost of a large airport such as Denver International Airport (DIA), is assumed to be $854.4M.
13. TSA Interest Rate: TSA interest rate is assumed to be at 7%.
14. Baggage screen equipment lifetime: The lifetime of baggage screening equipment assumed to be 10 years.
15. Cost of baggage screening equipment: The cost of the baggage screening equipment for a large and busy airport is assumed to be $1.5M for each machine and a total of 80 units required to service the airport.
16. Annual Maintenance Costs: The annual maintenance costs of is expected to be at 10% of cost of equipment with an added fixed cost of $400K.
17. Annual Leasing Costs: The annual leasing costs of is assumed at a minimum of 20% of unit cost price.
18. Number of employees in a large airport in a year: Using a large airport such as Denver International Airport in a year, the number of employees is set to 31000.
19. Number of checked baggage per travel: This is assumed to be 0.9.

20. Cost of screening a bag: This is assumed to be $0.525.
21. Dis-benefits: Dis-benefits are some losses the public has to face due to undertaking of the project. For example, if we have to widen a highway, we have to buy the arable land from the farmers near the highway. This the loss of arable land is a dis-benefit for the farmers along the highway. We have assumed this to be 0.

All of the assumed data described in this section and used in validating the model is summarized in Appendix 1.

c. Results

Applying the assumed data to the formulae described in the Section 7

- $E_b = P_{attack}*((P_{(intensity\ of\ threat|attack)}*P_{(originated\ in\ BG|\ intensity\ of\ threat)})*R_{due\ to\ security\ measure})*((P_{loss\ of\ life}*C_{loss\ of\ life})+(P_{loss\ of\ aircraft}*C_{loss\ of\ aircraft})+(P_{loss\ of\ property}*C_{loss\ of\ property}))$ = $59,984,042.55
- $E_C = AW(C_F) + C_o + C_I*B + ((P_{FA\_MIN}*C_{FA\_MIN})+(P_{FA\_MAX}*C_{FA\_MAX}))*(1-P_T)*B + P_{FC}*C_{FC}*P_T*B + C_{TA}*(1-P_{FC})*P_T*B + C_{TC}*(1-P_{FA})*(1-P_T)*B$ = $48,491,878
- B-C ratio = (AW (Benefits) – AW (Disbenefits))/(AW(Investment)+AW(O&M costs)) = $E_b \div E_C$ = 1.236991544

Given that the B-C ratio is greater than 1, the checked baggage screening device is expected to be a good investment and use of tax dollars.

9. Sensitivity Analysis

We decided to do some further analysis of the model and vary individual parameters to study the impact on the B-C ratio.

a. Varying P_{attack}

P_{attack} was varied with all other variables held constant, the resulting B-C analysis is shown in Figure 2. It showed that a $P_{attack} > 0.000008$ will yield positive return.

Benefit-Cost Ratio	P(attack)
0.618495772	0.000005
0.742194927	0.000006
0.865894081	0.000007
0.989593235	0.000008
1.11329239	0.000009
1.236991544	0.00001
1.360690699	0.000011
1.484389853	0.000012
1.608089008	0.000013
1.731788162	0.000014

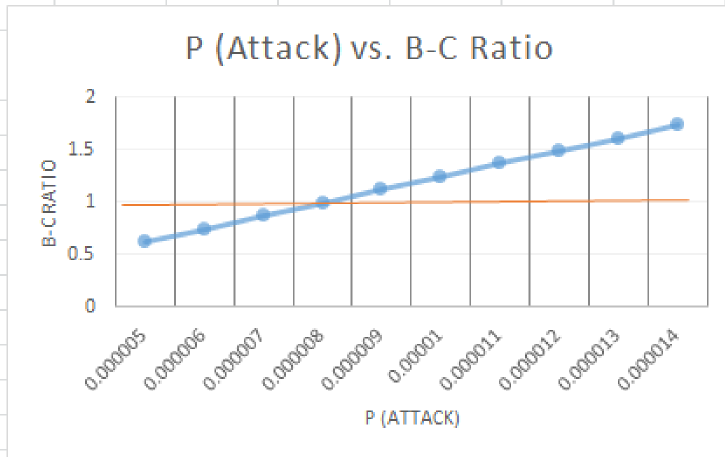

Figure 2. P_{attack} vs. B-C Ratio

b. Varying Cost of Equipment

When P_{attack} was held at 10^-5 and the cost of equipment was varied, the results of the B-C analysis is shown in Figure 3. This graph shows that a cost of over $2.4M (assumed cost of equipment) will result in a negative return.

B-C Ratio	Cost per machine ($)
1.236992	$1,500,000
1.205831	$1,600,000
1.176201	$1,700,000
1.147993	$1,800,000
1.121106	$1,900,000
1.095449	$2,000,000
1.070941	$2,100,000
1.047505	$2,200,000
1.025073	$2,300,000
1.003582	$2,400,000
0.982973	$2,500,000
0.963194	$2,600,000

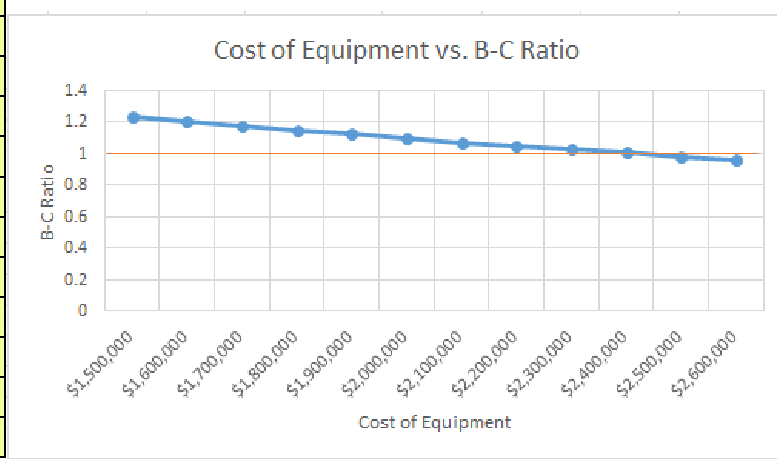

Figure 3. Cost of Equipment vs. B-C Ratio

c. Using an Equipment Lease model

When P_{attack} was held at 10^-5 and the cost of equipment was converted to an annual leasing cost, the results of the B-C analysis is shown in Figure 4. It shows that annual leasing cost of less than 23% of the price of a machine will yield a benefit.

B-C Ratio	Percent value of cost per machine
0.882442	29% of $1.5M
0.899917	28% of $1.5M
0.918099	27% of $1.5M
0.93703	26% of $1.5M
0.956758	25% of $1.5M
0.977336	24% of $1.5M
0.998817	23% of $1.5M
1.021264	22% of $1.5M
1.044744	21% of $1.5M
1.069328	20% of $1.5M

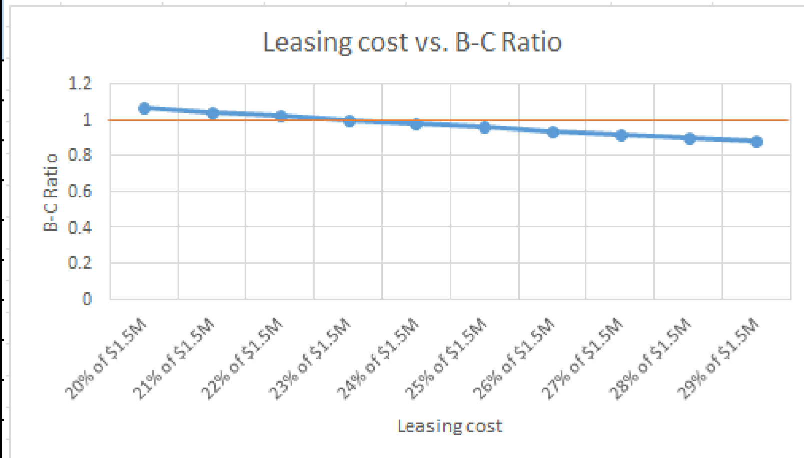

Figure 4. Leasing costs vs. B-C Ratio

d. Small vs. Large Airport

When the size of airport is reduced by 50% (number of baggage scanners reduced by 50%), the result of the B-C analysis is shown in Figure 5. It shows that the P_{attack} > 0.000008 will yield positive return in case of larger airports as well as smaller airports. The Benefit-Cost ratio trend for smaller airports almost matches the trend for larger airports.

P(attack)	B-C Ratio (Small airport)	B-C Ratio (Large airport)
0.000005	0.565444679	0.618495772
0.000006	0.678533615	0.742194927
0.000007	0.791622551	0.865894081
0.000008	0.904711487	0.989593235
0.000009	1.017800423	1.11329239
0.00001	1.130889359	1.236991544
0.000011	1.243978294	1.360690699
0.000012	1.35706723	1.484389853
0.000013	1.470156166	1.608089008
0.000014	1.583245102	1.731788162

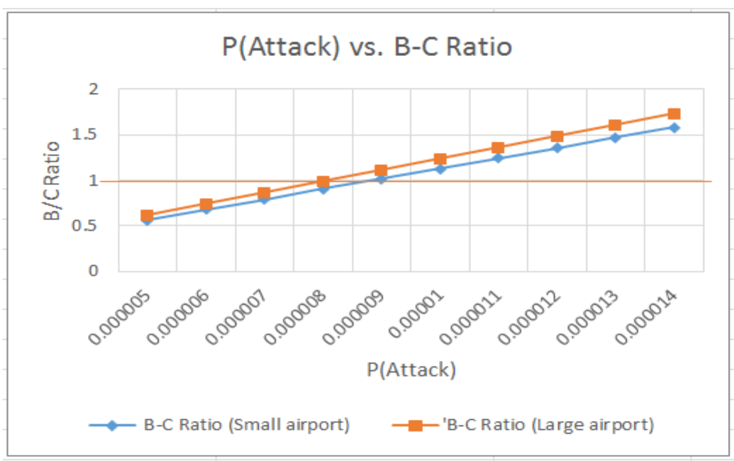

Figure 5. P_{attack} vs. B-C Ratio (Small & Large Airport)

10. Conclusion

With the information from public domain, references and historical data, it evident that the B-C ratio appeared to be greater than 1 thus indicating that using baggage scanners in the airport as a security measure is a good investment for the TSA.

Further sensitivity analysis carried out indicates that, the baggage scanners as a security measure is less cost effective when the probability of attack is lesser than the assumed probability of attack. It is also observed that the scanners are more cost effective if the equipment cost is less than 2.5 million or if the leasing percentage is less than 24% of the purchase price when all the other factors remain the same.

The analysis also indicates that security measure equipment which is cost effective in a large airport may also be cost effective in a smaller one.

Overall, the various results show that any security measure, the baggage screening equipment in this case, is cost-effective only when the benefits outweighs the cost of providing the security measure.

From the perspective of the TSA, investment in installing equipment with lower purchase price will prove to be effective. This model will help TSA to evaluate various baggage screening equipment bids based on their requirements.

11. Future Work

There are several variables affect the benefit –cost ratio that hard to be quantified to participate in this model. Baggage scanning is a time consuming procedure. By considering the dollar value of wasted time, it would impact the formulation result significantly. Some of the other possible benefits are not included in the model but can be expanded to include them. New technology and security application might be introduced to the airport security environment to provide different cost vision in that aspect. Further technical assessment for new baggage scanner to evaluate their strategically cost reduction might benefit of this model. Some security layer are more costly than others. Assessment of risks, costs and benefits help in deciding which security layers are sensitive and needs more protection.

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13. Appendix 1: Assumptions and Variables

Benefit Cost Analysis Assumptions/Variables							
Disbenefits	0	**TSA Interest Rate**	7%	**P(attack)**	0.00001	**Annual Maintenance cost**	10% of Cost per machine + $400000
High intensity attacks (1988-2013)	6	**TSA assumption for technical obsolescence in years**	10	**P(high intensity of threat | attack) [19]**	0.1	**False alarm probability (P_{FA}) [7]**	0.125
Number of passengers in the airport and flights per year	53,200,000	**Cost per machine**	$1,500,000	**P(threat originated in baggage)**	0.33333	**Percentage of bags requiring single rescreen (P_{FA_MIN})**	70%
Personnel/Employees at airport/year	31,000	**Total devices in an airport**	80	**P(loss of life)**	1	**Reduction in Risk due to security measures**	95%
Cost of each life	$3,000,000	**Average # of bags per passenger**	0.9	**P(loss of aircraft)**	1	**Annual Cost of single re-screen**	$0.13
Number of flights flying in and out of airport per year	593125	**Cost of screening per bag**	$0.525	**P(loss of airport property)**	0.17	**Annual Cost of second re-screen**	$2.00
Cost of an aircraft	$352,000,000	**(A/P, 7%, 10)**	0.1424	**P(checked baggage containing a threat)**	5.0005*10^-9	**Annual Cost of disposing a threat**	$37,272
Cost of an airport	$854,000,000	**No. of bags screened per year**	47880000	**Accuracy (P_{TA})**	0.95	**Min yearly leasing cost**	20% of Annualized Cost