

# Travel Behavior in the Face of Surface Transportation Terror Threat: The Israeli Experience

**Wafa Elias**

<sup>1</sup>Ran Naor Road Safety Research center  
Transportation Research Institute  
Technion - Israel Institute of Technology  
Haifa 32000, Israel  
Tel: 972-4-8295135, Fax 972-4-9888003, email: [Wafae@tx.technion.ac.il](mailto:Wafae@tx.technion.ac.il)

**Yoram Shiftan**

Transportation Research Institute  
Technion - Israel Institute of Technology  
Haifa 32000, Israel

**Gila Albert**

Holon Institute of Technology – H.I.T.  
Faculty of Technology Management  
Holon 58102, Israel

## **Abstract**

This paper focuses on the impact of the surface transportation terror threat on travel behavior. In particular we evaluate individuals' perceived risk of being involved in a surface terror attack on refraining from bus usage. The paper is based on a survey carried out in Haifa, the third largest city in Israel which experienced severe terror attacks in the post 9/11 era. The results indicate that fear and risk perception are central factors, there are differences in short and long-term travel behavioral effects, and intra buses are perceived as the most vulnerable mode. Women are more afraid from being involved in such tragedy, perceived its risk as higher and therefore the impact on their travel behavior is more intensive. The results also show that people are aware that the risk from road crashes is higher than the risk from terror attacks. Although this is in line with the reality where even in a country like Israel there are far more fatalities from road crashes than from terror attacks, people behavior may be strongly affected by threat from terror act despite its low probability of occurrence. Consequently an undesired shift from public transportation to passenger car, which is a much less safe mode, may occur.

## **Introduction**

Transport system and related infrastructure, as well as various destinations including shopping centers, hotels and restaurants have always been a target for terror attack and awareness to this phenomena has increased since the 9/11 attack. Different corners of the globe endure suicide attacks in public transportation facilities: the Madrid train bombings in 2004, London underground and double-decker bus bombing

in 2005, Mumbai train bombings in 2006, and Moscow Metro bombings in 2010 are painful examples of the disaster which the transport system is exposed to.

The surface transportation serves as a soft target, offers terrorists easy access and little security to penetrate. The widespread use of such transportation infrastructure under the fear of terrorist attack has the potential to cause mass panic, disruption and fear. In addition, the large crowds of strangers at surface transportation facilities guarantee anonymity for the attackers and facilitate their escape (Jenkins, 2004; Potoglou et al., 2010). This threat was an agonizing reality also before 9/11 with isolated incidents all over the world. Major terrorist attacks between the years 1920-2000 have targeted surface transportation, mainly trains and buses, with bombing being the most common tactic (Jenkins, 2004). Israel is a different example. Since 1948 with the establishment of the State, surface transportation has been a continuous main target of terror attacks. During the years 1994-2006 seventeen severe terror attacks occurred in Israeli public buses and related infrastructure such as buses stations; each attack causing ten or more fatalities and dozens of injuries (For details see Johnston, 2010).

Travelers' socio-economic characteristics and modal alternatives attributes such as travel time, travel cost, reliability, and convenient have been known for many years in the travel behavior literature as the main factors affecting travel mode choice. Security, however, has been a modest factor. In the changing reality, which is coping with enduring terrorism threats in transportation system, the security risk results from the fear of terrorism has become a reality for public transportation and security has become a key issue in providing public transportation. Security concern will significantly influence the manner in which transportation facilities and services are provided (Polzin, 2002; Holguin-Veras et al., 2003). Terror, like other forms of disaster, can trigger adaptation behaviors that would reduce the risk perception of being involved in such a tragedy (Kirschenbaum, 2006; Floyd et al., 2001).

Terror attacks in the surface transportation system and negative public perception about the security risk of public transportation have broad, short and long-term travel behavioral effects. Captive travelers may be mainly directly affected from terror incidents as they have to go on using public transportation whilst the other travelers have alternative modes available. In the short-run the demand for travel may be significantly reduced, travelers may adopt new behaviors including changes in travel mode, route and destinations, or even cancel activities and postpone others (Potoglou et al., 2010; Kirschenbaum, 2006; Exel and Rietveld, 2001; Holguin-Veras et al., 2003; Floyd et al., 2004; Stecklov and Goldstein, 2004). Long-run effects may include a decrease in the market share of a specific mode which is perceived as less secure, i.e., the public transportation one (Polzin, 2002; Exel and Rietveld, 2001; Holguin-Veras et al., 2003). In this regard, the aviation security model is definitely not applicable to surface transportation. Surface transportation cannot be protected in the way commercial aviation is protected. Trains and buses must remain readily accessible, convenient, and inexpensive (Potoglou et al., 2010; Jenkins, 2001). Furthermore, any security procedures in surface transportation may consider daily citizens privacy and liberty (Potoglou et al., 2010). Consequently, surface transportation requires its own security model (Jenkins, 2004).

Transit terrorism may cause more harm to society if travelers respond to terror attacks by shifting from public transit to less safe and more congestion generating modes, or if decision makers respond by reducing support for public transit. Despite transit

terrorism, public transit is a relatively safe mode of travel. The traffic fatality rate per passenger-kilometer is less than one-tenth that of automobile travel, even including terrorist attacks and other crimes against transit passengers, transit is far safer than private vehicle travel (Litman, 2005). Without a doubt, the public fear of terrorism - and reaction to it - is on a completely different scale to that of death on the road (Adams, 2005). Shifting travel from transit to automobile and creating less transit-oriented communities decreases the overall level of safety (Litman, 2005).

Security considerations may result in a multitude of changes in how transportation is planned, designed, implemented and operated (Potoglou et al., 2010; Polzin, 2002; Holguin-Veras et al., 2003) and thus may affect the level of service provided. Furthermore, Transportation system security investments should be seen as an important tool available to decision makers and policy in responding to terrorist incidents (Polinz, 2002; Sandler and Enders, 2004).

This paper focuses on evaluating changes in travel behavior in response to the terror threat in surface transportation based on the Israeli experience. Our hypotheses are: firstly, fear and risk perception are central factors in understanding travel behavior in the face of terror. Secondly, there are differences in short and long-term travel behavioral effects of terror attacks and threats. Thirdly, terror threats can have a stronger impact on travel behavior than the risk to be involved in road crashes; that is, individuals overestimate the risk of being involved in a terror attack in comparison to the risk of being involved in a road accident and thus tend to overreact to terror threats.

## **Methodology**

The methodology is based on questionnaires which have been distributed in the city of Haifa, the third largest city in Israel. Between the years 2001-2003 the city of Haifa suffers several severe suicide bombing in restaurants and buses, 68 citizens were killed in these terror attacks and over 200 were injured (Johnston, 2010).

The questionnaires were distributed to individuals in various locations in Haifa including parking lots and bus stations. Some locations were the places that experienced some of the past terror attacks in the city. While it is difficult to choose random places, the chosen places represent activity centers where a wide spectrum of the population arrives to. In each location individuals were approached randomly and were asked to complete a short questionnaire and return it to the interviewer upon completion.

The questionnaire was composed of two main parts. The first part asked about various socio-economic and demographic characteristics questions and the second part asked about changes in travel behavior in response to terror events and threat. This included actual change in regard to the number of trips, trip mode, destination and route after transport and shopping center terror attack took place as well as stated preference question regarding potential respond to hypothetical future terror attacks. Additional questions were related to attitude, perceptions, and beliefs regarding risk of transport terror attacks.

In total, 343 questionnaires have been collected, 6 of them were not completed and therefore excluded from further analysis. The rest 337 questionnaires served as a data base for the analysis. A descriptive data analysis was used to explore the impact of attitudes, risk perception, and demographic and socio-economic characteristics on travel behavior and mode choice in the face of terror threat. The significance of the changes in travel behavior and attitudes according to various characteristics were tested using t-test and chi-square test. Finally, a Multinomial Logit model was developed to estimate probabilities of refraining from bus usage as a result of a major terror attack on a bus in the route the respondent is taking.

The model estimates the probability that as a result of such attack including fatalities and injuries the respondent will not change his behavior or will refrain from using public transportation for a short time (one week); for some time (one month); or for long time (more than one month). These periods were chosen to distinguish between different time scales which the changes hold for.

## **Results and Analysis**

### ***Sample characteristics***

The sample consisted of 220 women (65%) and 117 (35%) men. Their ages ranged from 15 to 81 years (mean= 28.39; S.D=11.99), and 67% of them were unmarried. 10% of respondents have less than 12 years of education, and 38% percent acquired 12 years of education, 30% have bachelors degree and 12% have a graduate degree (Master's, Ph.D., or equivalent), and the rest have professional certification. A high percentage of respondents have a driving license (77%), 59% own a passenger car and 12% have high access to the car with high frequency, while the rest do not have any access to a car. The income of 43% of the respondents are less than the average (the average gross income in Israel is NIS 8,300 where \$1=NIS3.75), 23 % around the average and the rest is higher than the average. Relatively high percentage (19%) of the participants work and study, additional 27% only work and 29% only study, 5% are soldiers and the rest are not in the labor force. It should be noted that 6.6% of the respondents answered that they themselves or a close family member were wounded in a terror attack in Israel showing the relevance of this research.

### ***Travel patterns***

Table 1 and Table 2 presents travel behavior patterns of the sample population in the last six months prior to the survey. As can be seen the majority of the sample population (more than 50%) did not use public transportation at all and this is consistent with the Haifa regional travel habit survey that indicated that 55 percent of the Haifa population use private car either as a driver or passenger (Yefe Nof, 2006). The main trips purposes were work and education. Buses are the most common mode of public transportation in Haifa due to its relatively developed bus system and the lack of other public transport modes. Intra-city buses are used significantly more than

inter-city buses as expected for a big city. The respondents use public transportation more for work and education purposes and less for leisure and errands purposes.

	Inter-city bus	Intra-city bus	Taxi	Train
More than 10 times a week	8.8	47.5	1.5	3.2
5 to 10 times a week	3.2	18.3	5	1.5
Up to 5 times a week	5.9	13	6.2	6.7
Up to 5 times a Month	30	11.8	29.8	41.5
Not at all	52.1	9.4	57.5	47.5

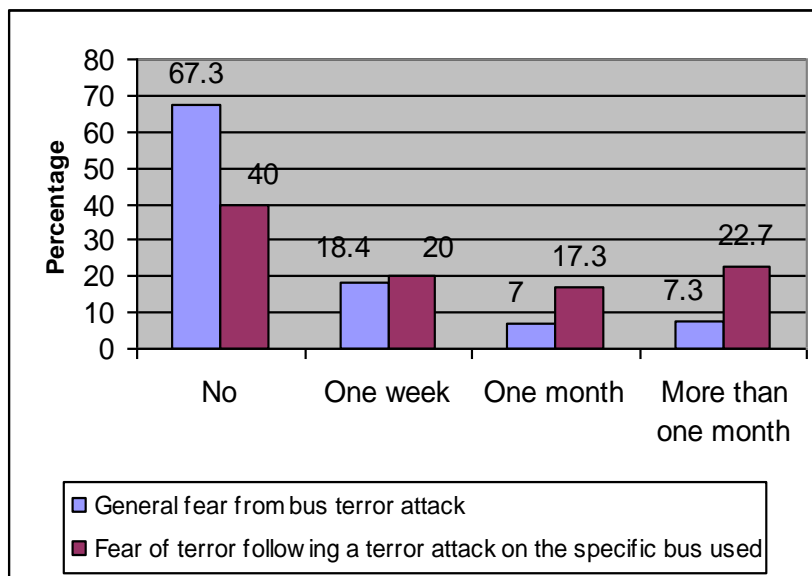
**Table 1:** Sample population- public transport usage (in percentage)

	Trip purpose	Bus (%)	Train (%)
	Work		
More than 10 times a week		21.4	2.4
5 to 10 times a week		14.6	0.9
Up to 5 times a week		10.7	4.2
Up to 5 times a Month		9.8	6.4
Not at all		43.5	86.1
	Leisure		
More than 10 times a week		3.3	0.3
5 to 10 times a week		6.0	0.6
Up to 5 times a week		12.3	1.2
Up to 5 times a Month		22.9	12.2
Not at all		55.5	81.6
	Education		
More than 10 times a week		25.0	0.6
5 to 10 times a week		13.0	0.9
Up to 5 times a week		12.0	2.7
Up to 5 times a Month		8.4	8.2
Not at all		41.6	87.6
	Self arrangements		
More than 10 times a week		9.3	1.2
5 to 10 times a week		11.3	0.3
Up to 5 times a week		19.7	0.6
Up to 5 times a Month		28.7	18.4
Not at all		31.0	79.5

**Table 2:** Sample population - public transport usage according to trip purpose

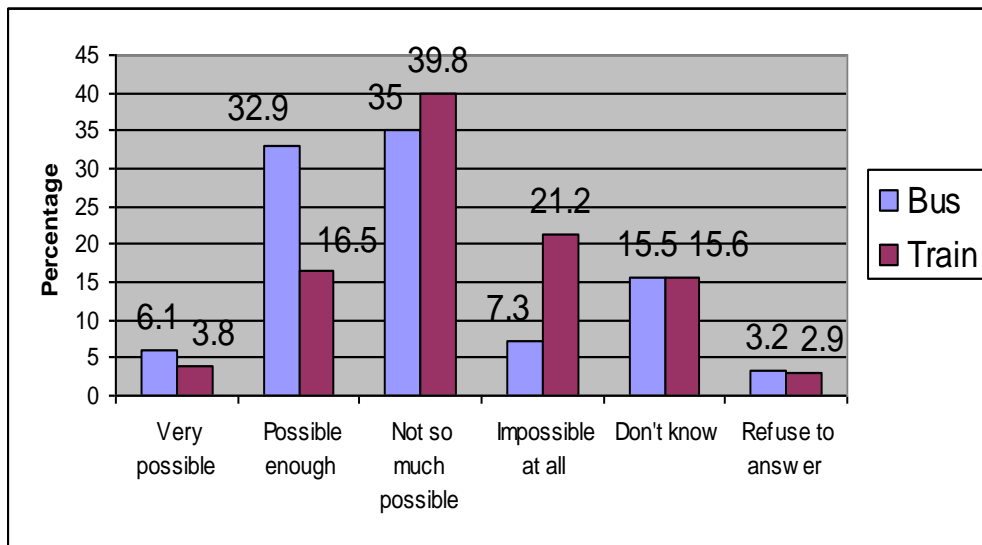
### *Travel behavior response to terror threat*

Figure 1 presents the results to two questions regarding travel behavior changes in response to terror act. The first question refers to reveal preference and is “if it happened at any phase in the past or present that you refrained from traveling by bus because of fear from terror attacks?” As can be seen general fear from terror attacks has a strong impact as one third of the sample population desisted from traveling by buses because of the fear from terror attacks for varying periods of time. The second question refers to stated response is: “if a terror attack would happen on the specific bus routes you are using would you refrained from traveling by buses?”, in this case 60% of the respondents stated that they would refrain from traveling by buses. More than 50% stated that they will use a passenger car and one-third will use a taxi instead of buses in such a scenario. As reported in the introduction, this behavior of shifting from public transportation to passenger cars is worrisome from transport policy point of view.



**Figure 1:** Refrain from traveling by bus

Figure 2 presents sample population believes regarding the possibility that a terror attack will occur on a bus or on a train at any place in Israel within the coming 12 months. As can be seen, almost 40% believes that it is likely to happen on buses and almost 20% believes that it is likely to occur on trains. An explanation for this difference is most likely due to the Israeli experience – the severe terror attacks occurred in buses facilities. In addition security procedures in intra buses are known to be more complicated, particularly due to high extent of passenger turnover.



**Figure 2** believes that a terror attack will occur

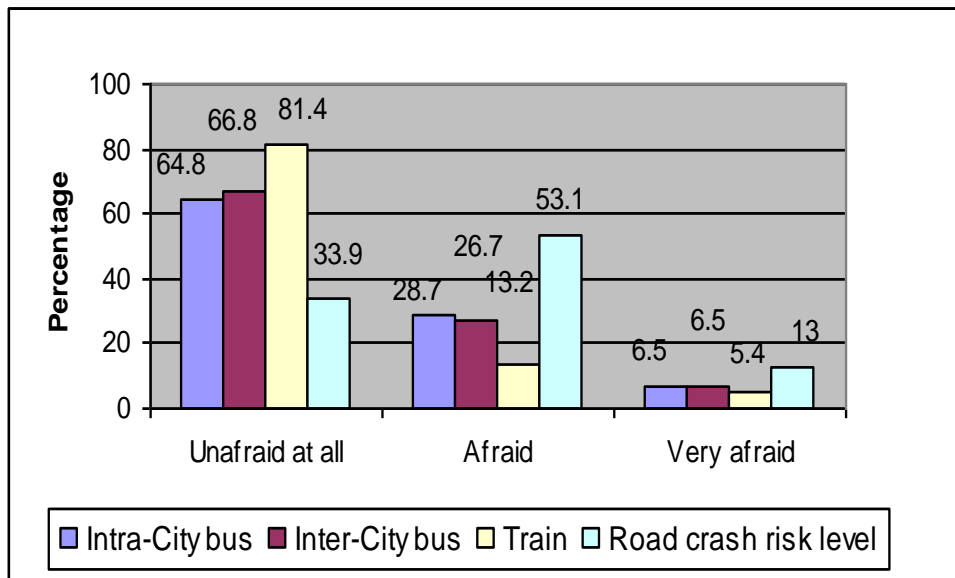
In another question one-third of the respondents stated that they do not think at all about a possibility of terrorist attack occurring during a journey in bus.

***Concern regards fear from terror attack vs. fear from road crash***

An interesting comparison of the extent of fear from being involved in a terror attack while traveling by various modes and the extend of fear from being involved in a road crash while traveling by a passenger car was captured in few questions; e.g. " to what extent they are you afraid of terrorist attack while traveling on inter- city buses?" These results are shown in Figure 3.

The results indicate that people are afraid of terror attack on buses than on rail which is consistent with the results presented in Figure 2 and with the history of terror attacks in Israel that so far targeted buses but not trains. The difference in the extent of fear from a terror attack in intra-city buses and inter-city buses is not significant.

Furthermore, intriguing are these results compare to the extent of fear from being involved in a road crash: as can be seen in Figure 3 the fear from an involvement in a road crash is notably higher (the extent of fear is approximately double). There is no doubt that this reflects rational concern as the risk of being involved in a terror attack is indeed much lower than the risk of being involved in road crash. For example, 2002 was the most horrible year in Israel; almost 200 citizens were killed in terror attacks. In comparison this is one-third of the number of deaths on Israel roads in that awful year.



**Figure 3** Comparing fear from car road crashes and fear from public transport terror attack

However, the relatively significant fear from terror act comparing to its low occurrence in comparison to road crashes is bothersome since a passenger car may be perceived as more secure mode and create an undesired shift from public transportation to passenger car, contributing to congestion and lowering safety levels.

***Risk perception according to gender***

The differences in risk perception according to gender are presented in **Error! Reference source not found.** Few questions (presented in the table) capture this risk perception and in all of them significant differences were found between men and women. Clearly, women are more afraid from being involved in a tragedy as well as in road crashes and perceive their risk as higher.



(Comment: 10 - very afraid, 1 not afraid at all)		(Female) N=220	(Male) N=117		
Question	Gender	$\mu$	$\sigma$	Sig. (2-tailed)	
To what extent you are afraid of terrorist act while traveling by bus on domestic municipal lines?	Female	3.52	2.46	0.001	
	Male	2.66	1.87		
To what extent you are afraid of terrorist act while traveling on inter-urban lines?	Female	3.32	2.46	0.001	
	Male	2.44	1.89		
To what extent you are afraid of terrorist act while traveling by train?	Female	2.48	2.23	0.010	
	Male	1.87	1.64		
To what extent you are afraid of being involved in road crashes while traveling by private car?	Female	5.01	2.42	0.003	
	Male	4.05	2.18		

**Table 3:** Risk perception according to gender

***Refraining from bus usage - model estimation results***

The stated preference data were used to develop a multinomial logit model estimating the probabilities that people will refrain from using public transportation (bus) as a response to a terrorist attack occurred on the bus line they are using including fatalities and wounded. Four alternative responses were considered: not refraining at all; refraining until one week; refraining until one month); and refraining for more than one month. The explanatory variables in this model include demographic and socio-economic characteristics of the respondent, and attitudes. The model estimation results are presented in

**Table 4 Error! Reference source not found..** The base case (which has a utility function equals to zero) is not refraining from using bus and is not shown in the table.

## Estimation results of the travel behavior model

N=334 Variable description	Refrained one week		Refrained one month		Refrained more than one month	
	$\beta$	t-statistics	$\beta$	t-statistics	$\beta$	t-statistics
Constant	-2.22	-3.26	-1.92	-3.59	-1.82	-3.69
Gender, men=1	-0.559	-2.04	-0.559	-2.04	-0.798	-2.31
Use Intra-city bus			0.203	1.77	0.299	2.86
D. license	-0.647	-1.69	-0.903	-2.24	-0.775	-2.04
Frequency of thinking about terror attacks while travelling by bus			0.268	1.83	0.288	2.15
Fear from terror attacks within enter-urban bus	0.193	2.49	0.263	3.24	0.279	3.66
	Init log-likelihood		-463.022	Final log-likelihood		-407.244

**Table 4** Estimation results – refraining from bus usage

The estimation results show that women, users of intra-bus transport and driving license owner are more likely to refrain from bus usage. The extent of fear from terror attack in urban buses and the level of frequency of thinking about terror attack while traveling also have a significant impact on refraining from buses usage.

### Conclusion

This paper provides some insight and better understanding of the factors affecting travel behavior in the face of surface transportation terror threat.

The results confirm the three hypotheses presented in the introduction:

- Fear and risk perception are central factors in understanding travel behavior in the face of terror. More specifically, the extent of fear from terror attack in urban buses, and the level of frequency of thinking about terror attack while traveling can explain refraining from bus usage. Intra-buses are perceived as a mode which frightens more compare to inter-city buses and trains, most likely due to the fact that the severe terror attacks in public transportation in Israel occurred on intra-buses.
- There are differences in short and long-term travel behavioral effects of terror attacks and threats and it depends on the individual experience in terror attacks. The results show that the effect is stronger and for longer time period (of up to one month) if a terror attack occurred on a specific line an individual is using.

- People are aware that the risk from road crashes is higher than the risk from terror acts. Although this is in line with the reality where even in a country like Israel there are far more fatalities from road crashes than from terror acts, people behavior may be affected by threat from terror attack despite its low probability of occurrence causing an undesired shift from public transportation to passenger car, contributing to congestion and lowering safety levels.

The results indicate significant gender differences in risk perception of being involved in terror attacks and road crashes. Women are more afraid and more affected by terror threats. They also think about the possibility of terrorist attack during a journey in bus significantly more than men.

The significant levels of fear of terror threat and the strong belief that a terror attack is a matter of time supports the relevance of this research; travel behavior in the face of terror threats is a reality. An on-going research on this topic refers to large and random sample in Haifa and a comparison to the two largest Israel cities: Tel-Aviv and Jerusalem which also suffered from severe terror attacks. Other interesting questions that arise are what should be the level of security provided in the surface public transportation? What is its cost and affect on privacy and liberty? Are people willing to pay for that? These issues should be investigated in further studies, especially since the threat of terror in the surface transportation system become recently pertinent in many corners of the globe.

## References

- Adams, J. (2005). What kills you matters, not numbers, The Social Affairs Unit [www.socialaffairsunit.org.uk/blog/archives/000512.php](http://www.socialaffairsunit.org.uk/blog/archives/000512.php)
- Exel, N. and Rietveld, P. (2001). Public transport strikes and traveller behaviour. *Transport Policy*, 8(4), 237-246.
- Floyd, M., Gibson, H. Pennington-Gray, L. and Thapa, B. (2004). The effect of risk perceptions on intentions to travel in the aftermath of September 11, 2001. *Journal of travel and Tourism Marketing*, Vol. 15, Iss. 2&3, pp. 19-38.
- Holguin-Veras, J., Paaswell, R.E., and Yali, A M. (2003). Impact of extreme events on intercity passenger travel behavior: the September 11<sup>th</sup> experience. *TRB 2003 annual meeting cd-rom*.
- Jenkins, B.M (2001). Protecting public surface transportation against terrorism and serious crime: An Executive Overview. *Mineta Transportation Institute Report 01-14*.
- Jenkins, B.M. (2003) Improving Public Surface Transportation Security: What Do We Do Now? The Lexington Institute, July 2003.
- Johnston, Wm.R. (2010). Chronology of terrorist attacks in Israel: introduction. <http://www.johnstonsarchive.net/terrorism/terrissrael.html>

Litman, T. (2005) .Terrorism, transit and public safety evaluating the risks. *Journal of Public Transit*, Vol. 8, No. 4, pp. 33-46.

Kirschenbaum, A. (2006). Terror, Adaptation and Preparedness: A Trilogy for Survival. *Journal of Homeland Security and Emergency Management*. Vol. 3, Iss. 1,article 3.

Potoglou, D., Robinson, N., Chong W. K., Burge, P. and Warnes, R. (2010). Quantifying individuals' trade-offs between privacy, liberty and security: The case of rail travel in UK. *Transportation Research Part A* 44, pp.169–181

Polzin, S.E. (2002). *Security considerations in transportation planning: a white paper for the Arizona Department of Transportation*. Southeastern Transportation center.

Sandler, T. and Enders, W. (2004). An economic perspective on transnational terrorism. *European Journal of Political Economy*. Vol. 20, Iss. 2, pp.301-316.

Stecklov, G. and Goldstein, J.R. (2004). Terror attacks influence driving behavior in Israel. *Proc Natl Acad Sci U S A*. 101(40): 14551–14556.

Yefe Nof (2006). The Haifa Transportation Master Plan – Travel Habit Survey.