International Journal of Architectural, Civil and Construction Sciences
ISSN: 2415-1734
Vol:2, No:12, 2008

Measuring the Performance of the Accident Reductions: Evidence from Izmir City

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***Abstract*—** Traffic enforcement units (the Police) are partly responsible for the severity and frequency of the traffic accidents via the effectiveness of their safety measures. The Police claims that the reductions in accidents and their severities occur largely by their timely interventions at the black spots, through traffic management or temporary changes in the road design (guiding, reducing speeds and eliminating sight obstructions, etc.). Yet, some other external factors than the Police measures may intervene into which such claims require a statistical confirmation. In order to test the net impact of the Police contribution in the reduction of the number of crashes, Chi square test was applied for 25 spots (streets and intersections) and an average evaluation was achieved for general conclusion in the case study of Izmir city. Separately, the net impact of economic crisis in the reduction of crashes is assessed by the trend analysis for the case of the economic crisis with the probable reduction effects on the trip generation or modal choice. Finally, it was proven that the Police measures were effective to some degree as they claimed, though the economic crisis might have only negligible contribution to the reductions in the same period observed.

***Keywords*—**Road Safety, Police, Enforcement units, Chi Square test, Economic Impact.

I. Introduction

ROAD safety is the prime concern for transportation community to govern effectively because of its irreversible consequences in case of failure such as deaths and serious injuries, thus, a heavy responsibility towards the public. Traffic enforcement units (called the Police, here) are partly responsible from the severity and frequency of the traffic accidents by their preventive safety measures due to their "raison d'etre" to alleviate the risk. The Police is expected to regulate traffic and road signs, etc., to protect human life and property. The reductions in accidents can be possible largely by long-term area-wide programs and timely local interventions at black spots, through traffic controls and necessary changes in the road design, especially after detecting some defectious road conditions. Most of the time, the task requires bitter recipe as enforcement (speed, lawsuits, punishments, fines and charges, etc.).

Although the prevention of crashes is not only through enforcement but also other managerial skills, the primary role of the Police should not be doubted. Yet, beyond the effectiveness of enforcement, many external socio-economic factors do play role in the increase or decrease of the safety on roads. For example, an increase in the income levels, and relatedly the increased rate of car ownership may face an unprepared situation of incapacitating of infrastructure to take precautions, and cause increased number of safety problems.

This paper discusses the effectiveness of chosen set of safety measures, if any, implemented by the Police on the real ground. In this study, the case of Izmir city was examined throughout the six-year period as before/after analysis between 1999 and 2005. From the rough examination of the results, a sharp decline in accidents was observed in 2001 both in numbers and in fatality rate between the initial years and later years of the period. But, it is not clear whether these reductions are significant enough and are due to the policy "intervention". Did the Police positively contribute to such an apparent success for the mentioned period? As a methodology, examining such an "appearance" of progress by employing the Chi square test as whether it is genuinely through the measures of the Police, or coincidentally from the then economic recession, or happened by chance, were preferred.

The testing concerns such issues subsequently; first stage is to find out whether these results (reductions in accidents) are significant pointing to the success in the reduction of accidents, which is also to assume that this success might result from the Police's preventive programs and measures; the second stage, depending on the finding of the first stage, is to learn whether the reductions are independent from the external factors such as economic developments, or the way is affected from these factors.

In the second chapter, a literature review on the costs of accidents upon society, the econometric evaluation of those costs and remedy types to aleviate accident risk is given. In the third chapter, the data used and the method of Chi square test are introduced, and the original way the tests are handled for the hypothesis are explained. Finally, the findings are evaluated and general conclusions are drawn.

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II. On Measuring Impact of Accidents upon Society

Total elimination of the traffic accidents has been challenging target for governments and transport authorities, while the number of cars and vehicle trips are at steady growth rate. Lately, EU has promulgated zero accident target to reduce road traffic accidents. Because, in Europe today [1], over 42 000 road users are killed annually and around 3,5 million are injured, costing over 160 billion Euros and suffering. The U.S. has the similar figures. Turkey, as a EU membership candidate, has the worst figures with around 5900 deaths [2].

Having known precisely which safety measures (or, combination of the measures) would be the best in reducing traffic accidents has vital importance in eliminating further occurrences of crashes. The effectiveness is also the matter of cost effectiveness of the measures to be applied; the choice about the least cost bundle of safety measures need to be optimized. In the cost analysis, for quantifiable commensurate analysis, cost analysis is made on the economic basis as combined damages to material and human life termed jointly as general "costs", also quantifying damage to human (death or injury) in monetary terms. The Police' measures are, thus, also subject to the optimization concern.

Economic evaluation of traffic safety measures must beforehand base on safe methods for the effective application of the measures [3]. Due to the extensiveness of huge costs upon society, every effort to increase the safety is welcome. The short-term operational solutions, enforcement, and patrolling also must take part in this process beside long term programs. Especially, of the police enforcement measures, drink-driving and speed (with radar) enforcement have significantly positive effects on the reduction of injury accidents. [4], [5], [6]. Examining the effectiveness of various safety measures, it has been known that the rate of return on road safety measures is always higher than that in other sectors, although such measures require a considerable spending. Yet, significant sums of money are spent on measures that may not become so effective due to the poorly identified priorities. Thus, targeted investments play significant role in the cost reduction before considering the investments to increase the safety on roads.

However, the duties and responsibility areas of enforcement bodies and local government-appointed traffic operation units intermingle; the role and responsibility share attributable solely to the Police in providing the safety becomes difficult to distinguish. Traffic authorities and police commonly apply four basic strategies for accident reduction through the use of countermeasures are as [3]:

- Single site (blackspot programmes) - the treatment of specific types of accident at a single location;
- Mass action plans - the application of a known remedy to locations with a common accident problem;
- Route action plans - tile application of known remedies along a route with a high accident rate;
- Area wide schemes - the applications of various treatments over a wide area of town/city, i.e. including traffic management and traffic claming (speed reducing devices).

The Police in Turkey has, in general, neither clear safety programs and measures to be applied for designated time and black spots, nor accident reporting in ideal form [7].

Within the scope of this study, the effectiveness of the measures applied for safety can be from two points: one is from cost effectiveness for the operator, and the other is from the number of saved lives and property of the drivers. A devoted Sweden study determined the cost of lost life to be between 1.2 and 3.8 million US$ [8]. Generally, it has been agreed that the monetary value of a human life is around 1 million Euros with respect to the European researches for EU projects. Suppose that the city invested an annual 15 million Euros for the safety measures in effect to reduce deaths from the accidents. Assume that 20 people are saved from the investment (ignoring the other costs). Then, it could be said that the city saved already a 5 million Euros, and the program is said to be cost-effective. But, if saving life is worth 500 000 Euros, then, the city would lose instead 5 million Euros in saving all lives.

A tremendous increase in the rate of accidents overall the world is largely because there is also an enormous paralleling trend; the number of car ownership is increasing at speedier pace than the number of incidents. But, also the number of crashes steadily increases, even in developed nations as Japan [9]. 760 000 fatalities in 1988 to approximately 1.2 million fatalities in 2004 (increase of about 30%) [10]. In fact, the number of fatalities decreases per thousand vehicles, while the injuries seem to be increasing. However, the case in the developing world is much more dramatic (Fig. 1): The urbanization rate and ever-increasing number of vehicles in many developing countries have led to the increased traffic congestion and turbulence in urban centers which were not originally designed for the volumes that have just emerged.

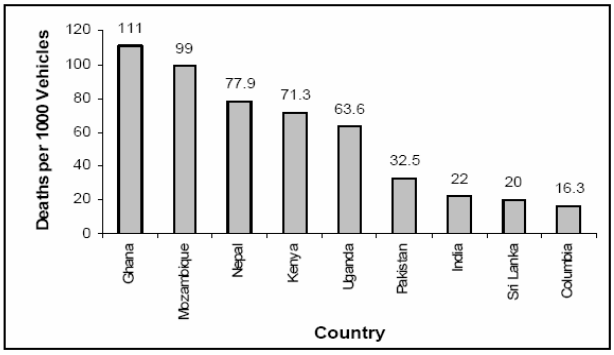

Fig. 1. Fatality Rates in selected developing countries (Source: Vivian and Veeraragavan, 2003)

Some interesting findings for effective measures are as: for the range of mean speeds typically found on 30 mph roads, the percentage accident reduction per 1 mph speed reduction is around 4% for cameras, and 7-8% for schemes with horizontal features [11]. Schemes with vertical deflections are the most effective in reducing both speeds and accidents. Another similar work of Vivian and Veeraragavan's [12], for example, conducted for Indian cities exemplifies some paralleling findings; the conversion of two – way roads into one – way roads has led to a significant reductions in the number of accidents. Similarly, the impacts of the erection of median barricades are as follows: Fatal accidents have reduced by 40%, injury accidents by 43%, and property damage accidents by 43% on the roads selected for the study, though the application of one-way and median barricades increased vehicle operating costs. However, small impact of road and infrastructure related measures on accident reduction until now may be well attributed to the high costs of such measures, which let inability to wider schemes of application.

In the meantime, effective reductions can also be achieved by low-cost measures [10]. The use of road signs and markings to channelize traffic through complex intersections, or providing safe waiting areas for turning vehicles are some examples in increasing safety. Or, reducing the number of decisions drivers must make at any one time simplifies the driving task and helps drivers to progress in safety and comfort with a minimum of conflict with other traffic and pedestrians. Drink-drive related measures of the Police have resulted in a reduction of 11%, while road safety engineering measures in a reduction of 6.5% [1].

Of the enforcement type measures, blackspot treatment is likely to be the most effective and straightforward in countries with no prior experience of accident remedial work. Timely interventions in the right places can reduce the costs incurred to patrolling service. The Police generally has local knowledge of where the road accidents tend to cluster, termed accident blackspots. It may be possible to make a start on remedial works at "known" blackspots, based on this knowledge.

For performance analysis, ideally, several years' data are required, from which a mean, annual accident rate can be calculated. Three-years data aggregation is generally regarded as a practicable minimum period for which a reasonably reliable annual average rate can be calculated. In the literature, such test methods like Chi square to measure the significancy of the program impacts were widely used, on a single step and singular cases or area-wide fashion. These are especially based on before and after analyses, to see whether there are significant changes between the previous case (policy-off) and the next case (policy-on), if any impact is expected by the policy applied. [13] used similar approach with Chi Square test to know the significancy of the enforcement of seat-belts in reducing both numbers of accidents and fatalities, as before and after the enforcement year. The authors also took into account the impact of economy and found that the fluctions in economy also affected the fatality rate significantly. Recently, a Korean study [14] showed that economic downwarding trend in Korea between the years 1997 and 2001 did affect the traffic density, and relatedly the number of accidents positively.

III. Data and the Method

This study tests the Police' performance in the case of Izmir city, which is the third largest city of Turkey, with the approximate population of 3.2 million. The Turkish traffic police in Izmir city (called the Izmir Police Department) claims that the observed improvement in the reduction of accidents should be linked to their preventive policies at least for the five years between 2000 and 2005, especially on the accident-prone streets, which will also be subject to this study. The remarkable reduction in the number of accidents may be illusive, and the claim must be taken with suspicion; whether this "meaningful" reduction is by the deliberate actions, especially by means of the Police effort, or just by some other external factor(s) including chance. The purpose of this paper study rather questions the situation with the positive hypothesis to be nullified that the significant reductions in traffic accidents occur by the Police' preventive measures, as they claimed, and rather free from the influence of the economic crisis (ie, as external factor) coincidentally experienced at the same period.

However, in the case the hypothesis is nullified, it is not to deny that Police did not take any claimed preventive steps and measures. But, it might rather mean that they are not so effective as expected, or mismanaged.

First of all, an overall rate of decrease in the number of accidents has been truely observed in the 5-year period, on especially the critical (pilot) streets of Izmir (Fig. 2). Two data sets were used in this study; one is general information about the economic recession in Turkey (Fig. 3, Fig 4, and Fig 5) and related trends from TUIK [15] and the other is the accident data for the concern period gathered from the local police department. The accidents data are also in two types; one is about general accident trend of the greater city of Izmir (metrop. Area) for the control group data, and the accidents data of the concerned steets as shown in Tables II, III and IV.

Shimizu et al. [16] used the Chi square technique but applied the tests in the variation of safety programs for a defined 5-year period. Some recently applied the test in defining the black spots of accidents in the synthesis of GIS techniques [7]. Similar to the Foldvary and lane's study, the method here will utilize the Chi square test as commonly used in the literature but at three successive steps:

1- Chi square tests of the case streets, as not influenced from the Economic Crisis,
2- Chi square tests of the case streets as influenced from the Economic Crisis

3- Reconsidering (1) by considering percent change impacts of the Economic Crisis on the Chi square results

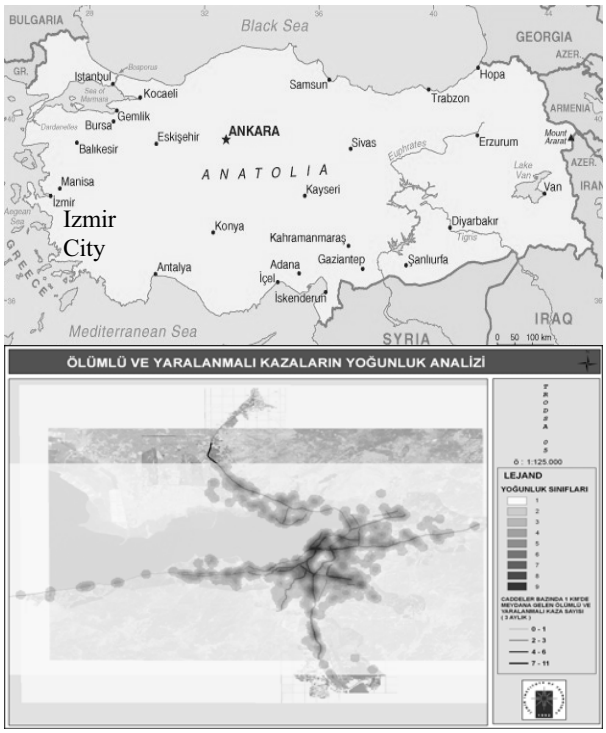

Fig. 2. Location of the Izmir city and the density of death/injury type accidents over the city streets

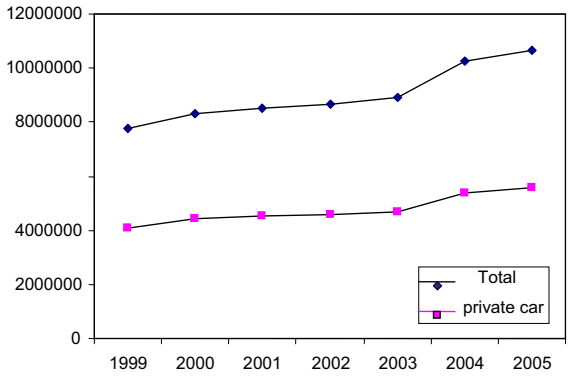

Fig. 3. Total and private car ownership trend between 1999 and 2005 (Source: Duvarci et al, 2008)

If it is influenced by an economic impact, then, in the second phase, the impact of economic crisis experienced following the 1999 Eastern Marmara earthquake, but solidly felt in 2001, need to be observed; thus, it is questioned whether the economic crisis of 2001 influenced the trip making behavior (esp, the private trips), and thus, naturally such an accident reduction appeared.

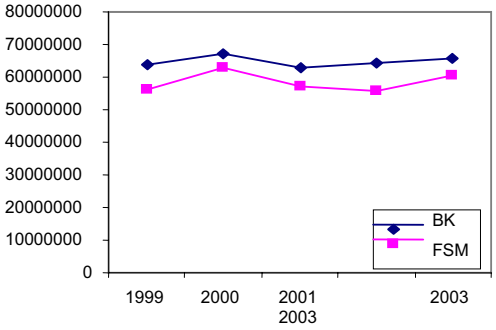

Fig. 4. The number of vehicles that pass from BK and FSM bridges in Istanbul as traffic increase indicator in Turkey for the concern period (Source: belgenet, 2005)

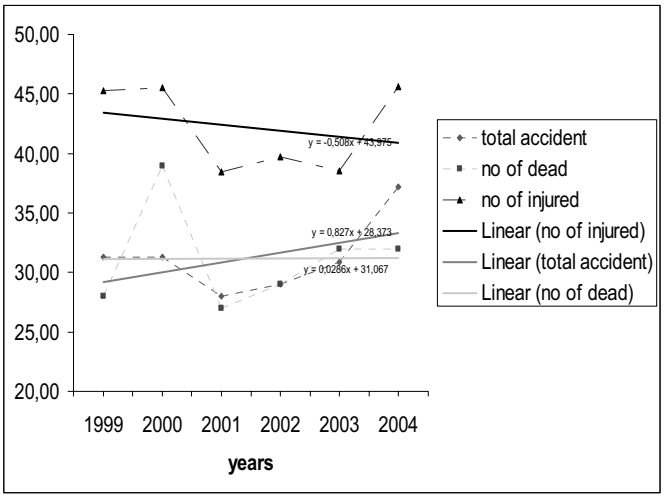

Fig. 5. Trend of traffic accidents by years between 1999 and 2004 (Source: Izmir Police Department, 2004)

According to the data of general indicators of economic development trend (See Figures 3, 4 and 5) , there is an overall 5 % decline in the economic performance, and in the trip generations as well. But, there arise a methodological problem as how this rate of trend could be reflected upon the Chi square test results in order to derive the new significant results as impacted from the economic recession. The author rather adopted a quite straightforward approach to see the impact of those economic recession on the reductions. Assuming that a 5% decrease in economic performance would cause similar rate of impact as the decrease on the number and severity of accidents. In other words, if the economic recession had not occured, an additional 5% of accidents would be added onto the current number of accidents. Based on this assumption, the Chi square test procedure should be recalculated with the new accident numbers for each year, which can be found from the following formula:

$$A_{new} = (A_{old} \,.\, e) + A_{old} \qquad (1)$$

where, A_{new} : New accident numbers (or, deaths or injuries) when the impact of economic recession is discounted

A_{old} : Previous "after" case accident numbers (or, deaths or injuries) when the impact of economic recession prevails

e : general rate of economic recession, which is assumed -5%

When the Chi square test is repeated again for new Chi square testing (A_{new}, for new accident numbers), the new results will be compared to the previous test results (where economic impact is neglected) regarding Eq. 2 and the impact (reflection) of economic situation will be explicated. Finally, the result will be aggregated for general conclusion.

As a method, Chi square tests are considered for each concern street (where Police has been implementing some accident countermeasures since 2000's) requiring the degree of freedom of 1 ((2-1) * (2-1) = 1), or (1,1)df. The performance of the significance levels are found over the number of streets that are found insignificant among the total number of concerned streets. The rate of insignificant ones (under the Chi square critical value) over the total number will provide a general degree of significance level for general comparability between the existent and non-existent economic impacts. Those matters are concerned regarding the method in finding the Police' effect:

- Deciding the breakpoint on the accident reduction trend (5-year period)
- Studying the area (the most risky streets above 80 accidents yearly) where the Police had already safety programs and claimed to have reduced accidents (Izmir Metropolitan area)
- Focusing rather on fatal and injury related accidents, which are the most critical indicators, and on the evaluation of the total figures

The breakpoint were decided to be the years 2000 and 2001 when the most significant improvement was observed as the reduction in the number of accidents as can be noticed in the Table I. One of the reasons can be the effectiveness of the measures as the Police claimed and the mass media education campaign started in the period. Another reason could be the decline in number of accidents due to the reduced travel demand and the traffic density because of the economic recession. The rate of reduction in the national income was 8%: from 204 to 187 billion US$ (from 3224$ to 2878$ per capita). As of 2005 (July), total vehicle and automobile ownership rate for the last seven years (1999 – 2005) was given in Fig 3 [2]. The country's economic shrinkage was 6.4% in 1999 in comparison with the previous year. The shrinkage in consumption is about 3% [16], [15], but a sharper increase can be noticed after 2003, paralleling to the economic recovery. According to the Fig 4, there has been no significant increase in the traffic amount as an indication to economic development. Also, the shrinkage in the transportation sector as GDP was around 4%. While the total number of registered vehicles was 540 162 in 2004, it was 704 903 in 2005 (July). According to the information obtained from the Police (Izmir Police Department, 2005), Izmir's total numbers of accidents, deaths and injuries between the years 1999 and 2004 are provided in Fig 5. Conclusively, though an overall increase in accidents, a significant decrease was observed in 2001. Thus, the year 2001 can be accepted as the turn point at which the two trends diverge.

TABLE I
ACCIDENT DATA OF IZMIR URBAN REGION BY YEARS

years	Accid's with death	Accid's with injury	Total accident	No of dead	No of injured
1997	39	3040	24 629	44	4078
1998	43	3080	30 818	46	4258
1999	26	3356	31 286	28	4526
2000	38	3298	31 323	39	4553
2001	27	2819	28 009	27	3847
2002	28	2916	28 970	29	3974
2003	30	2885	30 840	32	3853
2004	30	3254	37 171	32	4565

TABLE II
ACCIDENTS DATA FOR ALL AREA OF IZMIR CITY AND C VALUES

	year	death accids	injury accid's	total	rate (C)[a]
	1997	39	3040	24 629	For total
before	**1998**	43	3080	30 818	Accid.:
	1999	26	3356	31 286	0.88
	2000	36	3298	31 323	
	2001	27	2819	28 009	For
after	**2002**	28	2916	28 979	dead+injur:
	2003	30	2885	30 840	0.87
	2004	30	3254	37 171	

[a] the Before/After rates (C) were obtained by dividing the average of 'after' years values by the average of 'before' years values.

This study does not concern kinds of safety measures that the Police has taken. Only the focus is on the streets and junctions that the Police claimed to have taken certain safety precautions. The measures taken in Izmir are generally through police enforcement, singlesite (blackspot) treatment and mass action plan type as described in the Literature Review section.

The mentioned individual samples are the 25 streets to be concerned in this study as pilot streets where the most accidents happen (26 for the dead/injury accidents). The streets over 80 accidents for the initial year are taken into evaluation for the study.

The formula for χ^2 (Chi Square) test to be applied for each concern street is as below ;

$$\chi^2 = ((a - b).\ C)^2/((a + b).C) \quad (2)$$

where, a is the mean average (of 3 years) of the number of accidents of the 'before' case and b is of the 'after'

case. The number of accidents can be either the total accidents or the total dead/injury accidents. *C* is the rate of change in the values of the control group (total accidents of Izmir city) for the same period, which is calculated to be 0.88.

TABLE III
CHI SQUARE TEST FINDINGS FOR ALL ACCIDENTS (ECONOMIC IMPACT NOT CONSIDERED)

Street names	Ave. accid before 2000 (including)	Ave. accid. after 2000	χ^2 test value	insignif. for 0.05 (<3.84)	insignif. for 0.01 (<6.63)
Akçay	450	314	21.40		
Yeşillik	545	257	91.01		
İnönü	601	433	24.11		
F. Altay M.	126	83	7.89		
Güm.K.yalı	150	57	37.05		
9 Eylül Mey	174	121	8.48		
Yeşildere	443	163	113.64		
Menderes	283	179	20.602		
Gaziler	453	220	71.51		
Osman K. K.	123	97	2.81	*	*
Z. Payzın	148	95	10.50		
Altınyol	297	163	34.21		
Serinkuyu	79	91	0.73	*	*
Soğukkuy	105	93	0.69	*	*
Girne Kavş.	95	24	37.03		
Anadolu	615	441	25.39		
Buca köpr.	131	51	30.94		
Şaraphane	117	69	10.96		
Ege Üni. Kş	105	79	3.23	*	*
İkiçeşmelik	173	94	20.57		
Yeni Garaj	113	77	6.19		*
Şehitler	185	54	64.04		
Liman Silo	127	59	21.70		
Gazie Sarn	79	73	0.27	*	*
Naldöken	88	47	10.96		
Ankara	643	340	82.34		

There is a 13% decrease in the total accidents observed between the two periods (which corresponds to C = 0.88 in the previous section). The data of accident numbers as before and after period averages with both total and serious (death/injury type) accidents are given in Table 2 for all Izmir region, which constitutes the input for C, the rate for control group in the χ^2 calculation. Then, the individual χ^2 values were found for each street to take into general significance evaluation of the results. These are executed on the basis of both total accidents and the serious accidents on the streets, and tested according to both 0.05 and 0.01 error margins. These results were presented in Tables III and IV, and accordingly the evaluations were made.

For the 0.05 error margin, no significant improvement (less in accident) was observed in the 19% of all streets for total accidents. For the 0.01 error margin, this corresponds to 23%. Yet, the results are much more insignificant for the serious accidents; 63% for the 0.05 and 78% for the 0.01 error margins. These are the sole results of the first phase into which the impact of economic recession has not been incorporated. The most significant changes were observed in those streets: Akçay, Yeşildere, Zafer Payzın, Anadolu, Ankara streets ve Şaraphane bridge.

TABLE IV
CHI SQUARE TESTS FOR SERIOUS ACCIDENTS (ECONOMIC IMPACT NOT CONSIDERED)

Street names	Ave. accid before 2000 (including)	Ave. accid. after 2000	χ^2 test value	insignif. for 0.05 (<3.84)	insignif. for 0.01 (<6.63)
Akçay	100	62	8.11		
Yeşillik	84	63	2.82	*	*
İnönü	81	82	0.00	*	*
F. Altay M.	8	2	3.13	*	*
Güm.K.yalı	32	15	5.35		*
9 Eylül Mey	2	3	0.14	*	*
Yeşildere	96	40	20.06		
Menderes	40	48	0.63	*	*
Gaziler	60	39	3.97		*
Osman K. K.	6	5	0.27	*	*
Z. Payzın	30	11	7.96		
Altınyol	53	44	0.87	*	*
Serinkuyu Kş.	11	10	0.07	*	*
Soğukkuy Kş	6	11	1.07	*	*
Girne Kavş.	9	6	0.73	*	*
Anadolu	232	124	28.81		
Buca Köpr	8	6	0.40	*	*
Şaraphane	26	8	8.07		
Ege Üni. Kş	8	4	1.722	*	*
İkiçeşmelik	36	23	2.83	*	*
Yeni Garaj ö.	10	4	2.24	*	*
Şehitler	16	9	1.71	*	*
Liman Silo K.	7	17	3.92		*
Gazie Sarn K	16	18	0.03	*	*
Naldöken	15	5	5.15		*
Çiğli itf. Kş.	13	9	1	*	*
Ankara	120	73	10		

TABLE V
CHI SQUARE TESTS FOR ALL ACCIDENTS WHEN ECONOMIC IMPACT INCORPORATED

Street names	Ave. accid before 2000 (including)	Ave. accid. after 2000	χ^2 test value	insignif. for 0.05 (<3.84)	insignif. for 0.01 (<6.63)
Akçay	450	330	16.42		
Yeşillik	545	220	81.76		
İnönü	601	455	17.93		
F. Altay M.	126	87	6.33		*
Güm.K.yalı	150	59	34.37		
9 Eylül Mey	174	127	6.53		*
Yeşildere	443	171	105.69		
Menderes	283	188	16.88		
Gaziler	453	230	63.92		
Osman K. K.	123	101	1.84	*	*
Z. Payzın	148	99	8.57		
Altınyol	297	171	29.64		
Serinkuyu	79	95	1.36	*	*
Soğukkuy	105	97	0.27	*	*
Girne Kavş.	95	25	35.43		
Anadolu	615	462	18.99		
Buca Köpr	131	54	28.60		
Şaraphane	117	72	9.28		
Ege Üni. Kş	105	83	2.28	*	*
İkiçeşmelik	173	99	17.88		
Yeni Garaj	113	80	4.86		*
Şehitler	185	56	60.78		
Liman Silo	127	62	19.54		
Gazie Sarn K	79	76	0.06	*	*
Naldöken	88	49	9.57		
Ankara	643	357	72		

Lastly, the trend impact of economic recession was reflected on the significance test computation (i.e., the first

stage) with the calculation method defined in the section 3. In the absence of detailed information, it is the best to reflect the economic recession impact rate onto the 'after' case numbers of accidents. It was found previously that the country's overall general economic recession rate was about 5%. This rate was reflected equally onto all accident figures of the concern streets. Simply, if there were no economic recession impact, for example, the number of accidents would have been 105 instead of 100. In Table V, while the 'before' case values were left constant, the 'after' case values were raised, and then, the Chi square values were re-calculated. If the economic recession impact had not have happened, 19% of all concern streets (according to 0.05 error margin), or 31% of them (according to 0.01) (which was 23% before, if the economic impact had been ignored) did not record significant improvements. It seems that the economic recession had positive but only a trivial impact on the accident rate.

In a similar fashion, for the dead/injury accidents, no significant change was recorded in the Chi square significance values, which meant no significant influence resulting from the economic recession (Table IV). Similar to the case of the ignorance of economic impact, 67% of the concern streets (for 0.05), or 78% (for 0.01 error margin) show non-significance in reduced number of accidents, if the economic impact is to be reckoned. In other words, even if the economic recession impact is non-existent (more accidents in the same amount of recession rate), the dead/injury type accidents would be in the same level. It seems that the reduction in accidents happens in a considerable extent by means of the Police intervention.

TABLE VI
CHI SQUARE TESTS FOR THE SERIOUS ACCIDENTS WHEN ECONOMIC RECESSION IMPACT CONSIDERED

Street names	Ave. accid before 2000 (including)	Ave. accid. after 2000	χ^2 test value	insignif. for 0.05 (<3.84)	insignif. for 0.01 (<6.63)
Akçay	100	65	6.75		
Yeşillik	84	66	2.03	*	*
İnönü	81	86	0.12	*	*
F. Altay M.	8	2	3.00	*	*
Güm.K.yalı	32	16	4.81		*
9 Eylül Mey	2	3	0.19	*	*
Yeşildere	96	42	18.38		
Menderes	40	50	1.04	*	*
Gaziler	60	40	3.22	*	*
Osman K. K.	6	5	0.20	*	*
Z. Payzın	30	11	7.43		
Altınyol	53	46	0.52	*	*
Serinkuyu	11	10	0.03	*	*
Soğukkuyu	6	11	1.29	*	*
Girne Kavş.	9	6	0.61	*	*
Anadolu	232	130	25.19		
Buca Köpr	8	6	0.31	*	*
Şaraphane	26	8	7.61		
Ege Üni. Kş	8	4	1.57	*	*
İkiçeşmelik	36	24	2.34	*	*
Yeni Garaj	10	4	2.06	*	*
Şehitler	16	9	1.47	*	*
Liman Silo	7	18	4.44		*
Gazie Sarn K	16	18	0.10	*	*
Naldöken	15	5	4.88		*
Çiğli itf. Kş.	13	9	0.66	*	*
Ankara	120	76	8.54		

Although there are fair amounts of reductions in the dead/injury type accidents, the reason that the χ^2 test results are quite insignificant can be related to the lower numbers of that kind of accidents which can not provide sufficient data for statistical significance. Yet, sticking to the method proposed, the authors assumes those values as significant below the thresholds (critical) values of the Chi square test for given error margins.

As mentioned previously, 2000 and 2001 are the years when the country experienced a serious economic depression, and therefore, it may be possible to encounter relatively less travel demand and amount of accidents depending on less vehicles joining to the traffic. But, this is just crude expectation (or hypothesis) in this study which is not among basic purposes of the study to verify. As the Highways General Directorate [17] emphasized in the respective report, the reductions in accidents can be an economy-related phenomenon, and may cause such an illusion that the observed reductions were the consequence of the traffic improvements by the Police proaction. if the results are not coincidental, then there might be high probability that those significant results can be through "an intervention". The reason executing the first test with the "ignorance" of any economic impact is to see the significances neatly under no "impact" consideration such as "how the economic recession impacted?", "how far the traffic volumes declined since", etc., and not to let any "noise" effect on the results. The author did leave these considerations after this initial "no impact consideration" test, and had the chance to compare the test results between the "no impact" and "impact" considerations. It is also true that the Police had indeed some areawide effective programs and location-specific measures to help improve the safety of the roads especially in the last seven years.

Having found the partial role of the Police in reducing the accidents, we can have a cost-effectiveness evaluation of saving lives by subtracting the previous years deaths from the late years deaths, and then the economic return. Assuming a saved life worths 1 million Euros in the 22% (due to 78% of the sampled streets were insignificant) of the streets, where the economic recession impact is incorporated, the accidents are said to be successfully reduced, which makes 270 avoided serious accidents. Usually of all serious accidents, 2.7 (or, 3 deaths for 1.1 deaths per accident with death) death type accidents are to be avoided and 3 million Euros are saved. If this result is extended to all Izmir city, 422 serious accidents are to be avoided, which corresponds to %77 of the accidents to be reduced; 325 serious accidents can significantly be avoided in the city by the Police measures. Thus, lives to be saved yearly become 3.25 (3.5 deaths), or 3.5 million Euros. The saving can, in fact, be much higher including other injury type and material hazard accidents avoided, and also the grieve. For the average cost of an accident, 800 YTL, this roughly means (7557 x 0.69), 5214 x 800 = 4.171 million YTL (or 3.5 million US$) annual economic return besides the 3 million Euro-worth saved lives. Should the Police continue

its preventive measures to protect people's lives and avoid damage to property?

CONCLUSION

Deployment of right safety policies is an important matter both in terms of saving lives and cost effectiveness in reducing the traffic accidents from the point of the Police. Therefore, recent concerns deal with the optimization of existing accident reduction measures with the least cost bundle options. Enforcement (police) measures are said to be among the major inexpensive but effective tools. Likely, the Izmir Police Department lately claimed that the major reason behind the drops in accident reductions in the metropolitan area between 1999 and 2005 is due to their succesfully managed programs. But, in this period, there was the economic recession felt over all the country which might have had impacts on the travel behavior, and also the number and severity of accidents. This case is taken as test ground for the quest that whether their role is as important as they claimed, or not. Thus, this study tried to test, first, whether these reductions are significant using Chi square test, and then, whether the economic recession had impacts on these significance levels as an external factor independent from the Police' intervention.

As a method, after finding the individual Chi square (χ^2) values for each street, those insignificant ones are selected and the general insignificance rate (as %) were obtained from over the number of streets showing significant results that measured the performance of the Police' claim on the claimed pilot streets: it seems the reductions would not be happening by chance. Yet, the results are far from being significant from the point of serious 'death and injury' accidents, where the impact of economic recession was not taken into account. The reason can be that the measures put into action would not be so well designed and effective as much as expected.

When the economic recession impact (5%) were removed (i.e., taken into account) from the existing results, interestingly still not a great change occurred. That is, the economic recession can not be a good reason but the Police' preventive measures and programs. But, the effectiveness of the Police measures seems not strong. In this respect, the Police may need some further professional councelling in the designation of effective measures so to further decrease the number and severity of accidents. Knowing the effectiveness of the policy measures and frequent use of Chi square method for the critical areas in question can help the understanding of the Police's role in reducing the accidents. Further study can be devoted to the searching of the types of police measures that are the most effective in reducing accidents.

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