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CHARACTERISTICS OF INJURY CRASHES IN DUBAI, UAE

Mostapha Aldah, Dr Richard Frampton, Dr Andrew Morris
Loughborough University
ESRI, Loughborough University, Ashby Road, Loughborough, LE11 3TU, UK
Phone: +44 7884432030 Fax: +44 1509226960 E-mail: M2@aldah.com

ABSTRACT

The global road safety situation is briefly reviewed then focus is brought to the rapidly developing Middle-Eastern country of the United Arab Emirates, and specifically to the emirate and city of Dubai. Road safety is analysed using recent injury crash case files collected from the authorities for the twelve year period (1995-2006).

Some of the key problems found were the high overall severity of crashes and high propensity of pedestrian and single-vehicle crashes. Speeding was found to be the second most common reported cause. Countermeasures were reviewed for effectiveness and selected to match these problem areas. The effectiveness of these countermeasures was used to calculate an estimated reduction in crashes or casualties. Once this improvement in road safety was calculated, an economic calculation of cost savings was possible using UK crash costings from published material by the UK Department for Transport. The overall cost savings are found to be significant by any standard, amounting to £350m or AED2.1bn (Dirhams – the local UAE currency). This method can be extended and refined with more detailed crash data. It can also be validated with before/after studies if/when these measures are adopted locally.

1 INTRODUCTION

Road users in the city of Dubai, in the United Arab Emirates, vary by their modes of transport and the way they use these different modes. The era of rail travel dawned in the region in September 2009 with the advent of Dubai Metro and marine transport has been used historically to traverse the Dubai creek. Road transport is the dominant mode of transport, with annual increases in the number of motor vehicles registered (2006: 340,538; 2007: 389,010; 2008: 459,348; Dubai Statistics Centre, 2009b). The city has seen a growth in both resident and active populations over the past few years (Dubai Statistics Centre, 2009a) with a resident population of 1.65m and an active population of 2.45m in 2008. The population only three years before was found in a census to be nearly 1.2m (Ministry of Economy, 2005). With growth in these figures and in so many other dimensions, it follows that traffic will become a concern, both in terms of safety and congestion. The traffic safety dimension has been looked at in neighbouring areas like Abu Dhabi (Almubarak, 1998) with the analysis of crash data from 1989-1990 and for the whole UAE (1990-1992). Specific aspects of road safety have also been investigated by a few workers in the field as shown next in the literature review. However no comprehensive overview of crash data has been recently completed of such a depth as to provide a clear indication of the main areas of concern in road traffic safety, so this study comes at both a timely and critical period in the history of the UAE in general and Dubai in particular.

2 LITERATURE REVIEW

Global estimates of the effect of road crashes on populations vary in their methods and units. Recording or estimating deaths from traffic crashes is one of the earliest methods of counting the effect of adverse road safety, while more recently cost estimates have attempted to calculate this effect in monetary terms.

Recording deaths varies by region and level of development, with the World Health Organisation (WHO) estimating that only 115 countries around the world record this data, with 64 countries only considered to have complete data (Mathers et al, 2005). Estimates of global annual road deaths vary from half a million by TRL (Transport Research Laboratory estimate for 1999) to 1.18m (1998) by WHO (Jacobs et al, 2000). Cost estimates tend to be measured as a percentage of Gross National Product (GNP). This estimate varies according to the level of motorisation (the level of motor vehicle use in a country). TRL estimates that the economic costs of crashes range from 1 to 1.5% for developing countries and those in transition to development, while in highly motorised countries (HMCs) the cost estimate is about 2% of GNP (Jacobs et al, 2000).

Two common measures of comparing road safety between different countries are fatality risk and fatality rate (Jacobs et al, 2000; Kopits & Cropper, 2003). Fatality risk is a measure of the risk to the general population (driving and non-driving) of dying in a road crash, normally measured as the number of fatalities per 100,000 units of population. Fatality rate however is a measure of the number of fatalities per 10,000 motor vehicles. These rates can be used to compare Dubai and the UAE to the best-performing and worst-performing nations in road safety terms in the European Union (EU). Table 1 shows that there is a large difference in fatality measures while motorisation levels do not vary a lot.

Table 1: Comparison of Dubai and the UAE with some Highly Motorised Countries (Aldah, 2009).

Country	Motor vehicles per 1,000 population	Fatalities per 100,000 population	Fatalities per 10,000 vehicles
UAE	217	21.7	10
UAE (Dubai only, 2005)	525	20.5	3.75
Greece (2003)	-	14.6	-
Portugal (2004)	510	12.3	2.4
United Kingdom (2004)	552	5.6	1.0
Sweden (2004)	563	5.3	0.9

Data sources: DfT, 2006; Ashur, 2003; RTA, 2006; Ministry of Economy, 2005.

Unpublished works on road safety in the UAE were found from two sources. Almubarak (1998) used crash data from Abu Dhabi police (1989 – 1990) and the Ministry of Interior (1990 – 1992) to survey road safety at that time, concentrating on the urban area of Abu Dhabi. His findings showed that area to possess an adverse road safety record. Cost estimates were attempted and found that crashes cost approximately 1.5% of GNP (1991 figures). Haj Ahmed (2002) conducted research from the epidemiological perspective on 1995 crashes in the UAE and estimated the total economic costs to be closer to 2-3% of GNP. He also found 18 – 40 year olds the most involved age group in fatal crashes. Most of the data for UAE crashes as described in the previous studies was collected centrally by the Ministry of Interior, which makes it secondary, as opposed to data collected directly from the police as described here, minimising the risk of introducing errors in transmission or transcription.

Published studies on the subject in the UAE were found to be few and far between. A seat belt law introduced in the UAE for front seat occupants of motor vehicles in 1999 was reviewed for its effect on traffic safety (Abdalla, 2005). The findings showed fatalities and serious injuries to have decreased significantly. Another study on seatbelts from hospital admissions in the city of Al-Ain (150km south-east of Dubai) showed that minor injuries increased after introduction of the seat belt law (El-Sadig et al, 2004). Involvement of four-wheel-drive vehicles, pedestrians and young drivers were all highlighted as trends by another hospital-based study in Al-Ain in the year 2000 (Bener et al, 2006) which is indicative of the type of issues facing road safety professionals in the area. Young drivers also featured heavily in a study of crashes in the downtown section of Abu Dhabi city (Ashur et al, 2005).

Drivers were the focus of a couple of other studies based on questionnaires to survey self-reported safety-related behaviour and crash involvement (Al-Madani, 2000; Al-Madani & Al-Janahi, 2002). These studies covered not just the UAE but also the neighbouring countries of Bahrain and Qatar. Drivers with more experience were found to comprehend signs better, though this had little effect on their crash involvement. Drivers with a better understanding of road signs tend to use seat belts more (Al-Madani, 2000). An interesting finding was only 55 – 56% of drivers correctly identified warning and regulatory signs (Al-Madani & Al-Janahi, 2002).

Seat belt use was first legislated in the Australian state of Victoria in 1970 (Wagner, 1997). Over 40 countries had enacted seat belt legislation by 1990 (Evans, 1991) but many countries still have poor seat belt use rates, even with legislation. Seat belt use by traffic casualties admitted to a hospital in the UAE from a recent study in Al-Ain (2003-2004) was found to be very low, with only 29% of drivers and 14% of front-seat passengers using seatbelts, along with 2% of rear-seated adult passengers (Barss et al, 2008). Mandatory seat belt use was estimated to reduce the probability of death for front seat occupants by 40-50% and by 25% for rear seat occupants (Elvik & Vaa, 2004). A meta-analysis of data from numerous studies on the subject showed the average reduction in vehicle occupant injuries to be 12% (*ibid.*).

Electronic Stability Control (alternately known by many names according to manufacturer/supplier, such as Electronic Stability Program, Dynamic Stability Control, Vehicle Stability Control, etc.) is a relatively recent advancement in active safety. It is designed to sense an impending loss of control (that may preclude a crash) and intervene to regain control, thus decreasing the likelihood of a crash. It was introduced in the late 1990s in passenger cars (Weekes et al, 2009). The effectiveness of this measure has been studied in the USA, Europe and Japan. The results were mostly positive, especially in low-friction situation as found in extreme winter conditions (Aga & Okada, 2003; Farmer, 2004; Kreiss et al, 2005; Lie et al, 2005; Thomas, 2006). An overall effectiveness of 16.7% in reducing most injury crashes was used as estimated by Lie (2005) as that study covered the longest time period (over eight years).

Different styles of pedestrian crossings exist but little difference was found in crash rates (Zaidel & Hocherman, 1987) between the different crossing types. Numerous studies have shown the wide variety of options and safety effects of pedestrian crossings (Corben & Duarte, 2006; Elvik & Vaa, 2004; Reading et al, 1995). The one crossing type singled out in the meta-analysis was signalised pedestrian crossing facilities (upgraded from other crossing types) that have an estimated 30% reduction in injury crashes (Elvik & Vaa, 2004).

Impacts with stationary objects at the road side tend to be severe due to the fixed nature of many roadside objects (trees, utility poles, rocks, etc.). Reviews of roadside crashes and objects (Corben et al, 1997; Elvik & Vaa, 2004; Short & Robertson, 1998) have shown many methods for improving safety at such locations including changes to horizontal road geometry and large-scale shoulder sealing, along with the more traditional guardrails and crash cushions. Crash cushions for impacts at the site of stationary objects on the roadside have an

estimated 69% reduction in injury crashes, from the aggregate meta-analysis on a number of studies (mostly from the USA) by Elvik & Vaa (2004).

Speed limits and driver adherence to these limits have been studied in various locations and conditions. The deviation of drivers from average traffic speeds have been shown to increase their crash rates in a number of studies (Munden, 1967; Aljanahi et al, 1999). Reducing average speeds by 5 kph is claimed to result in a saving of over 11,000 deaths and 180,000 injury crashes annually in the EU (ETSC, 1995). Speed and crash incidence are not always related, as found in a review by Wilmot & Khanal (1999) in the USA, however crash severity was found to be directly linked to speed. Reducing existing speed limits in the higher ranges (from 130 kph down to 120 or 110 kph, and from 120 to 110 kph) was estimated to have an estimated injury crash reduction of 14% (Elvik & Vaa, 2004). The reduction of speeds in the lower speed ranges (70 kph down to 60 and 60 kph down to 50 kph) had a lower estimated effectiveness of 9% in reducing injury crashes, which is still an improvement. Speeds in the lower ranges are particularly relevant to pedestrian traffic safety as impact speeds of above 55 kph used to result in fatalities (Ashton & Mackay, 1979; Ashton, 1982). More recently this fatality threshold might have risen slightly with the improvement in vehicle design (Neal-Sturgess et al, 2002).

The automatic enforcement of speed limits using cameras and radar equipment has seen use in many countries around the world, generally with positive effects (Newstead & Cameron, 2003; Pilkington & Kinra, 2005). The advantage of such devices is the time saving when compared to traditional manned speed cameras (Wilmot & Khanal, 1999) in the man-hours needed for processing. A disadvantage of such a measure is the distance- and time-halo effect which means that traffic might adhere to the limit at the position and time of application only, while continuing to speed outside the area of deployment (Champness et al, 2005; Koushki & Hasan, 2000). The estimated effectiveness of this measure on reducing injury crashes from meta-analysis of a number of studies was 17% (Elvik & Vaa, 2004).

3 METHODOLOGY

Every crash that occurs on the roads of Dubai should be reported to the police to get an authorisation of vehicle repair, without which it is difficult to perform any bodywork at a garage or bodyshop. This leads to a fairly comprehensive crash database and little under-reporting (Abdalla, 2005; El-Sadig et al, 2002). These crashes are reported to the police and the data are input on a database shared by the police and roads and transport authority (RTA; Aldah, 2009). This database was used to extract all injury cases from 1995-2006 divided into three categories: a vehicle/driver file, a casualty file, and a crash case file. In total 29,856 vehicle/driver files were used with 30,942 casualty files and 18,142 crash files (all linked by the case ID) on a Microsoft Access database. These files contained base-level crash information such as crash date, time and location, with a few more fields allocated to the number of parties involved and the reported cause and type of crash, along with local conditions if available. They were imported, sorted and validated using the statistical software known as the Statistical Package for Social Sciences (SPSS Inc, 2006) which was also used for most of the univariate analysis performed.

The results of analysing each variable (in some cases on its own, and in others along with other sub-variables) serve to highlight the most frequently occurring scenarios, such as the most frequent crash types, times, locations, causes and severities. In some cases the results were not significant when compared to different years but when compared to other countries (such as the UK), differences were obvious (such as overall case severities – what percentage of the total reported injury cases are fatal). After the key problem areas were found, they were matched to safety countermeasures that were found to be effective in previous research studies as reviewed in the literature. Most of these studies on countermeasures also show an

effectiveness level as a percentage reduction in crashes or casualties, which allows the calculation of possible savings if such countermeasures were applied in Dubai.

Such a method was used in many other road safety studies (Corben et al, 1996, 1997; Keall & Newstead, 2007; Mansfield et al, 2008; Welsh & Lenard, 2001) and is common where carrying out individual before/after studies to measure effectiveness locally is not possible due to practical and cost constraints. The calculation of savings in terms of reduced crashes or casualties is straightforward, but calculating financial costs is more complicated due to the different methods available. Where up to date crash costs are not available it is possible to use costings from other countries – in this case the UK was chosen as recent crash costs were available from 2005 (DfT, 2007). Two main cost figures were used from the UK Department for Transport publication: the average cost of a crash where at least one person was injured (£64,440) and the average cost to the economy of treating one casualty from a car crash (£44,920). Most of the countermeasures related to reductions in crashes rather than casualties, so the first figure was most commonly used.

A number of assumptions need to be made as is typical in such work to enable estimated calculations to be made. Some of the key ones were that a similar number of crashes will occur in the next twelve years as has occurred in the past twelve. If more crashes occur, then these calculations might be conservative. The crash costs are not thought to be identical between the UK and UAE however no recent cost estimates were available from the UAE so UK costs were used. Also costs rise with time so again the economic figures might be conservative. The figure arrived at as a summary saving is large and significant by any measure.

Some countermeasures appear to duplicate measures already in existence in the UAE. However these were only suggested where such measures were known to be inactive in the UAE, such as the seatbelt legislation that was effective at the time of enactment but adherence dropped with time to very low levels (Barss et al, 2008). The effectiveness of countermeasures is not always transferable between countries and regions. The extent of transferability is discussed after the results.

4 RESULTS

Some of the key problem areas found from the aggregate data analysis are summarised in Table 2 below. The measure of speeding is subsequently split in to two speed ranges (high and low) in the next two tables as different effectiveness levels apply to these ranges.

Table 2: Key problems that stood out from the crash data analysis for Dubai (1995-2006).

No.	Problem found from analysis	Supporting analysis
1	High proportion of fatal crashes	13.5% of crashes fatal compared to 1.4% in UK*
2	Pedestrian crashes are most common type	28.6% of crashes are pedestrian-type, more than any other
3	High number of single-vehicle crashes	48.7% of cases involve a single vehicle
4	Urban areas account for many crashes	Most crashes (40.6%) occur on roads with a 60 kph limit, which are in urban areas
5	Speeding is the 2 nd most common crash cause recorded	Accounts for 12.6% of all crashes
6	Highways account for a lot of crashes	3 of top 6 crash locations are major highways

*Source: DfT, 2006.

Many of these problems are in common with other areas and findings of previous research as seen in the literature review. Each of these areas was then matched to a countermeasure whose effectiveness is known from previous research (Table 3). This is to enable the calculation of the estimated improvement if that measure was applied universally to this data set (ideally).

Table 3: Problem areas matched to countermeasures (Dubai 1995-2006 injury crashes).

No.	Problem area	Countermeasure (and sub-division of problem area to be addressed)	Best estimate of difference in injury occurrence/injury crashes
1a	High proportion of fatal crashes	Seat belt use legislation (for vehicle occupants)	-12% ¹ (injured vehicle occupants)
1b	High proportion of fatal crashes	Electronic stability control (to tackle rollovers)	-16.7% ² (crashes)
2	Pedestrian crashes are the most common type	Signalised (separate phase) pedestrian crossing facilities (upgrade)	-30% ¹ (crashes)
3	High number of single-vehicle crashes	Crash cushion at site of impact (for stationary object impacts)	-69% ¹ (crashes)
4	Urban areas account for many crashes	Reducing existing speed limits (from 70→60 and 60→50 kph)	-9% ¹ (crashes)
5	Speeding is the 2 nd most common crash cause recorded	Automatic speed enforcement	-17% ¹ (crashes)
6	Highways account for many of crashes	Reducing existing speed limits (to tackle higher speeds on highways) from 130→120 or 110, 120→110 kph	-14% ¹ (crashes)

¹Source: Elvik & Vaa (2004)

²Source: Lie et al (2005)

The next step is the actual calculation of the estimated savings, either in terms of casualties or injury crashes. The economic cost of every casualty and injury crash is known from a UK Department for Transport publication (DfT, 2007). This allows an overall savings estimate to be made, which is a staggering figure when viewed next to the overall size of the injured population annually (around 300 fatalities and 1500 casualties).

Table 4: Calculation of estimated savings from applying countermeasures to relevant crashes.

No.	Countermeasure (and sub-division of problem area to be addressed)	Estimated crash/casualty reduction (retrospective, rounded to last digit)	12-year reduction	Avg. value of est. saving in crash prevention cost (based on UK, 2005) ¹
1a	Seat belt use legislation (for vehicle occupants)	12,958 (relevant crashes) -12% = 1,555 (assuming all non-pedestrians are vehicle occupants)		£44,920 x 1,555 = £69,850,600
1b	Electronic stability control (to tackle rollovers)	1,970 -16.7% = 329		£64,440 x 329 = £21,200,760
2	Signalised (separate phase) pedestrian crossing facilities (upgrade)	5,180 -30% = 1,554		£64,440 x 1,554 = £100,139,760
3	Crash cushion at site of impact (for stationary object impacts)	1,719 -69% = 1,186 (taking all single-vehicle stationary-object injury crashes)		£64,440 x 1,186 = £76,425,840
4	Reducing existing speed limits (from 70→60 and 60→50 kph)	7,366 -9% = 663 (on roads with a recorded 60 kph speed limit)		£64,440 x 663 = £42,723,720
5	Automatic speed enforcement	2,288 -17% = 389 (note: increased use of speed cameras in the final period of study already shifted speeding to 6 th leading cause in 2006)		£64,440 x 389 = £25,067,160
6	Reducing existing speed limits (to tackle higher speeds on highways) from 130→120 or 110, 120→110 kph	2,150 -14% = 301 (on roads with a recorded 120 kph speed limit)		£64,440 x 301 = £19,396,440
	Total	4,422 crashes, casualties	1,555	£354,804,280 ≈ AED2.1bn (UAE Dirham)

¹Source: DfT (2007)

These were not the sole problem areas and suggested countermeasures identified but they provide a summary of key findings. With more detailed crash information this process can be repeated with better accuracy and confidence of the resulting estimations.

5 DISCUSSION

The results display a range of common road traffic safety ailments along with some traditional and recent countermeasures designed to improve outcomes in a crash, or avoid it altogether. The situation in Dubai is unique in many aspects, and reflects the overall position of the UAE as a growing regional economic powerhouse. With increased development it is not possible to move everything forward and advance at once, but one thing normally leads to another. The interaction with the various stakeholders in collecting this data and conducting the research shows that a lot of attention and investment is directed at the area of roads building, regulating, enforcement and monitoring.

The high proportion of fatal crashes could be tied in with the predominance of 4x4 and large vehicles in the fleet as they appear in a study of Al-Ain city (Bener et al, 2006), which is not far from Dubai and shares a lot of common environmental features. The high-speed highways connecting Dubai with neighbouring cities might also contribute to the high severity of crashes associated with speed. Pedestrians are commonly involved in crashes, which is to be expected in urban areas, but the unusual finding is their involvement in high-speed crashes on highways and areas where pedestrians are not normally expected to be. Contributing to this problem was the lack of pedestrian crossing facilities at such locations even when major developments may lie at opposite sides of a highway. Things are improving now with many airconditioned crossings planned (Al-Theeb, 2007) and completed. A crash between a motor vehicle at highway speeds with a pedestrian is expected to result in a severe injury and possibly death. Pedestrians active in urban city centres are a common safety concern with other countries (Corben & Duarte, 2006) but lower vehicle speeds might make a difference to injury outcomes.

Loss of control crashes involving single vehicles are also likely to happen on highways, especially if the surrounding terrain is monotonous with little visual stimulation, while adverse winter weather conditions are rare in the UAE. The low seatbelt use observed by many studies in the area (Abdalla, 2005; Barrs et al, 2008; El-Sadig et al, 2004) might also contribute to an increased mortality and morbidity from loss-of-control crashes, as unbelted occupants are likely to suffer an increased risk of ejection.

The dynamic and flexible nature of development in Dubai offers a ripe opportunity for trialling any and all of these countermeasures in some way. Then a controlled before-after comparison can be made to see the extent to which effectiveness levels are comparable between Dubai, UAE and different regions.

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