Assessing Vehicular Inspection Centers using Multiple Decision-Making Criteria

Mohamed Y. E. Selim[1], M. A. Maraqa[2,3], Y. E. Hawas[2,3] and A. M. O. Mohamed[2]

Abstract -- The process of vehicle inspection in the United Arab Emirates has been investigated in this study using multiple decision-making criteria. The objective was to assess the current situation and set out recommendations to improve vehicle inspection procedure. Inspected mechanical and environmental parameters have been compared among different inspection centers in the country. The assessment included inspection of both light and heavy vehicles as well as vehicles imported through ports. A set of surveys have been designed to collect information about the inspection process, opinion of the inspection technicians, public opinion, and opinion of vehicle inspection experts in the country. The study revealed significant differences among the inspection centers in the different Emirates and even within the same Emirate. It has been found that vehicle inspection forms are not uniform among the seven Emirates, with no Emirates Standards for vehicles safety and environmental inspection. Additionally, vehicle inspection equipments are not unified among the inspection centers and inspection of some important safety issues is not implemented. It was also found that there was no third-party auditing to assure quality control. Moreover, most of the customers did not abide to the rules of vehicle inspection and vehicle maintenance.

***Keywords*--** vehicle, inspection, standard, crash, pollution

1. Introduction

Accidents are one of the reasons that could put people to death or injury. Some traffic safety studies [Hawas, 2009] have shown a high rate of road accidents in the United Arab Emirates (UAE), which negatively affects the gross national product (GNP), and causes suffering to the community. On average, there is about one fatality due to motor vehicle crashes every eight hours, and more than 25 injuries per day in the UAE [Hawas, 2009]. The estimated economic loss due to vehicular fatalities and injuries reaches a total of about US$ 6 billion annually, with each fatality costs about US$1.92 million, while each severe injury costs about US$2.2 million [Hawas, 2009].. Overall, the economic cost due to fatalities and injuries associated with roadway crashes is about 2.5% of the country's GNP [Hawas, 2009].

Nowadays, the UAE is witnessing a sharp increase in the number of vehicles on roads due to economic development and population growth. This applies to vehicles of small gasoline engines (private-owned) as well as heavy vehicles using diesel engines (cargo and passengers, etc.). For example, the number of small cars in the UAE has increased from 309,539 in 1991 to 1,149,304 in 2005 to 1,178,878 in 2007 [Amer, 2005], with an annual rise of about 10%. This is accompanied by an increase in the annual number of road accidents, road injuries, traffic deaths, and traffic irregularities. In 1991, the number of traffic-related deaths was 490, but increased to 830 in 2005 and to 1024 in 2007 [Amer, 2005]. There has been also an increase in the number of traffic-related injuries with 8,695 in 1991, 10,194 in 2005, and 10,911 in 2007. However, the total number of reported accidents has decreased from 15,296 in 1991 to 8,828 in 2007, doubling, therefore, the rate of risk (the total number of victims/ number of accidents).

There are many factors that lead to high incidence of traffic accidents in a country [Stewart, 2005]. Mechanical defect of is considered as one of the reasons that lead to such incidents [Conroy et al., 2008, Moodley and Allopi, 2008, Hoque and Hasan, 2006]. Generally, 5-9% of traffic accidents are caused by mechanical defects [Taneerananon et al., 2005, Van Schoor et al., 2001]. However, this rate could reach as high as 27%, with the state of tires [Steyn and Haw, 2005], brakes or even lights [Ibrahim and Bari, 2008] are often the cause of the problem. Thus, vehicle inspection by traffic departments is vital to ensure road users' safety and security.

Vehicles in UAE are inspected annually at designated inspection centers located in all Emirates. The centers are under the authority of the Traffic Departments in each emirate (Selim et al., 2011). Mechanical and environmental inspections are supposed to be performed at the centers. However, little is known about the performance and the consistency of the inspection process among these centers. In this study, we explored the process of vehicle inspection in the UAE using multiple decision-making criteria, based on a distributed survey to inspectors, vehicle owners, and experts. It is anticipated that this assessment will be helpful for improvement of vehicle inspection process in the country in a way that planners come-up with a unified inspection protocol that assures vehicle safety and reduces vehicle emissions.

2. Methodology

The UAE consists of seven Federal Emirates (i.e. Abu Dhabi, Dubai, Sharjah, Ajman, Um-Al-Qween, Fujairah, and Ras Al-Khima). Vehicles are annually inspected in the emirates where they are originally registered. Currently, there are 54 inspection centers distributed among the emirates as shown in Table 1. In this study, 17 out of the 54 centers have been visited (Table 1). Some of the visited centers are for light duty vehicles (LDV), others are for heavy duty vehicles (HDV), and some inspect both types. As can be seen in the table, at least one center per emirate has been visited, except for Dubai and Abu Dhabi, where 5 or more centers have been

1Mechanical Engineering Department, 2Civil and Environmental Engineering Department, 3Roadway Transportation and Traffic Safety Research Center, UAE University, Al-Ain, UAE (email: mohamed.selim@uaeu.ac.ae)

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visited in each Emirate – as the number of centers is higher in these two emirates compared with the number of centers in the other Emirates. In addition to the 17 visited centers, three main ports that import used vehicles, were visited; one in Dubai, another in Abu Dhabi and the third in Sharjah.

The study tools consist of a set of forms and questionnaires that were designed and distributed to different groups of target respondents. The questionnaires were distributed and collected during the period of January to June, 2009. One of the forms given to each inspection centers was filled by an administrator, who knows the inspection standards and rules (one for each visited center with a total of 17), another form was filled by an inspector at the center (total 45 filled out of a total of 175 workers at the visited centers), and a third type of forms was filled by vehicle owners (total 82 filled forms among all visited centers). A fourth type of forms was distributed to experts in the country to collect opinion about the vehicle inspection process. An additional form was given to the Police Department to identify the causes of car accidents that took place during the last five years. Also, three forms were collected from the three visited main ports.

3. Results and Analysis

All forms and questionnaires have been filled and collected. Information has been tabulated for statistical analysis. There have been some discrepancies between the inspection centers with respect to the number of working hours per day or days per week. The number of inspection staff, the number of vehicles inspected per day and the average time allocated for vehicle inspection differs among the different centers. For example, the number of vehicles inspected daily at the visited centers by each worker ranges from 3-75 with an average of 22 vehicles. Also, the inspection period per vehicle at the centers ranges from 5-30 minutes with an average of 13 minutes. It was further found that the inspection cost is different from one Emirate to another for the same type of vehicle.

Selim et al. (2011) illustrated the different causes of vehicle failure during the inspection process in the UAE as given by the inspection center administrators and inspectors (Fig.1). As shown in Fig. 1, exhaust emission level as well as the conditions of the brakes are the most common cause of vehicle failure (each represents 67%), followed by chassis deficiency or frames (47%). Painting, spotlight mis-focus or vehicle modifications are ranked at the least occurrence of vehicle failure. The reason for such failure behavior is probably related to the current available inspection instruments at the centers (Fig. 2). As most of the centers (82%) have a brake testing system, then brakes failure appears as the most frequent reason of vehicle failure. Similarly, exhaust gas analyzers are available in many of the centers (71% availability), resulting in the ability to detect exhaust emissions violations and makes such a cause as one of the most frequent reasons of vehicle failure. Light focus testing system, however, exists in only 18% of the centers, which leads to less frequent cause of failure (13%). It may be seen also in Fig. 2 that 12% of the centers have no devices for inspection; rather they rely on visual inspection of vehicle conditions including clarity of exhaust gases from smoke. These centers are mainly located in the Northern Emirates. Nonetheless, these centers claimed they have future plans to use new inspection equipment.

The majority of the inspection centers (94%) check body corrosion and strength and number of chassis as shown in Fig. 3. However, one-third of the centers do not calibrate their exhaust gas analyzers as illustrated in Fig. 4. For those that calibrate their gas analyzers, the frequency of calibration varies from one week to one year. This shows a major inconsistency in the quality control measures as the devices need to be calibrated after fixed working hours.

Figure 5 illustrates the response of inspectors about the period after which the vehicle needs inspection. More than half of the inspectors (57%) believe that annual inspection is necessary especially for the brake system, tires and exhaust gas/smoke. On the other hand, 29% of the inspectors think that an inspection every 2 years will not harm. Figure 6 depicts the way to demonstrate the rules of inspection to vehicle owners. Many inspectors (83%) suggest that readable, audible and visible media can assist in educating the public about the rules of inspection and how vehicles could be maintained in safe conditions. This could also be utilized to disseminate information about frequent causes of vehicle failure during inspection. The majority of inspectors (83%) also suggest that inspection has to be carried out the way it is currently done (i.e. by government entities and not private companies) as seen in Fig. 7. However, 17% of the inspectors suggest that private companies can help in the inspection process as the number of centers increases, which will ease on people, prevent overcrowd, and offers a better service. Figure 8 suggests that 41% of the centers are not over-crowded while 59% are sometimes crowded. This is also related to the number of working staff and working hours as well as the location of the inspection centers. Crowded centers prevent inspectors from conducting a comprehensive and effective inspection. This should be avoided to assure quality control.

As may be seen in Fig. 9, the majority of inspectors (72%) gave advice to the owner of the vehicle about any inspection problem. They also depend on the results' sheet that given later to the owners for any technical problems.

Figure 10 depicts the allowable limits of certain pollutants emitted from vehicle exhaust gases. These gases are hydrocarbons (HC) (Fig.10-a), carbon monoxide (CO) (Fig.10-b) and diesel smoke (Fig.10-c). There are some discrepancies between centers for the allowable limits of HC (Fig.10-a) emitted from vehicles, while 24% of the centers do not measure HC at all. Similar variation between centers occurs for the CO allowable limits (Fig.10-b), with 17% of the visited centers do not measure it. For diesel smoke, 41% of the centers allow from 2.5 to 3 K, while 59% of the centers check diesel smoke visually. Most of the centers that do not check exhaust gases claimed that they will use the needed equipments and enforce exhaust gas measurements on all vehicles. It may be seen from these figures that there is no

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unified regulatory limits for vehicle mitted pollutants in the UAE; rather there are major differences in the adopted limits among the different Emirates. Furthermore, there are no regulatory limits for nitrogen oxides (NOx) in the exhaust gases of petrol or diesel engine in the country, which is now being enforced in developed countries.

Previous studies have shown that the permissible limits of pollutants from the exhaust have been lowered, in the European and American regulations. The limits of oxides of nitrogen have been reduced from 7.0 g/kWhr per Euro-2 in 1996 to 2.0 g/kWhr in Euro-5 in 2008. The US EPA reduced vehicle-emitted oxides of nitorgen from 4.0 g/kWhr in 1998 to 0.2 g/kWhr in 2007. Similarly, the limits of black smoke have been reduced from 0.15 g/kWhr per Euro-2 to 0.02 g/kWhr in Euro-5, while the American standards reduced black smoke from 0.1 g/kWhr in 1998 to 0.01 g/kWhr in 2007 [Anh and Dao, 2005].

Currently there are no unified regulatory limits for exhaust emissions from used vehicles in the UAE. However, for new vehicles imported from the manufacturers the UAE is following the Gulf Standards # 1680 for vehicles using unleaded gasoline with allowable exhaust emissions of 2.64 g/km for CO and 0.6 g/km for HC and NOx collectively. For diesel-powered vehicles, Euro-4 is adopted for heavy duty diesel engines (1.5 g/kWhr for CO, 0.46 g/kWhr for HC, 3.5 g/kWhr for NO, 0.02 g/kWhr for PM and 0.5 1/m for smoke opacity). Euro-5 is adopted for light duty diesel engines (500 mg/km for CO, 200 mg/km for NOx, 250 mg/km for HC and NOx together and 5 mg/km for PM).

Experts from road and transportation agents, environmental agency and standardization authority in the country expressed their feedback through forms given to them. They have: (1) expressed the urgent need to develop a comprehensive and accurate vehicle inspection processes and identify suitable equipments for monitoring purposes. ; (2) indicated lack of strict environmental limits for noise and exhaust gases from vehicles; (3) suggested that the inspection process to be unified among different inspection centers in the country and to update the current analyzers with the possibility of measuring the level of nitrogen oxides in the exhaust gases; (4) indicated that vehicles might be inspected every two years with allowable limits of exhaust pollutants according to the vehicle age, e.g. 4.5% CO for pre-1986 vehicles and 3.5% CO for post-1986 vehicles. For vehicles with catalytic converters fewer limits of hydrocarbons should be allowed in comparison with vehicles without converters; and (5) suggested the use of roller brake tester to test the brakes, tire thread depth gauge to measure the tire conditions, headlamp alignment tester and smoke meter.

It is worth noting that imported used vehicles through the three main ports in the UAE do not go through any mechanical or emission testing. Only routine checks for chassis information are conducted against the manufacture information for each vehicle.

4. Conclusions and Recommendations

Having reviewed the feedback and facts collected from the different inspection centers, from the importing ports in the UAE and the current Gulf standards, the following conclusions may be drawn:

- There is no standard specification to examine used vehicles, whether they are gasoline or diesel (light and heavy duty) vehicles.
- Test equipments used at the inspection centers in the UAE are not uniform, and some centers lack measurement devices. This applies to exhaust gas analyzers, measurement of headlights focus, side slip testers, brake testers, and tire quality device.
- The inspection form used at the various centers is not unified, reflecting the heterogeneity of the inspection process among the centers.
- Some important elements of the vehicle are not currently inspected, such as spare tire and headrest of the driver.
- Some items exist in the inspection form used at the inspection centers but are not inspected. These include presence of a fire extinguisher, first-aid kit and phosphorescence reflector triangle.
- Some of the technical staff at the inspection centers needs more training to ensure better quality of vehicle inspection.
- The limits of emitted pollutants from vehicles like HC, CO and smoke are not uniform among the different Emirates. Meanwhile, diesel engine emitted HCs are not currently measured.
- Gas measuring analyzers at different testing centers need to be calibrated after certain period of time.
- Inspection centers need to be evaluated by a third party to insure quality control.
- The public need more awareness about the reasons for the failure of the vehicle during inspection.
- The number of centers and/or working staff needs to be increased to avoid overcrowds.
- There is a need for standardization of vehicle inspection process in the UAE and to establish a uniform policy for the organization of vehicle inspection.
- There is a need to establish a National body to manage the environment, health and safety aspects of the inspection processes.

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Table1. Location and number of vehicle inspection centers visited

Emirate	Abu Dhabi	Dubai	Sharjah	Ajman	Um-Al-Qween	Fujairah	Ras Al-Khima
Number of inspection centers	18	28	1	1	1	3	2
Number of centers visited	5 (3 LDV, 2 HDV)	6 (4 LDV and 2 HDV)	1 LDV & HDV	1 LDV & HDV	1 LDV & HDV	1 LDV & HDV	2 (1 LDV and 1 HDV)

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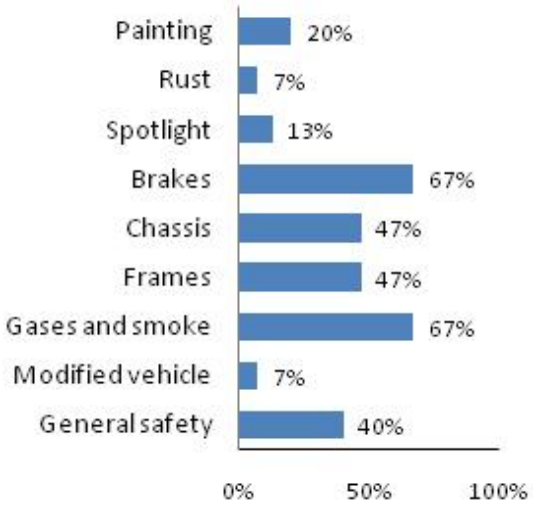

Figure 1. Causes of vehicle failure in UAE (Selim et al., 2011)

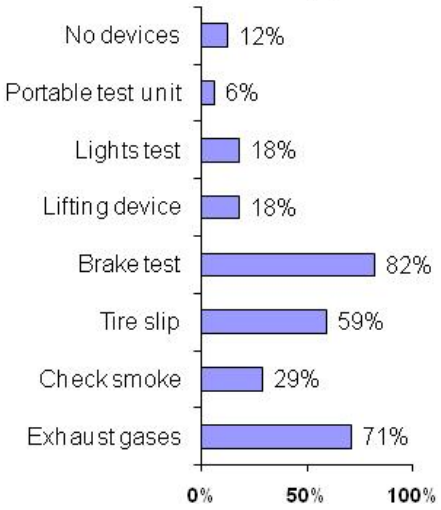

Figure 2. Available inspection equipment

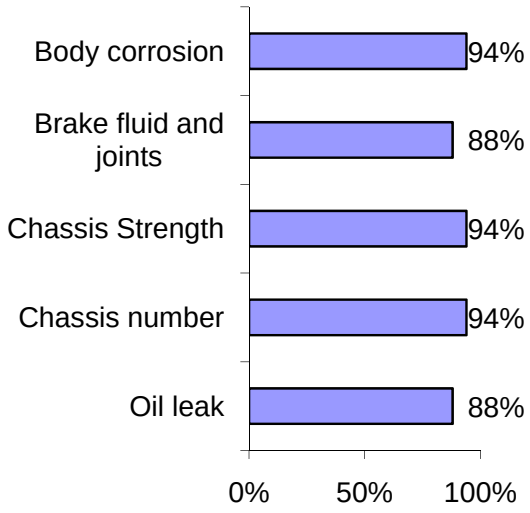

Figure 3. Most frequent inspection items

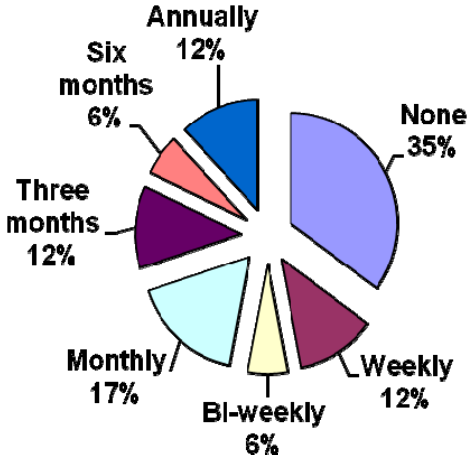

Figure 4. Frequency of exhaust analyzers calibration

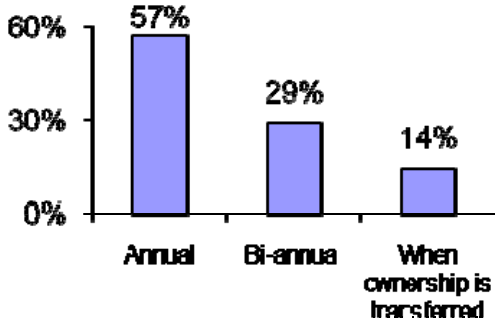

Figure 5. Response of inspectors for inspection time

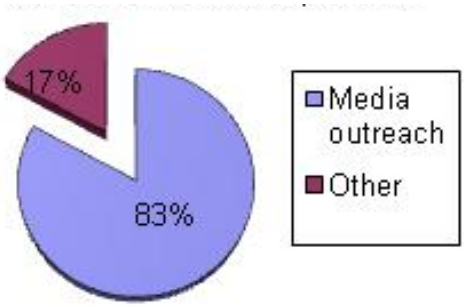

Figure 6. Response of inspectors for methods of public outreach

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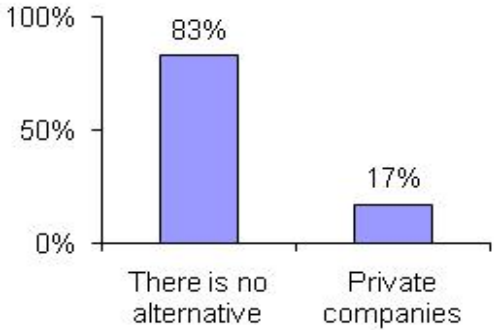


Figure 7. Alternatives to inspection

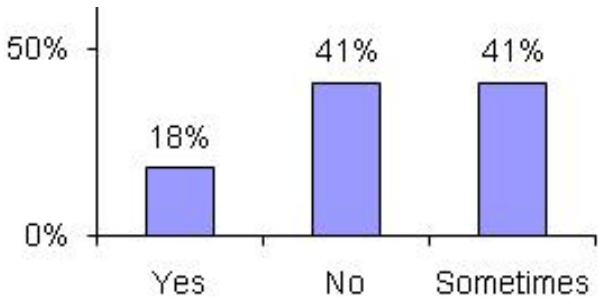


Figure 8. Response about center overcrowd

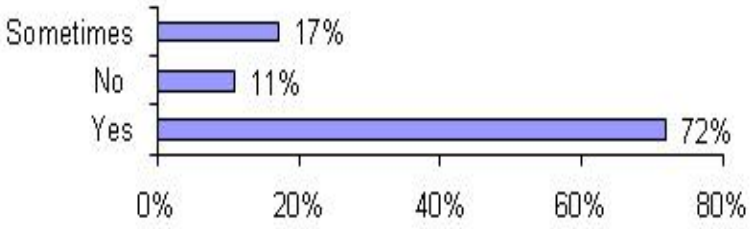
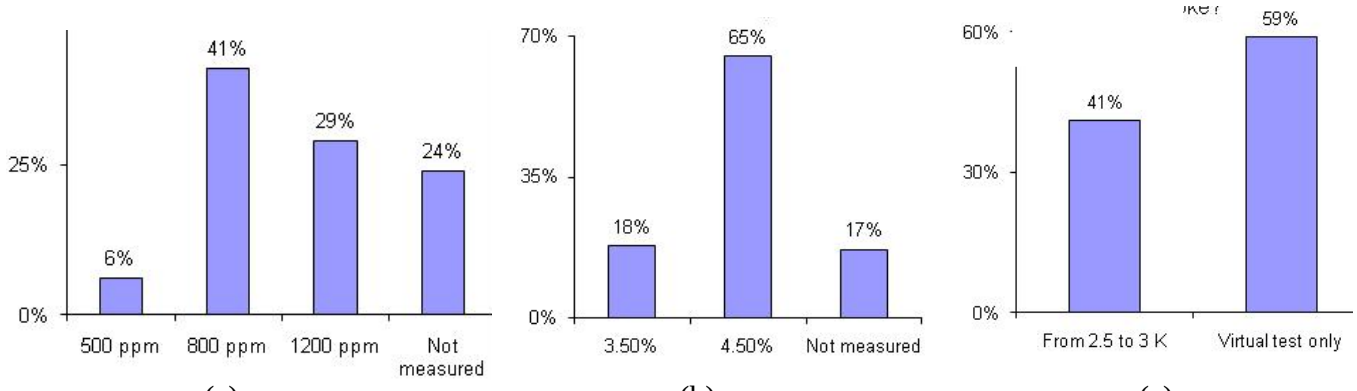


Figure 9. Response of inspectors about informing the public on how to solve the technical problem in vehicle



(a) (b) (c)

Figure10. Allowable limits of (a) HC, (b) CO and (c) diesel smoke in exhaust gas adopted at the inspection centers.

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