IDENTIFICATION OF VITAL VEHICLE MECHANICAL DEFECTS CAUSING ROAD TRAFFIC ACCIDENTS IN PAKISTAN

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ABSTRACT

Vehicle Mechanical Defects (VMD) is one of the major cause of Road Traffic Accidents (RTA) in developing countries. This paper presents the quantitative analysis of RTA on Motorways in Pakistan caused due to VMD. The data is collected from the National Highway and Motorways Police (NHMP). The Data for 1585 RTA on the Motorways of Pakistan for the years 2003-2012 were reviewed. The objective of this research was to establish the contribution of VMD to RTA. A vehicle survey, based on a convenience sample of 290 vehicles was also done at the Toll plaza of the Peshawar-Islamabad Motorway (M-1). The response rate to the survey was 64%. The survey identified that 80% of vehicles had no maintenance record. About 74% and 65% vehicles lacked annual wheel balancing and annual wheel alignment respectively. About 61% of the vehicles inspected had wheel related defects and 59% of the vehicles had brake fluid less than the recommended level, 20% vehicles had a brake fluid leak in their brake system, and these may, therefore, be at a risk of causing an RTA. In the RTA data from the NHMP, 32% of all RTA on Motorways are due to VMD and that the two vital vehicle mechanical defects (VVMD) are tyre blowouts and brake failures. The average tyre burst is 17.36% and average brake failure is 5.38%. Tyre blowouts were responsible for about 55.6% of all RTA caused due to VMD while brake failures were 18% of the total RTA caused due to vital causes. RTA in Pakistan can be reduced if regular vehicle fitness check and awareness campaigns about tyre and brake system defects are carried out to reduce RTA.

KEYWORDS: *Road Traffic Accidents, Vital Vehicle Mechanical Defects, Vehicle Fitness Check, Tyre Burst, Brake Failure, Maintenance.*

INTRODUCTION

The number of vehicles on roads is increasing every day and these vehicles are mechanical systems with a finite life, therefore they lose their function, hypothetically worn out mechanical components can contribute to RTA thus endangering the lives of people who use them. RTA is one of the major causes of mortality and disability. Every day, about 140,000 humans get injured on roads. More than 3000 lose their life and some 15,000 are disabled for life[1]. The Global Burden of Disease study conducted by W.H.O predicted traffic injury would be the third most frequent reason for mortality and morbidity by 2020 [2]. If no preventive steps are taken these injuries will increase significantly in the next 20 years and this increase will mostly be in low income countries[3]. Fatality rates are rapidly accelerating in Asia: between 2000 and 2020, road traffic deaths are likely to increase by 92% in China and 147% in India, much faster than in other developing countries [4].

Pakistan is one of the countries which have high rates of annual road traffic injury related deaths about 40,000 per year [5]. Pakistan, which is the sixth most populous country, more than 14000 RTA takes place every year on the motorways. Pakistan has a reasonably developed transport infrastructure. It has a large network of roads consisting of 259,758 km of major roads, of which 8,885 km is the National Highway, 2,027 km is the Motorway and 4,964 km makes up the Pakistani portion of the Asian Highway Network. Pakistan's Gross Domestic Product (GDP) per capita is $3,056 ranking 140th in the world. Pakistan is a rapidly developing country and is one of countries that have a high potential to become the world's largest economies in the 21st century. The shoreline of Pakistan is in a vital location that is viable for trade with other countries of the world by sea being situated at the intersection of South Asia, Central and West Asia and the Middle East. It has two harbors, Karachi and Gwadar. The road connecting Gwadar with Saindak is under construction which will be the shortest route between the energy rich central Asian States , Afghanistan, China and the sea. It is very clear that roads will be used to transport containers and shipments arriving at the two seaports to the central Asian states via Afghanistan and to China through the Karakoram

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Highway. The rapid rate at which motorization is taking place throughout the world, including Pakistan, all this will result in an increased number of RTA in Pakistan. A research project investigating the proportion of RTA due to VMD keeping in view the socioeconomic factors to understand the extent and nature of the problem was thus undertaken

The reasons that are responsible for RTA are categorized into human, environmental and Vehicle factors. The VMDs play a vital role in RTA causation, In U.K Sabey and Staughton (1975)[6] discovered that 2% of RTA is the result of mechanical defects in vehicles, in U.S.A Treat[7] (1980) found that 2% of RTA are caused due to vehicle mechanical defects (VMD) and 12% of RTA are caused due to combining the VMD in correlation with some other factors. In South Africa 40% of vehicles surveyed on the suburban roads and 29% of vehicles surveyed on the highways had VMDs [8]. However, in Ghana, Jacobs and Sayer [9] this figure was found to be 16%.

METHODOLOGY

Data Collection

The data were collected from NHMP. A road side vehicle survey was also conducted to get an idea of the issue of VMD in Pakistan. The data for ten years, i.e. 2003 to 2012 of all RTA on Motorways M1, M2 and M3 was collected with the exception of detailed data for 2006. The NHMP uses MAAP (Microcomputer Accident Analysis Package), to store RTA data. The hard and soft copies of different RTA were also collected from the NHMP.

Data Analysis

The collected data which included RTA data and vehicle survey data were analyzed using Microsoft Excel 2010. The RTA data were extensively examined and the different RTA in which the identified VMD were categorized under steering defect, wheel defect, tie rod problem, brake failure, tyre burst and any other mechanical defects shown in Table 1.

Figure 1 shows the Annual and Average percentage of RTA on the Motorways of Pakistan, which took place during 2003 to 2012. In the RTA data from the NHMP, 32% of all RTA on Motorways are due to VMD.

Vehicle Survey

In order to get a picture of vehicle mechanical defects the authors and a vehicle mechanic conducted a survey of this problem by selecting a convenient sample of vehicles at the Toll-Plaza of Peshawar- Islamabad Motorway (M-1). A sample of 290 vehicles was surveyed by stopping about 450 vehicles the drivers were requested to

Table 2: Two level factorial design matrix

Year	Total Number of RTA	Number of RTA Steering Defect	Number of RTA Wheel Defect	Number of RTA any other VMD	Number of RTA Tie rod	Number of RTA Brake Failure	Number of RTA Tyre Burst	Number of RTA VMD	Percentage of RTA VMD
2003	161	3	5	2	9	7	35	60	37.27
2004	141	1	2	6	3	8	23	43	30.50
2005	215	2	3	7	10	15	32	69	32.09
2007	177	1	2	4	5	13	24	49	27.16
2008	261	0	16	5	5	0	37	73	27.97
2009	157	0	4	4	4	7	41	60	38.22
2010	151	0	1	3	6	11	37	58	38.41
2011	158	0	4	1	3	10	26	44	27.85
2012	157	0	1	1	7	14	18	41	26.11

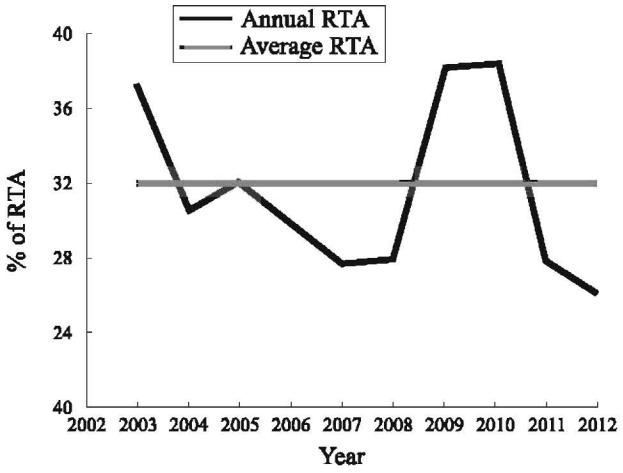

Figure 1: Annual and Average RTA (2003-2012) Motorways Pakistan

participate in this survey but only 290 drivers agreed to participate. The response rate was 64%. Initially, it was thought that the vehicles will be thoroughly examined for VMD, but this was very time consuming and most of the drivers who were stopped terminated the survey, therefore, the vehicle survey was limited to only vehicle tyre and brake fluid level inspection. The survey took about 15 to 20 minutes/vehicle. There was no predetermined sample size, but it was decided to survey all possible vehicles in one month time. Three checklists were used to record the data, namely vehicle information, wheel and brake system check list.

The respondents were informed about the importance of vehicle maintenance and its correlation with road safety. They were motivated by telling them that free tyre and brake inspection will be done. The research team first asked the respondents 3 simple questions with 'Yes' and 'No' options. The following 3 questions were asked.

i. Do you have a vehicle maintenance record?

ii. Have you conducted Wheel Balancing of your vehicle during last one year?

iii. Have you conducted of Wheel Alignment of your vehicle during last one year?

Next, the vehicle brake system was inspected visually, the brake fluid levels were checked, usually the brake fluid level marks are marked on the brake fluid container in most of the vehicles showing 'Maximum' and 'Minimum' levels. Brake fluid leakages were also thus inspected.

Tyre wear and pressures were checked. The tread of tyres was checked with a tread depth gauge and a tyre pressure gauge was used to check the air pressure in the tyres, which were compared to the recommended tyre pressures for a particular type of tyre and vehicle. This information is usually mentioned by a sticker which is pasted at the driver's side front door of most vehicles, in

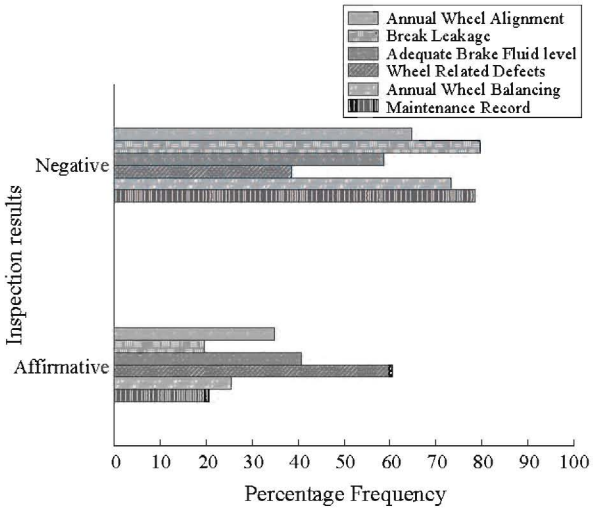

Figure 2: Vehicle survey Percentage Frequency of inspection results maintenance related issues

some of the vehicles this sticker was missing. For those cases the Make and Model of vehicle along with the tire specifications were noted down. Later on, this missing information was collected from other similar vehicles. In this research 'Wheel' is a term used for tyre and rim assembly. Figure 2 shows the vehicle survey Percentage Frequency results of maintenance related issues. It shows that 80% of the vehicles in the survey had no maintenance record. About 61% of the vehicles in the sample had some sort of wheel defects which included tyre under inflation, tyre over inflation, excessive tyre wear, unequal tyre pressure, defective rims and different Make tyres. The drivers were asked whether they had conducted a wheel balance during the past one year. About 74% of the drivers replied in negative. The response of drivers about annual wheel Alignment was that 65% of drivers had not done wheel alignment during the last year. About 59% of the vehicles inspected had brake fluid level less

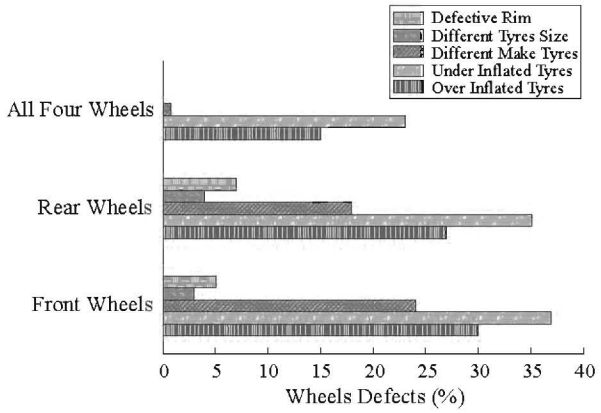

Figure 3: Vehicle Survey Percentage of Wheel Defects all 4 wheels

than the marked level while 41% had adequate levels. 20% of the vehicles had brake fluid leaks.

Figure 3 shows the results of common wheel defects in vehicle survey indicating that about 24% of the sample had different Make front tyres while 18% of the vehicles in the sample had different Make rear tyres. About 1% of the sample had all four different Make tyres. About 3% of the sample had different tyre sizes on front wheel and 4% on the rear wheels. Defective rim was determined by visual inspection of the wheels. Any rim that was not symetric was considered as defective. It was found that 5% of the sample had front defective rims while 7% of the sample had rear defective rims. 37% of the sample had underinflated front wheels, 35% of the sample had underinflated rear tyres, 24% had all four underinflated tyres, 30% of the vehicles in the sample

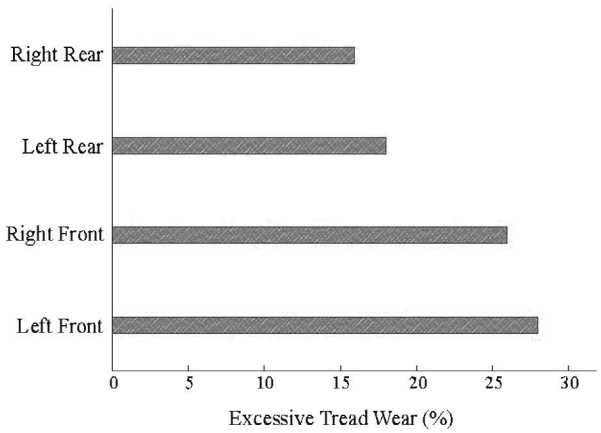

Figure 4: Vehicle survey percentage of excessive tread wear all 4 tyres

had overinflated front tyres, 27% of the sample had overinflated rear wheel tyres and 15% of all the tyres in the sample were overinflated.

Figure 4 shows the Percentage of excessive tread wear of all tyres in vehicle survey. The excessive tire tread wear indicates a tire, which has an average tread depth of less than 1.5 mm. Any tyre which had tread depth less than 1.5 mm was regarded as excessive tread wear. It was found that excessive tread wear in the left front tyre was 28%, excessive tread wear in the right front tyre was 26%, excessive tread wear in left rear tyre was 18% and the excessive tread wear in the right rear tyre was 15.6%. The survey indicated the VMD problem in Pakistan and these may, therefore, be at a risk of causing RTA.

RESULTS

The results of the analyzed NHMP data are reported in this section. In this analysis a fatal RTA is an accident in which a person dies, serious injury accident causes severe injury, minor injury accident results little or no injury while Property damage may include harm to an

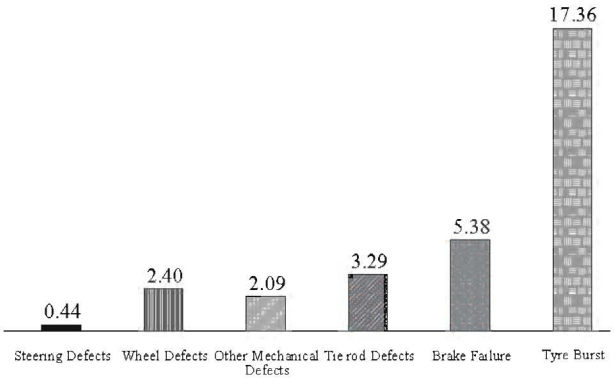

Figure 5: Percentage of Average VMD causing RTA in Pakistan (2003-2012)

automobile, a fence, a tree, a home, or any other possession property is damaged. According to NHMP during the period 2003-2012 most of the RTA caused serious injuries and a total of 934 serious injuries were reported.

As it can be seen from Figure 5 that the average contribution of tyre burst is 17.36% and the average brake failure is 5.38% of RTA respectively, these two are the VVD in Pakistan which causes RTA. Figure 6

shows the Comulative curve of VMD related RTA on Motorways of Pakistan for the period (2003-2012). Tyre blowouts were responsible for about 55% of all RTA caused due to VMD while brake failure was 17% of the total RTA caused due to VMD. Tyre burst and brake failure added together are responsible for 72% of VMD while the contribution other causes of VMD is 28%. According to Pareto principle, 20% of the causes will

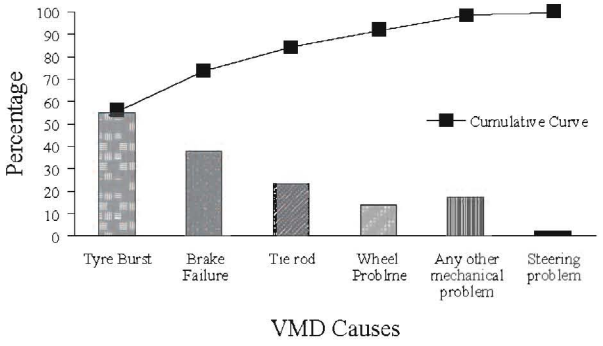

Figure 6: Cumulative Curve of VMD related RTA (2003-2012) Motorway Pakistan

account for 80% of the RTA and by categorizing causes of RTA, safety professionals can target those 20% of the hazards that cause 80% of the RTA. The Pareto principle is used in occupational health and safety to underline the importance of hazard prioritization.

DISCUSSION

It is evident from Figure 1 that on the average 32% of all RTA on Motorways are caused due to vehicle mechanical defects in Pakistan, which is very high compared to other countries of the world[5-8].

It is further identified that among the mechanical defects in vehicles, tyre bursts and brake failures are the two vital causes of RTA in Pakistan. Similar findings are reported in studies conducted in South Africa [8], Europe, Japan and U.S.A[10]. The average tyre burst accounts for about 19.5% of the total RTA as shown in Figure 6, constituting 55.6% of the total RTA caused due to VMD. The analysis of reported RTA data (2003-2012) shows that brake failure is responsible for an average 6% of the total RTA while it constitutes about 16% of the total RTA caused due to VMDs.

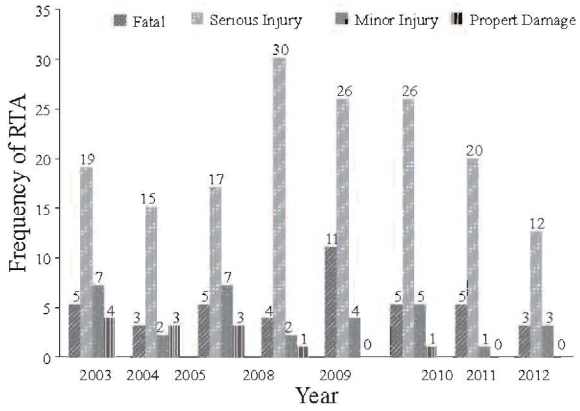

Figure 7: Frequency of RTA caused due to Tyre Burst (2003-2012) in Pakistan severity wise in 4 categories

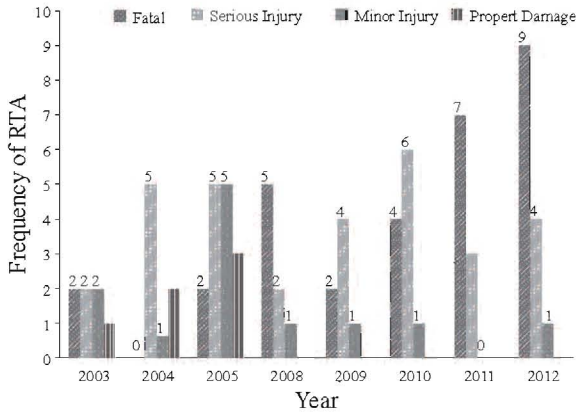

Figure 8: Frequency of RTA caused due to Brake Failure (2003 - 2012) in Pakistan severity in 4 categories

It can be seen from Figure 7 that most of these RTA results in serious injuries. A total of 165 serious injury RTA took place[10].

Figure 8 shows the frequency of RTA due to brake failure with severity in Pakistan for the period (2003-2012), showing that most of these RTA are fatal. A total of 31 fatal RTA took place. According to Fatality Analysis Reporting System (FARS) U.S.A, in 2001, out of the 5020 reported RTA, 533 (11%) had tyres related problems and 204 (4%) had brake failures. Institute for Traffic Accident Research and Data Analysis (IRARDA), Japan evaluated RTA data due to inadequate maintenance in the year 2000, the study indicated that tyre represents the highest cause 66.1%, while brake (14.2%).[10] In Finland, a study examined the reported RTA data for three years (1998-2000) it found that tyre failures were 19%. According

to DEKRA Automobil GmBh, a company which offers mobility and safety services for the automobile industry in Germany, identified while inspecting passenger vehicles during (1996-2000). A total of 36.8% RTA were due to tyre related defects and 36.5% due to brake defects.[10]

The reasons for tyre burst and brake failure are poverty,

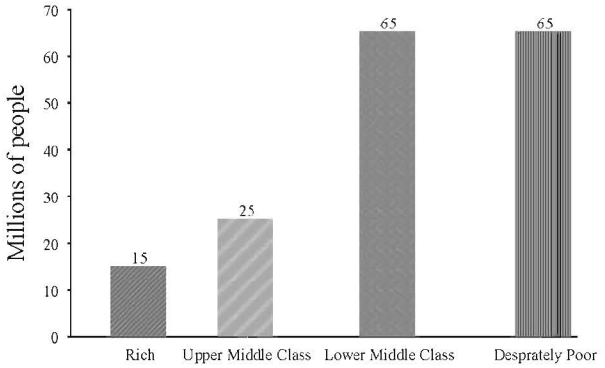

Figure 9: Socio- Economic Status in Pakistan

lack of maintenance, lack of safety awareness and lack of enforcement of law. Pakistan is a low income country and according to a World Bank study[11], 2013, 60% per cent of the population lives below the poverty line. The international poverty line is two dollars a day. A survey results reported in the press are shown in Figure 9[12].

According to United Nation Development Program, the Human Development Index (HDI) for Pakistan is 0.515[13]. Brand new tyres are expensive the drivers prefer to use second hand tyres, which are cheap and easily available. Majority of these second hand tyres are imported from developed countries. People living in the developed countries perform regular maintenance and discard used tyres. These discarded tyres find their way to junk yards from where they are imported to developing countries like Pakistan. These tyres are transported via sea and therefore are kept at different sea ports under severe conditions. When these tyres are fitted in vehicles they have high chances to burst and cause RTA. In the vehicle survey about 3% of the sample had the front tyres of different Make while 4% of the vehicles in the sample had different Make rear tyres.

The significant defect, brake failure, is because people use second hand brake pads, master cylinder assembly, and other brake system accessories which are imported from developed countries. They also use inferior quality brake fluid because it is cheaper. It is due to these reasons that when emergency brakes are applied, they do not work properly and fail, resulting in RTA. The above socioeconomic factors in Pakistan also lead to the lack of regular maintenance of vehicles. People usually prefer to buy used vehicles and they perform no maintenance. In the vehicle survey, it was found that 80% of the respondents had no maintenance record, 74% acknowledged that they have not done wheel balance. Misalignment of tyres leads to wear of treads. The heat created from the friction can weaken the tire and cause it to burst. It is found in the vehicle survey that 65% vehicles had not done annual wheel alignment and excessive tread wear in the left front tyre was 28%, excessive tread wear on the right front tire was 26%, excessive tread wear on left rear tyre 18% and the excessive tread wear on the right rear tire was 15.6% as shown in figure 4. About 59% of the vehicles inspected had brake fluid less than the marked level while 41% had adequate levels and 20% of the vehicles had brake fluid leaks.

Lack of safety and technical awareness is another factor. A large number of drivers in Pakistan are illiterate. A survey of 259 drivers in Pakistan, found that 76% of the drivers were illetrate[14]. They are ignorant about the aging of tyres, effects of under inflation and over inflation of tyres, wheel alignment and wheel balancing. Most drivers are not aware of the technical specifications of the tyres and are ignorant about which type of tyre is suitable for their vehicles like maximum load bearing capacity, aspect ratio, types of treads; pressure etc. The people usually keep on using the tyres for a long duration, they only look at the treads and do not take into account the age of tyre. The old tyres have cracked and perished walls. The steel bands in the side walls give strength to the tyre, but the rubber is still prone to perishing over time. The lack of awareness about tyre pressure leads to tyre burst. People use tyres, which are over inflated. The air pressure inside the tyre becomes high and it exerts a strong force on the walls of the tyre and as a result the tyre is not able to withstand the forces and hence, bursts. Another cause of blowouts is drastic under-inflation. This rapid flexing increases with faster wheel turn. It causes the tyre to heat up beyond its designed capabilities and it starts to break down resulting in a blowout. In the vehicle survey it was identified that under inflation was 37% in front tyres and 35% in rear tyres. The problem

of over inflation was 30% in front tyres and 27 % in rear tyres. In the vehicle survey conducted excessive tyre wear was 28% in left front tyres, 26% in right front tyres. About 23.6% of the sample had Front tyres of different Make while 18% of the vehicles in the sample had different Make rear tyres. Thus, wheel defects are common in Pakistan.

Lack of enforcement of law is another reason. In Pakistan, it is mandatory for all commercial vehicles to get a VFC under rule 35 of Motor vehicle Rules 1969. However, regular motor vehicle inspection is almost non-existent in Pakistan and the issuance of vehicle fitness certificate (VFC) is also questionable. This certificate is issued by Motor Vehicle Examiner who is neither technically trained nor equipped with the necessary machines. There is also no punishment for not obtaining a VFC.

CONCLUSIONS

It is found that 32% of all RTA on Motorways in Pakistan are caused due to mechanical defects of the vehicles and that the two VVMD are tyre blowouts and brake failures. Tyre blowouts were responsible for about 55.6% of all RTA while the contribution of brake failure was 18% of the total. These two causes together are responsible for 74% of the RTA which are caused due to mechanical defects. It was also found that 80% of the vehicles in the survey had no maintenance record. About 61% of the vehicles in the sample had some sort of wheel defect which included tyre under inflation, tyre over inflation, excessive tyre wear, unequal tyre pressure, defective rims and different Make tyres. About 74% of the drivers had not done wheel balancing during the past one year, 59% of the vehicles had brake fluid less than the recommended level, 20% vehicles had a brake fluid leak in their brake system. All these findings indicate that the vehicles may, therefore, be at a risk of causing an RTA.

The RTA and injuries statistics identified a deterioting safety situation in Pakistan. It is, therefore, recommended that with the co-ordination between transport departments and the traffic police the government should enforce the law and the VFC should be made mandatory for commercial as well as private vehicles. Awareness campaigns about tyres and brake system defects will reduce the RTA in Pakistan.

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