ROAD SAFETY ASPECTS OF MOTORCYCLE RICKSHAWS IN PAKISTAN

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Abstract

Motorcycle Rickshaws (MRs) are motorcycle driven three-wheeled paratransit vehicles that appear to be the largest informal public transport mode in Pakistan. There are widespread public concerns about their negative effects on safety, traffic flow, and air and noise pollution, but little relevant research or government policy exists because of the lack of registration systems for these vehicles and under-reporting in police crash data. In response to this identified gap in knowledge, this doctoral program was undertaken to: (1) examine the road safety aspects of MRs, and (2) identify appropriate policy measures and strategies that could improve the road safety of MRs.

Stuckey, LaMontagne, and Sim's (2007) 'Occupational Light Vehicle (OLV) use systems model' was adapted to develop an 'MR Systems Model' with five levels: the road crashes, injuries and fatalities; the vehicle; the external physical work environment; MR driver work patterns; and the policy environment. Four studies were conducted to better understand MR safety at each of these levels. Study 1 was a retrospective analysis of ambulance data, which addressed Research Questions 1 and 2: *What is the size of the MR crash problem?* and *What are the characteristics of MR crashes?* In Study 2, 500 MRDs were observed at signalised intersections in Lahore to answer Research Question 3: *What are the characteristics of MRDs (motorcycle rickshaw drivers) that influence the road safety of MRs?* Further information relevant to this research question was collected in Study 3, where 300 MRDs were surveyed in Lahore to better understand their sociodemographic characteristics, work patterns and road safety knowledge, attitudes and practices. The final study was a qualitative investigation, where 46 key stakeholders were interviewed to identify potential road safety and transport policy measures for MRs (Research Question 4).

The program of research demonstrated that MR crashes are a significant and growing road safety problem in Pakistan. Rickshaws (both MRs and Auto-rickshaws) were the third most frequent vehicle type involved in road crashes that ambulances attended in Punjab Province during 2011 and 2012. In 2014-2015 rickshaws had overtaken motorcycles, to become the second most frequent vehicle type in these crashes. This finding was confirmed in the driver interviews, where nearly three-

quarters of MRDs reported being involved in road crashes during the last 12 months, and a similar proportion admitted being at-fault in these crashes. The analysis of ambulance Emergency Response Forms (ERFs) from 500 MR crashes across Lahore in 2014 revealed that more than 80% were multi-vehicle crashes, with two-thirds involving motorcycles and pedestrians. Among the single-vehicle crashes, about half involved the MR overturning, which increased the odds of moderate, severe and fatal injuries by 8.7 times. MR crashes occurred in all major towns and on all road types (major, arterial and collector roads) across Lahore.

A range of driver and vehicle characteristics of MRDs and MRs were identified that influence the road safety of MRs. Many MRDs were younger than the minimum driver licensing age of 18 years in Pakistan. Almost a quarter of MRDs were judged to be underage in the observational survey, and 18% of those interviewed were underage, with some starting MR driving at 9 or 10 years of age. The odds of being involved in a self-reported crash were more than three times greater for the MRDs who admitted being underage compared to those aged over 27. However appearing to be underage was not associated with a higher rate of traffic conflicts in the observational study, suggesting that the mechanism underlying the increased crash involvement of younger drivers was not more frequent violation of traffic signals.

Less than 10% of drivers reported holding a valid motorcycle licence, and none of the drivers were observed wearing a helmet. While these factors may influence the safety of MRs, the low frequencies prevented this hypothesis from being tested.

Traffic violations by MRDs were prevalent and were a significant risk factor for traffic conflicts and crashes. More than half of MRDs were observed committing various traffic violations. Violating the red signal was associated with a ten-fold increase in the odds of a traffic conflict, while leaving when the signal was turning from ‘yellow to red’ and ‘yellow to green’ both increased the odds by about 2.5 times. The survey data showed that the odds of self-reported crash involvement was significantly higher for MRDs who reported having more than 10 traffic violations in the last year, compared to those reported less than 10.

The engineering experts interviewed expressed concern regarding mechanical and engineering defects in MRs and their lack of safety features. The survey confirmed that structural and design modifications to the MR were associated with increased odds of self-reported crash involvement. The presence of a bulky music system was also significantly associated with crash involvement, potentially because of the obstruction of the rearward view caused by the fitting of these systems.

While more than half of the MRs were overloaded with more than the nominal six passengers (from 7-15 passengers including children), the analyses found overloading was not significantly associated with observed traffic conflicts or self-reported crashes. Nevertheless, overcrowding may contribute to the severity of crash outcome, given the media reports of crashes in which large numbers of MR occupants were severely injured or killed.

Over half of MRDs had no formal education, were supporting large families (6-10 members) and operating rented or leased vehicles. Operating rented vehicles increased the odds of crash involvement compared to owned or leased vehicles.

The interviews with government officials revealed that the government has no workable transport or road safety policy for MRs, and is struggling to find an appropriate solution. While there have been government attempts to ban MRs, their dominant role in the public transport sector and the economy cannot be overlooked. They operate across Pakistan, providing mobility and transportation to millions of people throughout the country, and thousands of people earn their livelihood from this sector. For these reasons, the stakeholders suggested that MRs should continue to operate, but under a well-defined system and structure. The experts proposed policy measures and strategies related to MR registration, transport and road safety policies, manufacturing standards, overloading, feeder service and transport system, and MRDs' road safety behaviours, licensing standards and underage driving.

The research identified several organizational gaps among various governmental departments in Pakistan, and proposes measures to improve traffic enforcement and road safety policing, the driver licensing and vehicle safety inspection systems, and the ambulance data, which could assist to improve the overall road safety situation in Pakistan. Moreover, this research attempted to measure the scale of the MR sector in Pakistan, and outlines some major socioeconomic issues associated with this sector. Thus, this research addresses a significant national transport, road safety and social issue, and provides a balanced approach and opportunity for all stakeholders to determine the future of MRs in Pakistan.

Future research is needed to investigate if factors found to be prevalent in this research contribute to crash risk and injury severity (e.g. overloading, underage driving, unlicensed driving, vehicle characteristics), and by what mechanisms. The suitability and adaptability for Pakistan of improved approaches to driver licensing and management (graduated driver licensing, demerit point schemes), and modern vehicle safety inspection regimes require further investigation. The current research examined the road safety aspects of MRs from a public health and injury prevention perspective. Future studies could focus on identifying vehicle engineering solutions to make MRs safer and environmentally friendly.

From a global perspective, safer and better quality paratransit modes can bridge the gap between the formal and informal transport sectors. A comprehensive understanding of the safety, planning, policy, operational and socioeconomic issues related to MRs as an informal public transport mode in Pakistan, can assist other low-and-middle-income countries to plan and regulate similar transport modes.

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List of Abbreviations and Glossary

AR	Auto-rickshaw (a three-wheeled vehicle with a closed passenger cabin and seating capacity for three or four occupants)
ADB	Asian Development Bank
Chingchi	Urdu version of Qingqi Motorcycle Rickshaw
DGK	Dera Ghazi Khan (a city in the Southern Punjab of Pakistan)
ERF	Emergency Response Form
ECF	Emergency Call Form
HICs	High Income Countries
JICA	Japan International Cooperation Agency
KAP	Knowledge, Attitudes and Practices
KPK	Khyber Pakhtunkhwa (one of the four administrative provinces of Pakistan, located in the northwestern region)
LMICs	Low-and-Middle-income Countries
LTC	Lahore Transport Company
LRSA	Lead Road Safety Agency
MDGs	Millennium Development Goals
MR	Motorcycle Rickshaw (a three-wheeled open vehicle with a seating capacity of six which is a modified 70cc or 100cc motorcycle).
MRD	Motorcycle Rickshaw Driver
MoC	Ministry of Communication, Islamabad, Pakistan
NHMP	National Highways and Motorways Police, Islamabad, Pakistan
OLV	Occupational Light Vehicle
Paratransit vehicles	Comprises both public and private transport vehicles that operate between the formal taxi service and conventional, fixed routes and scheduled bus and rail transit transport systems.

PTD	Punjab Transport Department, Lahore
PQML	Plum Qingqi Motors Limited - Pakistan’s largest MR manufacturing company
PCIIP	Punjab Cities Improvement Investment Program
Rescue 1122	An emergency ambulance and rescue service that operates in all 36 districts of Punjab Province, Pakistan
RTIR & PC	Road Traffic Injury Research & Prevention Centre, Karachi, Pakistan
SDGs	Sustainable Development Goals
PTD	Sindh Public Transport Department
SWOT	Strength, weakness, opportunity and threat
TEPA	Traffic Engineering and Planning Agency, Lahore, Pakistan
UET	University of Engineering and Technology, Lahore, Pakistan
WHO	World Health Organization

Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: QUT Verified Signature

Date: _____________13 December 2017__________

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I dedicate this work to my dear parents, family and past and present teachers.

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Chapter 1: Introduction

This chapter presents an introduction and overview of the current research program, which aims to examine the road safety aspects of Motorcycle Rickshaws (MRs) in Pakistan. The major contents of the chapter include: an overview of the road safety and public transport situations across the world and specifically in Pakistan; the rationale of this research; research aims and questions; the research plan and methodology; and the scope of this research program. The key concepts extensively used in this research are also defined in this chapter, and it concludes with an outline of the whole thesis.

1.1 ROAD TRAFFIC CRASHES AND INJURIES

Road traffic crashes and injuries are a major public health concern globally. Every year road crashes cause more than 1.2 million fatalities, and 20-50 million injuries across the world (World Health Organization, 2015). Young people aged 15-29 years and 15-44 years are over-represented in the crash data worldwide. Young adults aged 15-44 years account for 59% of all traffic-related fatalities, and 77% are males (WHO, 2013, 2015). Losses associated with road crashes are numerous, and they place a heavy burden on individuals, society and the national economy (Bowman, Fitzharris, & Bingham, 2013; Dalal, Lin, Gifford, & Svanström, 2013; WHO, 2009, 2011, 2013, 2015).

The burden of road crashes and injuries is disproportionately distributed. High-income Countries (HICs), with 15.6% of the world's population and 52.1% of the total registered vehicles, account for 8.5% of global road fatalities. Conversely, Low- and Middle-income Countries (LMICs) with 84.5% of the world population and 47.9% of the total registered vehicles, comprised 91.5% of the world road fatalities (Bowman et al., 2013, WHO, 2015, 2009, 2011). It is estimated that by 2030, road fatalities will increase by 127% and 68%, respectively, in Africa and the Southeast Asian regions, whereas a 36% decrease in road fatalities is predicted in the European Union region (Bowman et al., 2013; Mathers & Loncar, 2006; Watkins & Sridhar, 2009). Growing population, urbanization and motorization rates, rising economic disparities, and weak law enforcement are some of the major reasons for increasing road crashes and injuries in LMICs (Aeron-Thomas & Jacobs, 2011; UN-Habitat, 2013).

The HICs have been successful in reducing road trauma to a great extent, because they have recognized the importance of this issue at an early stage, and have adopted appropriate road safety policies, strategies and legislation (Bowman et al., 2013; WHO, 2009, 2011). However, road safety does not seem to be a priority in the majority of LMICs, so the burden of road trauma is hindering their efforts to achieve the Millennium Development Goals (MDGs) pertaining to road safety and sustainable transport system (Bowman et al., 2013; Mohan, 2002, 2008; Watkins & Sridhar, 2009; WHO, 2015). This is particularly true in those LMICs where investment in road safety is not commensurate with the scale of road trauma problem in these countries, and which are struggling with many other socioeconomic and development challenges. Evidence suggests that road crashes and less focus on road safety in LMICs are costing an estimated up to 5% of their Gross Domestic Product (GDP), compared to an estimated 3% of GDP losses in road traffic injuries and fatalities globally (WHO, 2015).

On 25 September 2015, the United Nations (UN) adopted the Global Sustainable Development Goals (SDGs), which built on the MDGs, and specifically address the road safety issue globally (United Nations, 2015; Wismans, Skogsmo, Nilsson-Ehle, Lie, Lindberg, & Thynell, 2016). The SDGs aim to improve road safety by reducing global road fatalities and injuries by up to 50% by 2020, and promoting access to safe, affordable, accessible and sustainable transport systems for all by 2030 (United Nations, 2015; Wismans et al. 2016).

1.2 ROAD SAFETY AND PUBLIC TRANSPORT IN PAKISTAN

Like many other LMICs, Pakistan is facing a growing burden of road crashes and injuries. Pakistan along with nine other world's most populous countries (China, India, USA, Indonesia, Brazil, Nigeria, Bangladesh, Russian Federation & Japan) accounts for 56% of global road fatalities, and an estimated 25,781 road fatalities occurred across Pakistan in 2013 (WHO, 2015). Based on the findings of the first National Injury Survey of Pakistan, Ahmed (2007) projected that road crashes resulted in over two million injuries in Pakistan in 2006, and most of these injuries were among people aged 15 to 44 years. Similarly, Rescue 1122 (an ambulance and rescue service that operates in all 36 districts of Punjab Province – the province with the largest population in Pakistan) attended more than 1.2 million road crashes during 2004 to 2015, and over 1.3 million people were injured in these crashes (Rescue 1122, 2016).

Despite the high burden of road crashes and injuries across the country, road safety is not recognized as a significant public health issue in Pakistan. It has been considered an insignificant issue, for which only the transport department or police are responsible (Batool, Carsten, & Jopson 2012; Ghaffar, Hyder, & Masud, 2004). There is an absence of a national road safety policy and a dedicated lead road safety agency (Batool et al., 2012; Bhatti & Ahmed, 2014; Hyder et al., 2006; Imran, 2009; Ministry of Health, 2001). The WHO Global Status Report on Road Safety 2015 also shows the absence of a national road safety strategy, road fatality reduction targets, and a funded road safety agency in Pakistan. This situation suggests that Pakistan is not ready to adopt and achieve the road safety targets set in the SDGs.

Appropriate planning and facilities for vulnerable road users are also deficient across Pakistan. Traffic laws such as speed limits, mandatory helmet and seat-belt wearing for motorcyclists and drivers, prohibition of mobile phone use while driving, and driving under the influence of alcohol exist, but law enforcement is weak or absent throughout Pakistan. Consequently, compliance with the traffic and road safety rules is very low across the country (Ahmed, 2007; Batool et al., 2012; Ghaffar et al., 2004: Hashmi, Tahir, Akbar, Naseer, Rashid, & Zia, 2012; Jafar, Haaland, Rahman, Razzaq, Bilger, Naghavi, & Hyder, 2013; Klair & Arfan, 2014). There is a lack of implementation of vehicle fitness and safety standards in public transport systems in Pakistan. The current vehicle fitness certification system is not efficient and modernized. The Motor Vehicle Examiners (MVEs) are not appropriately trained and equipped to test vehicle safety and emission standards (Engineering Development Board of Pakistan, 2015).

Pakistan’s population is growing rapidly, and the existing public transport infrastructure and facilities are insufficient to meet the mobility needs of millions of people across the country (Imran, 2009, 2010; Masood, Khan & Naqvi, 2011). There is also a lack of sustainable public transport planning and policies at both the national and local levels. Most of the public transport policies implemented in Pakistan during the past few decades have been unsuccessful, for many reasons such as lack of political commitment, and weak technical capacity of transport-related organizations (Imran, 2009, 2010; Masood et al., 2011). The failures of these policies have resulted in inadequate quality public transport and increased usage of private vehicles all over Pakistan. The urbanization trends and growing use of private vehicles resulted in high motorization rates with associated transport-related problems such as traffic congestion, road crashes, and air and noise pollution across the country (Batool et al., 2012; Imran 2009; Japan International Cooperation Agency (JICA), 2012).

1.3 PARATRANSIT AND INFORMAL TRANSPORT

The term paratransit refers to 'alongside-of' transit. It comprises both public and private transport vehicles that operate between the formal taxi service and conventional, fixed routes and scheduled bus and rail transit transport systems (Lave & Mathias, 2003). The most important feature of these systems is that they do not have fixed routes or schedules, and usually operate as 'Demand Responsive Systems' to meet passengers' immediate travel demands (Lave & Mathias, 2003). Various types of paratransit modes are commonly found in many LMICs countries such as vans, mini-buses, taxis, three-wheelers and motorcycles. These small to medium size vehicles are also known as 'informal transport', because they generally operate without any official authorization in many parts of the LMICs (Cervero, 2000; Cervero & Golub, 2007).

'Indigenous Transport' is another term that has been used for these kinds of vehicles, which is defined as 'vehicles which are locally manufactured to meet the local community's travel needs and are well-contextualized to the local settings and cultures' (Ames, Mateo-Babiano, & Susilo, 2014; Mateo-Babiano, Susilo, Guillen, & Joewono, 2011; Mateo-Babiano, Susilo, Joewono, Vu & Guillen, 2013). Indigenous transport or informal transport provides mobility and accessibility to a vast population across the LMICs. However, these vehicles generally lack safety features and fitness criteria, and contribute significantly to air and noise pollution (Cervero, 2000; Cervero & Golub, 2007; Guillen & Ishida, 2004; Sengers & Raven, 2014; Shimazaki & Rahman, 1996). Globally, the majority of drivers of these vehicles are unlicensed and low-skilled young people, and contribute to various traffic problems such as traffic congestion and road crashes (Cervero, 2000; Cervero & Golub, 2007; Guillen & Ishida, 2004; Sengers & Raven, 2014; Shimazaki & Rahman, 1996).

1.4 MOTORCYCLE RICKSHAW

A Motorcycle Rickshaw (MR) is a 70cc or 100cc motorcycle that has been modified into a three-wheeled vehicle. The rear-wheel of the motorcycle has been detached, and an open metal ‘cart’ or ‘body’ comprising two-wheels is attached to form a three-wheeled MR. The cart or body of an MR is open from the sides, and it has a fibreglass or metal roof (Figure 1.1).

Figure 1.1: Front and rear view of a Motorcycle Rickshaw
(*Source: Author, 2017*)

Motorcycle rickshaws have two passenger seats, ‘front’ and ‘rear’, facing opposite to each other. They have conventional drum brakes, and open chains that run centrally or laterally between motorcycle and body of the MRs (*The Automark*, 2016). Drum brakes and open chains of MRs have significant safety implications, which were discussed in the following chapters.

An MR is different from a conventional auto-rickshaw (e.g. tuktuk, trishaw, autorick etc.) in several aspects. An MR is a motorcycle-driven open three-wheeled vehicle, with a nominal seating capacity of six passengers (including the driver), while a three-wheeled Auto-rickshaw (AR) has an enclosed cabin and a passenger tray (Figure 1.3). The majority of ARs have a seating capacity of two to three passengers, and they are a formal or regulated paratransit mode in many parts of the world (e.g. Bangladesh, Cambodia, Egypt, Guatemala, India, Pakistan) (UN-Habitat, 2013). However, MRs provide as an informal paratransit mode that specifically operates in Pakistan.

Motorcycle Rickshaw **Autorickshaw**

Figure 1.2: Motorcycle Rickshaw and Auto-rickshaw in Lahore, Pakistan
(*Source: Author, 2015)*

1.5 RATIONALE FOR THE RESEARCH

Previous research demonstrates that road crashes and injuries are increasing in Pakistan, and have become a significant public health, social and development challenge (Ahmed, 2007; Ghaffar et al., 2004: Hashmi et al., 2012; Jafar et al., 2013; Jamali, 2008; Klair & Arfan, 2014; Tahir, Naseer, Khan, Macassa, Hashmi & Durrani, 2012; Tahir, Macassa, Akbar, Naseer, Zia & Khan, 2013). There are many factors that contribute to growing road crashes and the worsening road safety situation in Pakistan, including lack of political commitment, absence of road safety policy, institutional and organizational issues, high motorization and urbanization rates, traffic mix, weak driver’s licensing and penalty systems, ineffective vehicle fitness and safety testing standards and regulatory systems, lack of fair and stringent police enforcement, a poor public transport system, absence of a trauma registry system, and reliance on outdated road safety research (Batool et al., 2012).

The concept of a safe and sustainable transportation system is missing in Pakistan (Imran, 2009, 2010; Masood et al., 2011). Public transport demand is mostly met by the unregistered private paratransit modes such as passenger vans, ARs (most registered but some are not registered) and MRs, which are often poorly constructed and overcrowded (JICA, 2012). In recent years, there has been a large growth of MRs across Pakistan, with no policy or legal framework to control the safety of their operations. Newspaper and media reports suggest that the proliferation of MRs and risky driving practices of MRDs are increasing traffic and road safety issues such as traffic congestion and road crashes across Pakistan. Newspaper crash reports from different parts of the country indicate that MRs are involved in road crashes on urban roads as well as on major highways across all four provinces of Pakistan (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Dawn*, 2015a,c; *The Express Tribune*, 2011, 2012a, 2013a,b, 2014a,b; *The Fox News*, 2013; *The Indus News*, 2015; *The Nation*, 2012a,b; *The Pakistan Today*, 2015a; *The Pakistan Headlines*, 2015; *The People's Daily Online*, 2007; *The PPI News Agency*, 2014, 2015; *The Nation*, 2012b, 2013a,b,c). In addition to safety and traffic congestion concerns, MRs are also considered to be a major source of air and noise pollution in Lahore and other parts of Pakistan (Aziz, 2015; Malik, 2012).

The road safety and public health issues related to MRs are growing across Pakistan, with most information coming from the various (print, electronic, documentaries etc.) media sources. However, the government has not formulated any workable road safety or transport policy for MRs, and they are the subject of limited scientific research. Therefore, road safety and public health problems associated with MRs, and the existing knowledge gaps in MR road safety research, planning, policy and operations, provide the rationale for this research program.

1.6 RESEARCH AIMS AND QUESTIONS

This research aims to examine the road safety aspects of MRs, and identify appropriate policy measures and strategies to address the road safety problems. To achieve these aims, the following research questions were investigated:

1. What is the size of the MR crash problem?
2. What are the characteristics of MR crashes?
3. What are the characteristics of Motorcycle Rickshaw Drivers (MRDs) that influence the road safety of MRs?
4. What policies and measures could improve the road safety of MRs?

1.7 RESEARCH PLAN AND METHODOLOGY

Stuckey, LaMontagne, and Sim's (2007) 'Occupational Light Vehicle (OLV) use systems model' was adapted to develop an 'MR Systems Model' with five levels: the road crashes, injuries and fatalities; the vehicle; the external physical work environment; MR driver work patterns; and the policy environment. Four studies were conducted to better understand MR safety at each of these levels.

Study 1: Analysis of Rescue 1122 road crash data

Study 2: Observations of road safety behaviours and practices of MRDs

Study 3: Survey of road safety knowledge, attitude and practices of MRDs

Study 4: Identification of policy measures and strategies to address road safety issues related to MRs.

Study 1 was a retrospective analysis of ambulance data, which addressed Research Questions 1 and 2: *What is the size of the MR crash problem?* and *What are the characteristics of MR crashes?* In Study 2, 500 MRDs were observed at signalised intersections in Lahore to answer Research Question 3: *What are the characteristics of MRDs (motorcycle rickshaw drivers) that influence the road safety of MRs?* Further information relevant to this research question was collected in Study 3, where 300 MRDs were surveyed in Lahore to better understand their sociodemographic characteristics, work patterns and road safety knowledge, attitudes and practices. Study 4 was a qualitative inquiry, in which 46 key stakeholders were interviewed to identify potential road safety and transport policy measures for MRs (Research Question 4). A detailed mapping of the research questions and study methodologies is presented later in Table 3.5.

All data collection was carried out in Lahore, Pakistan, while data analysis and writing were undertaken at the Centre for Accident Research and Road Safety, Queensland (CARRS-Q), Queensland University of Technology (QUT), Australia.

1.8 RESEARCH SCOPE

The current research examined the road safety aspects of MRs from a public health perspective, with a focus on the human behavioural, vehicular and environmental factors that contribute to MR road crashes, injuries and fatalities in Pakistan. While it is acknowledged that passenger behaviours and demands may affect safety, the focus of this research is restricted to the drivers, and no information was collected from passengers. The engineering and technology aspects of an MR (e.g. internal combustion engine technology, suspension, transmission and other fuels and engine technologies) were outside the scope of the research.

Given the under-reporting and data limitations of the police crash data in Pakistan (Ahmed, 2007; Ahmed, Khan, Khurshid, Khan, & Waheed, 2015; Batool et al., 2012; Bhatti, Razzak, Lagarde, & Salmi, 2011; Ghaffar et al., 2004; Hyder, Ghaffar, & Masood, 2000; Kayani, Fleiter & King, 2014; Razzak & Luby, 1998; WHO, 2009), police data were not used in the research. Instead, the data collected by Rescue 1122 emergency paramedics attending road crashes were analysed in Study 1. The analysis involved ambulance data for 2011-2012 and July 2013-June 2014 from all of Punjab, and MR crashes reported in Lahore during 2014. While the early aggregate data relate to the whole of Punjab Province, the observations and interviews in later studies took place in Lahore. Therefore the focus of the research was on MR safety in a large city, rather than in rural areas.

The Supplementary Study involved a survey of Rescue 1122 emergency paramedics in Lahore. Only those paramedics who worked with Rescue 1122 Lahore for all of 2014 were included. In Study 2, road-side observations were recorded using a paper-based survey form in Lahore.

In Study 3, active MRDs (i.e. currently driving) were interviewed in Lahore, using a survey questionnaire. Only MRDs who had a minimum of one year of MR driving experience were recruited, while Auto-rickshaw Drivers (ARDs) were excluded to limit the scope of this research. Study 4 involved semi-structured interviews of provincial government officials (e.g. Lahore Transport Company - LTC, the Traffic Engineering and Transport Planning Agency - TEPA, the Department of Transport - DoT, the Traffic Police, and National Highways & Motorways Police - NHMP), academics and road safety researchers (University of Engineering and Technology Lahore & NED University of Engineering and Technology, Karachi), transportation engineers and road safety experts working in the private sector, and people directly involved in the pre-hospital management of road crashes (Rescue 1122). An outline of the scope of the current research program is presented in Table 1.1.

Table 1.1: Scope of the current research program

Research objective	Included	Excluded
Study 1: Analysis of road crash data	• Rescue 1122 crash data • Crash data for all vehicles • Crash data for 2011-2012 and July 2013-June 2014 • MR crash data for 2014 from Rescue 1122 Lahore	Road crash data of other organizations e.g. police, traffic police and private ambulance services etc.
Supplementary Study: Assessment of relative frequency of MR crashes	Emergency paramedics of Rescue 1122 Lahore, who worked with the service throughout 2014.	Emergency paramedics who did not work with Rescue 1122 Lahore for all of 2014. Emergency paramedics working in the rest of Punjab
Study 2: Observations of road safety behaviours and practices of MRDs	Written observations using paper-based survey forms	Video recording, photographs
Study 3: Examine road safety knowledge, attitude and practices of MRDs	• Active MRDs of any age • MRDs with minimum one year of MR driving experience	• Auto-rickshaw drivers • Inactive/past MRDs • MRDs with less than one year of MR driving experience
Study 4: Identification of policy measures for MR	Interviews with provincial government officials: LTC, TEPA, DoT, NHMP, Rescue 1122, Traffic Police and other MR stakeholders	

1.9 STRUCTURE OF THE PHD THESIS

This thesis is structured into eight chapters, and the results of the Supplementary Study are presented in Appendix B. These chapters follow a logical sequence in accordance with the research progression. An outline of this thesis is shown in Figure 1.4.

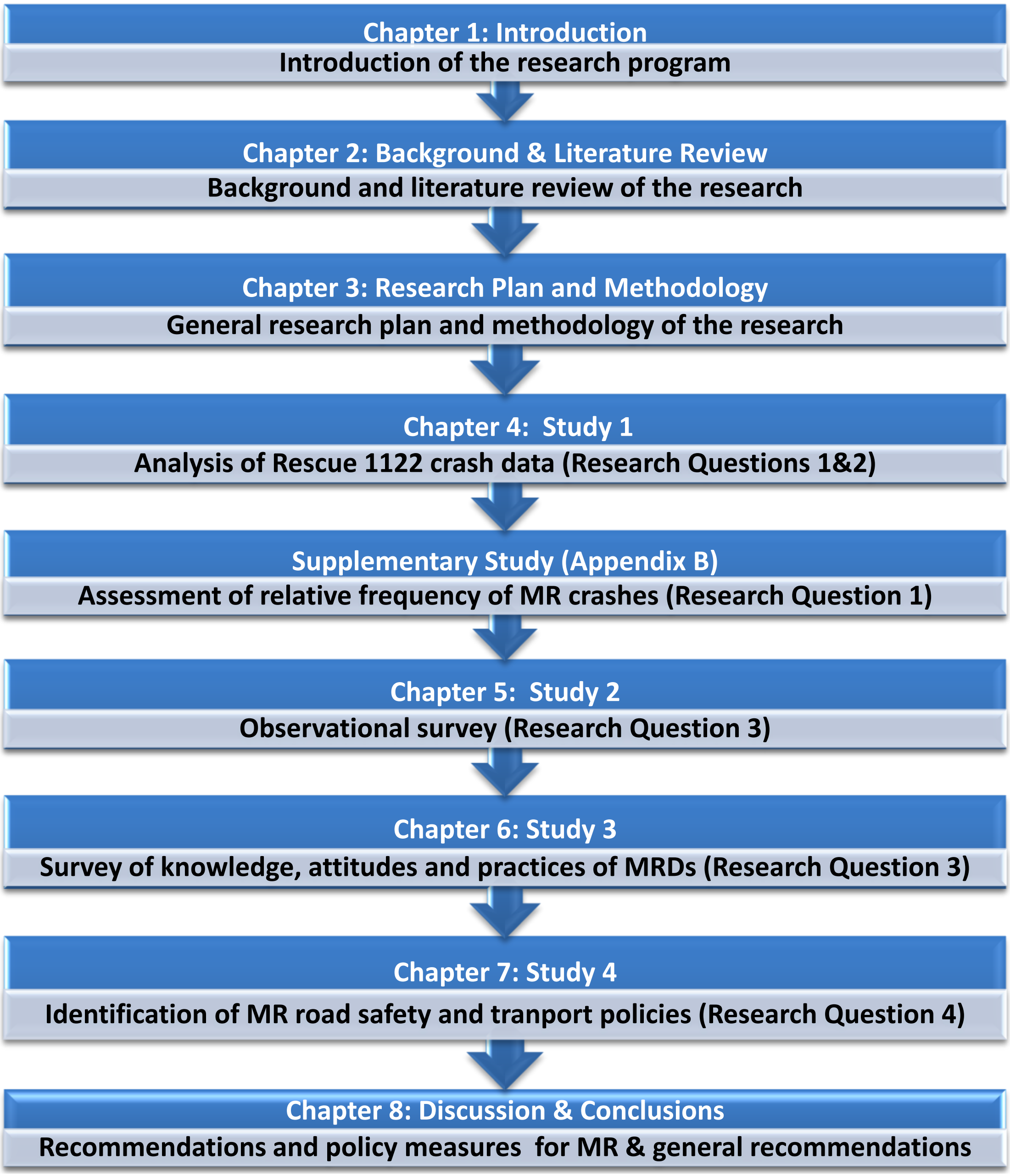

Figure 1.3: An outline of the thesis

A summary of the main contents of the thesis chapters is given below.

Chapter 2: This chapter presents the background and literature review of the research program. It includes topics such as: motorization and road safety, global perspectives of the paratransit services, road safety and public transport situation and the driver licensing system in Pakistan. The design and safety features of MRs, their role in the public transport sector, and road safety aspects are discussed in the last section of this chapter.

Chapter 3: A description of the research program and research methodology is given in this chapter. The research aims, objectives and research questions are set out in the first section, while the research methodology and plan of execution of the proposed studies (Studies 1 to 4) are presented in the second section. This chapter also describes the conceptual framework of the research and the characteristics of the study setting, Lahore.

Chapter 4: This chapter presents the results of Study 1**.** The chapter begins with an introduction of Rescue 1122 and the characteristics of its operational database. Analysis of Rescue 1122 crash data and the results of three different crash datasets (Studies 1A and 1B) are described in the later sections of this chapter.

Chapter 5: Results of an observational survey (Study 2) are presented in this chapter. The methodology, results and discussion are the main contents. A part of this chapter was presented as a full conference paper at the Australasian Road Safety Conference held at Brisbane, Australia in October 2015. This paper was published as:

Tahir, M. N., Haworth, N., King, M., & Washington, S. (2015, October). Observations of road safety behaviours and practices of motorcycle rickshaw drivers in Lahore, Pakistan. In *Proceedings of the 2015 Australasian Road Safety Conference*. Australian College of Road Safety (ACRS).

Chapter 6: The results of Study 3 are presented in this chapter. The development of the survey questionnaire, methodology, results and discussion are the main contents. An abstract based on this study was presented at the International Conference on Traffic and Transport Psychology held in Brisbane, Australia in August 2016.

Chapter 7: This chapter describes the results of a qualitative investigation (Study 4). In Study 4, key stakeholders were interviewed and the study findings are described under five major themes. Policy measures proposed by various stakeholders regarding road safety or transport policy of MR are presented.

Chapter 8: This chapter discusses the main findings of all four studies of the current research. It summarizes the main findings, and recommends some policy measures for MR. In addition to policy measures for MRs, it also includes some general recommendations to improve the overall road safety situation in Pakistan. Research strength and limitations, and some areas for future research are also identified in this chapter.

Supplementary Study: The results of the Supplementary Study (a survey with Rescue 1122 emergency paramedics) are presented in Appendix B.

Chapter 2: Background and Literature Review

Chapter 2 presents the background and literature review of this research program. This chapter is structured into three major sections. The first section presents the global road safety situation and various paratransit modes operating worldwide. Section two outlines the current road safety and public transport conditions and the driver licensing system in Pakistan. An introduction of MRs, their paratransit role and road safety aspects are discussed in the last section of this chapter. This chapter begins with an outline of different information sources that were used to search the relevant literature.

2.1 LITERATURE SEARCH METHODOLOGIES

The 'literature synthesis approach' was used to systematically analyse the literature, and identify the existing gaps in knowledge, policy and practice related to the road safety of MRs. Different sources of information were explored to form a solid theoretical foundation for this research program. Major sources of information included, but were not limited to: journal research articles, reports, books, conference proceedings and online resources (i.e. websites).

A wide range of databases and search engines was explored, such as Google Scholar, Scopus, Psych INFO, MEDLINE, PubMed, Science Direct, QUT specific Library databases and many other road safety or transport-related research databases. Various search terms were used for searching relevant material in combination with terms such as road safety, road crashes, injuries, paratransit, transport, public transport, transport policy, motorcycle rickshaw, chingchi rickshaw, Pakistan. References were documented using the American Psychological Association (APA) citation style.

Table 2.1 shows the summary of research papers from Pakistan that were used in the literature review of this research. Given the scarcity of published research on MRs in Pakistan, newspaper articles and media reports were the major sources of information regarding transport, road safety and public health issues related to MRs. Moreover, the websites of various national and provincial governmental departments such as the Pakistan Bureau of Statistics (PBS), Ministry of Communication and Transport, National Highways and Motorway Police (NHMP), Lahore Transport Company (LTC), Punjab Transport Department (PTD), City Traffic Police Lahore (CTPL) and Rescue 1122 were searched for relevant information, and to understand their current policies and projects.

2.2 MOTORIZATION AND ROAD SAFETY

Motorization has played a vital role in human development by providing access to many social and economic benefits. Nevertheless, these benefits have come at a price (Sharma, 2008). Today, road crashes and injuries have become one of the greatest public health challenges across the world. With an existing annual total of over 1.2 million road fatalities globally, if sustainable preventive actions are not taken, road crashes will become the fifth major cause of mortality by 2030 (Bowman, Fitzharris & Bingham, 2013; Chen, Wu, Chen, Wang, & Wang, 2016; Watkins & Sridhar, 2009; WHO, 2009, 2013, 2015).

Road crashes disproportionately affect young people globally, people aged 15 to 44 years comprise around 60% of the world's road fatalities (Eid & Abu-Zidan, 2015; WHO, 2013). Road crashes are not merely a public health problem, but comprise a multifaceted issue of human health, development and economics (Dalal, Lin, Gifford & Svanström, 2013; Evaniew, Godin, Schemitsch & Bhandari, 2014; Krug, 2012; Lozano, Naghavi, Foreman, Lim, Shibuya, Aboyans & Ohno, 2012). Estimates suggest that road fatalities and injuries cost around 3% to global economies, and up to 5% of GDP (Gross Domestic Product) losses to LMICs (Dahdah & McMahon, 2008; WHO, 2015).

Table 2.1: Summary of the major research studies on road safety and public and informal transport from Pakistan and other countires

Author	Study context and methodology	Summary of the key findings
Batool et al., 2012	A qualitative inquiry to explore road safety issues in Pakistan.	Study identified institutional & executional issues, operational issues, behavioural issues and lack of road safety research as main factors worsening the road safety situation.
Cervero, 2000; Cervero & Golub, 2007	Reviews on informal transport sector across the world	These reviews describe various features of informal sector operating in different countries around the world. The informal transport sector provides benefits such as transportation to millions of people worldwide, jobs for low-skilled workers, and service coverage in areas where other transport modes cannot access. Conversely, informal sector is also responsible for increased traffic congestion, air and noise pollution, and road crashes.
Imran, 2009	Historical overview of public transport policies in Pakistan.	All previous transport policies in Pakistan failed due to low level of political commitment, private sector involvement and capacity issues of public transport organizations.
Imran, 2010	The study used the theoretical framework of path dependence to explain the mismatch of replicating the transport policies of HICs to LMICs.	Most transport policies failed in Pakistan, because they were not suited to local contexts. Strengthening of relevant institutions is necessary to revitalize the public transport system in Pakistan.
JICA, 2012	Eleven transport or traffic surveys were conducted to formulate Lahore urban public transport plan.	The study presented an urban transport plan for city of Lahore. The report highlighted the major transport and road safety issues in Lahore.
Mateo-Babiano et al. (2013)	A systematic review to describe the salient features of Indigenous Transport	Indigenous transport caters to the mobility needs of local inhabitants and it is specific to local contexts such as a distinct geographic feature, climate or air quality. These systems respond to cultural accessibility needs and are popular among the general public.
Muhammad, 2013	Three questionnaire-based surveys were conducted in Lahore to assess public perception regarding feasibility of different	Road users' travel behaviour, perceptions, lifestyle and local culture are important considering factors in integrating the TDM measures

	Transportation Demand Management (TDM) measures in Pakistan. Survey 1 related to traffic radio was conducted through email and then in field. Surveys 2 & 3 were conducted with the help of university students and 631 and 354 people were interviewed.	in any setting.
Masood et al. 2011	A review article that identifies the key factors responsible for continued failures of governments to provide efficient public transport systems in Pakistan.	Poor planning, lack of administration and accountability are the key factors in poor public transport systems.
Sohail et al. 2006	Research used three case studies from three LMICs (Sri Lanka, Pakistan & Tanzania) to describe the significance of an effective urban transport regulatory framework.	To promote sustainable urban transport systems, regulations should be fair and properly implemented and there should be a strong mechanism of accountability to check corruption.
Shabiralyani, et al 2015	Quantitative analysis of road crashes reported to Rescue 1122 in the district of Dera Ghazi Khan (DGK), Pakistan during the period 2010-2014	The study investigated the major crash contributing factors in DGK. Of the 18,063 road crashes attended by Rescue 1122 during the study period, rickshaws (both MR and AR) were involved in 1,609 crashes.
Tahir et al. 2012, 2013	Both studies examined the characteristics of road crashes attended by Rescue 1122 in Lahore city in 2005–2010 and during Ramadan 2011.	Tahir et al., 2012 found that rickshaws were involved in 22,488 road crashes, which was 18% of total reported crashes in 2005-2010. In second study, rickshaws were involved in 1,407 road crashes in Lahore during the first 10 months of 2011.

Recognizing the health, societal and economic impacts of road trauma, in 2010 the United Nations Road Safety Collaboration (UNRSC) adopted a 'Global Road Safety Action Plan' (2011–2020) that aims to prevent 5 million road fatalities and 50 million serious injuries globally. This action plan is based on five 'pillars': road safety management, safer roads, vehicles, and road users, and enhancement of the emergency response and post-crash care (Bliss & Breen, 2012; UNRSC, 2011; Evaniew et al., 2014; Forjuoh, 2010; WHO, 2015). Moreover, five key risk factors (speeding, drink driving, not wearing a motorcycle helmet or seat-belt, and not using child restraints) were also identified as increasing the crash risk. In the decade of action for road safety (2011–2020), governments around the world were encouraged to introduce and improve legislation and enforcement regarding the five key risk factors (Wismans et al. 2016; WHO, 2011).

The majority of the HICs have been successful in reducing road fatalities and injuries (WHO, 2009, 2013, 2015), due to effective implementation of transport and road safety policies (e.g. Swedish Vision Zero, the Netherlands' Sustainable Safety Vision & Safe System Approach etc.) that involved a range of measures (safer infrastructure and vehicles) and legislation (e.g. speed limits, helmet and seat-belt wearing, child restraints, drink driving) to improve safety for all road users. These measures have enabled the HICs to deal with modern day transport-related problems (Johansson, 2009; Krug, 2012; Wegman, Aarts & Bax, 2008; WHO, 2013).

Road safety is not a priority in most LMICs. Consequently, they are experiencing a high rates of road fatalities (Mohan, 2008). The LMICs account for over 90% of the world's road fatalities, these rates are the highest in emerging economies, where motorization and urbanization trends are escalating (WHO, 2015). For instance, in India the numbers of cars, heavy vehicles and two-wheelers are growing at a rate of more than 20% per annum (Pan, 2011; Tiwari, 2011; UN-Habitat, 2013), and private vehicle use is increasing by a factor of three to its population (Jain, 2011; UN-Habitat, 2013). Similarly, by 2035, China alone will have around 350 million cars (International Energy Agency, 2010; UN-Habitat, 2013). Thus, growing motorization rates are a major contributing factor in increasing road crashes in LMICs, as road safety priorities have not kept pace with vehicle increase and other economic developments in these countries (WHO, 2015).

The higher rates of road crashes and injuries in LMICs are also attributed to traffic patterns in these countries that are quite complex compared to HICs. This complexity involves high motorization and urbanization trends, a large modal share of motorcyclists and non-motorized vehicles, high traffic volume and density, traffic mix, road quality and haphazard growth of various types of locally designed and modified paratransit modes (Mohan, 2008). The poor road safety performance of most LMICs indicates that their institutions responsible for road safety including any Lead Road Safety Agency (LRSA), are not working well (Bhatti & Ahmed, 2013).

2.3 PARATRANSIT TRANSPORT SERVICES - A GLOBAL PERSPECTICE

Access to affordable, safe and eco-friendly transportation is an essential requirement for the social well-being of citizens, as well as for the smooth working and progress of cities (UN-Habitat, 2013). Recent urbanization and motorization trends have resulted in numerous health and safety related issues. To overcome these challenges, the HICs have established safe and sustainable public transport systems, involving provision of a wide range of public transport modes such as buses, trains and trams, as well as pedestrian facilities and non-motorized transit lanes (Guillen & Ishida, 2004). However, in most LMICs, governments are unable to provide adequate public transport facilities to the general public. To fill these gaps, many locally developed transport modes have entered (formally or informally) to the market in most parts of the LMICs. These privately owned small to medium size motorized or non-motorized vehicles are termed as ‘paratransit’ or ‘informal transport services’ (Cervero, 2000; Cervero & Golub, 2007; Guillen & Ishida, 2004; Regidor, Vergel, & Napalang, 2009; Sengers & Raven, 2014; Shimazaki & Rahman, 1996). Cervero (2000), initially described the market, organizational structure and regulatory issues of the informal sector in the book *Informal Transport in a Developing World*, and later Cervero & Golub (2007) further extended this work.

Another term ‘Indigenous Transport’ was also used for these kinds of vehicles, initially used by Cervero (2000), and later by other researchers (Ames et al., 2014; Mateo-Babiano et al., 2011, 2013). Mateo-Babiano et al. (2013), in a systematic review described the salient features of this transport sector (Table 2.2).

Table 2.2: Salient features of the indigenous transport

Features	Description
Demand responsive	Caters for the mobility and accessibility needs of local inhabitants
Context sensitive	Suits specific local contexts such as a distinct geographic feature, climate or air quality
Socio-culturally appropriate	Responds to cultural mobility and accessibility needs
Locally operated	Owned and operated by local residents
Socially accepted	Widely used and popular among the public

Source: Mateo-Babiano et al. (2013)

Paratransit transport services are most commonly found in Asian and African countries. These vehicles are usually locally manufactured and purpose-built to perform different tasks. They are available in different sizes and shapes such as motorcycle taxis, mini vans, tricycles or pedicabs. Most paratransit modes are two to three wheelers, and their passenger carrying capacity varies between 1 and 24 passengers, according to their size and shape. They act as a ‘feeder service’ and operate in both urban and rural areas (Cervero, 2000; Cervero & Golub, 2007; Kumar, Singh, Ghate, Pal & Wilson, 2016).

Some common examples of motorized paratransit modes are: *Becaks, Ojeks, Bajajs, Bemos and Toyokos* - pedicabs and motorcycle taxis in Jakarta, Indonesia; *Okadas* - motorcycle taxis in Lagos, Nigeria; *Mishuks* - three-wheelers in Dhaka, Bangladesh; *three-wheeler taxis* in Sri Lanka; *Kombis* - mini vans in Johannesburg, South Africa; *Habal-habal, Skylab, Tricycles, Pedicabs, Motorlea and Jeepneys* in Manila, the Philippines; *Motorcycle-taxis, Tuk-Tuks and Samlor* in Bangkok, Thailand and Nigeria; *Matutus* in Narobi, Kenya and many other African countries (Cervero, 2000; Cervero & Golub, 2007; Guillen & Ishida, 2004; Ogunrinola, 2011; Regidor, Vergel, & Napalang, 2009; Sengers & Raven, 2014; Shimazaki & Rahman, 1996).

A few examples of non-motorized animal-powered paratransit modes include *Dokar* in Indonesia, *Calesa* in Philippines, and *Tonga* in India and Pakistan (Shimazaki & Rahman, 1996). Some examples of human-powered non-motorized paratransit modes are *Xiclos* in Vietnam, *pedal tricycle* in Philippines and *cycle-rickshaws* in Bangladesh (Shimazaki & Rahman, 1996).

Uber and Careem are more recent examples of modern ride sharing or dial-a-ride systems, operating both in LMICs and HICs. Uber operates in 633 cities worldwide (Uber, 2017), while Careem is operational across 77 cities of the Middle East, North Africa, and South Asia (including 9 cities of Pakistan) (Careem, 2017).

The concept of paratransit services however differs between the HICs and LMICs, because in the HICs, they are mainly used as 'Demand Responsive Systems' such as shared-ride-taxis, dial-a-ride and subscription buses, and in some places they are used for tourist purposes for short trips such as human-powered pedicabs in some Australian and European cities. However, in most LMICs due to inadequate public transport services, the informal sector has emerged as 'gap-filler' and holds a major share in the public transport sector (Cervero & Golub, 2007; Godard, 2006; Kumar et al., 2016; Shimazaki & Rahman, 1996).

Prices and fares are also important factors in choosing paratransit or public transport in LMICs (Pojani & Stead, 2015; United Nations, 2013). For instance, in Bogota, Columbia, people prefer to use Bus Rapid Transit (BRT) system, because fares have been structured in a way that the low-income groups are subsidised through high-income groups. The system has a flat fare for all trips, hence the longer trips of low-income groups who mostly live on the city's outskirts are subsidised by shorter trips of high-income groups, who are concentrated in the city centre (United Nations, 2013).

In addition to meeting the mobility needs of millions of people in LMICs, the informal sector also provides a large job market for unemployed youth and low-skilled workers. The majority of drivers of informal transport are untrained and unlicensed, and do not have mandatory route permits or authorization. They are often small-operators and work on low margins. They compete for passengers, and are flexible in accommodating commuters' travel demands such as 'getting-on' and 'getting-off' anywhere on the road (Cervero, 2000; Cervero & Golub, 2007; Guillen & Ishida, 2004; Kumar et al., 2016; Sengers & Raven, 2014; Shimazaki & Rahman, 1996). Given their low earnings, their vehicles are often very old, unsafe and ill-maintained. These vehicles generally do not meet vehicular safety standards such as size, age and fitness criteria. Consequently, they contribute to environmental pollution, traffic congestion and road crashes (Cervero, 2000; Cervero & Golub, 2007; Godard, 2006; Sengers & Raven, 2014).

2.4 ROAD SAFETY IN PAKISTAN

Pakistan is located at the north-west of the South Asian subcontinent, and it is bordered by India on the east, Afghanistan on the north, Iran on the west and China on the northeast (Figure 2.1) (Population Council of Pakistan (PCP), 2002). Pakistan is the sixth most populous country in the world, with an estimated population of over 191 million in 2015 (Pakistan Economic Survey, 2014-2015). Pakistan's urban population is growing rapidly, and with approximately 40% urban populace, it is the most urbanized country in South Asia (UN-Habitat, 2015).

Pakistan has a land area of around 796,000 square kilometres, and it has four provinces: Punjab, Sindh, Khyber Pakhtunkhwa (KPK), Baluchistan and the Federally Administered Tribal Areas (FATA) (PCP, 2002).

Road crashes and injuries are a significant public health issue in Pakistan. In the WHO Eastern Mediterranean Region which constitutes 22 countries *(Afghanistan, Egypt, Bahrain, Djibouti, Iran, Iraq, Jordan, Morocco, Kuwait, Lebanon, Libyan, Oman, Pakistan, Qatar, Sudan, Saudi Arabia, Somalia, Syrian Arab Republic, Tunisia, United Arab Emirates and Palestine)*, Pakistan was at the top in terms of road fatalities, with an estimated 41,494 road fatalities in 2007 (Soori, Hussain & Razzak, 2011), 30,131 in 2010 (WHO, 2013), 32,700 in 2012 and 32,200 in 2013 (Ahmed, Khan, Khurshid, Khan & Waheed, 2015). The decrease in the official number of road fatalities may not necessarily reflect an improving situation, but also could mean that the data are getting worse.

Shamim, Razzak, Jooma & Khan, (2011) presented the findings of the Road Traffic Injuries Surveillance Program (RTIRP) in Karachi. The data were collected from the emergency departments of the five major tertiary care hospitals in Karachi for the three years 2006-2009. A total of 99,272 casualties and 3,097 fatalities (with a mortality rate of 5.7 per 100,000 inhabitants and an injury:fatality ratio of 32:1) were reported during the study period. Most casualties were male (89%) and 73% were aged ranged from 15 to 44 years. Riders of two wheelers (45%) were the most common group who sustained road traffic injuries and fatalities.

Rescue 1122 recent road crash data showed a 57% increase in road crashes across Punjab from 2011 to 2015 (Table 2.3).

Figure 2.1: Map of Pakistan
(Source: Pakistan, 2016)

Table 2.3: Number of road crashes attended by Rescue 1122 in Punjab, Pakistan, 2011-2015

Year	No of road crashes
2011	144,605
2012	158,327
2013	180,827
2014	201,120
2015	227,382
Total	912,261

(Source: Rescue 1122, Lahore)

The Rescue 1122 crash data indicates that 912,261 road crashes were reported across Punjab during 2011-2015, while police crash records in the corresponding period suggest a large under-reporting of road crashes. Pakistan Bureau of Statistics (PBS) road crash statistics are based on the police records from four provinces. The PBS data shows that a total of 2,438 road crashes (including both fatal and non-fatal crashes) were reported across Punjab, and 40,703 road crashes (including both fatal and non-fatal crashes) were reported across Pakistan between 2011 and September 2015. This is substantially less than the 912,261 road crashes recorded by Rescue 1122 in Punjab from 2011 to 2015, clearly indicating the significant under-reporting of road crashes in police records in Pakistan.

A similar problem exists with the recording of road fatalities in Pakistan. For example, in 2007, WHO estimated that there were about 41,494 road fatalities in Pakistan, but the police recorded only 5,615 fatalities (PBS, 2015; WHO, 2009). Similar disparities were evident in the WHO estimates and police recorded road fatalities during 2010 (30,131 versus 5,271) and 2013 (25,781 versus 4,348) (PBS, 2015; WHO, 2013, 2015). Likewise, Ahmed et al. (2015) developed an Ordinary Least Square (OLS) regression model to predict annual road fatalities in Pakistan. The WHO fatality estimates and International Road Federation data were used to predict the number of road fatalities in Pakistan during 2012 and 2013. The study predicted 32,700 and 32,200 road fatalities in 2012 and 2013 respectively, which is even higher than the WHO estimates for the corresponding years.

The under-reporting of road crashes and fatalities is a well-established problem in Pakistan, and has been consistently reported by a range of previous studies from different parts of the country (Ahmed, 2007; Ahmed, Khan, Khurshid, Khan & Waheed, 2015; Batool et al., 2012; Bhatti, Razzak, Lagarde & Salmi, 2011; Ghaffar et al., 2004; Hyder, Ghaffar & Masood, 2000; Kayani, Fleiter & King, 2014; Razzak & Luby, 1998; WHO, 2009). Kayani et al. (2014) revealed that the lack of police training in road safety and road crash reporting, a poor data management system, fatalism *(a crash is considered to be a will of God that cannot be prevented)*, and low value of road safety at the national level, are some of the major factors behind under-reporting of road crashes and fatalities in Pakistan. Given the considerable under-reporting and limitations in police crash data, Rescue 1122 ambulance data were preferred for examination in Study 1 of this research program.

All the above data, coupled with the socioeconomic implications of injuries and fatalities, suggest huge personal and societal costs for the country, as they disproportionately affect young and middle-age males (aged 16-45 years), who are often the sole breadwinners of their extended families (Ahmed, 2007; Batool et al., 2012; Tahir, et al., 2012). Each injury accounts for work losses of 17 days (mean) and 15% of these injuries entail long term hospitalization that incurs additional direct or indirect costs (Ghaffar et al., 2004; Jafar et al., 2013). Fatmi et al. (2007) in the National Health Survey of Pakistan (1990-1994) found that road traffic injuries cause more handicaps and long-term disabilities than any other types of unintentional injuries such as drowning, poisoning, suffocation, and fire and burn-related injuries. It was estimated that besides pain, grief and sorrow, road crashes and injuries cost around US$ 1.6 billion per annum (more than 2% of GDP) to the Pakistani economy (Asian Development Bank, 2007; Batool, et al., 2012; Ghaffar et al., 2004; Jafar et al., 2013).

Despite these huge human and socioeconomic losses, road safety does not appear to be a priority for the government in Pakistan. Over the last two decades, three national health policies (1990, 1997 and 2001) were formulated in Pakistan, and two of these policies (1990 and 2001) did not even recognize road crashes and injuries as an important public health issue (Hyder, & Razzak, 2013). Similarly, the '1997 National Health Policy' briefly mentioned 'road crashes' as a public health problem, but failed to provide any operational or management plan to deal with this issue (Hyder, & Razzak, 2013). The government only spent US$ 0.07 per capita (0.015% of GDP/capita) for road safety in 1998 (Bishai, Hyder, Ghaffar, Morrow & Kobusingye, 2003), and WHO recent global road safety reports (2009, 2013, 2015) showed no funding allocation for the national road safety lead agency in Pakistan.

In terms of road safety, the establishment of the National Road Safety Secretariat (NRSS) as a Lead Road Safety Agency (LRSA) in Pakistan in 2005-2006, was the only visible effort of the national government in recent years (Bhatti & Ahmed, 2014). The NRSS was initially funded by the World Bank; later it was the responsibility of the Pakistani government to support the LRSA, but this support was not forthcoming. Consequently, the NRSS was dissolved in 2008, and the Ministry of Communication was nominated as an LRSA in Pakistan, and the National Transport Research Centre and National Highway and Motorway Police (NHMP), (which have distinct functions such as transport research and traffic enforcement, respectively), were declared its executing bodies (Bhatti & Ahmed, 2014; National Transport Research Centre, 1999; Khoso, Ekman, & Bhatti, 2011).

Presently, the LRSA works on an ad hoc basis, and it requires strong political support, sustainable financial, legal and technical resources to fulfil its objectives (Bhatti & Ahmed, 2014). This situation indicates that currently there is no organization in the country specifically involved in road safety research, planning, policy and practice.

2.5 PUBLIC TRANSPORT IN PAKISTAN

2.5.1 Motorization and Private Vehicle Use in Pakistan

A well-organized transport system with modern infrastructure plays a vital role in the socioeconomic development of a nation (Pakistan Economic Survey, 2014-2015). Pakistan has an extensive road network of 263,942 kilometres (km) including 9,324 km of National Highways, 2,280 km of Motorways, and 100 km of Expressways and Provincial Highways. These roads carry more than 96% of inland freight and 92% of passenger traffic across the country (Pakistan Economic Surveys, 2012-2015).

Over the last two decades, there has been a large growth in motorized vehicles (especially private vehicles) across Pakistan. There were over 4.7 million registered vehicles in 2000, and this number reached 15 million registered vehicles in 2014 (a growth rate of 223%) (PES, 2014-2015; Pakistan Bureau of Statistics, 2015). This increase was remarkably high during the period 2001 to 2006, where an increase of 410% was witnessed in all kinds of vehicles in Pakistan. Private vehicles such as motorcycles (525%) and cars (300%) had the highest growth rates during this period (Ahmed, 2007).

In Peshawar (the capital city of KPK Province), the number of new registered vehicles increased by 126.4% between 1998 and 2009, and about three-quarters (76.15%) of these were private vehicles (Ali, Shah & Hussain, 2012; Excise and Taxation Office, Peshawar, 2013). Similarly, in Karachi (the capital city of Sindh Province) of the total of more than two million registered vehicles in 2011, around 88% were private vehicles such as motorcycles (50%) and cars (38%) (Heraa, 2013; Urban Resource Centre, 2011).

Clearly, the numbers of private vehicles are growing exponentially in Pakistan. Some of the major factors identified behind these trends include: an inefficient and unintegrated public transport network; lack of infrastructure for pedestrians and other non-motorized road users; an increasing population and high urbanization rates; expanded urban centres such as Lahore and Karachi, where trip length has increased, resulting in the shift from non-motorized to motorized modes; banks' car leasing policy especially after 2002; changes in lifestyle; and easy availability of various brands of motorcycles payable in small instalments (Imran, 2009; Javid, Okamura, Nakamura, Tanaka & Wang 2014; JICA, 2012; Masood et al., 2011).

Public transport infrastructure, facilities and networks are underdeveloped in Pakistan, and are typically characterized by low quality of service delivery; little customer focus; high transportation costs; haphazard growth on urban roads and limited services in rural areas; low levels of repair and maintenance and operational safety standards; and loss to public revenues (Masood et al., 2011; Toor, Kommakulla & Kenneth, 2003). The public transport situation in Pakistan is discussed in an official report entitled the "Punjab Cities Improvement Investment Program'' (PCIIP). The PCIIP was funded by Asian Development Bank (ADB) to improve basic urban facilities such as sanitation, water supply and public transport in 12 Punjab districts *(Chiniot, Gujrat, Sargodha, Bahawalpur, Dera Ghazi Khan, Jhang, Okara, Sahiwal, Rahim Yar Khan, Kasur, Sheikhupura and Sialkot)* (PCIIP, 2011). A SWOT (strength, weakness, opportunity and threat) analysis was conducted to examine the capacity of provincial and local governments with regard to existing basic urban facilities. The SWOT analysis identified the following organizational gaps in the technical and functional capacity of the Punjab Transport Department (PTD) and other related organizations (PCIIP, 2011):

(1) Despite the fact that the City District Government has the authority and mandate to plan, develop, and manage the city's public transport, they are unable to perform their functions due to a lack of technical and management capacity of the related public organizations.

(2) Deficient technical capacity and inefficiency of urban transport organizations are coupled with duplication and overlapping of functions. Public transport planning, regulation and operations are generally mixed, and none of the city governments has any existing urban transport plan and future vision. Lack of

coordination among different organizations and stakeholders further worsens this situation. All these factors ultimately lead to poor planning, decision making, management and performance of the relevant transport organizations.

(3) Road infrastructure was adequate in most of the study areas, however the effective capacity of roads is reduced by deficient road engineering standards in all districts. There was an absence of any urban public transport service (bus or van) in all study areas, and the public travel demand (as well as movement of goods) is mostly met by MRs. Traffic management and enforcement were poor, and traffic mix (non-motorized and motorized) further complicates the problem. Large growth in motorized vehicles and poor traffic control are resulting in traffic congestion and air and noise pollution that have serious health and safety hazards.

The public perception surveys and transport surveys conducted in various large cities of Pakistan (Faisalabad, Sheikupura and Gujranwala in Punjab Province; Karachi in Sindh Province and Peshawar in KPK Province) have also shown a high level of public dissatisfaction regarding existing public transport facilities and road safety conditions in these cities (Ali, Shah & Hussain, 2012; Sohail, Maunder & Miles, 2004; Sultan & Macário, 2009; Punjab Transport Department, 2013a,b; Rao, Khan, Jafri & Sheeraz, 2013). For instance, a survey in Sheikhupura city of Punjab revealed that more than half of the citizens (59%) considered the traffic situation as 'very bad' or 'bad'. The people were unsatisfied with operating hours, frequency, availability, accessibility, routes and schedules, speed, fares, bus stop facilities, on-board comfort and transfer convenience of the public transport service in the city (Punjab Transport Department, 2013b). Moreover, about a quarter (22%) of respondents was involved (directly or indirectly) in road crashes during the past five years, and 40% had sustained major injuries (Punjab Transport Department, 2013b). Similarly, in Karachi people were also dissatisfied with the current public transport network, and they identified many problems such as the poor condition of buses; irregular frequency, schedule and fares; overloading; and no proper space and security for women, the disabled and children (Rao et al., 2013).

2.5.2 History of Public Transport Planning and Policy in Pakistan

Three ministries are responsible for planning and policy for the four different modes of transportation in Pakistan: the Ministry of Communication (MOC) - *road and sea transport*, the Ministry of Railways - *rail*, and the Ministry of Defence -

airways. These ministries work and plan independently with little coordination, although it was recommended in the 1970s that all transport ministries be brought under one structural umbrella (Hisam, 2006).

As far as public transport planning and policies are concerned, the MOC is the national authority in Pakistan, and the National Transport Research Centre (transport research and development function), National Highways and Motorway Police (traffic and law enforcement), National Highways Authority (planning and development of national highways and other roads) are its main executing bodies. At the provincial level, transport departments and their allied organizations are responsible for the provincial and regional transport planning, policy and management (Ministry of Communications Pakistan, 2016; Hisam, 2006).

Public transport planning and policies have remained weak and deficient in Pakistan. Since the 1950s, transport authorities have formulated several transport plans and policies, with or without the support of international organizations such as World Bank, Asian Development Bank, and JICA, but none of these policies have solved the transportation problems of the rapidly growing population of Pakistan (Imran, 2009; Hisam, 2006).

Imran (2009) conducted an in-depth ‘historical overview’ of transport policies in Pakistan. This comprehensive review involved a critical analysis of the public transport planning and policies across three time periods, including the British India period (1853-1947), 1947-1990 and from 1991 onwards. This review identified many important factors overlooked while developing various transport policies. The study revealed that during the past 60 years, several public transport plans (first five year plan 1955-1960, second five year plan 1960-1965, Ten Year Perceptive Development Plan 2001-2011, Medium Term Development Framework 2005-2010, Integrated Master Plan 2001-2021), and policies and transport projects (National Transport Policy 1991, Prime Minister’s Public Transport Scheme 1991, National Conservation Strategy 1992, Faisalabad Urban Transport Society 1994, Lahore Transport System 1997, People’s train and Awami Bus Train Project 1996, National Integrated Transport Policy 1977, National Integrated Transport Policy 1998, Transport Sector Development Initiative 1999) were initiated, but none were successful (Imran, 2009).

All policies to operate public transport through the public sector, the semi-public sector, the private sector (pubic transport privatization), and the public-private-community sector transport projects failed successively (Imran, 2009). The review found that during the British India period, Pakistan was connected with a railway network between Karachi and Kotri in 1861, and until 1865 all important cities of the country were connected by railway networks. This railway network was further extended to Afghanistan border in 1878 and to Zahidan, Iran in 1918; in total, Pakistan inherited a 8,070 miles long railway network from British India (Imran, 2009; Vakil, 1944). Besides developing an extensive intercity railway network, the British also initiated urban tramways in Karachi in 1885, and feeder bus services in Lahore and Karachi. Additionally in 1904, locomotive workshops were established in Lahore, to support the extensive railways network (Imran, 2009; Vakil, 1944).

All these developments show that Pakistan entered the 20th century with a well-integrated intercity railway system and an urban tram system. However, unfortunately, in the 21st century, these systems were either shut down or in poor condition and about to collapse. Major reasons identified behind these failures were the weak governance, management, planning and technical capacity of public transport organizations (Imran, 2009; Hisham, 2006).

Imran (2009) found that in Pakistan, road and infrastructure development authorities (e.g. National Highway Authority, Communication and Works Department) have the institutional set-up and technical capacity to plan and deliver. However, public transport organizations are weak in technical and professional capacity, as no government has tried to strengthen this sector, despite inheriting an extended intercity railway network, which had the potential to develop into mass urban-rail networks (Imran, 2009). In annual development plans, the emphasis was placed on promoting road transport and building larger road projects that left no money for railways (Imran, 2009; Hisam, 2006).

With regard to the history of the transport regulatory framework in Pakistan, the British enacted the ‘Motor Vehicles Act’ in 1939 and the ‘Motor Vehicle Ordinance’ in 1942. Later the same Act and Ordinance were amended into the Motor Vehicle Ordinance 1965 and Motor Vehicle Rules 1969 (Hisam, 2006). After 35 years of redrafting exercises from 1965 to 2000, finally in 2000, the National Highway Safety Ordinance was promulgated. However, the National Highway

Safety Ordinance 2000 is only applicable to transport that operates on the national highways; it has also several other limitations and needs revision (Hisam, 2006; Hyder et al., 2006). The Motor Vehicle Ordinance 1965, despite its limitations, remains applicable to transport operating on all other roads across Pakistan (Batool et al., 2012; Hisam, 2006; Hyder et al., 2006; Razzak, Luby, Laflamme, & Chotani, 2004).

2.6 DRIVER LICENSING SYSTEM IN PAKISTAN

The minimum age for obtaining a driving licence is 18 years in Pakistan. A 'learner licence' is issued at the first stage and after six weeks of the learner period, one can apply for a full driving licence. Theoretical and driving tests are mandatory to obtain a full driving licence. In the recent past, a computerized driving licensing system has been introduced in some large cities of Pakistan. However, there are many loopholes in the existing licensing system that enable people to misuse this system with power and corruption. Moreover, once the licence is issued, there is no mechanism and penalty system to check the driver's driving history and deter repeat offenders (Batool et al., 2011; Durrani et al., 2012). For instance, Durrani et al. (2012) investigated the relationship between traffic safety attitudes and ticket fixing behaviours (i.e. pay-off with the police) among the general driving population (motorcycle riders, car, van, bus and rickshaw drivers – it is not clear whether it includes MRDs) in Lahore. Around 32% of drivers had no driving licence and about the same number had obtained it without passing any test. Another 38% did not answer this question. Around 5% of the drivers were under the legal age limit (i.e. 18 years) for driving, while more than half (52%) reported being involved in a road crash. Additionally, nearly 80% admitted involvement in various traffic violations (e.g. speeding, signal violation, reckless driving), while 66% were involved in ticket fixing or bribing a policeman.

Another survey conducted in Islamabad, Pakistan reported similar findings. All study participants reported being involved in traffic violations (frequency was once per month for 71% participants and once per day for 13% participants), and nearly all (99%) had experienced a road crash during the last 12 months. Likewise, 89% of respondents were involved in traffic violations without being penalized or escaping easily, while 63% had bribed the police (Batool et al., 2012; Zulfiqar Ali Bhutto Institute of Science & Technology, 2009).

There is also a lack of uniformity in licensing standards and regulations at the national and provincial levels, so one may obtain an illegal driving licence from anywhere outside of their native city or province. For example, a recent newspaper report claimed that around 60% (around 0.5 million drivers) of commercial transport drivers (including heavy vehicle drivers) in Karachi had an illegal driving licence (either an official licence received through illegal means such as bribery, without going through mandatory theoretical and practical driving tests, or a completely fake document), and some even had two to five illegal licences (*The Jang*, 2015). Power and influence are also prevalent features of Pakistani culture and society, so law enforcement is not equally applied to all segments of society: influential people usually escape punishment and the poor are held accountable. These factors also promote unsafe driving practices and encourage people to break the law (Batool et al., 2012).

2.7 MOTORCYCLE RICKSHAWS IN PAKISTAN: PARATRANSIT ROLE AND ROAD SAFETY ASPECTS

Motorized and non-motorized paratransit transport services have operated in Pakistan for many years. The most common examples of various paratransit modes are Tonga (horse driven non-motorized vehicle), AR, Minibus, Passenger Van, car taxi, Suzuki pickup/carry dibba, and MR (Figure 2.2) (Imran, 2009; Muhammad, 2013; Sohail, Maunder & Cavill, 2006).

Previous studies have discussed some aspects of MR or AR as a component of a larger research project (Batool et al., 2012; Ezdi, 2009; Hashmi, 2012; JICA, 2012; Masood et al., 2011; Muhammad, 2013; Sohail et al., 2006; Shabiralyani, Tariqalyani, Hamad & Iqbal, 2015; Tahir et al., 2012, 2013). However, there is an absence of literature that takes a comprehensive approach to MR (Table 2.1).

Auto-rickshaw **MR** **Suzuki pickup/carry dibba**

Passenger Van **Minibus**

Figure 2.2: Various types of paratransit modes in Lahore, Pakistan

(Source: Author, 2017)

Most of the earlier studies (Table 2.1) mainly examined the various road safety and public transport issues in Pakistan. For instance, Batool et al. (2012) conducted an exploratory qualitative study to identify major road safety issues in Pakistan. A total of 31 interviews were conducted with national and provincial transport and traffic department officials, road safety and transportation engineering experts and academics, and 20 drivers from the general driving population of Lahore. The sample of 20 drivers included professional public transport drivers (*n*=3, including two MR drivers), housewives (*n*=2), businessmen (*n*=2), office employees (*n*= 9) and students (*n*= 4). A thematic analysis technique was used for data analysis. The study identified several institutional and executional, physical and operational, attitudinal and behavioural, and road safety research and data bank issues that potentially contribute to the poor road safety situation. The study proposed some institutional, physical and operational reforms for various government departments and road users' behavioural changes through advocacy, awareness and strict implementation and enforcement of traffic and road safety rules.

Muhammad (2013) explored public perceptions regarding implementation of various Transportation Demand Management (TDM) measures to mitigate traffic-related problems in Pakistan. Three questionnaire-based surveys were conducted in Lahore to assess road users' travel peferences and the feasibility of implementing different TDM measures in Lahore city. In Survey 1, an email-based questionnaire was used to evaluate the usefulness of a radio traffic information service (RASTA-Road and Street Traffic Awareness) for all road users in Lahore. The RASTA was launched and operated by Lahore traffic police to ensure smooth traffic flow and traffic management across the city. The RASTA program includes a traffic helpline 1915, website hosting, and FM 88.6 traffic radio to create awareness among the general public about road safety and the ongoing traffic situation in Lahore. In Survey 2, satisfaction with different public transport modes operating in Lahore, and attitudes towards the application of various TDM measures in the city were assessed by interviewing 631 commuters. Survey 3 involved a sample of 354 road users to identify the factors that were likely to influence their acceptance of various TDM measures. This survey also identified the influencing factors for commuters to use different modes of public (including MRs) and private transport modes.

The commuter surveys showed that two types of travel patterns are dominant in Lahore: 'auto-dependent' (private vehicles users), and 'non-auto captive behaviour' (public transport users). Time saving, flexibility, convenience, freedom and status are the major factors in the use of private vehicles such as cars, motorcycles and ARs (auto-dependent), while low-income and non-vehicle ownership are the main factors of non-auto modes use, and usage of various public transport modes including MRs in Lahore (non-auto captive). The research recommended some TDM measures to reduce traffic congestion, the use of private vehicles, and air and noise pollution in Pakistan. This research also highlighted some paratransit features of MRs and commuters' perception regarding service quality and safety of MRs:

> *Motorcycle Rickshaw and passenger van drivers are involved in speeding that cause disturbance for other road users such as bus drivers, who do not find the way and resultantly half an hour trip on a bus takes one-hour. Speeding behaviour of drivers sometimes leads to road crashes. Passengers also feel unsafe in MR, autorickshaw and van due to presence of gas cylinders.* (Survey participant)

Motorcycle Rickshaw is convenient and easily available, however it is open on all sides and exposed to smoke and dust. Moreover, MR drivers play loud music and there is a gender discrimination, as female do not feel comfortable in sitting with male. (a female survey participant)

JICA (2012) formulated a comprehensive Lahore Urban Transport Master Plan (LUTMP) by conducting eleven transport surveys across Lahore in 2011. The main objectives of the LUTMP were to: (1) develop an urban transport master plan for Lahore up till 2030; (2) identify public transport projects for Lahore up to 2020; and (3) provide technical assistance to the Punjab government for implementing the LUTMP. The LUTMP study area included the whole of Lahore District, and part of Kasur and Sheikhupura Districts. It was observed that the traffic situation was worsening in Lahore, and traffic and environmental problems would be severe in future if proper transport planning and management solutions were not implemented. The report stated that about 40,000 illegal MRs were operating in Lahore, most on major primary and secondary roads. Moreover, growing numbers of informal and poorly maintained MRs, passenger vans, coasters and ARs had replaced old non-motorized modes such as Tongas and buses from many routes in Lahore. The LUTMP proposed some transport projects such as Urban Rail Mass Transit (URMT) and Bus Rapid Transit (BRT), and development of feeder services such as buses and passenger vans along the mass transport modes. The LUTMP also recommended some infrastructure development projects and establishment of the Transport Planning Unit (TPU) and Lahore Transport Company (LTC) to strengthen technical, planning and management capacity of the Punjab Transport Department (PTD).

Other studies (Imran, 2009, 2010; Masood et al., 2011; Sohail et al., 2006) mainly examined current and past transport policies of national and provincial governments, and highlighted different issues in the public transport sector. Hence none of the previous studies have thoroughly investigated the transport, road safety and public health implications (road crashes, injuries and fatalities) of MRs in Pakistan. The current research attempts to bridge this significant knowledge gap. The literature review indicates that the majority of the previous studies have investigated public transport and road safety issues in Pakistan from an engineering or transportation engineering perspective. However, as outlined in the scope of this research (Chapter 1), the current research examines the road safety implications of a paratransit mode (i.e. MR) from a public health perspective - injury prevention and road safety, which appears to be a novel approach in Pakistan.

2.7.1 Motorcycle Rickshaw or Chingchi

Motorcycle Rickshaws are commonly known as ‘Chingchi’ or ‘Chand Gari’ (moon car) in Pakistan. Chingchi is an Urdu version of Qingqi, the name of a Chinese company which began producing 70cc and 100cc 2-stroke 3-wheeled MRs in Pakistan in 1994 (Plum Qingqi Motors Limited, 2015). Later, the company introduced a 100cc 4-stroke 3-wheeled MRs as well. The company’s objective was to produce vehicles for everyone (particularly for the poor) at affordable prices. The Qingqi’s MRs gained so much popularity among the general public that despite many other MR brands across Pakistan, all of them are known as Chingchis. However, the Plum Qingqi Motors Limited (PQML) remains the largest manufacturer of the 3-wheeled MRs in Pakistan (PQML, 2015).

Motorcycle rickshaws were first introduced in Lahore under the ‘President Rozgar Scheme’ (Rozgar stands for employment) in 2001 (*The Express Tribune*, 2012a, 2013a, b). The primary objective of the government was to provide employment opportunities to low-skilled young people, and to replace the traditional horse-driven Tongas, which had operated for centuries (*The Express Tribune*, 2012a, 2013a,b).

The MR sector has provided job opportunities to thousands of people in Pakistan, and also replaced the Tongas in Lahore and other large cities. Motorcycle rickshaws emerged as a ‘gap-filler’ due to deficient public transport facilities and infrastructure across the country (*The Express Tribune*, 2012a, 2013a, b). Their low fares, easy availability and transit flexibility have made them popular among the general public, and they have multiplied everywhere in Pakistan. The production of MRs increased by 143% in Pakistan during 2010-2011 (*The Express Tribune*, 2012a). Estimates suggest that approximately 50,000 to 70,000 MRs are operating in Lahore, and over 100,000 in Karachi, and a similar situation exists in other parts of Pakistan (Malik, 2012; *The Express Tribune*, 2012a, 2013a,b, 2016a). The All Karachi Qingqi Welfare Association (AKQWA) projected that around 300,000 MRs were operating across the Sindh Province in 2014, and in Karachi alone MRs were operating on about 300 different routes across the city (*The Express Tribune*, 2015e).

A survey conducted by the LTC (the public transport regulatory authority in Lahore) in 2014, revealed that there were around 32,000 MRs across the city (*The Express Tribune*, 2014a). However, this survey mainly focused on the major operational areas of MRs in Lahore, and did not include outlying areas and adjoining towns, where large numbers of MRs operate. The Punjab Rickshaw Taxi Union Federation estimated that there were around 100,000 MRs and 200,000 people associated with this business in Lahore (*The Dawn*, 2014a). The exact number of MRs is still unknown to the authorities, because they are only registered as motorcycles, and thus have a registration number plate only for motorcycles, not for the back-cart or MR body. There was only one MR manufacturer company (i.e. PQML) in Pakistan during 1994, but now there are 46 local MR body manufacturing companies (most unregistered), and 22 motorcycle manufacturing companies in Lahore city alone (Figures 2.3-2.4). A similar situation exists in Karachi and other parts of Pakistan, indicating exponential growth in MR numbers, constituting the largest informal public transport mode.

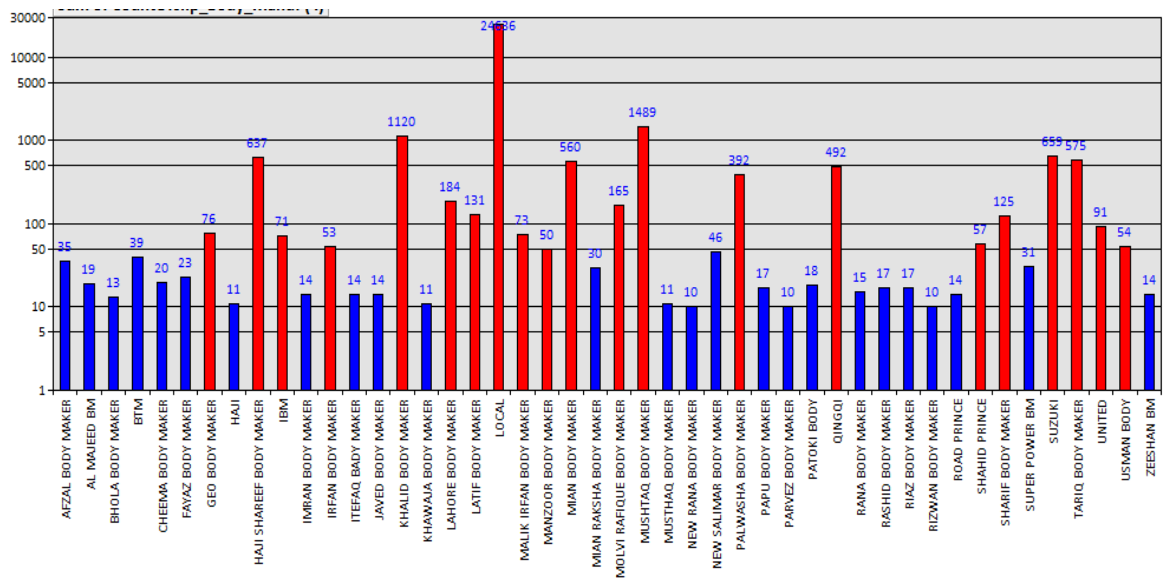

Figure 2.3: MR body or cart manufacturing companies across Lahore

*(Source: Lahore Transport Company, 2014) *Blue and Red colour bars in Figure 2.3 represent the number of various MR manufacturing companies across Lahore*

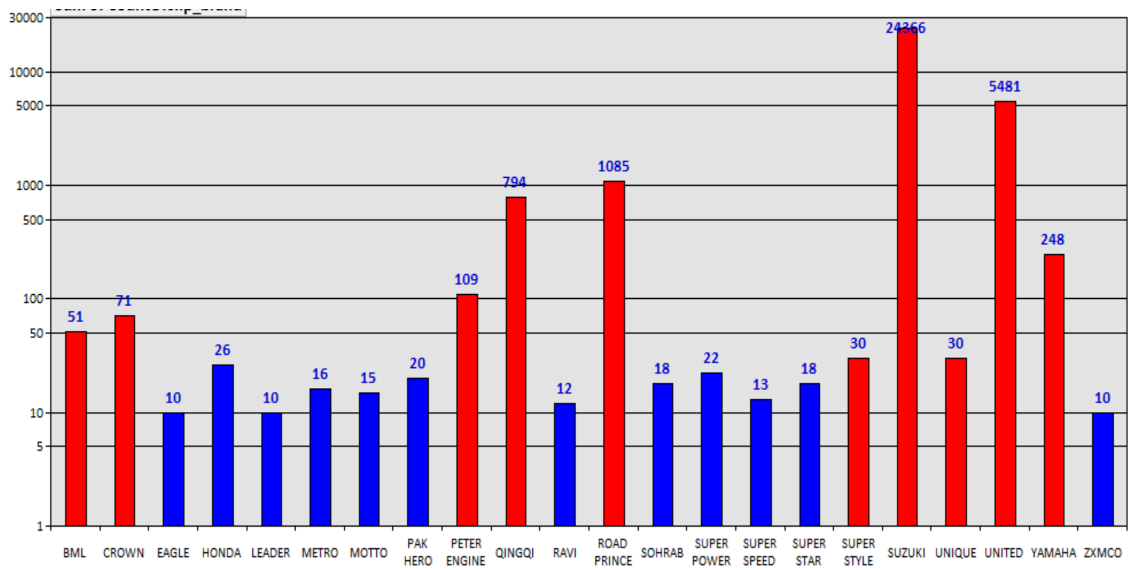

Figure 2.4: MR motorcycle manufacturing companies across Lahore

*(Source: Lahore Transport Company, 2014) *Blue and Red colour bars in Figure 2.4 represent the number of various MR motorcycle manufacturing companies across Lahore*

2.7.2 **MR - Design and Safety Features**

Compared to an AR that costs around AUD 2,000-2,500, a new MR comes at a low price about AUD 1,200-1,600 (*The Express Tribune*, 2012a, 2013a). Newspaper and media reports suggest that local unregistered MR manufacturing companies are expanding across Pakistan, with many road-side and home-based units producing varying types of MRs. This proliferation of local companies and units has made it easy to construct an MR, as any 70cc or 100cc motorcycle can be joined to any two wheeled-cart with the help of a welder (*The Express Tribune*, 2012a, 2013a; Hasan & Raza, 2015; *Medill Reports Chicago*, 2016).

A documentary (produced by Medill Reports Chicago in collaboration with City42 TV Lahore, and the Centre for Excellence in Journalism, Karachi) which interviewed local MR manufactures in Lahore, claims that around 50,000 people are involved in manufacturing of MRs along only one major road in the northern part of Lahore. In total, approximately 500,000 people are involved in road-side manufacturing of MRs across Lahore (*Medill Reports Chicago*, 2016). The documentary also claims that about 70 new MRs are manufactured every day in the city. This local manufacturing involves all manual work, retrofitting and decoration of MRs (*Medill Reports Chicago*, 2016).

The second-hand MR carts are also easily available in Lahore, and can be fitted to any motorcycle to form an MR. The price of a second second-hand MR cart varies between AU$ 100 and 300, while a second-hand motorcycle costs around AU$ 200-500 depending on its repair and maintenance condition (Figure 2.5).

Figure 2.5: Second-hand MRs and carts in Lahore
(Source: Author, 2015-2016)

In Karachi, there are many variations in design and structure of MRs, and different workshops produce their own designs. For instance, a six-seater MR has been converted into a nine-seater MR, which is operating in Karachi as well as in other parts of Pakistan. The workshops which perform these kinds of modifications are mostly small illegal units across Karachi (Hasan & Raza, 2015).

The Sindh Public Transport Department (SPTD) recently identified 17 mechanical and engineering defects in MRs including: no hydraulic brake system and reverse/parking brakes; low-capacity motorcycle engines; unbalanced structural stability and lack of proper vehicle differential system; wheels powered by chains instead of a vehicle-shaft; and passenger cabinet or MR cart lacking safety features - open from the sides, no side-doors, no head restraints, seat-belts, hand-grips, indoor light, leg-guard or front screen for MRD (*The Automark*, 2016 and information extracted from LTC documents). The use of a low-capacity 70cc motorcycle engine is also common in MRs, as a report from the Excise and Taxation Department, Government of Punjab states (information extracted from LTC documents):

> *It has been observed that the complaints are arising due to non-approved and undersized prime-movers 70cc Engines used in Motorcycle Rickshaws. Road-side illegal MR manufacturers are a major source of producing non-standard products. These under power (70cc) and non-approved motorcycle rickshaws are a major source of crashes on the roads.*

Most MRs do not have side mirrors, and many do not even have rear-view mirrors, so MRDs are unable to see the left /right and rear traffic flow properly. Newspaper reports claim that repair and maintenance of MRs is often compromised, as MRDs are less likely to spend money on their vehicles due to their low earnings. Hence, MRs are considered as unsafe vehicles (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Express Tribune*, 2012a, 2013a,b; *The Nation*, 2012a,b, 2013a,b,c,d, 2015a; *The Pakistan Today*, 2015; *The Sargodha News*, 2014).

> *Passengers can suffer serious injury in MR crashes even at low speed, because MRs are locally converted from motorcycles that tend to fall sideways even at low speeds.* (*The Express Tribune*, 2013a)

Newspaper reports have also noted that due to the absence of any regulatory framework and legislation for MRs, they are only registered as a motorcycle, not as a commercial vehicle. This prevents traffic wardens from penalizing MRDs for carrying too many passengers or for incorporating hazardous modifications in design and shape of MRs (*The Express Tribune*, 2011, 2013b). Similarly, MRs also cause significant environmental air and noise pollution in Lahore because of poor maintenance, but due to the lack of necessary legislation, MRDs are not prosecutable by the environmental inspectors of Punjab Environment Protection Department (Siddiqui, 2014; *The Express Tribune*, 2011, 2013b).

2.7.3 MR - Road Safety Aspects

2.7.3.1 Overloading

Overloading of MRs is very common and has been described in several newspaper reports (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Express Tribune*, 2011, 2012a, *The Nation*, 2012a; *The Pakistan News Index*, 2016). Motorcycle rickshaws have a nominal seating capacity of six passengers (including the driver), but they are commonly overloaded with seven to ten passengers (Figure 2.6). Overloading of MRs is particularly seen in congested urban areas, small cities, towns and villages across Pakistan, where other public transport modes are absent or deficient (Khawaja, 2011; *The Express Tribune,* 2011).

Figure 2.6: An overloaded motorcycle rickshaw in Lahore
(*Source: Author, 2015*)

Newspapers have reported that due to many local modifications in MR design and structure, MRs are used for multiple purposes such as a mini passenger van, freight vehicle, advertising vehicle, and school van. Motorcycle rickshaws transporting school children are particularly dangerous, as they are overloaded with an average of 10 to 15 children, and are commonly seen in Lahore and other parts of Pakistan (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Express Tribune*, 2012a, *The Nation*, 2012a; *The Pakistan News Index*, 2016).

2.7.3.2 MRDs - Risky Driving Practices

Newspapers and media reports often claim that the majority of MRDs are unlicensed and unskilled drivers, who commit various types of traffic violations such as overtaking, speeding, one-way violation, traffic signal violation, and competing with other drivers for passengers (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Dawn*, 2015a; *The Express Tribune*, 2011, 2012a, 2013a,b; *The Nation*, 2012a). These reports indicate that MRs do not have fixed stops or routes and terminals. Therefore, the majority of MRDs stop haphazardly to collect or drop passengers, and in doing so, they often engage in speeding and overtaking other vehicles (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Dawn*, 2015a; *The Express Tribune*, 2011, 2012a, 2013a,b; *The Pakistan News Index*, 2016).

It has also been claimed that MR operators are a kind of 'street-mafia', who have set up illegal terminals in various bus stops, roads, service lanes, and footpaths in Lahore, Rawalpindi, and other large cities (Siddiqui, 2014; *The Express Tribune*, 2011; *The Nation*, 2012a). These illegal terminals and the unregulated proliferation of MRs create traffic chaos and congestion, block pedestrians paths and cause safety issues for all road users (Siddiqui, 2014; *The Express Tribune*, 2011; *The Nation*, 2012a).

2.7.3.3 Underage MRDs

Newspaper and media reports suggest that underage MRDs operate all over Pakistan, especially on the outskirts of large and small cities, towns and villages. The media portrays underage MRDs as unlicensed and unskilled drivers, uneducated and with no knowledge of traffic rules (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Express Tribune*, 2011, 2012a, 2013a; 2014a, b; *The Sargodha News*, 2014; *The Nation*, 2012a, 2015a). The newspapers claim that in Lahore about half of MRDs are underage and unlicensed, while in Sargodha (another city in Punjab), there are about 2,000 underage drivers. They drive recklessly on busy roads and are often involved in road crashes (Siddiqui, 2014; *The Sargodha News*, 2014). Similarly, in Peshawar (capital city of KPK Province), underage MRDs are claimed to comprise approximately 80% of the total underage drivers' population in the city (*The Express Tribune*, 2014b). A similar situation exists throughout the country:

> *"Children as young as 12 years are seen driving MR. Motorcycle rickshaw does not exist as a vehicle with the excise department, no licensing is required, either for the vehicle or the driver, which is fatal for the general public".* (Karachi Transport Department Official, *The News*, 2015a)

> *"Chingchi rickshaws are very much vulnerable to road crashes and tragedies, as these are usually being driven by underage and inexperienced drivers. The majority of them do not have proper knowledge of traffic rules and training. Therefore, they not only put human lives at risk, but also cause disturbance for other road users"* (*The Tribal News Network* from Charsadda District of KPK Province, 2015)

2.7.4 **MR Road Crashes**

Tahir et al. (2012) examined the epidemiology of road crashes attended by Rescue 1122 ambulances in Lahore from 2005 to 2010. Rescue 1122 road crash data were aggregated records, where both MR and AR crashes were collectively recorded under the category of 'rickshaws'. The study demonstrated that rickshaws (both MR and AR) were involved in 22,488 road crashes, 18% of the total Rescue 1122 attended crashes in Lahore during the study period. The study also found that rickshaws (both MR and AR) were the third highest vehicle type involved in collisions (after motorcycles and cars) in Lahore between 2005 and 2010 (Table 2.4).

Table 2.4: Types of vehicles involved in road crashes attended by Rescue 1122 in Lahore, 2005-2010

Type of vehicle	No of road crashes	Percentage (%)
Motorcycles	55,840	45
Cars	35,747	29
Rickshaws	22,488	18
Vans	6163	5
Trucks	2198	2
Buses	832	1
Total	123,268	100

Source: Tahir et al., 2012

Tahir et al. (2013) analysed road crash data from Rescue 1122 for 2011. The study revealed that rickshaws (both MR and AR) were involved in 1,407 road crashes in Lahore during the first 10 months of 2011, and they were the third most common vehicle involved in crashes after cars and motorcycles during the study period. In a recent study, Shabiralyani et al. (2015) investigated the major contributing factors in road crashes attended by Rescue 1122 in Dera Ghazi Khan District of Punjab during 2010-2014. The study found that of the 18,063 road crashes attended by Rescue 1122 in the study period, rickshaws (both MR and AR but mainly MRs) were involved in 1,609 crashes. However, all these studies (Tahir et al., 2012, 2013; Shabiralyani et al., 2015) analysed the Rescue 1122 aggregated crash datasets, so could not provide specific information about MR crashes.

Newspaper and media reports claim that the growing number of MRs and their unregulated operation across Pakistan are creating many transport and road safety issues such as road crashes on both urban roads and major highways (*The Dawn*, 2015a, b, c; *The Express Tribune*, 2011, 2012a, 2013a, b; 2014a, b, 2015a; *The Fox News*, 2013; *The Indus News*, 2015; *The Jang*, 2016a,b,c; *The Nation*, 2012a,b, 2013a,b,c; *The Pakistan Today*, 2015a; *The PPI News Agency*, 2014, 2015; *The Pakistan Headlines*, 2015; *The People's Daily Online*, 2007). For instance, in a recent incident reported on a main highway near Pattoki city of Punjab, a total of 14 persons including 12 school children were killed in a collision between a long trailer and MR (*The Associated Press of Pakistan*, 2015). Similarly, in a road crash between an MR and passenger van on a main highway in the Dera Ghazi Khan District of Punjab, six members of the same family (including three children) were killed and two others were seriously injured (*The Express Tribune*, 2015a). Seven persons (including four children) died in a collision between a bus and MR that was carrying 11 passengers near Faisalabad (*The Dawn*, 2015c). In Sheikhupura, 14 persons were killed (including two children) when an MRD tried to cross a railway crossing and was hit by a train. It was reported that this MR was carrying more than 16 passengers (*The Dawn*, 2013b). Likewise, a newspaper article from Charsadda District of KPK Province reported:

> *"There are round around 2,000 chingchi rickshaws in the Charsadda district. With growing number of these chingchis, the ratio of crashes has increased manifolds. The district hospital receives 15 to 20 road crash emergencies every day, and the reason for most of these crashes are chingchi drivers".* (*The Tribal News Network*, 2015)

A newspaper report from Sindh Province of Pakistan stated:

> *"Minimum 70 road crashes involving Chingchi rickshaws were reported in 'Talhar' during the last month, in which over 100 people were injured. Chingchi rickshaws have become the major cause of road crashes in the city, as most of these dangerous rickshaws are driven by young underage drivers of aged 10 to 16 years. These young chingchi drivers are driving across Sindh".* (*The PPI News Agency*, 2014)

An extensive literature search on the internet showed that MR crashes are reported from across Pakistan on almost a daily basis, and many of these reports are available online. These reports indicate that MRDs make a significant contribution to road crashes, injuries and fatalities throughout the country.

2.7.5 **MR - Current Operational and Legal Status in Pakistan**

Two-stroke 70cc MRs and ARs were declared illegal and banned by the Lahore High Court in 2005, and the Punjab Transport Department was required to remove them from Lahore by 2007, but this did not occur (*The News*, 2015b). In 2009 and 2011, the Punjab Transport Department and the Punjab Environment Protection Department made another collaborative effort to ban MRs, which was also unsuccessful. The production of MRs was banned in five large cities of Punjab (Lahore, Faisalabad, Rawalpindi, Gujranwala and Multan) in 2010-2011, but the authorities failed to enforce this ban. In the meantime, MRs continued growing in number and coverage across Pakistan (*The News*, 2015b).

At the beginning of 2014, the government of Punjab imposed an immediate ban on MR operations in Lahore. Given the large number of MRDs and others associated with this sector, huge protests started across the city, and ultimately the government had to reverse its decision (*The Daily Times*, 2015; *The News*, 2015b).

The situation was similar in Karachi, where the Sindh Transport Department and traffic police banned MRs in 2013. The ban was imposed on the following grounds: MRs had no legal standing; were not registered with the Motor Vehicle Registration Authority; were mostly constructed from stolen motorcycles; and were causing traffic problems such as congestion, crashes and air and noise pollution (*The Dawn*, 2013c). However, on the appeal of the All Karachi Motorcycle Rickshaw Welfare Association, the Sindh High Court issued a stay order against the government’s decision, so MRs continued to operate in Karachi and other cities of Sindh Province (*The Pakistan Today*, 2015b).

On 05 August, 2015 the Sindh High Court imposed a ban (on appeals by government agencies, mainly the transport department) on MR operations in the whole of Sindh Province (*The Express Trib*une, 2015b; *The Da*wn, 2015a; *The News*, 2015a). Consequently, large protests occurred in Karachi and other cities of Sindh, as thousands of people are associated with this business across the province. The MR business network not only includes MRDs and their families, but many other stakeholders such as MR manufacturing companies and their employees, MR retailers and their employees, and MR spare-parts dealers and mechanics (*The Express Tribune*, 2015b; *The Dawn*, 2015a; *The News*, 2015a).

Thousands of MRDs were rendered jobless after the ban on MRs in Karachi. Consequently, a poor 27 year old MRD committed suicide (leaving a wife and three children). The MRDs and their families, political parties and local community organizations protested against the government about this tragic incident, and the ban (Figure 2.20) (*The Pakistan Today*, 2015).

Motorcycle rickshaws were operating around 300 different routes in Karachi, and were transporting approximately five million people daily across the city, and a sudden ban incapacitated these commuters (*The Dawn*, 2015a; *The Express Tribune*, 2015b,c; *The News*, 2015a). The All Karachi Qingqi Welfare Association (AKQWA) claimed that the ban had severely affected the mobility of all commuters, but especially women, elderly and students, and many women left their jobs due to the lack of any other transport facility (*The Express Tribune*, 2015e).

Karachi has a population of over 20 million, and existing public transport facilities are severely deficient and inefficient (*The News*, 2015a). It was reported that of the 329 official bus routes in Karachi, currently only 111 were functional, on which around 9,527 minibuses were operating. Karachi Metropolitan Corporation estimated that at least 8,676 additional high-capacity buses were required to meet (to some extent) existing public transport needs (*The Express Tribune*, 2015c).

The majority of MR passengers are from low and middle socioeconomic levels, who cannot afford expensive transport modes such as taxis or ARs. Therefore, members of civil society, political parties and media joined the MR association to restore MR operations (*The Dawn*, 2015a,b,c; *The Express Tribune*, 2015b,c; *The News*, 2015a,c).

The All Karachi Motorcycle Rickshaw Welfare Association' (KMRWA) filed an appeal in the Sindh Supreme Court (SSC) to lift the ban on MRs. The SSC issued notices to the traffic police and transport authorities and inquired of them, why they proposed banning MRs, when there were no alternative transport facilities available. The court also asked stakeholders to find a solution for this problem (*The Dawn*, 2015b, c). On 11 September 2015, a meeting of concerned stakeholders (Sindh Transport Department, traffic police, KMRWA and a political party) was held in Karachi to discuss the issue (The Express Tribune, 2015d). On 6 January 2016, the Supreme Court of Pakistan conditionally allowed MRs in Karachi. The court asked government to register and regulate MRs, and ensure their vehicle safety standards

(*The Dunya News*, 2016). However, until recently (April 2017) the government is unable to regulate MRs in Pakistan, and they are operating without any transport or road safety policy across the country.

2.7.6 **MR - Socioeconomic Aspects**

Newspaper and media reports suggest that the main reasons for the large growth of MRs across Pakistan are increasing poverty, unemployment and the absence of any regulatory mechanism for MRs (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Dawn*, 2015a; *The Express Tribune*, 2011, 2012, *The Nation*, 2012a).

Another important reason for the increasing MRs and the prevalence of underage MRDs is the socioeconomic circumstances of a family that likely to force them to make their child an MRD, instead of sending him to school (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Dawn*, 2015a; *The Express Tribune*, 2011, 2012, 2013a, b; 2014a,b; *The Nation*, 2012a, 2015). Sarfraz & Hussain (2010) report:

> *"I do not know what the meaning of an underage driver is. I know that I have to earn over 800 Rupees daily, as I have to pay instalment of 4,000 Rupees every month for my MR. I have paid the fines several times on account of traffic violations. I do not have licence and motorcycle rickshaw registration certification. Daily fuelling cost of my motorcycle rickshaw is around 300 Rupees. I am driving about 16 hours every day. This is not a problem for me"*. (an underage MRD operating in Lahore)

> *"Ejaz is in early teens and he is driving motorcycle rickshaw since last 3 years. He purchased it on monthly instalments. He has 7 family members to look after them. He acknowledges that motorcycle rickshaw is dangerous to drive. He had three serious road crashes, but his zeal to work knows no bounds, as he still has to pay 100,000 Rupees in monthly instalments. He has managed to pay 50,000 Rupees. To make some extra money, he loves to participate in all motorcycle rickshaw races over the weekend"*. (an underage MRD operating in Lahore)

> *"Eight years old Shahzad is a grade two student of Government Public School near Sheller Chowk. He is driving the MR on the Grand Trunk (GT) road, and*

its neighbourhoods for almost a year. "I earn 200 to 300 Rupees after eight hours of driving every day. My elder brother drives it from 9pm to 11am and he earns around 700 to 800 Rupees daily. However, still we are unable to meet our needs and to feed our family". (an underage MRD operating in Lahore)

2.8 RESEARCH GAPS AND RESEARCH CONTRIBUTION

The literature review identified significant knowledge gaps in areas such as road safety, planning, policy, management and operations of MRs in Pakistan. None of the previous studies have thoroughly examined the transport, public health and road safety aspects of MRs, and newspaper reports are the only major source of information on MRs in Pakistan. Although these reports give some idea of prevalence of MR crashes and characteristics of MRDs, the credibility of these reports is questionable. Therefore, comprehensive research is needed to examine the human, vehicular and environmental factors that contribute to MR crashes.

Extensive newspaper and media coverage, the situation in Lahore and Karachi and personal communication with LTC officials, suggested that road safety and socioeconomic issues related to MRs have become a national challenge for the government. It appeared that presently, the government has no active transport or road safety policy for MRs, and given their large countrywide growth and business network, it is struggling to devise appropriate policy measures for MRs. This warrants a rational and national solution, based on a comprehensive examination of planning, policy and operational aspects of MRs.

The current research examines the characteristics of MR road crashes, estimates the burden of MR road trauma, and observes and assesses the road safety knowledge, attitudes and practices of MRDs. Moreover, key stakeholders (MRD association, law enforcers, policy makers, government officials, road safety experts) are interviewed to propose policy measures that could address MR road safety issues.

2.9 CHAPTER SUMMARY

The literature review suggests that presently there is a dearth of quality public transport across Pakistan, and the government has failed to provide basic transport facilities to the general public. To fill this vacuum, MRs have emerged as a 'gap-filler', and currently they are providing transport to millions of people across the country.

Newspaper articles and media reports show that MRs are locally manufactured and modified to perform different functions. These reports claim that many MRDs are underage and unlicensed, and are frequently involved in various road safety and traffic violations (e.g. overloading, signal violations, illegal terminals, unlicensed and underage driving). Newspaper crash reports from across Pakistan suggest that MRDs are contributing to road crashes in the whole country. Conversely, the prevailing situation indicates that the MR sector provides employment (and access to employment) and business opportunities to thousands of people in the country.

The government has not formulated any workable transport or road safety policy for MRs. There is limited research in this area, and the current research appears to be the first comprehensive study in Pakistan that examines the road safety aspects of MRs. It is anticipated that this research will have local, national and international implications. The next chapter presents the research plan and methodology of the current research program.

Chapter 3: Research Plan and Methodology

Chapter 3 outlines the plan and methodology of this research program. It also describes the conceptual framework underpinning this research. The chapter is structured into three main sections. Section 3.1 describes the theoretical framework for the research; Section 3.2 outlines the characteristics of the study setting and justification for its selection. Section 3.3 discusses the research plan and methodology used to address research aims and questions. The final part of this section outlines the ethical considerations of this research.

3.1 CONCEPTUAL FRAMEWORK

In developing a program of research, two questions need to be considered before the execution of the project: first, what methodologies will be used to investigate the topic and second, what is the justification for this selection. Therefore, a strong theoretical foundation is required that can inform the whole research process, and the conceptual framework of the study serves this function (Crotty, 1998).

The literature review suggested that an in-depth understanding of the MR problem is required to devise appropriate strategies and policy measures to address the transport, road safety and public health issues related to MRs. The Stuckey, LaMontagne, and Sim's (2007) systems model for occupational health and safety of Occupational Light Vehicle (OLV) use was adapted as a conceptual framework for this research to identify the factors that are likely to affect the safety of MRs.

3.1.1 OLV-use Systems Model

Stuckey et al. (2007) proposed a systems model to better understand the health and safety issues of the OLV-use. The OLVs are light passenger and freight vehicles (e.g. car, station-wagon, van, light trucks), used for various work purposes (Stuckey, Lamontagne, Glass, & Sim, 2012). There was limited research in this area, despite OLV-use being a major cause of work related fatalities in the Western world (Stuckey & LaMontagne, 2005; Stuckey et al., 2007). Stuckey & LaMontagne (2005) found that the OLV injury toll is even higher than that of heavy vehicles. They proposed a comprehensive systems model to address the OLV-use research, policy, and practice gaps. This model offers five comprehensive levels of investigation, under which various determinants can be examined (Figure 3.1) (Stuckey et al., 2007):

1. Locus of injuries and fatalities - drivers and passengers
2. Immediate physical work environment - vehicle
3. External physical work environment - road environment
4. Organizational environment - work arrangements
5. Policy environment: external influences - relevant local, national and international public policies.

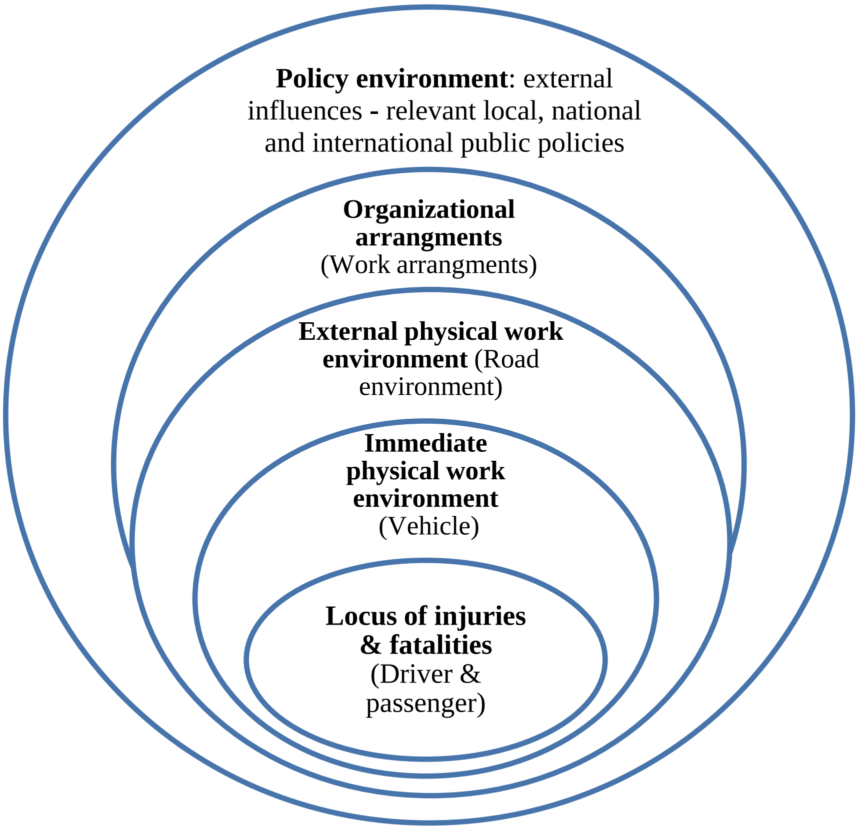

Figure 3.1: Occupational light vehicle (OLV) use systems model
(*Source: Stuckey, LaMontagne, & Sim, 2007*)

Table 3.1 summarizes various human, environmental, organizational and policy determinants that potentially contribute to OLV crashes and injuries. The multiple levels of the OLV-use systems model provide a comprehensive framework to study these determinants (Stuckey et al., 2007).

Table 3.1: Potential determinants of crashes, injuries and fatalities in OLV-use systems model (Stuckey, LaMontagne, & Sim, 2007, Table 1)

Model level		**Potential Determinants**
Locus of injury	Driver and passenger/s	Age, gender, driving experience, number of users Driving exposures: frequency, kilometres, hours, patterns, times of driving, day/night, trip length, occupation, industry, number of jobs, driving purpose, number of vehicles driven, income, work equipment Driving behaviours, drug and alcohol consumption, driving demands, work fitness, sleep patterns
Physical work environments: immediate and external	Vehicle	Ownership, purpose, usage, age, type, model, engine capacity, fuel type, mass, weight, size, occupant capacity, maintenance, condition, odometer reading, colour, load capacity, road worthiness, crash worthiness
	Road environment	Design: single, multiple lanes, divided, freeways, intersected, rural, urban, suburban, local, state, national. Other road users: traffic, pedestrians, animals – congestion, population density Road design elements: surface, condition, geography, topography, lighting, curves. Weather conditions
Organizational environment	Work arrangements	Work patterns: management structures, production requirements, control, autonomy Work arrangements: traditional work, contingent work, outsourcing, sub-contracting Work design: shift work, safety policies, training, systems management and monitoring, driving activities, scheduling, work demands and pressures, in-vehicle communication systems, work equipment Vehicle ownership, maintenances arrangements, turnover, management systems, etc. Incident recording, data management systems, External business demands and expectations
Policy environment: external influences: local, national and international	Public policy	Road safety legislation Work safety legislation Vehicle road worthiness standards and implementation processes Driving behaviour related legislation: phone use, seat-belt use, traffic violation management OLV population surveillance: crash, injury and fatality data classification, collection, coordination and management Registration and insurance management & OLV OHS enforcement systems Terminology: local, national and international

3.1.2 **MR Systems Model**

The MR Systems Model was used for the present study, and adapted from the OLV-use systems model. The MR systems model was also conceptualized on multiple investigation levels, which offered a broad spectrum to inspect various determinants that could affect MR safety. Figure 3.2 shows the five main levels of the MR systems model:

1. **MR road crashes, injuries and fatalities**: Locus of injury (MRDs, passengers & other road users): MR crash characteristics, MRD demographics and socioeconomic profile, MRD driving characteristics and MRD road safety behaviours and practices.
2. **Immediate physical work environment**: Vehicle - MR
3. **External physical work environment**: road infrastructure and environment
4. **Organizational arrangements**: MRD work arrangements and patterns
5. **Policy environment:** external influences (relevant local, national and international public policies)

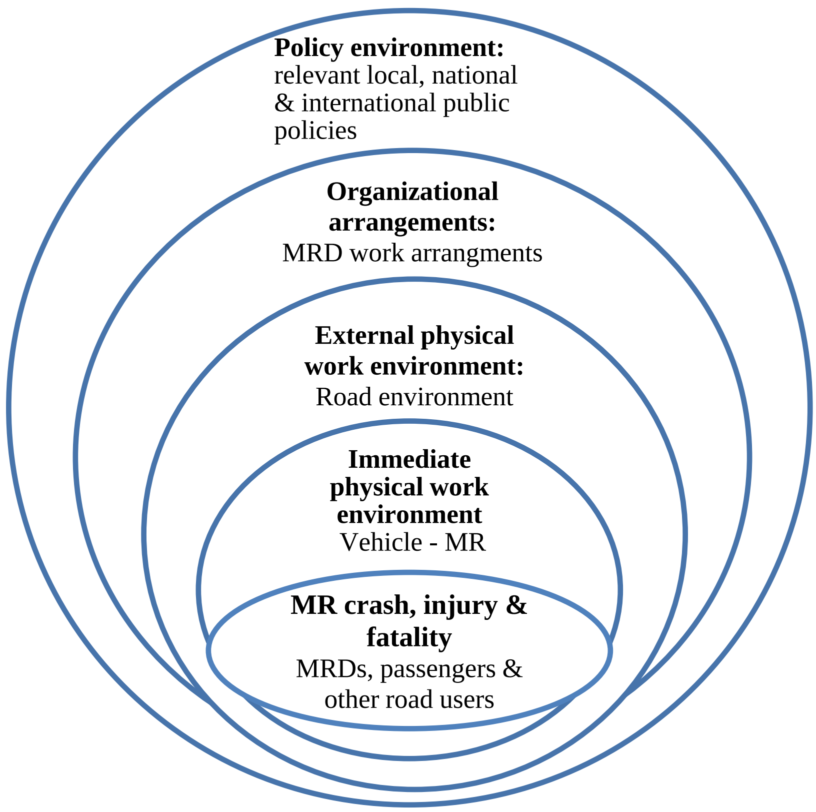

Figure 3.2: MR Systems Model (adapted from Stuckey, LaMontagne, & Sim 2007)

Under the five major investigation levels of the MR systems model, a comprehensive analytical framework was constructed to study the risk factors or determinants that potentially contribute to MR crashes, injuries and fatalities, and influence possible transport and road safety policies for MRs. Table 3.2 illustrates that each major investigation level was divided into sub-levels, potential determinants and the studies in this program of research relevant to each of the levels.

Given that the current research primarily examined the road safety issues of MRs, some determinants in the OLV-use systems model related to occupational work arrangements (*production requirements, traditional and contingent work, outsourcing, sub-contracting, external business demands and expectations*) were not studied. The 'data management system' was discussed under the 'policy environment' component, and the 'vehicle ownership and its management system' was discussed under the 'immediate work environment' level.

Similarly, the first level of the MR systems model, 'MR crashes, injuries and fatalities', was elaborated and structured into four sub-levels: (1) MR crash characteristics (*crash trends, vehicle involved, casualty characteristics, injury severity, injury type, crash contributing factors);* (2) MRD demographics and socioeconomic profile *(age, gender, marital status, family, educational status, house ownership, income);* (3) MRD driving characteristics *(MRD driving licensing information was added under 'driving exposures');* and (4) MRD road safety behaviours and practices *(*traffic violations - *signal violations, speeding, overtaking, overloading, illegal terminals, illicit drug and alcohol use)* and MR road crashes were included under the 'locus of injury' level (Table 3.2).

The determinants such as *MR vehicle registration and route permit, traffic situation and traffic congestion* were added under the 'immediate and external physical environment' levels. Public policies in Pakistan related to road safety and public transport; vehicle inspection and fitness certification system; driver behaviour-related legislation (*e.g. speeding, mobile phone use while driving etc*.); road crash data surveillance and management system; MR crash surveillance system; MR vehicle registration system; MR road safety and transport policies; MR operation and traffic enforcement were examined under the 'policy environment' (Table 3.2).

Table 3.2: Potential determinants of MR crashes, injuries and fatalities in MR systems model *(adapted from Stuckey, LaMontagne, & Sim, 2007)*

Main investigation level	**Sub-level**	**Potential determinants**	**Study examined this level**
MR crash, injury & fatality Locus of injury – MRDs, passengers and other road users	MR crash characteristics MRD demographics & socioeconomic characteristics MRD driving characteristics MRD road safety behaviours and practices	**MR crash characteristics:** crash trends, vehicle involved, casualty characteristics, injury severity, injury type, crash contributing factors, scale of MR crash problem **MRD demographics & socioeconomic characteristics:** age, gender, marital status, family, educational status, house ownership, income levels, general health status, driving stresses **MRD driving characteristics:** driving licensing information, MR driving experience, number of MR users, trip frequency, route length, working hours, patterns, driving time - day/night, number of jobs, MR use/driving purpose **MRD road safety behaviours & practices** traffic violations - signal violation, speeding, overtaking, overloading, underage & unlicensed driving, illicit drug and alcohol use etc. and self-reported road crashes and traffic violations	Major input: **Study 1, 2 & 3** Minor input: **Supplementary Study & Study 4**
Immediate physical work environment	Vehicle - MR	MR ownership, vehicle registration, route permit, purpose, use, age, engine capacity, size, passenger & loading capacity, repair & maintenance condition and arrangements, vehicle balance, road & crash worthiness, modifications in MR design	Major input: **Study 3** Minor input: **All remaining studies**
External physical work environment	Road infrastructure & environment	**Road type**: single/multiple lane, major, arterial or residential, one-way/divided, highways, rural, urban, suburban, local, state, national **Other road users**: traffic situation, traffic congestion, pedestrians' safety	Major input: **Study 1, 2 & 3** Minor input: **Supplementary Study & Study 4**

Organizational environment	MRD work arrangements	**Work patterns**: MR association structure, powers & influences, autonomy **Work design & policies:** road safety policies, driving training, systems management and monitoring, driving activities, scheduling, work demands & pressures	Major input: **Study 3** Minor input: **All remaining studies**
Policy environment: relevant local, national & international public policy)	Public policies in Pakistan	• Road safety and transport policies • Driver licensing system • Vehicle safety inspection system • Driver behaviour related legislation (speeding, helmet, seat-belt & mobile phone use) • Road crash data surveillance & management system • MR crash surveillance system • MR vehicle registration system • MR road safety and transport policies • Enforcement and control on MR operation • Terminologies & definitions used for paratransit modes: local, national & international	Major input: **Study 4** Minor input: **All remaining studies**

Table 3.2 shows that the MR analytical framework adapted from the OLV-use systems model provides a comprehensive framework to examine different human, vehicular, demographic, socioeconomic, environmental and political determinants that may influence the road safety behaviours and practices of MRDs. The MR analytical framework provided a strong theoretical foundation to guide the whole research program. This process involved two major steps: as a first step, using the MR systems model, the literature review was conducted and research gaps were identified. Based on the research gaps, the research questions were formulated (presented in Section 3.3). As a second step, using the MR analytical framework, four studies were designed, examining different determinants of MR road safety issues.

3.2 STUDY SETTING

Data collection for all four studies was conducted in Lahore (Figure 3.3). Lahore is the provincial capital of Punjab, and with over 10 million inhabitants, it is the second most populated city in Pakistan, and the 34th in the world (Kamal, Qamar, Gulfraz, Anwar & Malik, 2015; World Atlas, 2016).

Figure 3.3: Map of Pakistan
(*Source: World Atlas, 2016*)

Lahore has seen high urbanization trends in recent decades, and along with Karachi, it hosts approximately 35% of Pakistan's urban population (Anwar, Viqar, Sawas, Iqtidar, Nausheen, Amiera & Sawas, 2014; Jan & Iqbal, 2008). The metropolitan region has a land area of 1,792 km^2 and around 82% of its population is urban, with nearly 70% living within 7 to 8 kilometres of the city centre (Ali, Iqbal, Amin & Malik, 2015; JICA, 2012; Muhammad, 2013).

The high population growth and urbanization rates in Lahore are associated with increased travel demand and motorization. Lahore has one of the highest vehicle growth rates in the country (17% per year in 2004-2008), and all transport modes generate more than 18 million trips across the city every day (LTC, 2015). The growing number of vehicles is worsening the traffic situation and environmental conditions, and if proper planning and infrastructure developments do not keep pace with the increasing motorization, by 2030 existing road capacity will be insufficient to accommodate all vehicles (JICA, 2012).

Table 3.3 presents data on the number of motorized vehicles registered in Lahore from 2010 to 2015, a total of nearly two million vehicles registered, with a more than doubling rate (224% increase on 2010 figures). Table 3.3 indicates that ARs (n=73,138) were registered with the Lahore Excise and Taxation Department in 2010-2015. However, as MRs are not registered as 'motorcycle rickshaws', only the motorcycle component of MRs is registered, and MR numbers are calculated under the category 'motorcycle/scooter'. This confirms that the exact number of MRs in Lahore is unknown to the authorities, and they are unregistered vehicles in their specific role.

Table 3.3: Number of vehicles registered in Lahore from 2010 to 2015

Vehicle type	2010	2011	2012	2013	2014	2015	Total	%
Ambulance	233	342	106	178	65	110	1034	0.1
Bus	380	1289	1623	1853	2795	1919	9,859	0.5
Crane	71	82	50	50	91	160	504	0.0
Delivery Van	565	396	528	764	984	958	4,195	0.2
Double Cabin	9	226	377	302	297	456	1,667	0.1
Double Cabin (L)	24	41	36	62	64	56	283	0.0
Earth Machinery	10	6	33	254	102	50	455	0.0
Mini Bus	2	5	3	1	5	0	16	0.0
Car	33,144	45,480	61,550	65,038	64,726	83,133	353,071	17.9
Car (luxury)	257	197	125	85	106	47	817	0.0
Motorcycle/Scooter	141,287	189,962	240,341	298,814	291,139	308,897	1,470,440	74.5
Non-AC Bus	284	123	26	32	76	21	562	0.0
Pickup	1509	2113	2743	2582	2247	8,045	19,239	1.0
Autorickshaw	10,352	11,400	9,773	10,969	14,984	15,660	73,138	3.7
Taxi Cab	16	330	3074	2	24	6,288	9,734	0.5
Tractor	2131	1914	2406	2379	2440	2,110	13,380	0.7
Tractor with Trolley	88	106	170	178	222	242	1006	0.1
Truck	1149	1474	1911	1865	1663	1,012	9074	0.5
Wagon	283	443	412	1242	1565	1,225	5170	0.3
Total	191,794	255,929	325,287	386,650	383,595	430,389	1,973,644	100

Source: Excise & Taxation Department, Lahore, 2015

Table 3.3 indicates that from 2010 to 2015, the numbers of private vehicles, especially motorcycles and cars, have substantially increased, and they comprised 92.4% of the total registered vehicles in Lahore. Past studies have also documented this trend across the country (Batool et al., 2012; Imran, 2009, 2010; JICA, 2012; Javid, Okamura, Nakamura, Tanaka & Wang 2014; Masood et al., 2011). For instance, a JICA (2012) study showed that the modal share of public transport vehicles (bus and passenger van) was only 12.5% in Lahore during 2011-2012, while private vehicles such as motorcycles and cars comprised 30.8% of total motorized vehicles (Figure 3.4) (JICA 2012; Muhammad, 2013).

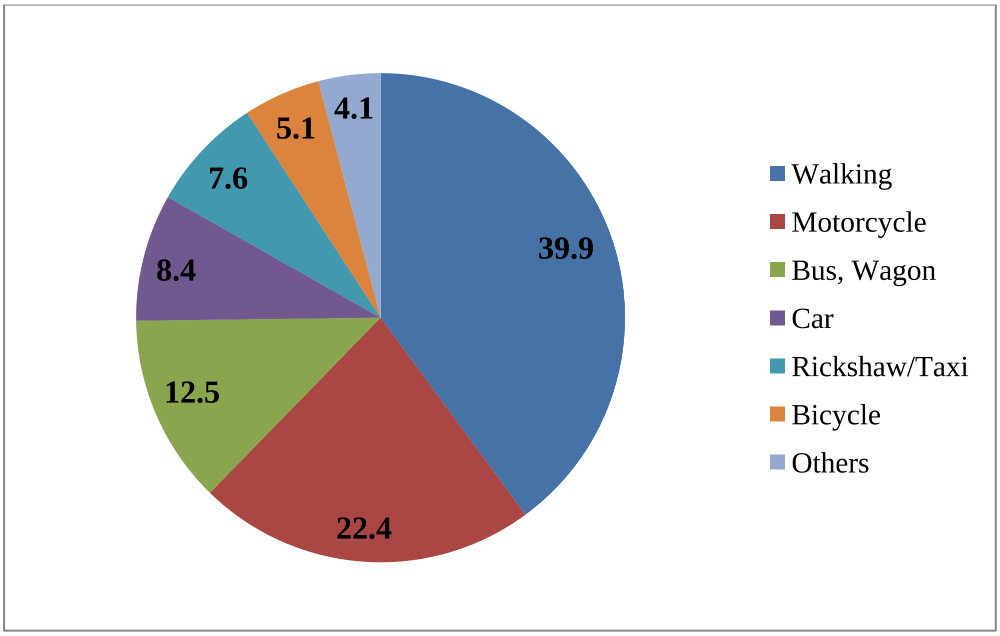

Figure 3.4: Percentage of vehicle modal share in Lahore in 2011-2012
(Source: JICA 2012; Muhammad, 2013)

People prefer to use private vehicles in Pakistan, because the existing public transport network and facilities are insufficient, unintegrated and underdeveloped across the country (Javid, Okamura, Nakamura, & Wang, 2013; Javid et al., 2014; Muhammad, 2013). Every day, around one million people use public transport in Lahore, and there were only around 800 buses in 2012, along with a saturation of paratransit modes throughout the city. All public transportation modes (bus, passenger van, rickshaws and taxi) comprise about 20% of the total vehicles in Lahore (Javid, Okamura, Nakamura & Wang, 2013; Javid et al., 2014; JICA, 2012; Muhammad, 2013).

Recently, some improvement has been noted in formal public transportation, after the introduction of the Metro Bus System on one route (from Shahdara to Gajumata) in Lahore. Nevertheless, current formal public transport facilities do not cater to the large population of the city. Therefore, MRs have a major modal share in Lahore's public transport sector. Hence, this research was appropriately sited in Lahore.

3.3 RESEARCH PLAN AND METHODOLOGY

The MR systems model was used to formulate a comprehensive research plan to address all aspects of MR road safety. This research plan is outlined below.

3.3.1 Research Aims and Questions

This research program had two major aims:

1. To examine the road safety aspects of MRs.
2. To identify appropriate policy measures and strategies to address the road safety issues related to MRs.

The following research questions were formulated to address these aims.

1. What is the size of the MR crash problem?
2. What are the characteristics of MR crashes?
3. What are the characteristics of MRDs that influence the road safety of MRs?
4. What policies and measures could improve the road safety of MRs?

3.3.2 Research Studies

Using the analytical framework of the MR systems model, four studies were undertaken to address the research questions:

Study 1: Analysis of Rescue 1122 road crash data

Study 2: Observations of road safety behaviours and practices of MRDs

Study 3: Survey of road safety knowledge, attitudes and practices (KAP) of MRDs

Study 4: Identification of road safety and transport policy measures for MRs.

The data collection for all four studies was completed in the first and second years (2014-2015) of this doctoral program. A systematic approach was adopted and four studies were organized in such a way that they informed each other (Figure 3.5), and addressed one or more of the specific research questions (Table 3.4).

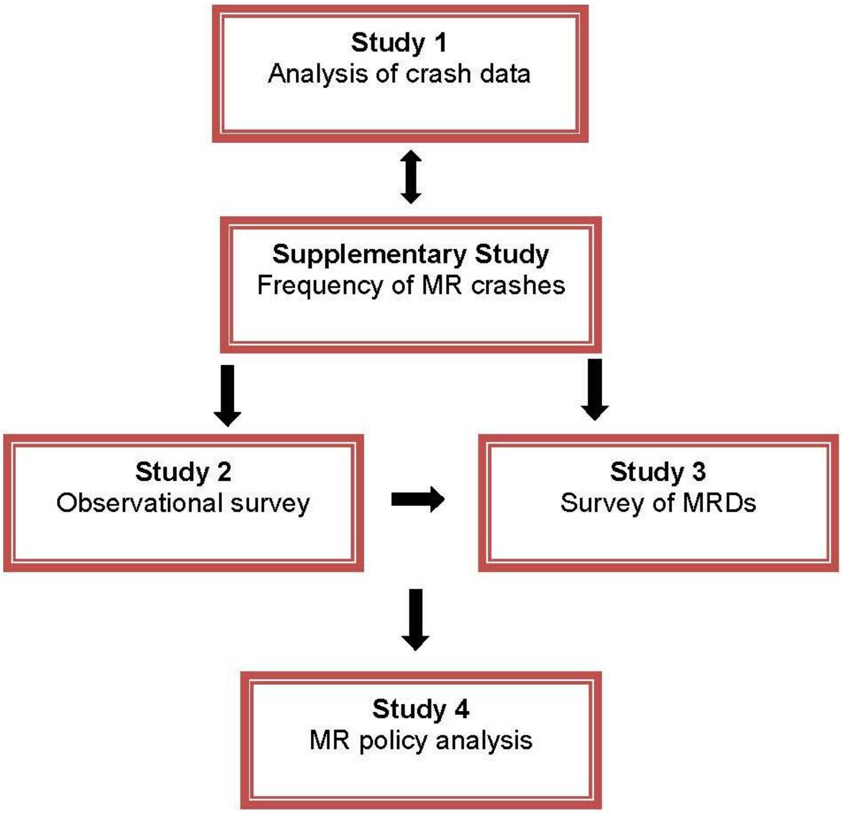

Figure 3.5: An outline of the research studies undertaken in this research program

Table 3.4: Relationship between research studies and research questions

Studies	**RQ1:** What is the size of the MR crash problem?	**RQ2:** What are characteristics of MR crashes?	**RQ3:** What are characteristics of MRD that influence the road safety of MRs?	**RQ4:** What policies and measures could improve the road safety of MR?
Study 1: Analysis of road crash data	Quantifies rickshaw (MR & AR) crashes in Punjab, Pakistan	Describes characteristics of MR crashes	Describes some characteristics of MRDs	
Supplementary Study: Assessment of relative frequency of MR crashes	Assesses relative frequency of MR crashes in Punjab	Identifies some MR crash contributing factors	Presents experiences of emergency paramedics about MRDs road safety practices	
Study 2: Observational survey	Assists to determine the size of the MR crash problem in Lahore	Identifies potential MR crash contributing factors	Observes risky driving practices of MRDs that lead to crashes	
Study 3: Survey of MRDs	Assesses the level of involvement of MRDs in road crashes in Lahore	Gives a better understanding of MR crashes	Provides a comprehensive understanding of MRDs' road safety profile	
Study 4: MR road safety and transport policies	Presents perspectives of experts regarding size of MR crash problem	Gives better understanding of MR crashes	Enhances knowledge about MRDs' road safety practices	Identifies road safety and transport policy measures for MRs

This section presents an overview of aims, objectives and methods of all four studies undertaken as part of the current research program. The detailed methodology of each study is presented in their respective chapters. Table 3.5 shows a summary of the current research plan and methodology.

Table 3.5: Summary of research plan and methodology

Research Objective	**Study Design**	**Participants/Materials**	**Sample Size**	**Data Collection Methods**
Study 1: Examine the characteristics of MR crashes	- Retrospective descriptive	Road crashes attended by Rescue 1122 in 36 districts of Punjab MR crashes attended by Rescue 1122 in Lahore in 2014	-Rescue 1122 crash data for 2011-2012 and July 2013-June 2014 - 500 MR crashes	Data retrieved from Rescue 1122 road crash database Data extracted from Emergency Response Forms
Supplementary Study: Assessment of relative frequency of MR crashes	-Quantitative cross-sectional survey -Convenience sampling	Emergency Paramedics (EPs) of Rescue 1122 Lahore	109 EPs	Administration of self-completion questionnaire
Study 2: Observational survey	Quantitative cross-sectional survey -Random sampling	MRDs	500 MRDs	Observations recorded using paper survey forms
Study 3: Survey of MRDs	-Quantitative cross-sectional survey - Convenience sampling	MRDs	300 MRDs	Verbal administration of questionnaire
Study 4: Identification of policy measures to improve road safety of MR	-Qualitative	-Govt. officials -Academics -Road safety experts -other stakeholders	46 interviews	Individual interviews Audio-recorded

3.3.3 **Study 1: Analysis of Road Crash Data**

Study 1 examined the characteristics of MR road crashes using data collected by Rescue 1122 in Punjab. It had three major objectives:

1. Analysis of road crashes attended by Rescue 1122 across 36 districts of Punjab from January 2011- December 2012.
2. Examination of road crashes attended by Rescue 1122 across 36 districts of Punjab during July 2013 - June 2014.
3. Analysis of 500 MR crashes attended by Rescue 1122 in Lahore in 2014.

Study 1 involved a retrospective analysis of the secondary crash data retrieved from the Rescue 1122 operational database. This study was divided into two sub-studies 'Study 1A' and 'Study 1B', because three different crash datasets were available for analysis.

Study 1A involved descriptive analysis of the two-year crash data (2011-2012), and one-year crash data (July 2013-June 2014) from all 36 districts of Punjab. Study 1B involved the development of an MR crash database, extracting data from 500 Emergency Response Forms. Figure 3.6 shows the structure of two sub-studies (Studies 1A and 1B) conducted as part of Study 1.

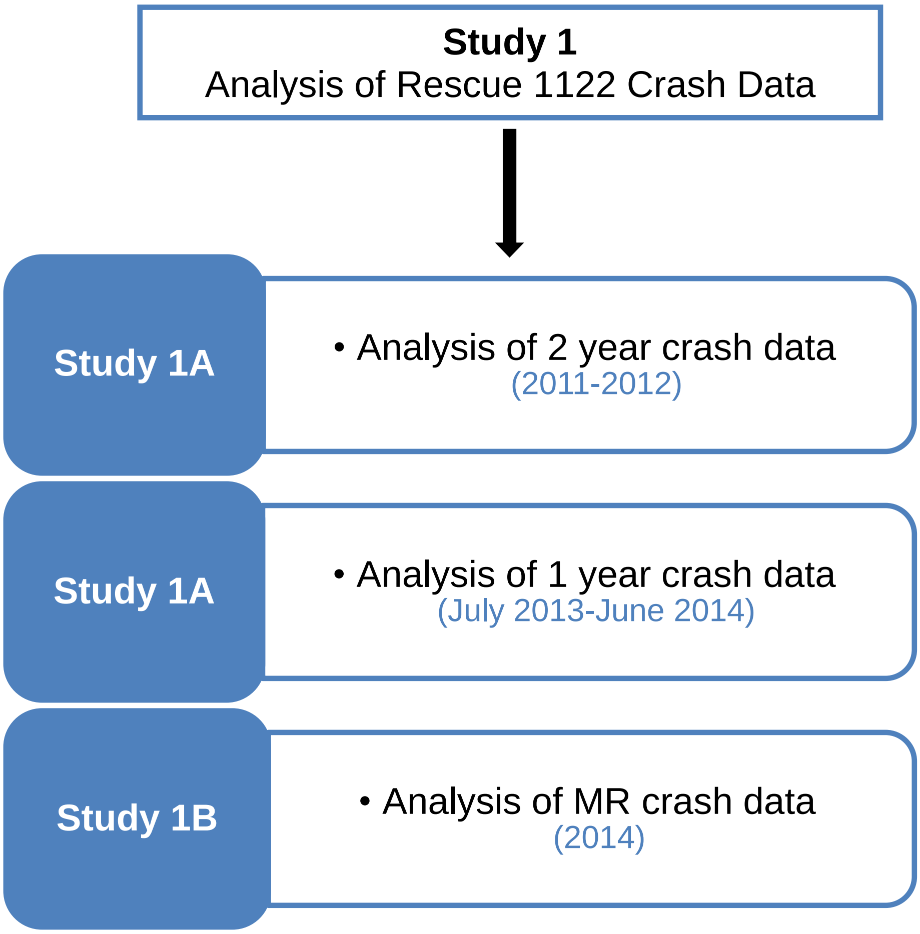

Figure 3.6: The structure of Study 1

3.3.4 Supplementary Study: Assessment of relative frequency of MR crashes

A Supplementary Study assessed the relative frequency and potential contributing factors of MR road crashes. This study had two main objectives:

1. Assess the relative frequency of MR and AR crashes attended by Rescue 1122 in Lahore during 2014.

2. Identify human, vehicular and environmental factors that contributed to MR crashes attended by Rescue 1122 in Lahore in 2014.

A questionnaire-based survey was conducted with the emergency paramedics recruited from various Rescue 1122 ambulance stations located in different areas of Lahore. The descriptive analysis of the data was conducted, and histograms were developed to interpret the survey results.

3.3.5 Study 2: Observational survey

Study 2 observed the road safety behaviours and practices of MRDs in Lahore. This study had the following objectives:

1. Observe road safety behaviours and practices of MRDs that contribute to road crashes.
2. Identify some vehicular characteristics of MRs that contribute to road crashes.

An observational survey was conducted. The MRDs were observed at various signalised intersections in different areas of the city. Two paper survey forms were used to collect the data. A binary logistic regression was formulated to examine the contribution of various factors in the occurrence of MR traffic conflicts.

3.3.6 Study 3: Road safety knowledge, attitude and practices of MRDs

This study investigated the road safety knowledge, attitudes and practices (KAP) of MRDs, and it had the following objectives:

1. Examine the sociodemographic characteristics and work patterns of MRDs
2. Assess the knowledge of MRDs of basic traffic and road safety rules such as traffic signals, driving licence, road crashes, safety of pedestrians and other road users
3. Investigate MRDs' attitudes towards certain traffic offences such as speeding, overloading, overtaking, unlicensed and underage driving
4. Measure the frequency of MRDs traffic and road safety violations e.g. *how often do you involve in speeding, overloading, red-signal violation.*

A cross-sectional survey was conducted with MRDs. The MRDs were recruited from different MR 'terminals' distributed across Lahore. A binary logistic regression was applied to identify significant factors that contributed to MR crashes. Road safety knowledge, attitudes and practices of MRDs and the frequency of a certain driving violation or behaviour were assessed using a five-point Likert Scale. An Independent Samples T-Test was used to compare the means of two independent groups, 'MRD involved in crashes/Crashed-group' and 'MRD not involved in crashes/Non-crashed group'.

3.3.7 Study 4: Identification of potential MR road safety and transport policy measures

Study 4 canvassed appropriate strategies and policy measures to address the road safety issues related to MRs. This study had the following objectives:

1. Explore the government’s current and future transport or road safety policy for MR
2. Seek perspectives of the key stakeholders regarding road safety or transport policy for MRs
3. Develop policy recommendations for improving MR safety that recognise the paratransit role of MRs.

Study 4 was qualitative in nature, where semi-structured interviews were conducted with a diverse range of stakeholders in Lahore. The study participants were recruited from various government and private organizations involved in public transport planning, management and operations. Other participants such as academics, road safety experts, Rescue 1122 emergency paramedics, traffic police, journalists, representatives of the AR and MR association and MR manufacturing companies were also interviewed. Thematic analysis was used for data analysis; major themes related to MR road safety were discussed, and some recommendations proposed.

3.4 RESEARCH ETHICS

This research program was conducted in accordance with the Australian National Statement on Ethical Conduct in Human Research, 2014. Before the data collection process, ethics approval was obtained for each study from the QUT Human Research Ethics Committee. Study 1 was exempted from the ethics review, as it involved analysis of the secondary data. For the remaining studies, separate ethics applications were submitted, and approvals were granted in February and September 2015.

3.5 CHAPTER SUMMARY

Chapter 3 has outlined the plan and methodology of this research program. It also described the theoretical framework chosen for the current research, and characteristics of the study setting. Given the large informal network of MRs in

Lahore, it was selected as the research setting. The OLV-use systems model was adapted to develop an MR Systems Model. Based on the five levels of the MR systems model, a comprehensive research plan was formulated and four studies were designed to address the research questions.

The planned studies addresses specific research questions, and involved a range of research methodologies *(crash data analysis, quantitative surveys, observational survey and qualitative interviews)* to examine the various human, vehicular and environmental factors that potentially contribute to MR road crashes. The next chapter presents the results of Study 1.

Chapter 4: Study 1 - Analysis of Rescue 1122 Road Crash Data

Chapter 4 describes the results of Study 1, which examines the characteristics of road crashes attended by Rescue 1122 ambulances across Punjab. Given the incompleteness of police crash records in Pakistan, Rescue 1122 ambulance data were used. Study 1A analysed aggregated crash data from across Punjab to address Research Question 1 *(What is the size of the MR crash problem?),* and Research Question 3 (*What are the characteristics of MRDs that influence the road safety of MRs?)*. In Study 1B, individual ambulance records for MR crashes were used to develop a database to address Research Question 2 (*What are the characteristics of MR crashes?).*

Chapter 4 is organized into four major sections: Section 4.1 introduces Rescue 1122, describes its organizational structure and operational procedures, and the characteristics of its operational database from which crash data for this study were extracted. Sections 4.2 and 4.3 present the methodology and results of Studies 1A and 1B, respectively. The final sections of this chapter (Sections 4.4-4.7) discuss the results of Study 1 and its limitations, concluding with the chapter summary.

4.1 RESCUE 1122

Rescue 1122 is an emergency ambulance and rescue service in Punjab Province which is the most populous province in Pakistan with a population of around 101 million. It has 36 districts, and Lahore is its provincial capital (Figure 4.1) (Population Welfare Department Punjab, 2015).

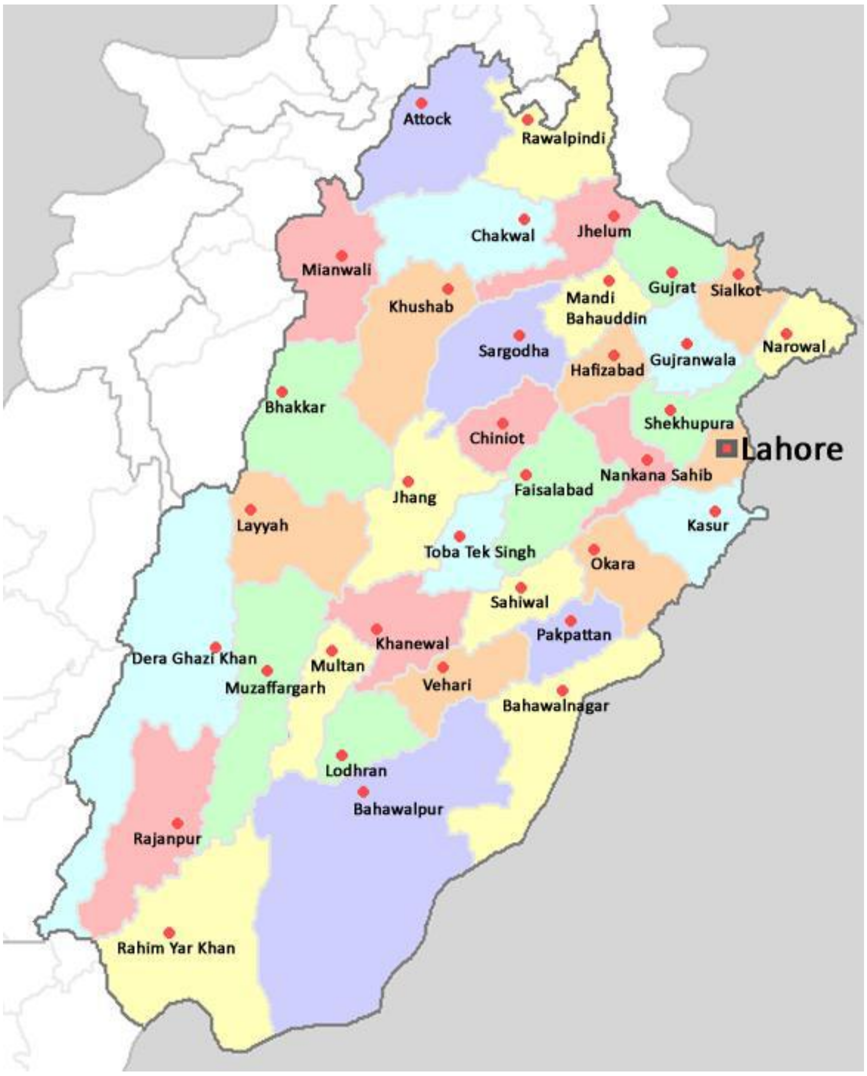

Figure 4.1: Map of Punjab Province, Pakistan
(*Source: Population Welfare Department Punjab, 2015*)

Rescue 1122 is a governmental organization, launched as an ambulance service from Lahore in 2004. Over the years the scale and scope of services has increased, and it has covered all 36 districts of Punjab since 2010 (Tahir et al., 2012, 2013; Rescue 1122, 2016; Waseem, Naseer & Razzak, 2011). It has become an integrated emergency service, offering ambulance, fire and rescue, water rescue, disaster management, and community safety programs across Punjab (Rescue 1122, 2016). Rescue 1122 mainly operates in urban areas, but in some situations, it also responds to emergencies on other roads such as highways, sub-urban and rural roads. It offers free of charge services; public hospitals and treatment facilities are also free for the general public in Pakistan. Hence people widely use Rescue 1122 and public hospital facilities in emergency situations.

The website of Rescue 1122 (see Table A1.1 in Appendix A) shows that it attended over 3.3 million emergencies (road crashes, fire and rescue, medical, injuries in crime incidents, drowning, blast/explosions), and rescued nearly 4 million injured persons across Punjab from 2004 to March 2016 (Rescue 1122, 2016). During the same period, Rescue 1122 attended over 1.2 million road crashes in Punjab, and over 0.3 million road crashes in Lahore alone (Rescue 1122, 2016). These figures suggest that Rescue 1122 faces a heavy burden of road crash emergencies in all Punjab, but particularly in Lahore. This also justifies Lahore's selection as the study setting for the current research program, along with its comprehensive dataset.

4.1.1 **Rescue 1122 Operational Procedures**

Rescue 1122 has several rescue stations and one control room in each district of Punjab. The number of rescue stations depends on the population size of the district. Lahore being the largest district has 13 rescue stations, while Muzaffargarh, a medium size district (around 4 million estimated population) of Southern Punjab, has three rescue stations. The headquarters of Rescue 1122 in Lahore is responsible for planning, policy and monitoring the remaining 35 districts, through a Provincial Monitoring Cell (PMC). The PMC has a Global Positioning System (GPS) based vehicle tracking system, and a call-monitoring system to monitor rescue operations across the province (Tahir et al., 2012, 2013; Waseem et al., 2011).

After receiving an emergency call on the toll free number 1122, the control room of Rescue 1122 enters basic information on the Emergency Call Form (Figure A1.1 in Appendix A), and dispatches an ambulance to the incident site. An ambulance crew consists of two emergency paramedics and a driver. The emergency paramedics are trained in the assessment of injury severity (minor, moderate, critical and fatal injuries), triage (determining the casualty's treatment priority based on injury severity), providing first aid to casualties, and completing the Emergency Response Form (ERF). The emergency paramedics fill out a paper-based ERF at the crash scene, and during transportation to the hospital. The ERFs are first collected at the local rescue station of the emergency paramedics, and later they are deposited at the main rescue station of the district.

4.1.2 **Rescue 1122 Operational Database**

The Rescue 1122 Operational Database (ROD) is housed within the PMC in Lahore. The ROD is an aggregated database that contains data for all emergencies (road crashes, fire and rescue, medical, building collapse, injuries in crime incidents, drowning, blast/explosions) attended by Rescue 1122 across Punjab. It is centrally connected with all districts in Punjab, and all districts have their own ROD dashboards. The districts are required to enter the data of all emergencies into the ROD dashboard on a daily basis (after 24 hour shift). The districts enter some information from the ERFs, and send an electronic copy of the report to the PMC. At the PMC, data from all districts is aggregated to generate various types of reports (e.g. road crash, fire etc.) on a daily, weekly, fortnightly and monthly basis. The process of data collection and functioning of the ROD is shown in Figure 4.2.

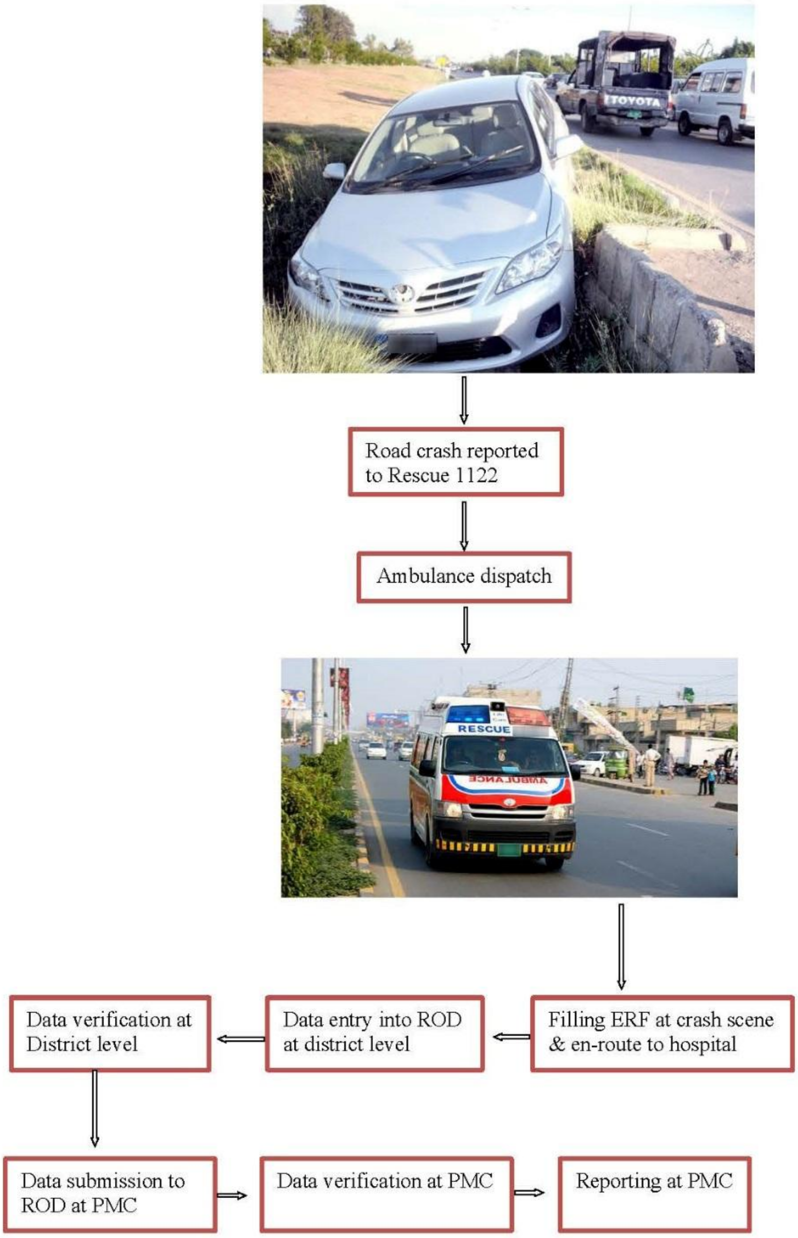

Figure 4.2: Process of data collection and functioning of ROD at Rescue 1122

4.2 STUDY 1A

Study 1A involved analysis of the two aggregated crash datasets (January 2011-December 2012 and July 2013-June 2014) to examine the characteristics of road crashes reported to Rescue 1122 in Lahore and the rest of Punjab.

4.2.1 Methodology

Given that Study 1 involved analysis of the secondary data or records that contained only non-identifiable information, the QUT Human Research Ethics

Committee (UHREC) exempted this study from the UHREC review, and an approval was granted (Exemption number 1400000533) in July 2014.

Road crash data for Study 1A were extracted from the Rescue 1122 ROD, and received as emailed Excel spreadsheets. In Study 1A, two data crash datasets were examined (January 2011- December 2012 and July 2013-June 2014). This approach was undertaken, because Rescue 1122 added some new variables between 2011 and 2014. In the first dataset of Study 1A, monthly aggregated crash data for all vehicles for the two-year period (January 2011-December 2012) from 36 districts of Punjab were analysed. In this dataset, Rescue 1122 added a new variable, 'patient on the scene', in 2012. Similarly, three new variables 'road user type', 'motorcycle one-wheeling' and 'tyre burst' were added in 2013. To avoid inconsistencies in the data, only those variables which were consistent across 2011-2012 were analysed.

In the second dataset of Study 1A, crash data for the one-year period (July 2013-June 2014) was examined, as it was the most recent crash data available for the whole of Punjab, and was consistent across the study period. Two datasets analysed as part of Study 1A were aggregated in nature, and were not single units detailing each crash separately. Road crashes involving MRs and ARs were also counted under the common category of 'Rickshaws'. Given the aggregated nature of crash data, a descriptive analysis was conducted, and frequencies and percentages of all variables were calculated. Pearson's Chi-Square Test (χ^2) was applied to determine the association between two categorical variables. A significance level (α) of .01 was used to control the effect of the large sample sizes in Study 1A.

4.2.2 **Results of Study 1A**

4.2.2.1 Results of two-year crash data (January 2011-December 2012)

Road Crashes in Lahore and the rest of Punjab

Table 4.1 presents the summary of the total number of road crashes, persons injured and vehicles involved in road crashes, attended by Rescue 1122 in Lahore and the rest of Punjab over January 2011-December 2012. A total of 302,932 road crashes were reported across Punjab during the two-year study period, with nearly a quarter (23.66%) reported in Lahore. In reported crashes, a total of 356,919 persons were injured, and 340,392 vehicles were involved across Punjab. The data shows an increasing number of road crashes and injuries in both Lahore and the rest of Punjab.

Table 4.1: Summary of road crashes reported to Rescue 1122 in Lahore and rest of Punjab, 2011-2012

	Lahore		Rest of Punjab		All of Punjab	
Road crashes	**N**	**%**	**N**	**%**	**N**	**%**
2011	34,637	48.32	109,968	47.55	144,605	47.74
2012	37,044	51.68	121,283	52.45	158,327	52.26
	71,681	100.00	231,251	100.00	302,932	100.00
Number of Persons injured in road crashes						
2011	32,645	45.17	137,000	48.13	169,645	47.53
2012	39,619	54.83	147,655	51.87	187,274	52.47
	72,264	100.00	284,655	100.00	356,919	100.00
Number of Vehicles involved in road crashes						
2011	34,637	48.77	130,526	48.45	165,260	48.55
2012	36,379	51.23	138,850	51.55	175,332	51.51
	71,016	100.00	269,376	100.00	340,392	100.00

Rickshaw Crashes in Lahore and the rest of Punjab

Table 4.2 presents the number and types of vehicles involved in road crashes in Lahore and the rest of Punjab from January 2011-December 2012. As outlined earlier, MRs and ARs were combined under the category of 'Rickshaws'. A total of 36,520 rickshaws were involved in road crashes across Punjab during the study period. Thus rickshaws accounted for 10.73% of all vehicles involved in road crashes.

An association *(P<.001)* was found between location and the number of vehicles involved in road crashes. A higher proportion of rickshaws was involved in road crashes in Lahore (17.20%), compared to the rest of Punjab (9.02%). Similarly, among other vehicle types, a higher proportion of cars was involved in road crashes in Lahore (26.20%), compared to the rest of Punjab (11.18%), while a higher proportion of road crashes involving motorcycles was reported in the rest of Punjab (57.74%), compared to Lahore (45.58%) (Table 4.2).

Table 4.2: Number and vehicles types involved in road crashes reported to Rescue 1122 in Lahore and the rest of Punjab, January 2011-December 2012

Vehicle	Lahore		Rest of Punjab		All of Punjab	
	N	%	N	%	N	%
Rickshaw	12,215	17.20	24,305	9.02	36,520	10.73
Motorcycle	32,370	45.58	155,527	57.74	187,897	55.20
Car	18,605	26.20	30,129	11.18	48,734	14.32
Van	3,817	5.37	13,026	4.84	16,843	4.95
Truck	1,306	1.84	8,022	2.98	9,328	2.74
Bus	644	0.91	6,784	2.52	7,428	2.18
Others	2,059	2.90	31,583	11.72	33,642	9.88
Total	71,016	100.00	269,376	100.00	340,392	100.00

**Others category refers to vehicle types other than known categories*

Monthly numbers and proportions of vehicles involved in road crashes across Punjab during 2011-2012 are given in Table A1.2, Appendix A. There were no clear monthly trends seen in rickshaw crashes during the study period. In 2011, the highest number of rickshaw crashes were reported in September (1,828 or 10.47%), November (1,698 or 9.73%), and October (1,523 or 8.72%), respectively. In 2012, the highest number of rickshaw crashes was reported in December (2,123 or 11.14%), October (1,856 or 9.74%) and August (1,677 or 8.8%), respectively.

The district-wise comparison of rickshaw crashes reported in Lahore and other districts of Punjab during January 2011-December 2012 is presented in Table A1.3, Appendix A. This comparison shows that the highest number of rickshaw crashes were reported in Lahore (12,215 or 33.45%) followed by Faisalabad (4,347 or 11.90%) and Gujranwala (2,018 or 5.53%) districts, respectively. The lowest number of rickshaw crashes were reported in Murree (n=50), Chakwal (n=157) and Mianwali (n=184) districts, respectively.

Demographic Characteristics

Table 4.3 presents the overall numbers of gender and age groups involved in road crashes in Lahore and the rest of Punjab, from January 2011-December 2012. It is important to note that these numbers relate to all road crashes reported during the study period, not merely those involving rickshaws. Overall, a higher proportion of males (78.25%) were injured in reported road crashes, compared to females (21.75%). This was true for both Lahore and the rest of Punjab (Table 4.3).

The age groups used in this study were based on the Rescue 1122 categorization that was used to collect and present the data. Road users aged 11-40 years were the most common casualties in Lahore (83.91%), and the rest of Punjab (83.88%). An association *(p<.001)* was found between age and gender distribution of people injured in road crashes across Lahore and rest of the Punjab (Table 4.3).

Table 4.3: Demographics of casualties involved in road crashes reported to Rescue 1122 in Lahore and the rest of Punjab, January 2011-December 2012

	Lahore		Rest of Punjab		All of Punjab	
Gender	**N**	**%**	**N**	**%**	**N**	**%**
Male	54,352	75.21	224,947	79.02	279,299	78.25
Female	17,912	24.79	59,708	20.98	77,620	21.75
Total	72,264	100	284,655	100	356,919	100
Age groups						
1-10	3,296	4.56	18,313	6.43	21,609	6.05
11-20	24,058	33.29	82,225	28.89	106,283	29.78
21-30	22,559	31.22	94,677	33.26	117,236	32.85
31-40	14,022	19.40	61,865	21.73	75,887	21.26
41-50	4,335	6.00	10,706	3.76	15,041	4.21
51-60	1,746	2.42	9,680	3.40	11,426	3.20
> 60	2,248	3.11	7,189	2.53	9,437	2.64
Total	72,264	100	284,655	100	356,919	100

**The age group 1-10 years also contained a number of casualties aged under one-year (<1 year children)*

Injury Types

The aggregated datasets analysed in Study 1A did not provide specific information about different injury severity levels (minor, moderate, severe, fatal) and injury types according to anatomical body regions. Instead they categorized injuries as minor, leg fracture, multiple fracture, head and spinal injuries. Minor injuries comprised more than half (52.24%) of the total injuries reported across Punjab, and fractures (single and multiple) accounted for nearly one-third (32.79%) of the total injuries (Table 4.4).

An association *(p<.001)* was found between location and the proportion of different injuries sustained in reported road crashes. Higher proportions of spinal injuries (3.34%), multiple fractures (19.33%) and minor injuries (58.41%) were recorded in Lahore, compared to the rest of Punjab (1.75%, 15.93% and 50.68%, respectively). Head injuries and leg fractures were more prevalent in the rest of Punjab (14.48% and 17.17%, respectively), compared to Lahore (6.68% and 12.24%, respectively).

Table 4.4: Injuries sustained in road crashes reported to Rescue 1122 in Lahore and the rest of Punjab, January 2011-December 2012

Injury type	Lahore		Rest of Punjab		All of Punjab	
	N	%	N	%	N	%
Spinal	2,416	3.34	4,990	1.75	7,406	2.07
Head	4,828	6.68	41,204	14.48	46,032	12.90
Leg fracture	8,845	12.24	48,865	17.17	57,710	16.17
Multiple fracture	13,968	19.33	45,339	15.93	59,307	16.62
Minor	42,207	58.41	144,257	50.68	186,464	52.24
Total	72,264	100.00	284,655	100.00	356,919	100.00

Crash Contributing Circumstances

Speeding (35.14%) and careless driving (34.85%) were identified as major contributing factors in reported road crashes across Punjab during January 2011-December 2012. An association *($p<.001$)* was found between location and the proportion of different crash contributing factors recorded in Lahore and the rest of Punjab. A higher proportion of speeding-attributed crashes was reported in the rest of Punjab (37.76%), compared to Lahore (26.67%), while carelessness, wrong-turning *(turning from the wrong-side of the road including one-way violation*) and U-turning *(crashes occurred during wrong U-turn*s) were more commonly reported in Lahore (38.24%, 14.62% and 6.30%, respectively), compared to the rest of Punjab (33.80%, 6.11% and 3.40%, respectively) (Table 4.5).

Table 4.5: Major crash contributing circumstances in road crashes reported to Rescue 1122 in Lahore and the rest of Punjab, January 2011-December 2012

Crash contributing factor	Lahore		Rest of Punjab		All of Punjab	
	N	%	N	%	N	%
Speeding	19,115	26.67	87,325	37.76	106,440	35.14
Carelessness	27,411	38.24	78,162	33.80	105,573	34.85
Wrong-turn	10,478	14.62	14,125	6.11	24,603	8.12
U-turn	4,514	6.30	7,861	3.40	12,375	4.09
Unspecified	10,163	14.18	43,778	18.93	53,941	17.80
Total	71,681	100.00	231,251	100.00	302,932	100.00

* *Unspecified stands for those road crashes where exact cause could not be determined*

4.2.2.2 Results of one-year crash data (July 2013-June 2014)

This section presents the results of aggregated crash data for the one-year period (July 2013-June 2014) from the whole of Punjab. This data is different from the two-year crash data (January 2011-December 2012), because for July 2013-June 2014, Rescue 1122 had added four new variables: (1) types of road users such as driver, passenger, pedestrian injured in road crashes; (2) motorcycle one-wheeling - *crashes attributed to motorcycle one-wheeling*; (3) tyre burst - *crashes attributed to vehicle tyre-burst;* and (4) casualties on the crash scene - *condition of the injured person when emergency paramedics arrived at the scene*. New variables were the focus of the analysis in the one-year crash data (July 2013-June 2014): however a general description of other variables is also provided for comparative purposes.

Road Crashes in Punjab

Table 4.6 presents the monthly numbers of road crashes, persons injured and vehicles involved in road crashes reported across Punjab during July 2013-June 2014. A total of 191,554 road crashes were attended by Rescue 1122 during this time. This is 33,227 more road crashes or a 21% increase in road crashes reported across Punjab in 2012 (*n*= 158,327).

During July 2013-June 2014, the highest number of road crashes (*n*= 17,987) was reported in October 2013, followed by 17,269 in June 2014, and 16,661 in May 2014. The lowest number (*n*= 14,070) was recorded in February 2014. A total of 233,976 persons were injured, and 234,431 vehicles were involved in reported crashes across Punjab during the study period (Table 4.6).

Table 4.6: Road crashes attended by Rescue 1122 in Punjab, July 2013-June 2014

Month	Road crashes		Persons injured		Vehicles involved	
	N	%	N	%	N	%
Jul-13	15,510	8.10	19,013	8.13	18,767	8.01
Aug-13	16,659	8.70	20,805	8.89	20,282	8.65
Sep-13	15,705	8.20	19,049	8.14	19,091	8.14
Oct-13	17,987	9.39	22,159	9.47	22,027	9.40
Nov-13	14,391	7.51	17,429	7.45	17,443	7.44
Dec-13	14,836	7.75	17,800	7.61	18,197	7.76
Jan-14	15,339	8.01	18,313	7.83	18,767	8.01
Feb-14	14,070	7.35	16,932	7.24	17,040	7.27
Mar-14	16,494	8.61	20,127	8.60	20,363	8.69
Apr-14	16,633	8.68	20,370	8.71	20,535	8.76
May-14	16,661	8.70	20,414	8.72	20,511	8.75
Jun-14	17,269	9.02	21,565	9.22	21,408	9.13
Total	191,554	100.00	233,976	100.00	234,431	100.00

Table A1.4 in Appendix A, presents monthly trends of vehicles involved in road crashes attended by Rescue 1122 in Punjab during July 2013-June 2014. A total of 11,469 rickshaw (both MR and AR) crashes were reported for this year. The highest number of rickshaw crashes (1,640 or 14.30%) were reported in July 2013, followed by 1,083 (9.44%) in October 2013, and 964 (8.41%) in June 2014. On average, 956 rickshaw crashes were reported per month across Punjab during the study period. These monthly numbers are different from those observed from January 2011-December 2012.

Table A1.5 in Appendix A, presents the district-wise comparison of rickshaw (both MR and AR) crashes reported across Punjab in July 2013-June 2014. Similar to the two-year road crash data (2011-2012), the highest numbers of rickshaw crashes were reported in Lahore (2,385 or 21%), followed by Faisalabad (1,638 or 14.28%) and Gujranwala (980 or 8.54%) districts. A noticeably high number of rickshaw crashes was reported in a medium size district, Jhang (n= 849), compared to other similar size districts such as Gujrat (n= 291) and Toba Tek Singh (n= 33).

Injury and Crash Characteristics

Table 4.7 shows an overall comparison of Lahore with the rest of Punjab in terms of demographics of casualties and other crash characteristics. Similar proportions of males (82% and 79%) and females (18% and 21%) were injured in Lahore and the rest of Punjab, respectively.

In both Lahore and the rest of Punjab, the age group that comprised the highest proportion (30% and 31%) injured in road crashes was young people aged 21-30. Across the two areas, similar proportions of casualties were recorded among age groups 1-10 years (5-6%, and 20-21%) and 11-20 years, respectively. However, people aged over 60 comprised a larger proportion of the injured in Lahore than in the rest of Punjab (12% versus 5%).

A higher proportion of crashes involving rickshaws (both MR and AR) (5.68%), cars (10.53%) and trucks (12.75%) was reported in Lahore, compared to the rest of Punjab (4.76%, 8.75%, and 7.83%, respectively). Among various road users injured in road crashes, passengers (44.95%) and drivers (37.81%) were most commonly injured in road crashes across Punjab. A larger proportion *(P<.001)* of passengers (47%) were injured in Lahore, compared to the rest of Punjab (43%). A slightly higher proportion of pedestrians was injured in the rest of Punjab (14.52%), compared to Lahore (12.37%).

A total of 2,449 road fatalities were recorded across Punjab during the one-year of study period. A higher proportion *(P<.001)* of road ‘fatalities’ (1.65%), and the ‘alive and stable’ casualties (57.58%) were recorded in the rest of Punjab, compared to Lahore (0.21% and 52.19%, respectively). A higher proportion (47.60%) of casualties was found ‘alive and unstable’ on the crash scene in Lahore, compared to 40.77% in the rest of Punjab.

High proportions of minor injuries (52.46% and 69.72%) were recorded both in Lahore and the rest of Punjab, respectively, while fractures (single and multiple fracture) were more prevalent in Lahore (29.41%), compared to the rest of Punjab (17.98%). The same was true for head and spinal injuries: these injuries were more common in Lahore, compared to the rest of Punjab.

Table 4.7: Road crash characteristics - comparison of Lahore with the rest of Punjab, July 2013- June 2014

Variable	Lahore		Rest of Punjab		All of Punjab	
	N	%	N	%	N	%
Gender						
Male	38,657	81.52	148,165	79.42	186,822	79.85
Female	8,766	18.48	38,388	20.58	47,154	20.15
Total	47,423	100	186,553	100	233,976	100
Age groups (years)						
1-10	2,599	5.04	10,740	5.89	13,339	5.70
11-20	10,675	20.69	37,004	20.29	47,679	20.38
21-30	15,561	30.16	56,420	30.94	71,981	30.76
31-40	7,970	15.45	36,935	20.25	44,905	19.19
41-50	5,460	10.58	23,666	12.98	29,126	12.45
51-60	3,067	5.94	8,885	4.87	11,952	5.11
Above 60	6,266	12.14	8,728	4.79	14,994	6.41
Total	51,598	100	182,378	100	233,976	100
Vehicle types						
Rickshaw	2,385	5.68	9,084	4.76	11,469	4.89
Motorcycle	26,265	62.53	121,856	63.89	148,121	63.18
Car	4,424	10.53	16,682	8.75	21,106	9.00
Van	335	0.80	2,648	1.39	2,983	1.27
Truck	5,355	12.75	14,938	7.83	20,293	8.66
Bus	439	1.05	4,818	2.53	5,257	2.24
Other	2,802	6.67	20,709	10.86	25,202	10.75
Total	42,005	100	190,735	100	234,431	100
Road users						
Pedestrian	12,117	12.37	21,853	16.06	33,970	14.52
Passengers	46,238	47.21	58,932	43.32	105,170	44.95
Driver	36,737	37.51	51,720	38.02	88,457	37.81
Underage driver	2,846	2.91	3,533	2.60	6,379	2.73
Total	97,938	100	136,038	100	233,976	100
Injury Types						
Spinal	2,709	2.81	2,292	1.67	5,001	2.14
Head	14,795	15.32	14,614	10.64	29,409	12.57
Leg-fracture	17,687	18.31	17,475	12.72	35,162	15.03
Multiple-fracture	10,724	11.10	7,230	5.26	17,954	7.67
Minor	50,659	52.46	95,791	69.72	146,450	62.59
Total	96,574	100	137,402	100	233,976	100
Condition of casualties on the crash scene						
Fatalities	207	0.21	2,242	1.65	2449	1.05
Alive & unstable	46,674	47.60	55,416	40.77	102,090	43.63
Alive & stable	51,169	52.19	78,268	57.58	129,437	55.32
Total	98,050	100	135,926	100	233,976	100
Crash contributing factors						
Speeding	21,773	51.83	61,537	41.15	83,310	43.49
Carelessness	7,779	18.52	53,838	36.00	61,617	32.17
Wrong-turning	5,444	12.96	8,900	5.95	14,344	7.49
U-turn	3,965	9.44	5,444	3.64	9,409	4.91
One-wheeling	20	0.05	187	0.13	207	0.11
Tyre burst	39	0.09	1,392	0.93	1,431	0.75
Others	2,986	7.11	18,250	12.20	21,236	11.09
Total	42,006	100	149,548	100	191,554	100

Similar to 2011-2012 crash data, speeding and carelessness were identified as the leading crash contributing factors in July 2013-June 2014. However, unlike 2011-2012, speeding was more noticed in Lahore (51.83%) than in the rest of Punjab (41.15%), while the reverse was true in the case of carelessness-related crashes.

4.2.2.3 Summary of Findings of Study 1A

Study 1A involved analysis of two aggregated crash datasets obtained from Rescue 1122. More than 36,000 rickshaw (both MR and AR) crashes were attended by Rescue 1122 across Punjab during January 2011-December 2012 and more than 11,000 were attended in July 2013-June 2014.

In January 2011-December 2012, the percentage of crashes attended by Rescue 1122 that involved rickshaws was almost double in Lahore, compared to the rest of Punjab (17% versus 9%). Of all of the rickshaw crashes across Punjab in 2011-2012, a third occurred in Lahore.

Speeding and careless driving were identified as the major contributing factors in reported crashes across Lahore and the rest of Punjab, respectively. Minor injuries, fractures, head and spinal injuries were the most common injuries sustained by casualties in rickshaw crashes.

4.3 STUDY 1B

The aggregated datasets analyzed in Study 1A described some of the characteristics of road crashes involving all vehicle types in Punjab. However, this data could not provide specific information about the characteristics and proportion of MR crashes in the aggregated numbers of rickshaw (MR and AR) crashes reported across Lahore and the rest of Punjab. Therefore, Study 1B took a more indepth approach to specifically examine the characteristics of a sample of MR crashes reported across Lahore in 2014.

4.3.1 Methodology

4.3.1.1 Development of MR Crash Database

To examine the characteristics of MR crashes, an analysis of 500 Emergency Response Forms (ERFs) was undertaken, and data were extracted to develop an MR crash database. The contents of an ERF are shown in Figure A1.2 in Appendix A.

Five-hundred (n=500) ERFs were obtained from Rescue 1122 Central Rescue Station in Lahore. The Central Rescue Station has a large data store room, where all ERFs from different rescue stations are kept. The following criteria were used to select the ERFs:

- Emergency Response Forms for road crashes involving MRs in Lahore during 2014.
- Convenience sampling or sorting of ERFs: in the Rescue 1122 data store-room, there are a large number of ERFs for all kinds of emergencies such as road crashes, fire, building collapse, medical, drowning emergencies etc. The 500 ERFs for this study were selected from the MR road crash ERFs which were most recent, easily accessible to rescue staff, and where the hand-written information was clear and comprehensible.
- All identifiable information (name, address and contact number of casualty) was erased to meet QUT human research ethics requirements. The original ERFs were kept by Rescue 1122, and photocopies were dispatched to the researcher in Australia.

4.3.1.2 Data Entry, Processing and Analysis

Rescue 1122 emergency paramedics generate only one ERF for each road crash. The ERF has limited space (one side of an A4 size paper) and variables to enter the information of casualties; originally it was designed for the injury details of only one person. Therefore, in multi-casualty incidents, the emergency paramedics enter the details of casualties at different places on the ERF, utilizing space on the front and back.

To retrieve maximum information from the ERFs, and to describe various demographic, human, vehicular and environmental factors of MR crashes, three different types of data-entry method: ‘person-based’, ‘crash-based’ and ‘vehicle-based’, were used in this study. As Figure 4.3 shows, a ‘person-based’ data entry method allowed making separate entries for each casualty in the MR crash-database. For example, in the case of three injured persons, their details were entered separately as Person 1, 2 and 3, and similar entries were made in the case of multi-vehicle crashes e.g. vehicle 1, 2 and 3. This approach generated 1,151 records from the 500 ERFs.

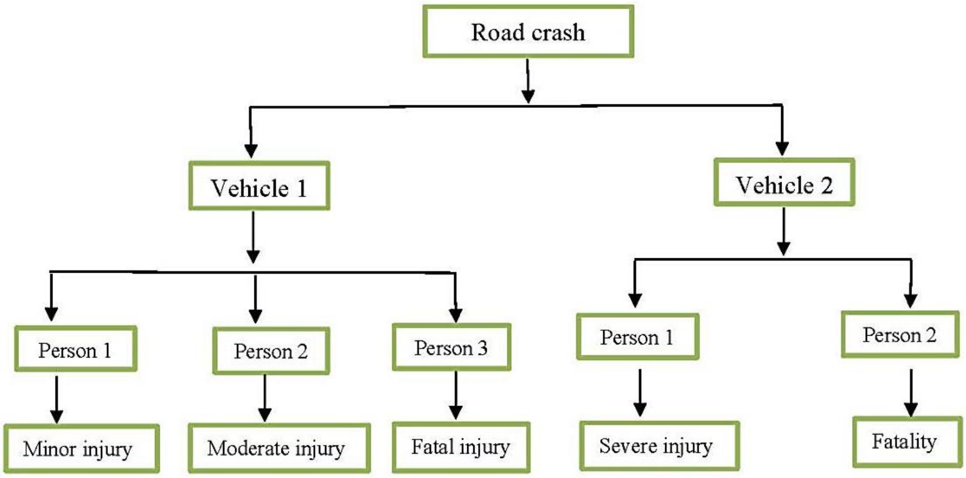

Figure 4.3: Example of a hierarchical structure of the crash/collision data and person-based data entry method (*Source:* adapted from Usman et al., 2016)

Some new variables and codes (Table 4.8) were also generated to capture all information from the ERFs. After completing the coding and data-entry process, all data-entries were rechecked and revised to ensure the consistency and accuracy of the data.

The data analysis was performed in two steps. In the first step, a descriptive analysis of the data was conducted to understand the general characteristics of MR crashes, and the Pearson's Chi-square test (χ^2) was applied to assess the statistical association between various categorical variables. The significance level at P<0.5 was considered significant. Second**,** for injury severity analysis, a Binary Logistic Regression Model was formulated to examine the effect of various human, vehicular and environmental factors on the outcome of injuries sustained in MR crashes. All data analysis was performed using SPSS software, version 22.0 (*IBM SPSS Statistics for Windows, Version 22.0*).

Table 4.8: New codes or variables in MR crash-database

	New code/variable
1	Day, Month, Year, Person no (1, 2, 3 etc.), Unit no (1, 2, 3 etc.)
2	Time of emergency
3	Age groups (1-10, 11-20, 21-30, 31-40, 41-50, 51-60, above 60)
4	Road user type (pedestrian, MRD, passenger, car driver, truck driver, motorcycle rider, motorcycle pillion rider, bicyclist, ARD, van driver, others)
5	Total no of victims (victim 1, 2, 3 etc.)
6	Vehicle No (1, 2, 3 etc.). MR is coded as Vehicle 1, and other colliding vehicles as Vehicle 2 and Vehicle 3, respectively.
7	Injury severity (minor, moderate, critical, dead, unclear, missing, none)
8	Injury types (head, cut/abrasion, upper & lower limb injury, upper & lower limb fracture, multiple fracture, eye, foot, face, chest, abdominal, internal injury etc.)
9	How emergency occurred (collision between MR and a pedestrian, car, motorcycle, truck, AR, MR, bicycle, tractor, van, MR overturned due to speeding; passenger fell-down from MR, others)
10	Injured person transported to hospital (government hospital, private hospital, discharged from the scene, none, unclear, missing)
11	Crash types (single and multi-vehicle crashes)
12	Crash location (crash locations were coded according to ten major towns in Lahore)

4.3.1.3 Injury Severity Modelling

The Abbreviated Injury Scale (AIS) reportedly is the most widely used scale in the world for the assessment of injury severity (Baker, o'Neill, Haddon Jr & Long, 1974; Copes, Champion, Sacco, Lawnick, Keast & Bain 1988; Songer, 2008). The AIS anatomically *(head or neck, face, chest, spine, abdominal, pelvis region, upper and lower extremities, external and other injuries)* classifies each injury into six major categories (1. Minor, 2. Moderate, 3. Serious – *but not life threatening*, 4. Severe - *life threatening but survival possible*, 5. Critical – *survival uncertain*, and 6. Maximal – *untreatable*) (Baker et al., 1974; Copes et al., 1988; Songer, 2008).

Rescue 1122 categorized the injury severity into four main levels: minor, moderate, critical, and dead/fatal. In the current study, the 'person-based' data entry approach (Figure 4.3) generated five injury severity levels (none, minor, moderate, critical, and dead/fatal). Based on the Rescue 1122 injury classification criteria, various injury severity levels were defined as:

1. **None:** no injury sustained.
2. **Minor injury:** where injuries were not serious (e.g. minor cuts/abrasions) and casualties were discharged from the crash scene, after provision of first-aid.
3. **Moderate injury:** where injuries were moderate and required hospitalization (e.g. lower-limb or upper-limb injury). However, these injuries were not life-threatening.
4. **Critical injury:** refers to the life-threatening conditions such as severe head injury, unconsciousness, excessive blood loss etc.
5. **Dead/fatal:** where a person was found dead on the crash scene or died during transportation to the hospital.

In road safety research, for 'crash-data analysis' or 'injury severity analysis', previously three different crash data aggregation or entry methods were used, such as 'person or occupant based', 'vehicle-based', and 'crash or collision based' (Usman, Fu & Miranda-Moreno, 2016). Usman et al. (2016) conducted an empirical study to compare the effectiveness of various multilevel logistic regression models (multinomial logit model, binary logit model, ordered logit model) in injury severity analysis, using three different crash data aggregation methods. The study found that the results obtained from the 'person-based' data aggregation method were more reliable than those from vehicle and crash-based data aggregation methods. The person-based data entry method maintains an inherent multilevel structure of the collision data, where persons are nested within vehicles and vehicles within crashes (Figure 4.3). This method captures the entire information of a road crash at three major levels (occupant, vehicle and collision), which is not possible with vehicle and crash-based data aggregation methods (Usman et al., 2016).

Usman et al. (2016) found that in injury severity modelling, the Multinomial Logistic Regression Model (MLRM) is the best-fit model to predict injury severity at each injury level. Therefore, in the current study, first injury severity modelling (with five injury severity levels no injury, minor, moderate, critical, and dead/fatal) was performed using the MLRM. However, due to some limitations and incompleteness of the MR crash data (many missing and unclear values and low frequencies in some dependent and independent variables), despite attempting many predictor combinations, the 'best-fit model' was not achieved with the MLRM.

Therefore, a Binary Logistic Regression Model (BLRM) was formulated by merging critical and fatal injuries with moderate injuries, and taking 'minor injuries' (=0) and 'moderate/critical/fatal injuries' (=1) as the binary outcomes in the BLRM. Injury severity modelling with the BLRM resulted in a better-fit-model (goodness of fit), with a wide range of explanatory variables, compared to the MLRM. Many previous studies have also used the BLRM for crash severity analysis or assessing the reliability of various multilevel logit models in injury severity modelling (Dissanayake & Lu, 2002; Donnell & Mason, 2004; Holdridge, Shankar & Ulfarsson, 2005; Jones & Jørgensen, 2003; Lenguerrand, Martin & Laumon, 2006; Goldstein & Rasbash, 1996; Rodriguez & Goldman, 1995; Rodriguez & Goldman, 2001; Saccomanno, Nassar & Shortreed, 1996; Usman et al., 2016; Williamson, Bangdiwala, Marshall & Waller, 1996).

Saccomanno et al., (1996) assessed the reliability of various statistical crash severity models, using criteria such as 'goodness-of-fit', 'robustness of risk factor coefficients' and 'consistency of the output'. The study revealed that the reliability of a statistical model is not sensitive to the number of injury categories fixed in the model or the level of model aggregation; rather, it primarily depends on the accuracy and completeness of crash data used for analysis. All models tested in their study consistently identified the same crash risk factors and variations in injury severity outcomes. It was also observed that multivariate statistical models used for predicting occupant injury severity levels are overwhelmed by the large discrepancies existing among the number of cases available within each severity level. Principally, there is substantial information available for differentiating among non-severe injury levels through the associated crash risk factors, whereas limited data are generally available within severe injury levels (Saccomanno et al., 1996).

Usman et al., (2016) also concluded that despite some differences observed in the 'goodness-of-fit' estimates and 'effect sizes' of different parameters examined in various logit models and data aggregation methods, in terms of statistically significant crash risk factors, all logit models (multinomial logit model, binary logit model, ordered logit model) identified similar factors. Therefore, considering past research findings and the limitations of the current data (outlined in Section 4.5), the BLRM was found to be an appropriate approach for this study.

4.3.2 Results of Study 1B

The results of Study 1B are described under three major headings: **Crash characteristics** - *crash severity, crash type, crash contributing factors, crash locations, day of week, time of day and ambulance response time*; **Vehicle characteristics** - *type of vehicles;* and **Person characteristics** - *age, gender, injury severity, and road user type.* The results of injury severity modelling are presented in the last part of this section. Crash characteristics are described in accordance with the crash severity, while person characteristics are described as per injury severity.

4.3.2.1 Crash characteristics

Crash Severity and Crash Type

Crash severity was based on the level of severity of injury to the most severely injured person in the crash (which may not have been the MR). Table 4.9 presents the crash severity and crash types of MR crashes reported across Lahore in 2014. Among the 500 MR crashes analysed, about three-quarters (74.6%) were of moderate injury severity, and 18.8% were minor injury crashes. Some severe/critical (*n*=27) and fatal (*n*=6) crashes were also reported during the study period.

Table 4.9: Crash severity of MR crashes attended by Rescue 1122 in Lahore, 2014

Crash severity	Crash type SVC		MVC		Total	
	N	%	N	%	N	%
Minor	12	15.38	82	19.43	94	18.8
Moderate	60	76.92	313	74.17	373	74.6
Severe/critical	5	6.41	22	5.21	27	5.4
Fatal	1	1.28	5	1.18	6	1.2
Total	78	100	422	100	500	100

Among crash types, two major types of MR crashes or collisions were recorded: **Multi-vehicle crash (MVC)**: a crash where two or more than two motorized or non-motorized vehicles were involved *e.g. collision of an MR with a motorcycle, car, truck.* In this study, collision of a motorcycle rickshaw with a pedestrian was also recorded as an MVC.

Single-vehicle crash (SVC): a crash where only one vehicle (motorized or non-motorized) was involved *e.g. collision of an MR with a footpath, overturning or roll-over of MR due to any reason such as speeding, brakes failed, MR wheel came off, tyre puncture.*

The majority of MR crashes were MVCs (84.4%). In most MVCs (98.82%), two vehicles (MR and any other vehicle) were involved, but in some MVCs (*n*=5) three vehicles were involved, such as involvement of an MR, motorcycle and van in a crash. About three-quarters of SVCs (76.92%) and MVCs (74.17%) were of moderate injury severity, while of the six fatalities, five (*n*= 5) were recorded in MVCs. No significant association was found between crash severity and crash type [χ^2 (2) = .807, p<.668]. Almost similar proportions of minor, moderate, severe and fatal crashes were observed in both SVCs and MVCs.

Crash Contributing Circumstances

Table 4.10 presents the major circumstances or factors that potentially contributed to MR crashes. Some of the MR crash contributing factors identified by Rescue 1122 emergency paramedics included: MR overturned due to speeding (*n*=35), MR hit footpath due to careless driving (*n*=19), passenger fell from MR (*n*=6), MR brakes failed (*n*=6), MR wheel came off (*n*=5). Nearly half (45%) of single-vehicle crashes were reported due to overturning of MRs.

The analysis of ERFs provided minimal information about specific MR crash contributing factors, because Rescue 1122 emergency paramedics generally mentioned only the collision type or types of vehicles involved in a crash, instead of mentioning specific crash contributing factors such as overtaking, signal violation, or one-way violation.

Table 4.10: Crash contributing circumstances in MR crashes reported to Rescue 1122 in Lahore, 2014

Crash contributing circumstances	Minor		Moderate		Severe		Fatal		Total	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
MR hit motorcycle	37	39.36	145	38.87	10	37.04	0	0.00	192	38.40
MR hit pedestrian	10	10.64	69	18.50	3	11.11	1	16.67	83	16.60
MR hit car	13	13.83	33	8.85	3	11.11	1	16.67	50	10.00
MR overturned due to speeding	2	2.13	28	7.51	5	18.52	0	0.00	35	7.00
MR hit MR	10	10.64	18	4.83	0	0.00	0	0.00	28	5.60
MR hit truck	1	1.06	17	4.56	3	11.11	2	33.33	23	4.60
MR hit footpath due to careless driving	3	3.19	16	4.29	0	0.00	0	0.00	19	3.80
MR hit bicycle	5	5.32	8	2.14	1	3.70	0	0.00	14	2.80
MR hit AR	3	3.19	4	1.07	1	3.70	0	0.00	8	1.60
MR hit bus	0	0.00	7	1.88	1	3.70	0	0.00	8	1.60
Passenger fell from MR	1	1.06	5	1.34	0	0.00	0	0.00	6	1.20
MR brakes failed	3	3.19	3	0.80	0	0.00	0	0.00	6	1.20
Others *(MR hit van, animal cart, tractor-trolley, crane & emergency vehicle; MRD shawl stuck into MR open chain; MR tyre puncture; MR wheel came off & MR vehicle shaft broken)*	6	6.38	20	5.36	0	0.00	2	33.33	28	5.60
Total	94	100	373	100	27	100	6	100	500	100

To better understand the severity of the different crash circumstances, the crashes were grouped into similar categories and Chi-square tests were applied (Table 4.11). A highly significant association was found between crash severity and various crash contributing circumstances or factors [$\chi^2(10) = 28.611$, $p<.001$]. Crash severity was highest for MRs collisions with heavy vehicles *(truck, bus, tractor-trolley, crane)* (81.5% moderate injury, 14.3% severe and fatal injury), and crashes where speeding and carelessness were recorded on behalf of the MRDs and other vehicle drivers (81.5% moderate injury, 9.3% severe and fatal injury). The lowest levels of crash severity were associated with crashes involving MRs and other light passenger vehicles *(car, MR & AR)* and vehicles in the 'others' category.

Table 4.11: Association between crash severity and crash contributing factors or how crash occurred in MR crashes attended by Rescue 1122 in Lahore, 2014

Crash contributing factors/how crash occurred		Crash severity: Minor	Moderate	Severe & fatal	Total
MR hit pedestrian	**N**	10	69	4	83
	%	12.0%	83.1%	4.8%	100%
MRD speeding & carelessness	**N**	5	44	5	54
	%	9.3%	81.5%	9.3%	100%
MR hit light passenger vehicles *(Car, MR & AR)*	**N**	26	55	5	86
	%	30.2%	64.0%	5.8%	100%
MR hit motorcycle	**N**	37	145	10	192
	%	19.3%	75.5%	5.2%	100%
MR hit heavy vehicle *(Truck, bus, tractor-trolley, crane etc.)*	**N**	2	34	6	42
	%	4.8%	81.0%	14.3%	100%
Others *(Passenger fell from MR, MR hit animal cart, MRD shawl stuck into MR open chain; MR tyre puncture; MR wheel came off & MR vehicle shaft broken)*	**N**	14	26	3	43
	%	32.6%	60.5%	7.0%	100%
Total	**N**	94	373	33	500
	%	18.8%	74.6%	6.6%	100%

Crash Locations

Rescue 1122 emergency paramedics rarely documented the exact place and the road segment where the crash occurred. For example, it was reported that an MR crash occurred on the ‘Double roads, Gulshan-e-Ravi’ Lahore, which is about a two kilometres long, two-lane arterial road that connects Multan Road (3-lane major road) with Bund Road (5-lane major road) in Lahore. Therefore, the exact location of the crash and road segment (intersection, roundabout, mid-block etc.) cannot be determined from the information. Nevertheless, all available information from the ERFs was extracted to describe the locations of MR crashes in Lahore.

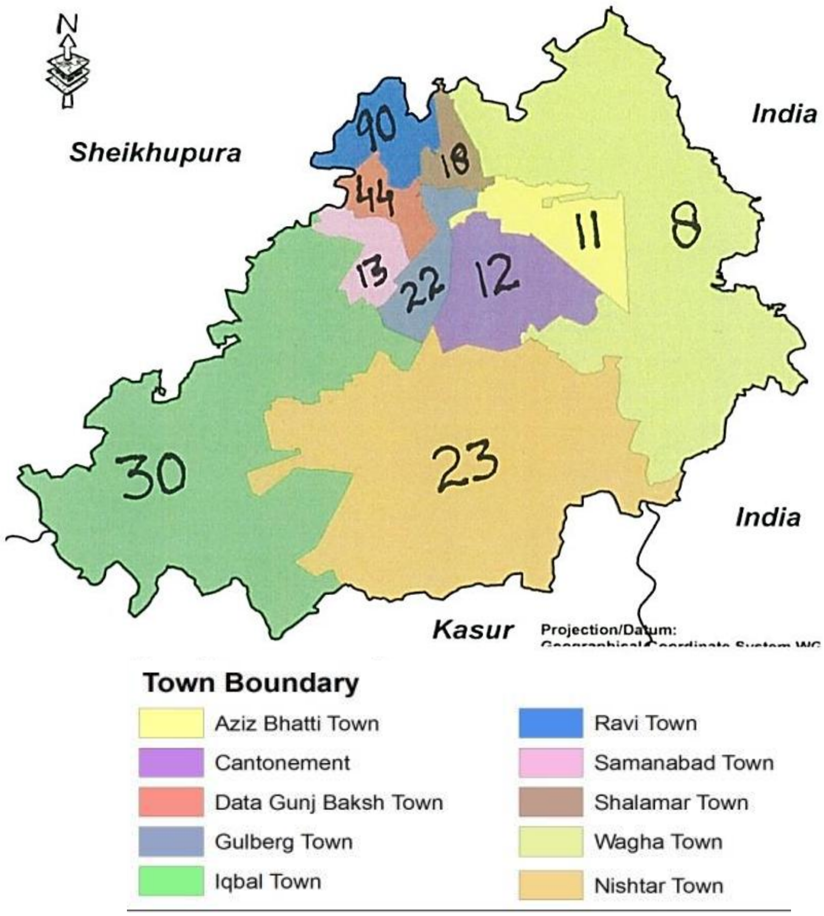

Figure 4.4: Distribution of MR crashes in different towns of Lahore
(Figure source: Tariq & Zaidi, 2014)

Figure 4.4 shows major towns in the Lahore district. Administratively, Lahore is divided into ten major towns, namely: Ravi, Shalimar, Wagha, Aziz Bhatti, Data Gunj Bakhsh, Gulberg, Samanabad, Allama Iqbal, and Nishter towns and Lahore Cantonment area (Tariq & Zaidi, 2014). Given that multiple crashes occurred at some places, analysis of the 500 ERFs identified 279 MR crash locations in different towns of Lahore.

The distribution of MR crashes in Figure 4.4 shows that MR crashes occurred in all major towns of Lahore. The highest number of MR crashes were reported in Ravi Town 90 (32.26%), followed by Data Gung Baksh Town 44 (15.77%) and Allama Iqbal Town 30 (10.75%). Other towns and areas *(Nishter Town, Gulberg Town, Shalimar Town, Samanabad Town, Lahore Cantonment, Aziz Bhatti Town and Wagha Town)* accounted for 115 (41.22%) of MR crashes.

The data analysis shows that MR crashes occurred on all types of roads (major, arterial and collector roads) in Lahore. Nearly half of MR crashes (47.04%) were reported on arterial two-lane roads, while 39.72% were reported on major three to five-lane roads. A further 13.24% of MR crashes were reported on the collector roads, which connect local streets to the arterial roads or major roads. The details of each MR crash location including number of reported crashes on a specific location, town and road type have been provided in Table A1.7 of Appendix 1.

A highly significant association was found between road type and crash severity [$\chi^2(2)= 13.963$, $p<.001$]. A higher proportion of minor injury crashes was reported on arterial roads (44.3%), compared to major (40.9%) and collector (14.8%) roads. Similarly, a larger proportion of moderate/severe/fatal injury crashes was reported on major roads (50.1%), compared to arterial (45.6%) and collector (4.2%) roads (Table 4.12).

Table 4.12: Association between road type and crash severity in MR crashes attended by Rescue 1122 in Lahore, 2014

		Road type			
Crash severity		**Major road**	**Arterial road**	**Collector road**	**Total**
Minor	N	36	39	13	88
	%	40.9%	44.3%	14.8%	100%
Moderate/severe/fatal	N	189	172	16	377
	%	50.1%	45.6%	4.2%	100%
Total	N	225	211	29	465
	%	48.4%	45.4%	6.2%	100%

Temporal Characteristics

The distribution of MR crashes according to day of the week is given in Table 4.13. Overall, similar proportions of MR crashes were reported across the whole week (Monday to Sunday), and no significant association was found between day of the week (weekdays and weekends) and crash severity [$\chi^2(2) = .232$, $p<.891$]. Similarly, no significant association was found between day of the week (weekdays and weekends) and crash types (SVC and MVC) [$\chi^2(1) = .001$, $p<.984$]. A similar proportion of SVCs and MVCs were reported on weekdays and weekends.

Table 4.13: Day of the week and crash severity in MR crashes reported to Rescue 1122 in Lahore, 2014

	Crash severity									
Day	**Minor**		**Moderate**		**Severe/critical**		**Fatal**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Monday	18	19.15	46	12.33	2	7.41	0	0.00	66	13.20
Tuesday	9	9.57	52	13.94	5	18.52	0	0.00	66	13.20
Wednesday	10	10.64	46	12.33	2	7.41	3	50.00	61	12.20
Thursday	11	11.70	51	13.67	4	14.81	0	0.00	66	13.20
Friday	12	12.77	50	13.40	3	11.11	3	50.00	68	13.60
Saturday	8	8.51	51	13.67	5	18.52	0	0.00	64	12.80
Sunday	15	15.96	55	14.75	5	18.52	0	0.00	75	15.00
Unclear	10	10.64	20	5.36	1	3.70	0	0.00	31	6.20
Missing	1	1.06	2	0.54	0	0.00	0	0.00	3	0.60
Total	94	100	373	100	27	100	6	100	500	100

**'Unclear' are those data entries on ERFs which were incomprehensible*

The distribution of MR crashes according to time of day is presented in Table 4.14. The largest proportion (22.4%) of MR crashes was reported between 12:01pm and 03:00pm, followed by 19.6% between 09:01am and 12:00pm and 17.4% between 03:01pm and 06:00pm. Overall, three-quarters of MR crashes (75%) were reported between 06:00am and 06:00pm.

Table 4.14: Time of day and crash severity in MR crashes reported to Rescue 1122 in Lahore, 2014

	Crash severity									
Time	**Minor**		**Moderate**		**Severe/critical**		**Fatal**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
12:00-03:00am	2	2.13	4	1.07	0	0.00	0	0.00	6	1.20
03:01-06:00am	3	3.19	6	1.61	1	3.70	1	16.67	11	2.20
06:01-09:00am	13	13.83	56	15.01	8	29.63	1	16.67	78	15.60
09:01am-12:00pm	23	24.47	71	19.03	3	11.11	1	16.67	98	19.60
12:01-03:00pm	19	20.21	89	23.86	4	14.81	0	0.00	112	22.40
03:01-06:00pm	21	22.34	59	15.82	6	22.22	1	16.67	87	17.40
06:01-09:00pm	6	6.38	55	14.75	2	7.41	0	0.00	63	12.60
09:01-11:59pm	7	7.45	33	8.85	3	11.11	2	33.33	45	9.00
Total	94	100	373	100	27	100	6	100	500	100

** Crash times are the timings when an ambulance dispatched to an incident site*

No significant association was found between crash severity and time of day [$\chi^2(4) = 2.686$, $p<.612$]. A similar proportion of minor, moderate and severe and fatal crashes were reported during various day and night periods. Similarly, no significant association was found between time of day and crash types (SVC and MVC) [$\chi^2(2) = .548$, $p<.760$]. A comparable proportion of SVCs and MVCs was observed in different day periods.

Ambulance Response Time

Table 4.15 presents Rescue 1122 ambulance response times, while attending MR crashes across Lahore in 2014. Response time is measured from when an ambulance is dispatched to the time it arrives at the crash scene. Rescue 1122 ambulance service has an average response time of seven minutes across Punjab (Rescue 1122, 2016), therefore response time categories of 1-7, 8-15 and over 15 minutes were used in this study.

In about half of MR crashes (48.80%), Rescue 1122 ambulances reached the incident site within 1-7 minutes. Ambulance response time was 8-15 minutes in 38.40% of crashes, and more than 15 minutes in about 6.8% of incidents. The major reasons noted for a delayed response time (over 15 minutes) in Lahore included: traffic congestion (*n*=18), traffic jam due to a closed railway crossing (*n*=13), and a long traffic queue due to rain (*n*=8).

Table 4.15: Rescue 1122 ambulance response times and crash severity in MR crashes attended by Rescue 1122 in Lahore, 2014

	Crash severity									
Ambulance response time	**Minor**		**Moderate**		**Severe/critical**		**Fatal**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
1-7	44	46.81	183	49.06	14	51.85	3	50.00	244	48.80
8-15	35	37.23	144	38.61	11	40.74	2	33.33	192	38.40
>15	7	7.45	27	7.24	0	0.00	0	0.00	34	6.80
Unclear	3	3.19	10	2.68	1	3.70	0	0.00	14	2.80
Missing	5	5.32	9	2.41	1	3.70	1	16.67	16	3.20
Total	94	100	373	100	27	100	6	100	500	100

**'Unclear' are those data-entries on ERFs which were incomprehensible*

The majority of injured persons (81%) were transported to government hospitals; only two (*n*=2) casualties were transported to private hospitals. Around

18% of injured persons were discharged from the crash scene, after provision of first-aid.

No significant association was found between ambulance response time and crash severity [$\chi^2(2) = .131$, $p<.936$]. Rescue 1122 ambulances attended similar proportions of minor injury crashes (18%, 18.2% and 20.6%, respectively) and moderate/severe/fatal injury crashes (82%, 81.8% and 79.4%, respectively) in various response timings: 1-7, 8-15 and over 15 minutes, respectively. Similarly, no significant association was found between ambulance response time and number of crashes reported on weekdays or weekends [$\chi^2(2) = 4.436$, $p<.109$], and on various road types (major, arterial and collector roads) [$\chi^2(4) = 4.177$, $p<.383$].

4.3.2.2 Vehicle Characteristics

Table 4.16 shows the number and types of various vehicles (motorized and non-motorized) that collided with MRs in reported MR Multi-vehicle Crashes (MVCs). The 'MR-pedestrian crashes' were also counted under the category of MVCs. A total of 427 vehicles (counterparts) were involved in 422 reported MR MVCs. In most MVCs (98.82%), two vehicles (MR and any other vehicle) were involved, while in five MVCs (n=5) three vehicles (MR and two other vehicles) were involved.

Motorcycle rickshaws had collisions with almost all kinds of motorized and non-motorized vehicles. Among motorized vehicles, the majority of MR collisions were with motorcycles (45.50%) and cars (11.85%). In around 10% of the incidents, MRs had collisions with heavy vehicles such as trucks (5.45%), buses (1.87%), vans (1.18%), tractor-trolleys (0.95%), and crane and emergency vehicles (0.47%). Among non-motorized vehicles or road users, MRs had frequent collisions with pedestrians (19.67%).

A highly significant association was found between various types of vehicles involved in MVCs and crash severity [$\chi^2(6) = 22.940$, $p<.001$]. A higher proportion of minor (45.1%), moderate (46.3%), and severe and fatal (37%) injury crashes were observed in MR collisions with motorcycles, compared to MR collisions with other vehicle types (heavy vehicles and pedestrians) (Table 4.17).

Table 4.16: Number and vehicle types involved in multi-vehicle MR crashes attended by Rescue 1122 in Lahore, 2014

Vehicle type	N	%
Motorcycle	192	45.50
Pedestrian	83	19.67
Car	50	11.85
MR	28	6.64
Truck	23	5.45
Bicycle	14	3.32
Autorickshaw	8	1.90
Bus	8	1.90
Van	5	1.18
Animal cart	5	1.18
Tractor-trolley	4	0.95
Others *(crane & emergency vehicle)*	2	0.47
Total	422	100.00

Table 4.17: Association between vehicle types and crash severity in MR MVCs attended by Rescue 1122 in Lahore, 2014

		Vehicle types				
Crash severity		**Motorcycle**	**Heavy vehicles**	**Pedestrian**	**Other vehicles**	**Total**
Minor	N	37	2	10	33	82
	%	45.1%	2.4%	12.2%	40.2%	100%
Moderate	N	145	34	69	65	313
	%	46.3%	10.9%	22.0%	20.8%	100%
Severe & fatal	N	10	6	4	7	27
	%	37.0%	22.2%	14.8%	25.9%	100%
Total	N	192	42	83	105	422
	%	45.5%	10.0%	19.7%	24.9%	100%

4.3.2.3 Person Characteristics

Under ‘person characteristics’, characteristics such as injury severity, injury types, age, gender and road users involved in MR crashes are presented. It is important to note that figures or data presented in this section are based on the ‘person-based’ data entry method (Figure 4.3).

Injury Severity

A total of 1,151 persons were involved (injured/not injured) in the 500 MR crashes, and the five injury severity levels were generated: none, minor, moderate, critical, and dead/fatal. There were six fatalities, 32 critical injuries, 484 moderate injuries and 147 minor injuries. In the majority of MR crashes (66.8%) only one person was involved, and in the remaining one-third of crashes (33.2%), two to six persons were involved (Table 4.18).

Table 4.18: Injury severity in MR Crashes attended by Rescue 1122 in Lahore, 2014

Injury severity	N	%
Minor	147	12.8
Moderate	484	42.1
Critical	32	2.8
Dead/fatal	6	0.5
No injury	426	37.0
Unclear	55	4.8
Missing	2	0.2
Total	1151	100.0
No of persons involved (injured/not injured) in an MR crash		
1	769	66.8
2	232	20.2
3	84	7.3
4	48	4.2
5	5	0.4
6	13	1.1
Total	1151	100.0

**'Unclear' are those data entries on ERFs, which were incomprehensible*

No significant association was found between injury severity and crash types [$\chi^2(4) = 2.517$, p<.284]. A comparable proportion of minor (16.4% and 23.1%), moderate (78.2% and 71.2%), and critical and dead/fatal (5.5% and 5.7%) injuries were observed in both SVCs and MVCs, respectively.

Age and Gender

Table 4.19 summarises the gender and age groups of persons involved (injured/not injured) in MR crashes. Among the 1,151 persons involved in MR crashes, 93.40% were males. Young people aged 21-30 years were involved in 21.03% of crashes, followed by the 31-40 age group (12.08%) and 11-20 age group

(6.43%). Those aged 51-60 and over 60 years were involved in 7.65% of crashes.

The people aged 21-30 years were most commonly injured in MR crashes, and they sustained the largest proportion of minor (38.78%), moderate (35.12%), critical (37.50%) and fatal (33.33%) injuries. Of the six fatalities (n=6), two (n=2) were each among people aged 11-20 and 21-30 years, while one (n=1) was each among people aged 31-40 and over 60 years (Table 4.19).

Road Users

After MRDs (45.79%), motorcycle riders (17.03%) and passengers (15.73%) were the most common road user groups involved in MR crashes. Non-motorized road users such as pedestrians, bicyclists and animal-cart drivers were involved in 17.38% of MR crashes (Table 4.20).

The analysis shows that motorcycle riders sustained the highest proportion of minor (27.89%) and moderate (27.07%) injuries, while passengers sustained the largest proportion of critical (28.13%) and fatal (33.33%) injuries (MRDs also sustained the same proportion of fatal injuries i.e. 33.33%). Among the six fatalities (n=6), two (n=2) were each among MRDs and passengers, and one (n=1) was each among pedestrian and an animal-cart driver (Table 4.20).

Injury Types

Table 4.21 shows the various types of injuries sustained in MR crashes. Cut/abrasions (14.60%), lower-limb (7.60%) and head (6.60%) injuries were the most common injuries sustained in MR crashes. Bone-fractures such as upper-limb, lower-limb and multiple fractures accounted for 8.50% of total injuries, while face and foot injuries comprised 4.40% and 2.30%, respectively. About 2.50% of the injured persons sustained multiple and internal injuries.

Table 4.19: Gender and age groups of persons involved in MR crashes attended by Rescue 1122 in Lahore, 2014

	Injury severity													
Gender	**Minor**		**Moderate**		**Critical**		**Fatal**		**Unclear & Missing**		**No injury**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Male	138	93.88	421	86.98	29	90.63	6	100	57	100	424	99.76	1075	93.40
Female	9	6.12	63	13.02	3	9.38	0	0.00	0	0.00	1	0.24	76	6.60
Total	147	100	484	100	32	100	6	100	57	100	425	100	1151	100
Age group (years)														
0-10	0	0.00	10	2.07	1	3.13	0	0.00	0	0.00	0	0.00	11	0.96
11-20	19	12.93	51	10.54	2	6.25	2	33.33	0	0.00	0	0.00	74	6.43
21-30	57	38.78	170	35.12	12	37.50	2	33.33	0	0.00	1	0.24	242	21.03
31-40	33	22.45	100	20.66	5	15.63	1	16.67	0	0.00	0	0.00	139	12.08
41-50	19	12.93	41	8.47	2	6.25	0	0.00	1	1.82	0	0.00	63	5.47
51-60	8	5.44	41	8.47	0	0.00	0	0.00	0	0.00	0	0.00	49	4.26
>60	5	3.40	29	5.99	3	9.38	1	16.67	0	0.00	1	0.24	39	3.39
Unclear	4	2.72	29	5.99	3	9.38	0	0.00	56	98.18	1	0.24	91	7.91
Missing	2	1.36	13	2.69	4	12.50	0	0.00	0	0.00	422	99.29	443	38.49
Total	147	100	484	100	32	100	6	100	57	100	425	100	1151	100

‘Unclear’ represents *all those data entries on ERFs which were unclear or incomprehensible*

Missing: *Paramedics only documented the age of an injured person, so age was entered as ‘missing’ for those uninjured*

Table 4.20: Road user types and injury severity in MR crashes attended by Rescue 1122 in Lahore, 2014

	Injury severity													
Road user	**Minor**		**Moderate**		**Critical**		**Fatal**		**Unclear & missing**		**No injury**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
MRD	40	27.21	107	22.11	8	25.00	2	33.33	47	82.46	323	76.00	527	45.79
Motorcycle rider	41	27.89	131	27.07	7	21.88	0	0.00	7	12.28	10	2.35	196	17.03
Passenger	40	27.21	130	26.86	9	28.13	2	33.33	0	0.00	0	0.00	181	15.73
Pedestrian	10	6.80	72	14.88	3	9.38	1	16.67	0	0.00	0	0.00	86	7.47
Car driver	0	0.00	1	0.21	0	0.00	0	0.00	1	1.75	46	10.82	48	4.17
Motorcycle pillion rider	7	4.76	30	6.20	3	9.38	0	0.00	1	1.75	0	0.00	41	3.56
Truck driver	0	0.00	2	0.41	1	3.13	0	0.00	0	0.00	20	4.71	23	2.00
Bicyclist	5	3.40	8	1.65	1	3.13	0	0.00	0	0.00	0	0.00	14	1.22
Autorickshaw driver	0	0.00	1	0.21	0	0.00	0	0.00	0	0.00	7	1.65	8	0.70
Bus driver	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	8	1.88	8	0.70
Van driver	1	0.68	0	0.00	0	0.00	0	0.00	0	0.00	5	1.18	6	0.52
Animal-cart driver	2	1.36	2	0.41	0	0.00	1	16.67	0	0.00	0	0.00	5	0.43
Others *(ambulance, tractor & crane driver)*	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	6	1.41	6	0.52
Unclear	1	0.68	0	0.00	0	0.00	0	0.00	1	1.75	0	0.00	2	0.17
Total	147	100	484	100	32	100	6	100	57	100	425	100	1151	100

Table 4.21: Injury types in MR crashes attended by Rescue 1122 in Lahore, 2014

Injury type	N	%
Cut/abrasions	168	14.60
Lower limb injury	88	7.60
Head	76	6.60
Fracture lower-limb	72	6.30
Upper limb injury	59	5.10
Face	51	4.40
Foot	27	2.30
Multiple injuries	20	1.70
Fracture upper-limb	19	1.70
Chest	9	0.80
Internal injury	9	0.80
Multiple fracture	6	0.50
Others *(abdominal, eye & back injuries and unconsciousness)*	14	1.20
Missing	2	0.20
Unclear	101	8.80
No injury	426	37.00
Total	1151	100.00

**'No injury' refers to all those people involved in crashes, but not injured*

Table A1.6 in Appendix A summarises the various injuries sustained by different road users in MR crashes. The highest proportions of fractures (single and multiple fractures (34.02%), upper and lower limb injuries (28.57%) and head injuries (28.75%) *(Passengers also sustained same proportion of head injuies as did the motorcycle riders)* were sustained by motorcycle riders. A similar proportion of different injuries were observed in both SVCs and MVCs [$\chi^2(4) = 3.431$, $p<.488$].

4.3.2.4 Injury Severity Modelling

A binary logistic regression model was formulated with a set of eight (n=8) explanatory variables or predictors including: gender, age group, crash type, how crash occurred/crash contributing factors, road user type, time of day, day of the week and ambulance response time. The selection of the explanatory variables was based on the outcomes of univariate analyses. The aim of the regression modelling was to examine the association of various human, vehicular and environmental factors with the outcome of injury severity (set as minor injuries=0 and moderate/critical/fatal injuries=1) in the BLRM.

Table 4.22 presents the results of the injury severity modelling in a binary logit model. The results showed that compared to other crash contributing factors, ‘MR overturned due to speeding’ ($p<.009$, OR: 8.764 95%CI: 1.713-44.824) was more likely (8.7 times) to result in moderate/critical/fatal injuries, while ‘MR hit MR’ ($p<.001$, OR: .171 95%CI: .062-.471) was less likely (0.2 times) to result in moderate/critical/fatal injuries.

Compared to other times of the day, road crashes that occurred between 6pm and 11:59pm’ ($p<.046$, OR: 3.446 95%CI: 1.022-11.619) had an increased (3.4 times) likelihood of moderate/critical/fatal injuries. Likewise, MR crashes occurred during weekdays (Monday-Friday) ($p<.049$, OR: .578 95%CI: .335-.997) had a decreased (0.6 times) likelihood of moderate/critical/fatal injuries, compared to weekends (Saturday-Sunday).

4.3.2.5 Summary of Findings of Study 1B

Study 1B involved analysis of the ERFs to understand the characteristics of MR crashes. About three-quarters of MR crashes were of moderate injury severity, and almost a fifth of minor severity. Motorcycle rickshaws had collisions with various types of motorized and non-motorized vehicles, and most MR crashes were MVCs. The MR road crashes were reported in all major towns of Lahore, and on all road types (major, arterial and collector roads) across the city.

In MR crashes, males were most commonly involved and young people aged 21-30 years sustained the largest proportion of minor, moderate, critical and fatal injuries. Road users such as MRDs, motorcycle riders, passengers and pedestrians were those most commonly involved in MR crashes.

Injury severity modelling showed that the odds of moderate/critical/fatal injuries were 8.7 times higher for ‘MR overturned due to speeding’ attributed crashes, and 0.2 times lower for ‘MR hit MR’ related crashes. Similarly, the odds of moderate/critical/fatal injuries were 3.4 times higher for MR crashes reported during 6pm-11:59pm, and 0.6 times lower for MR crashes reported during weekdays.

Table 4.22: Association between risk factors and injury severity in a binary logistic regression model

					95% CI	
Explanatory variables	**Categories**	**Beta**	***p*-value**	**OR**	**Lower**	**Upper**
Gender	Male	-.717	.107	.488	.204	1.168
	Female=0	Reference				
Age group (years)	1-30	-.571	.160	.565	.255	1.252
	31-50	-.775	.065	.461	.202	1.050
	> 50=0	Reference				
Road users	Pedestrian	-18.996	1.000	.000	.000	.000
	Passenger	-.579	.097	.560	.283	1.111
	Motorcycle rider	-.013	.982	.987	.333	2.930
	MRD	.165	.823	1.179	.278	4.997
	All other road users=0	Reference				
How crash occurred	MR hit pedestrian	-19.996	1.000	.000	.000	.000
	MR turned over due to speeding	2.171	.009	8.764	1.713	44.824
	MR hit car	-.697	.131	.498	.202	1.231
	MR hit motorcycle	-.661	.291	.516	.151	1.760
	MR hit MR	-1.765	.001	.171	.062	.471
	MR hit footpath due to careless driving	.924	.227	2.519	.563	11.274
	Other reasons=0	Reference				
Crash type	MVC	.916	.084	2.500	.883	7.076

	SVC=0	Reference				
Time of day	6am-12pm	.767	.201	2.154	.664	6.983
	12pm-6pm	.839	.162	2.313	.713	7.501
	6pm-11:59pm	1.237	.046	3.446	1.022	11.619
	12pm-6am=0	Reference				
Day of week	Weekdays (Monday-Friday)	-.548	.049	.578	.335	.997
	Weekends (Saturday-Sunday)=0	Reference				
Ambulance response time (minutes)	1-7	.255	.553	1.291	.556	2.999
	8-15	.252	.561	1.286	.550	3.009
	>15=0	Reference				

4.4 DISCUSSION

Study 1 aimed to address Research Question 1 *(What is the size of the MR crash problem?)*, and Research Question 3 *(What are the characteristics of MRDs that influence the road safety of MRs?)*. Results of the two sub-studies (Studies 1A and 1B) of Study 1 have been presented separately, but this discussion is based on the findings of all three datasets analysed in these two sub-studies. The study results are discussed in terms of the five major levels of the MR systems model, general characteristics of MR crashes, and outcomes of the injury severity modelling.

4.4.1 **Prevalence of MR Crashes in Punjab**

More than 36,000 rickshaw (both MR and AR) crashes were attended by Rescue 1122 across Punjab during January 2011-December 2012 and more than 11,000 were attended in July 2013-June 2014. After motorcycles and cars, rickshaws were the third most common vehicle type involved in road crashes across Punjab from January 2011-December 2012, while they dropped to number four during July 2013-June 2014. The ban on MRs in Lahore in early 2014 may have contributed to the falls in the numbers and percentage of rickshaw crashes in both Lahore and the rest of Punjab across July 2013-June 2014.

Rickshaw crashes were reported from all 36 districts of Punjab, confirming the presence and operation of rickshaws in the whole province. The distribution of rickshaw crashes across Punjab also suggests that the number of rickshaw crashes reported in different districts varied according to the district population size, and the number of rickshaws operating in these districts. For instance, Lahore is largest populated district in Punjab and has the largest number of rickshaws in the province (Kamal, Qamar, Gulfraz, Anwar & Malik, 2015; Malik, 2012). Accordingly, it had the highest number of rickshaw crashes (n=14,600) during January 2011-December 2012 and July 2013-June 2014. Conversely, Murree is a small mountainous city in the northern Punjab, with fewer rickshaws (Malik, 2012), and it had the lowest number of rickshaw crashes (n=142) in the province across the study periods.

Given the aggregated data of rickshaws (MR and AR) crashes in Study 1A, the exact prevalence and burden of MR crashes could not be determined. However, the literature review shows that ARs, being a more expensive mode than MRs, mostly operate in large cities, while MRs operate in large and small cities, towns and villages throughout the province (Khawaja, 2011; Siddiqui, 2014; *The Dawn*, 2015a; *The Express Tribune*, 2011, 2012, 2013a,b; 2014a,b; *The Nation*, 2012a, 2015). This suggests that compared to ARs, MRs constitute the majority of rickshaw crashes reported across Punjab. However, the data in the current research was collected from the large urban centres in Punjab where Rescue 1122 ambulances operate, and it did not include data from small cities, towns and villages. Police enforcement and monitoring is minimal or absent in small cities, towns and villages throughout Punjab. This situation increases the likelihood of under-reporting of MR crashes in small settlements. In particular, minor and moderate injury MR crashes are more likely to be under-reported. Previous studies has shown a large underreporting of road crashes and fatalities in police reported data in Pakistan (Ahmed, 2007; Ahmed et al., 2015; Batool et al., 2012; Bhatti et al., 2011; Ghaffar et al., 2004; Hyder et al., 2000; Kayani et al., 2014; Razzak & Luby, 1998; WHO, 2009).

4.4.1.1 Prevalence of MR Crashes in Lahore

Study 1A showed that the highest number of road crashes involving rickshaws and other vehicles was reported in Lahore. Lahore’s large proportion of rickshaw crashes indicates that MR-related road safety problems are more prevalent in Lahore, compared to the rest of Punjab. This also justifies the selection of the study location.

The crash location data in Study 1B showed that MR crashes occurred in all major towns of Lahore. Motorcycle rickshaws are particularly concentrated in densely populated low-economic areas such as Ravi Town (around two million population) and Data Gung Buksh Town (over one million population) (Relief-web, 2014), where around 47% of MR crashes occurred.

The crash location data also revealed that MR crashes were reported on all types of roads (major, arterial and collector roads) in Lahore. In Lahore, roads range from one to five lanes and have mixed-traffic conditions. For example, the General Trunk Road (GT Road) is a major four-lane road in Lahore, where MRs and all other motorized (including heavy vehicles such as trucks) and non-motorized vehicles operate round the clock (GT Road, 2015).

A higher proportion (44.3%) of minor injury crashes was reported on arterial roads, and about half of moderate, severe and fatal injury crashes were reported on major roads. Increased MR crash severity on major roads is likely due to the higher travelling speed of all vehicles on major roads compared to small roads. Past research found a direct relationship between speed and crash severity (Aarts & Van Schagen, 2006; Mao, Zhang, Robbins, Clarke, Lam & Pickett, 1997; Woolley, 2005; WHO, 2008). An impact at high speed produces a high amount of kinetic energy and thus increases the crash and injury severity (Aarts & Van Schagen, 2006).

4.4.2 Demographics, Road Users and Injury Characteristics

In all three datasets analysed as part of Study 1, there was a higher proportion of males involved in road crashes compared to females. Similarly, people aged 11-40 years were most commonly involved in rickshaw/MR crashes, comprising more than half of the casualties in aggregated datasets. These findings suggest that young and middle-aged males are most vulnerable to road crashes and injuries in Pakistan, which is consistent with the findings of the previous studies from different parts of the country (Ahmed, 2007; Batool et al., 2012; Ghaffar et al., 2004; Jamali, 2008; Klair & Arfan, 2014; Tahir et al., 2012, 2013).

In Pakistan, males are traditionally responsible for the livelihood of their families, so their work outside the house increases their exposure to the road environment and their likelihood of being involved in road crashes (Ahmed, 2007; Batool et al., 2012; Ghaffar et al., 2004; Tahir et al., 2012). For instance, a recent hospital-based study in Dera Ismail Khan, Pakistan showed that 84.6% of fatalities were males, and people aged 1-40 years constituted 79.4% of fatalities in road crashes during 2013 (Saleem, Haider, Khan & Saleem, 2015).

After MRDs, motorcycle riders, passengers and pedestrians were most commonly injured in MR crashes. Motorcycle riders sustained the highest proportion of minor and moderate injuries, while passengers sustained the largest proportion of critical and fatal injuries. Study 1A also showed that they are the largest group in ambulance data in Punjab. Past research has identified motorcyclists as the largest group involved in road crashes, injuries and fatalities in Pakistan (Aslam et al., 2008; Hyder et al., 2000; Khan, Khan, Aziz, Islam & Shafqat, 2008; Shamim, Razzak, Jooma & Khan, 2011; Tahir et al., 2012; Tahir et al., 2013). For instance, nearly half (45%) of the casualties and fatalities in the Road Traffic Injuries Surveillance Program (RTIRP) in Karachi during 2006-2009 were motorcyclists and only 7% of these motorcyclists were wearing helmets at the time of the crash (Shamim et al., 2011). Motorcycles were involved in 45% of the road crashes attended by Rescue 1122 in Lahore during 2005–2010 (Tahir et al., 2012) and 57% of the crashes attended during Ramadan in 2011 (Tahir et al., 2013). Speeding (40%, 38%), Carelessness (25%, 29%) and Wrong-turn (22%, 9%) were nominated as major causes of these crashes (Tahir et al., 2012, 2013).

The variable ‘road user type’ was missing in the ERF, so it was difficult to differentiate the various road users injured in MR crashes. In particular, information about ‘passengers’ was limited: in cases where emergency paramedics did not clearly record which passenger of which vehicle was injured, it was difficult to ascertain this. Nevertheless, given that Study 1B focused on MR crashes, and MR are open vehicles while other vehicles are enclosed vehicles, and in single-vehicle crashes only passengers of MRs were injured, it is expected that most passengers involved in MR crashes were, in fact, the occupants of MRs.

Motorcycle rickshaws have two passenger seats - front and rear - facing away from each other. The MR crash data did not provide information about the seating position of injured passengers and so it cannot be determined whether passenger sitting position has any influence on injury severity. Schmucker, Dandona, Kumar & Dandona (2011) in a hospital-based study in Hyderabad, India, examined the crash and injury patterns for three-wheeled motorised rickshaw occupants and road users hit by these rickshaws. Their study found an increased risk of fatal injuries and Glasgow Coma Score for front-seat passengers of rickshaws than rear-seat passengers. The influence of seating position on injury severity for MR occupants (passengers and MRDs) needs to be further examined.

In both Studies 1A and 1B, lower-limb fracture was the most common injury, and along with multiple fractures, comprised around one-quarter (25%) of the injury burden. Lower-limb fractures were particularly common among motorcycle riders in MR crashes. Previous studies have also reported a high incidence of lower-limb injuries and fractures among motorcycle riders across Pakistan (Aslam et al., 2008; Khani et al., 2013; Lateef, 2002; Yousaf, Iqbal, Akram & Choudary, 2013). Similarly, Schmucker et al., (2011) in Hyderabad, India also found a higher incidence of lower-limb fractures among occupants of three-wheeled motorised rickshaws, riders of motorised two-wheeled vehicles, and pedestrians.

Head injuries constituted a significant proportion of injuries (13%, 13% and 7%, respectively) in all three datasets examined as part of Study 1. Like lower-limb fractures, head injuries were also more prevalent among motorcycle riders in Study

1. Head injury is often fatal and it is a common injury among motorcyclists, who do not wear a safety helmet. Previous research has shown that helmet-wearing rates are low (between 10% and 15%) among motorcycle riders across Pakistan (Bhatti, Ejaz, Razzak, Tunio & Sodhar, 2011; Hashmi et al., 2012; Khan et al., 2008; Nasrullah & Muazzam, 2012; Shamim, Razzak, Jooma & Khan, 2011).

Study 1A also provided some information about underage drivers (below 18 years) operating across Punjab. Underage drivers comprised about 3% of casualties, and similar proportions of underage drivers were observed in both Lahore and the rest of Punjab. Some underage drivers were also found in the MR crash data, but correct estimates cannot be made due to some missing data, outlined in the Study 1 limitations. The proportion of underage MRDs in Lahore will be assessed in later studies of the current research.

4.4.3 **Crash Contributing Circumstances**

In Study 1A, speeding and careless driving were identified as the major contributing factors in about three-quarters of road crashes reported across Punjab. Earlier research studies which examined the Rescue 1122 crash data also identified speeding and careless driving as the main crash contributing factors in Lahore and the rest of Punjab (Tahir et al., 2012, 2013).

As outlined earlier, crash contributing factors were not well-defined or recorded in the MR crash data. The ERF relates to treatment and its administration, so it is useful for treatment details, crash outcome, demographics of casualties, and ambulance response times, but not very useful for crash contributing factors. The current ERF asks ‘how emergency took place and which vehicles were involved’, so paramedics usually mention the types of vehicles involved in crashes, instead of documenting the specific human, vehicular or environmental factors. Moreover, given the large coverage area of Rescue 1122 in Lahore, and the high burden of emergencies (on average Rescue 1122 ambulances attend around 150 road crash and medical related emergencies daily in Lahore), emergency paramedics generally record only what they consider to be the most important information about a crash.

‘MR turned over due to speeding’ was identified in only 7% of the MR crash reports, but it was associated with 8.7 times higher odds for moderate/critical/fatal injuries. The increased injury severity in these crashes may result from MRs being open vehicles where their occupants (passengers and MRDs) are fully exposed to the external environment, and are as vulnerable to crashes and injuries as motorcycle riders. They are likely to be at higher risk of sustaining severe injuries in road crashes, compared to occupants of protected vehicles such as cars, which have a vehicle shell designed for crashworthiness in accordance with international safety standards.

Overturning of MRs at higher speeds would also influence the crash severity and injury severity. The crash simulation-based studies in India demonstrated that three-wheeled scooter taxis can cause serious injuries to their occupants even in crashes occurring at a speed of 30 km/hour, because they are open and do not have safety devices such as airbags and seat-belts (Chawla, Mukherjee, Mohan, Singh & Rizvi, 2003; Mohan Kajzer, Bawa-Bhalla & Chawla, 1997; Schmucker et al., 2011). Injury levels for pedestrians were also found to be quite high at an impacting rickshaw speed of 30 km/hour (Chawla et al., 2003; Mohan et al., 1997). Three-wheeled scooter taxis were involved in 2-3% of the total incidents, which resulted in 1,768 road fatalities in Delhi during 2001, and about 2% of these fatalities were among the occupants of these three-wheelers (Chawla et al., 2003; Ojha, 2002).

In about 7% of MR crashes, emergency paramedics identified other crash contributing factors: MR brakes failed; injuries to MRD/passenger due to cloth stuck into MR open chain; MR vehicle shaft broken, MR wheel came off; MR caught fire, frequent tyre puncture; and passengers fell from open MRs. These factors highlight mechanical problems in the design and structure of MRs, but this data is limited, and hence it is difficult to draw any conclusions about their safety features. Biomechanical studies from India however have shown that three-wheeled motorised rickshaws have limited stability and crashworthiness features (Chawla et al., 2003; Mohan et al., 1997; Schmucker et al., 2011).

4.4.4 **Crash Types**

More than three-quarters of the MR crashes were multi-vehicle crashes, resulting in about three-quarters of moderately severe injuries and five of the six fatalities. However, the analysis did not show a significant association between MR collision type and crash severity and injury severity. Past research however, establishes that single-vehicle and multi-vehicle crashes have different mechanisms of occurrence and risk factors (Baker, 1991; Chen & Chen, 2009, 2011) and under specific conditions, multi-vehicle crashes are more severe than single-vehicle crashes (Islam, 2015; Viano, Culver, Evans & Frick, 1990). Schmucker et al. (2011) found that among motorised rickshaw occupants, single-vehicle crashes were more frequent than multi-vehicle crashes, and the risk of fatal, upper limb and multiple injuries was higher (though not statistically significant) in multi-vehicle crashes.

The analysis revealed that MRs had collisions with various types of motorized and non-motorized vehicles, reflecting their operation in mixed-traffic conditions in Lahore. The exposure of MRs to other vehicles in a heterogeneous traffic mix is likely to affect the risk, rates and severity of MR crashes. Past research has determined that due to the underlying heterogeneous causal mechanisms in various collision types, the likelihood of crash occurrence by collision type is associated with roadway infrastructure, environmental factors and vehicles in different ways, so these factors influence the risk, rates and severity of crashes (Donnelly-Swift & Kelly, 2015; Kim, Lee, Washington & Choi, 2007).

About two-thirds (66%) of MR multi-vehicle crashes involved vulnerable road users such as motorcyclists and pedestrians, which may suggest that their vulnerability has increased due to the growing numbers of MRs in Lahore. Newspaper and media reports also claim that the unregulated sporadic growth of MRs and risky driving practices of MRDs are creating safety related issues for pedestrians and other road users across Pakistan (Khawaja, 2011; Sarfraz & Hussain, 2010; Siddiqui, 2014; *The Sargodha News*, 2014; *The Nation*, 2012a). More information will be collected in the remaining studies of the current research to ascertain this finding.

In about 10% of multi-vehicle crashes, MRs had collisions with heavy vehicles. The crash severity was highest ($p<.001$) in these collisions, with half (n=3) of the total fatalities recorded in these crashes. Collisions between an MR and a heavy vehicle would be likely to increase the risk of more severe injuries to MR occupants. Earlier research has also demonstrated that crashes involving heavy vehicles on urban roads and highways are generally fatal, and injury severity, as well as their social cost, is higher than crashes involving two light passenger vehicles (Al-Bulushi, Edwards, Davey, Armstrong, Al-Reesi & Al-Shamsi, 2015; Islam, 2015).

About 16% of MR crashes were single-vehicle crashes, and more than three-quarters were of moderate injury severity. The single-vehicle crashes mostly involved collisions of MRs with objects such as the footpath or road boundary, and overturning of MRs. Overturning was reported in nearly half of the single-vehicle crashes. In MR overturning or roll-over crashes, in addition to speeding, there may be other compounding factors such as overtaking by MRDs to catch passengers, sharp turning from narrow road ends, brake failure, tyre puncture and road-related factors such as road bumps and holes. Schmucker et al. (2011) identified similar factors (as identified in MR crashes) in single-vehicle crashes involving motorized three-wheeled rickshaws in India, where overturning resulted in one-third of all injuries among the occupants of these rickshaws.

In addition to five major fatal crash risk factors identified globally *(speeding, drink driving, careless driving, not wearing a seat-belt or helmet, distracted driving such as use of mobile phone while driving),* past research has also shown the significance of environmental or temporal factors such as time of day and day of week (weekend/weekdays) in the likelihood and severity of single and multi-vehicle crashes (Donnelly-Swift & Kelly, 2015; Híjar, Carrillo, Flores, Anaya & Lopez, 2000; Schmucker et al., 2011; Yau, 2004). However, in MR crashes, temporal factors (time of day and day of week) were not found significant in determining the severity of either single or multi-vehicle crashes. Previous studies have also identified the importance of demographic factors such as driver's age in the likelihood and crash severity of both single and multi-vehicle crashes (Donnelly-Swift & Kelly, 2015; Híjar et al., 2000). In MR single and multi-vehicle crashes, 'MRD age' (particularly underage MRDs) could have been an important factor; however this information was missing in the Rescue 1122 crash data. Age-related and other sociodemographic factors which potentially influence the road safety behaviours of MRDs will be examined in the subsequent studies.

4.4.5 **Temporal Characteristics**

In injury severity modelling, the likelihood of moderate/critical/fatal injuries was slightly increased (0.6 times) during weekends, compared to weekdays. This study did not identify any clear reason for the slight variations in the occurrence of different levels of injury severity during weekdays and weekends. However, the researcher noticed that on holidays and weekends in Lahore, there is less traffic police enforcement. Less presence or the absence of police might have encouraged

MRDs to more often engage in violations of traffic rules and risky driving practices, which increased the risk of more serious injuries on weekends.

The analysis shows that MR crashes were reported throughout the day across Lahore. This shows that MRs operate round the clock in Lahore, and also highlights the significant paratransit role of MRs in Lahore's public transport sector. About three-quarters of MR crashes were reported between 6am and 6pm, which correspond to peak rush hours (office, school and business hours), where people's mobility and exposure on the road are high. A similar crash-time pattern was also observed in previous studies that analysed Rescue 1122 crash data to examine road crash trends across a five year period (2005-2010), and during the Islamic month of Ramadhan 2011 in Lahore and Punjab, respectively (Tahir et al., 2012, 2013).

The likelihood of moderate/critical/fatal injuries was 3.4 times higher in MR crashes reported between 6pm and 11:59pm. This could be attributed to: (1) MRs not having rear lights or indicators and some do not have functional headlights, making them almost invisible for other vehicles under dark conditions (*The Automark*, 2016, and information extracted from LTC documents); (2) MRs not having side-view mirrors and many not having even back view mirrors (*The Automark*, 2016 and information extracted from LTC documents); consequently, MRDs cannot properly observe their rear and sideways traffic flow, and at night their visibility would be further reduced, possibly increasing the likelihood of serious crashes and injuries; (3) MRs not having fixed routes and stops, so MRDs pick and drop passengers anywhere on the road. In doing so, they change traffic lanes frequently without indication (MRs do not have indictors), and also engage in risky driving practices (*The Dawn*, 2015a; *The Express Tribune*, 2011, 2012a, 2013a, b; Khawaja, 2011, Siddiqui, 2014; Sarfraz & Hussain, 2010); (4) in recent years there has been a power energy crisis in Pakistan, so load-shedding and power-failures are quite common across the country. During the load-shedding hours, street-lights and road-lights are off, which may also increase the risk of more serious MR crashes and injuries during the dark-hours.

In India, Schmucker et al. (2011) also found a high frequency of motorised rickshaw crashes involving pedestrians/cyclists/motorised two-wheeled vehicles during evening and night hours (04:30–10:30pm), and similar trends were recorded in multi-vehicle rickshaw crashes. Past research has also found that road crashes for all drivers (particularly young male drivers) per unit of distance travelled were higher during the hours of darkness, compared to daylight hours (Clarke, Ward, Bartle & Truman, 2006; Laapotti & Keskinen,1998; Ward, Shepherd, Robertson & Thomas, 2005; Williams, 2003).

In the current study, no clear reasons were found for higher rickshaw (both MR and AR) crash trends seen in all three datasets in specific months such as September 2011, December 2012, March 2013 and June 2014). Nevertheless, Tahir et al. (2013) found a higher frequency of road crashes in the month of Ramadan in 2011, and during the other busy festive periods such as Eid celebrations and 14th August (Pakistan Independence Day). This earlier study revealed that about 13,000 road crashes were attended by Rescue 1122 across Punjab in August 2011 (Ramadan), compared with an average of about 11,500 road crashes per month between January and August 2011. Among road crashes reported in Ramadan, almost half of the crashes occurred in peak rush hours (14:00–18:00) before Iftar (breaking the fast) time, and speeding was the most common crash contributing factor identified in these crashes (Tahir et al. 2013).

4.4.6 Ambulance Response Time

Time is a crucial factor in determining the outcomes of road trauma, and an efficient ambulance response and pre-hospital care saves lives and reduces injury severity (Berlin & Liebman, 1974). In about half of MR crashes reported across Lahore in 2014, Rescue 1122 ambulances transported casualties to the hospital in one to seven minutes. This shows the efficiency of Rescue 1122 ambulance service in Lahore, despite the challenge in maintaining an average response time of seven minutes in a highly densely populated city, with high motorization rates and busy traffic conditions.

In about 7% of incidents, the ambulance response time was over 15 minutes in Lahore. Traffic congestion and traffic jams were the two major reasons behind a delayed ambulance response. Delays can result in serious consequences such as death, disabilities or serious injuries. Ambulance response time could be improved by minimizing the traffic delays and congestion through a better traffic management system, and community awareness. An electronic and print media campaign could also play an important role in this respect (Larson, Metzger, & Cahn, 2006).

4.5 LIMITATIONS OF STUDY 1

The limitations of Study 1 are related to: (1) being unable to separate MRs and ARs in Study 1A, (2) the ERF being unsuitable for recording details of more than one casualty and several other limitations, and (3) incomplete information regarding crash locations.

The aggregated data analysed in Study 1A combined MRs and ARs under a common category of 'rickshaws'. To address this limitation, a small Supplementary Study (Appendix B) was conducted, wherein 109 emergency paramedics of Rescue 1122 were asked to estimate the relative frequency of MR and AR crashes in Lahore during 2014. Nearly half of the emergency paramedics estimated that MRs were involved in 81-100% of the rickshaw crashes, and almost 60% reported that ARs were involved in only 1-20% of the rickshaw crashes they attended. These estimates suggested that the majority of rickshaw crashes reported in Study 1A were MR crashes, and therefore the patterns identified in Study 1A largely reflected the patterns of MR crashes rather than AR crashes.

In Study 1B, the crash contributing factors were not well-defined and identified. To address this limitation, the Supplementary Study identified some human and vehicular factors that likely to contribute to MR crashes. Emergency paramedics estimated that MRDs were more often involved in speeding, reckless driving, signal violations, overloading, underage and unlicensed driving than other drivers in crashes they attended across Lahore in 2014. They also noticed more mechanical defects in MRs, compared to other vehicles.

Rescue 1122 uses the same ERF to record information for all emergencies. The form has limited space and variables, and it cannot capture all relevant information for a road crash such as driver, vehicle and environmental characteristics, and it does not code injury severity in terms of accepted international classification. Moreover, only one ERF is used, even in multi-casualty incidents. Therefore, in multi-casualty incidents, there were many missing and unclear values. Similarly, in many cases, there was incomplete information regarding age of MRDs, underage MRDs, or driving licensing status. Likewise, in the aggregated datasets, crash types, injury types and injury severity were not separately coded, and no information was available about moderate and critical injuries and crash severity. The ERFs did not contain the variable 'road user type', so if emergency paramedics did not enter this information manually, it was difficult to differentiate between different road user types (especially passengers) injured in MR crashes. Moreover, data analysed in Study 1A was not consistent in the three-year study periods (2011-2012 and July 2013-June 2014), as Rescue 1122 added new variables over that period of time.

Among the 500 crashes, single vehicle crashes were less than 20% of the total and only a small number of these involved “MR hit footpath due to careless driving”. Therefore, a very much larger sample would have been needed to observe statistical significance.

While many countries have comprehensive police crash data which includes details of the road environment at the crash location, the ERF provides only those location details needed to dispatch the ambulance. These were examined in the study to assess the distribution of MR crashes across Lahore and provided a general understanding about the prevalence of MR crashes in Lahore, and could be used to identify locations for further, more in-depth, research. Road environment features can be important contributors to crash occurrence and severity, particularly for two- and three-wheeled vehicles, so it was unfortunate that this information was not available in the ERFs.

4.6 CHAPTER SUMMARY

Study 1 examined three crash datasets from Rescue 1122 to understand the characteristics of MR crashes. Study 1A showed that during 2011-2012, rickshaws (both MR and AR) accounted for 17% and 9% of the total crashes attended by Rescue 1122 across Lahore and the rest of Punjab, respectively. This revealed that after motorcycles and cars, rickshaws were the third most common vehicle type involved in road crashes across Punjab in the two-year study period. Rickshaw crashes were reported from all 36 districts of Punjab, showing that rickshaws contribute to road crashes throughout the province. Given the province-wide coverage of MRs and limited coverage of ARs, emergency paramedics estimated that most rickshaw crashes reported across Punjab were MR crashes.

The crash location data showed that MR crashes occurred in all major towns and on all road types. Males were over-represented in MR crashes, and young people aged 21-30 years sustained the largest proportion of minor, moderate, critical and fatal injuries. Road users such as MRDs, motorcycle riders, passengers and pedestrians were most commonly involved in MR crashes.

About 84% of MR crashes were multi-vehicle crashes, involving various types of motorized (including heavy vehicles) and non-motorized vehicles. About two-thirds of MR multi-vehicle crashes involved motorcycles and pedestrians, which shows their higher vulnerabilities in MR crashes. The 'MR turned over due to speeding' and MR crashes occurring during darkness (6pm-11.59pm) had 8.7 and 3.4 times, respectively, higher odds for moderate/critical/fatal injuries. Overturning of MRs was reported in almost half of single-vehicle crashes.

Study 1 investigated some determinants under the first four levels of the MR systems model, but mainly it identified factors that lead to AR/MR crashes, injuries and fatalities. This study provides some input to the first three research questions: *What is the size of the MR crash problem? 2. What are the characteristics of MR crashes*? and 3. *What are the characteristics of MRDs that influence the road safety of MRs?*

Study 1A and the Supplementary Study assist to determine the size of the MR crash problem in Lahore and Punjab, while Study 1B describes some of the human, vehicular and environmental characteristics of MR crashes. Study 1 offers baseline data to plan and initiate in-depth studies to further investigate the specific road safety behaviours and practices of MRDs that contribute to MR crashes. The next chapter presents the results of Study 2 of this PhD program.

Chapter 5: Study 2 - Observations of Road Safety Behaviours and Practices of MRDs

Study 1B described some of the characteristics of MR crashes such as demographics of casualties, crash types, crash and injury severity, injury types, how crash occurred, types of vehicles and road users involved, and temporal characteristics. However, due to limitations in the ERFs and recording of road crashes (outlined earlier), this study could not provide comprehensive information about specific behaviours of MRDs that are likely to contribute to road crashes. Therefore, Study 2 was conducted to address Research Question 3 (*What are the characteristics of MRDs that influence the road safety of MRs?)*. It identifies specific road safety behaviours of MRDs that potentially contribute to MR crashes. The results of this study were presented as a full peer-reviewed paper at the Australasian Road Safety Conference held at Brisbane, Australia in October 2015. This paper was published as:

Tahir, M. N., Haworth, N., King, M., & Washington, S. (2015, October). Observations of road safety behaviours and practices of motorcycle rickshaw drivers in Lahore, Pakistan. In *Proceedings of the 2015 Australasian Road Safety Conference*. Australian College of Road Safety (ACRS).

A modified version of the published paper is presented in this chapter. The contents of this chapter include survey design and methodology, results, discussion, limitations of Study 2 and chapter summary.

5.1 METHODOLOGY

5.1.1 **Survey Design and Survey Sites**

An observational survey was conducted in Lahore city. Motorcycle rickshaw drivers were observed at 30 approaches to 12 major signalised intersections located in different areas of Lahore. An ‘approach’ was defined as traffic flow on one side of the road. For instance, if an intersection has four roads leading in different directions, this is counted as four approaches. Similar to most other parts of the world, in

Pakistan, traffic signals have three colours, green, yellow and red. The traffic signal phasing is red-yellow-green-yellow-red. Thus, the yellow signal serves two functions. In the green to red signals phase, it is a warning sign for the driver to be ready to stop. In the red to green signals phase, it is an indication for the driver to be ready to proceed, once the signal changes from red to green.

Before survey commencement, the researcher travelled across the city to identify suitable sites for the survey. After a thorough inspection, 12 sites were selected in different areas of Lahore. The following criteria were used for the selection of the survey sites: intersections and approaches with functional traffic signals; intersections with large numbers of MRs operating; and observer safety, visibility and comfort. All selected survey sites were situated on major roads having three to five traffic lanes.

5.1.2 **Survey Instruments**

Two paper-based survey forms comprising two sides of an A4 size paper were developed to collect the data: (1) Site Details Form, and (2) Vehicle and Driver Behaviours Form (Appendix C). The Site Details Form recorded location details such as site name, address, total number of signalized approaches at the site, number of traffic lanes on each approach, date and time of the day, time of survey commencement and completion, traffic warden present or absent, road type, weather conditions and total MRDs observed at this site. The Site Details Form was completed once for each site, before commencing the observations.

The Vehicle and Driver Behaviours Form (VDBF) was structured into two main parts. The first part recorded vehicular characteristics of MRs such as overall repair and maintenance conditions of MRs *(good, medium and poor)*, any number plate displayed *(yes/no)*, and the number and type of passengers *(adults, school age and pre-school children)* and goods carried *(a lot, moderate, little and none)*.The second part of the VDBF comprised some of the characteristics of MRDs including estimated MRD age *(possibly under 18, clearly under 18, 18-30, 31-40, 41-50, 51-60 and over 60 years)*; mobile phone use while driving *(no, yes-talking, yes-texting, and yes-any other activity with mobile)*; traffic lane use *(left, right and middle)*; colour of traffic signal when MR passed the intersection *(green, red, yellow turning green and yellow turning red)*, and traffic conflicts of MRs. A separate VDBF was completed for each observed MRD.

5.1.3 **Sampling Procedure**

The MRDs were observed by one the author standing close to the MRs at a safe position at a signalized intersection. The focus of the observations was on MRs at the front or rear of the traffic queue, since it was expected that their drivers would be predominantly involved in traffic violations, and they were also easy to observe. Observations were recorded in 30 minute blocks on each approach at different time periods, and after finishing one approach, the next approach was sampled.

Apparent age of MRDs and general repair and maintenance conditions of MRs were determined from their physical appearance, based on the best judgment and experience of the observer. In Pakistan, all motorized vehicles need to display registration plates on the front and rear of the vehicle. However, for MRs, only one registration plate displayed at the front or rear was recorded. It was possible for the observer to record only one number plate in a short span of time. Observations were recorded for a full week in May 2015 between 9am and 7pm. This time period was selected, because the largest number of MRs operate during these times. During the survey week, weather was clear, sunny and very hot.

5.1.4 **Survey Pilot Testing**

Before undertaking the full-scale survey, a pilot survey was conducted to pre-test the reliability, validity and suitability of the survey instrument. In the pilot-phase, 50 MRDs were observed at two study sites in Lahore. Based on the results of the pilot survey, two new items *(number of signalized approaches and traffic lanes)* (as not all approaches had traffic signals and roads had multiple traffic lanes) were added to the Site Details Form, and new categories covering four items *(goods carried, traffic lane use, colour of traffic signal when MR entered/passed the intersection, and movement prior to violation)* were included in the VDBF. All data collection (piloting and full-scale survey) was carried out solely by the researcher.

5.1.5 **Data Analysis**

The data from the paper survey forms were entered into Excel spreadsheets, coded and cleaned for any inconsistencies, and then exported to SPSS (Version 22) for analysis. The data analysis was performed in two steps. First, a descriptive analysis was conducted to understand the general demographics and driving characteristics of MRDs and vehicular features of MRs. The Chi-square Test of

Independence (χ^2) was applied to examine the association (significance level at $p<0.05$) between various categorical variables.

Second, a binary logistic regression was formulated to examine the potential contribution of various demographic, human and vehicular factors to the occurrence of MR traffic conflicts. The binary outcomes 'MR traffic conflict' (Yes=1 and No=0) was set as the response/dependent variable. A set of explanatory/independent variables was included in the model with the 'enter' method. Explanatory variables were selected on the basis of general characteristics of data analysed in the first step, and results of the Chi-square tests. The Hosmer-Lemeshow goodness-of-fit test was performed to assess the appropriateness of the logistic model (Hosmer & Lemeshow, 1989). Odds Ratios (OR) with 95% Confidence Interval (CI) and *P* values were calculated for all predictors or explanatory variables.

5.1.6 **Ethics Considerations**

This study was approved by the 'QUT Human Research Ethics Committee' (approval number 1500000144). Ethical obligations were fulfilled throughout the survey process. No videos or photographs of participants were taken. To ensure the safety of pedestrians and other road users, and to avoid any disruption in the traffic flow, the observer was positioned at an appropriate place. At some survey sites, traffic police were informed about the survey process to gain their confidence and avoid any unforeseen situation.

5.2 RESULTS OF OBSERVATIONS

A total of 500 MRDs were observed at 12 survey sites in the full-scale survey. Only the results of the full survey are presented in this section, under four sub-headings covering survey sites and temporal characteristics; vehicular characteristics of MRs; MRDs age related characteristics and road safety behaviours, and the results of the regression model.

5.2.1 **Survey Sites and Temporal Characteristics**

5.2.1.1 Characteristics of Survey Sites

Figure 5.1 shows some of the roads in Lahore where this survey was conducted. All were major roads (three to five lanes in each direction), including two national highways the Grand Trunk Road (GT Road) and Multan Road. On these roads all kinds of motorized (including heavy vehicles) and non-motorized traffic operate round the clock. The 12 survey sites were sampled along these roads*: GT Road, UET, Gadi Shahu Chowk, Akbar Chowk, Boharwala Chowk, Yateem Khana Chowk, Kadak Nala, Samanabad Chowk, Railway Station, New Campus, Moon Market, Scheme More and MAO College Chowk)*.

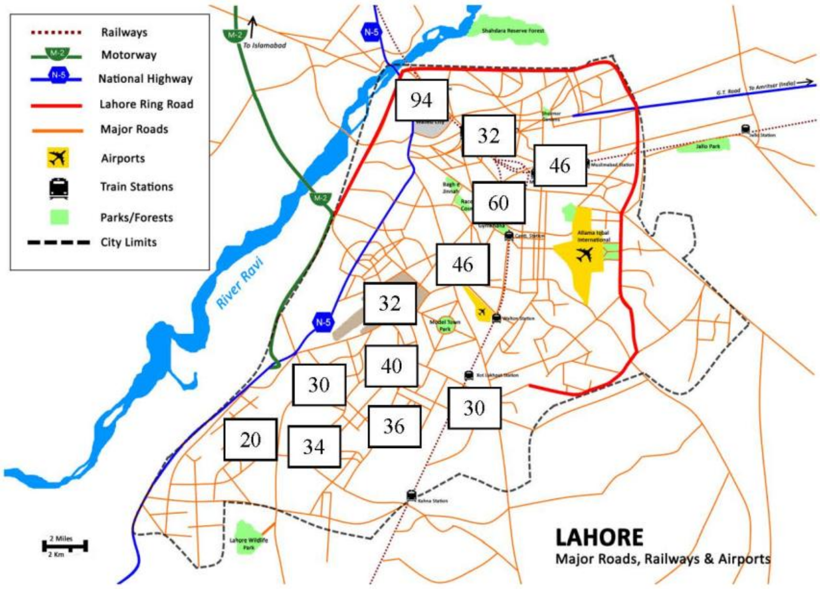

Figure 5.1: Major survey sites or roads in Lahore
(*Figure Source: Lahore Ring Road, 2016*)

The highest number of MRDs (*n*=94) was observed at the GT Road near the University of Engineering and Technology (UET), Lahore, followed by Gadi Shahu Chowk (Chowk is an Urdu word for an intersection) (*n*=60), and Akbar Chowk and Boharwarwala Chowk (*n*=46) (Table 5.1).

During the survey period, a traffic warden was controlling the traffic at four survey sites *(Moon Market, MAO College, Samanabad and New Campus)* and was absent at two sites *(Kadak Nala and Akbar Chowk)*. At five other sites *(Gadhi Shahu, Yateem Khana, GT Road, Boharwala Chowk and Scheme More)*, a traffic warden was present, but was not actively controlling the traffic. At two other sites *(Railway Station and New Campus)*, a traffic warden arrived during the observation period.

Table 5.1: Number of MRDs observed at various survey sites in Lahore

No	Survey Site/Road	No of MRDs observed	%
1	Grand Trunk Road, UET	94	18.8
2	Gadi Shahu Chowk	60	12.0
3	Akbar Chowk	46	9.2
4	Boharwala Chowk	46	9.2
5	Yateem Khana Chowk	40	8.0
6	Kadak Nala, Multan Road	36	7.2
7	Samanabad Chowk	34	6.8
8	Railway Station	32	6.4
9	New Campus, Punjab University	32	6.4
10	MAO College Chowk, Lower Mall Road	30	6.0
11	Scheme More, Multan Road	30	6.0
12	Moon Market, Allama Iqbal Town	20	4.0
	Total	500	100

5.2.1.2 Temporal Characteristics

Table 5.2 presents some temporal characteristics of the survey. The highest number of observations by day was recorded on Monday (*n*=94), followed by Tuesday and Wednesday (*n*=80). Similarly, the highest number of observations by time period was 225 for 9am to 11am, and 146 for 11am to 1pm.

Table 5.2: Temporal characteristics of survey

Day	No of MRD observed	%
Monday	94	18.8
Tuesday	80	16.0
Wednesday	80	16.0
Thursday	60	12.0
Friday	72	14.4
Saturday	52	10.4
Sunday	62	12.4
Total	500	100
Time		
09:00am-11:00am	225	45.0
11:01am-01:00pm	146	29.2
01:01pm-03:00pm	12	2.4
03.01pm-05:00pm	80	16.0
05.01pm-07:00pm	37	7.4
Total	500	100

5.2.2 **Vehicle Characteristics**

Nearly half of MRs appeared to be in 'moderate' (46.2%) or 'poor' (45%) repair and maintenance condition, and only 8.8% appeared to be in 'good' condition. The majority of MRs (98.6%) had a motorcycle registration plate displayed on the front or back of the vehicle, while 1.2% did not have any registration plate displayed, and one seemed to have a fake number plate (Table 5.3).

Table 5.3: Vehicular characteristics of MRs

Characteristics	N	%
MR apparent repair and maintenance condition		
Poor	225	45.0
Moderate	231	46.2
Good	44	8.8
Total	500	100
Number plate display		
Yes	493	98.6
No	6	1.2
Others (Fake)	1	0.2
Total	500	100

Table 5.4 shows the number of passengers and amount of goods carried by the observed MRs. About half (50.6%) of MRs were carrying more than the nominal seating capacity of six passengers: 22.6% were carrying seven passengers, 13.8% had eight passengers, 13.2% had nine to 12 passengers and about 1% were carrying 13 to 15 passengers. Overall, approximately 3,172 passengers were travelling on 500 observed MRs, including 2,734 adults (86.2%), 293 school age children (9.2%) and 145 pre-school children (4.6%). Moreover, about a third (35.6%) of MRs were carrying passengers as well as goods, and 1.2% carried a large quantity of goods as well as passengers.

Table 5.4: Number and types of passengers and goods carried by MRs

Characteristics	N	%
Number of passengers carried *(including children)*		
1-6	247	49.4
7-10	230	46.0
11-15	23	4.6
Total	500	100
Types of passengers		
Adults	2,734	86.2
School-age children	293	9.2
Pre-school children	145	4.6
Total	3,172	100
Goods carried		
A lot	6	1.2
Moderate	9	1.8
Little	178	35.6
None	307	61.4
Total	500	100.0

Table 5.5 summarises the number of passengers carried by MRs across the different survey sites. The prevalence of overloading (7-10 passengers) was highest at GT Road, UET (69.1%) and Gadi Shahu Chowk (63.3%). Extreme overloading (11-15 passengers) was observed around Yateem Khana Chowk (10%) and New Campus areas (9.4%).

Table 5.5: Number of passengers carried by MRs across various survey sites

Survey site	1-6		7-10		11-15		Total	
	N	%	N	%	N	%	N	%
Boharwala Chowk	34	73.9	11	23.9	1	2.2	46	100
Akbar Chowk	28	60.9	15	32.6	3	6.5	46	100
MAO College chowk	24	80.0	6	20.0	0	0.0	30	100
Scheme more	24	80.0	5	16.7	1	3.3	30	100
Yateem Khana Chowk	22	55.0	14	35.0	4	10	40	100
GT Road, UET	22	23.4	65	69.1	7	7.4	94	100
Gadi Shahu Chowk	21	35.0	38	63.3	1	1.7	60	100
Moon Market	19	95.0	1	5.0	0	0.0	20	100
Samanabad chowk	15	44.1	18	52.9	1	2.9	34	100
Kadak Nala	13	36.1	21	58.3	2	5.6	36	100
New Campus	13	40.6	16	50.0	3	9.4	32	100
Railway Station	12	37.5	20	62.5	0	0.0	32	100
Total	247	49.4	230	46.0	23	4.6	500	100

A highly significant association was found between passenger overloading and time of day [$\chi^2(4) = 39.196$, $p<0.001$]. The larger proportion of 7-10 and 11-15 passengers were carried during 9am-11am and 11:01am-3pm, respectively (Table 5.6).

Table 5.6: Association between passenger overloading and time of day

		Number of passengers			
Time of day		**1-6**	**7-10**	**11-15**	**Total**
09:00am-011:00am	N	89	128	8	225
	%	39.6%	56.9%	3.6%	100%
11:01am-03:00pm	N	74	71	13	158
	%	46.8%	44.9%	8.2%	100%
03:01pm-07:00pm	N	84	31	2	117
	%	71.8%	26.5%	1.7%	100%
Total	N	247	230	23	500
	%	49.4%	46.0%	4.6%	100%

5.2.3 Apparent Age of MRDs

Table 5.7 presents various age groups of MRDs observed across different survey sites. Among the MRDs observed, 15.6% were possibly and 7.8% were judged to be clearly under the driver licensing age of 18 years. Nearly a quarter of MRDs (24.2%) appeared to be aged between 18 and 30 years, and around 2% appeared to be more than 50 years old.

Table 5.7: MRDs age groups observed across various survey sites in Lahore

Age group (year)	No. of MRD observed	%
Possibly under 18	78	15.6
Clearly under 18	39	7.8
18-30	121	24.2
31-40	152	30.4
41-50	101	20.2
51-60	4	.8
Over 60	5	1.0
Total	500	100

No significant difference was found in the prevalence of underage MRDs (possibly and clearly under 18) across various survey sites [$\chi^2(2) = 3.62$, $p < .164$]. Similarly, no significant association [$\chi^2(1) = .655$, $p<.418$] was found between overloading (carrying over 6 passengers) and underage MRDs. Both underage (< 18 years) and higher aged MRDs (≥ 18 years) carried almost similar proportions of passengers.

5.2.4 **Road Safety Behaviours and Practices**

5.2.4.1 Traffic Lane Use and Signal Violations

Table 5.8 presents some of the driving and road safety practices of MRDs such as traffic lane use and compliance with the traffic signals, and mobile phone use while driving. It is important to note that MRs are only registered as motorcycles, and therefore they are required by law to travel in the left traffic lane, along with other motorcycles and non-motorized vehicles. However, in this study the majority of MRDs (71.6%) were travelling in the middle traffic lane, while 18% were using the right lane and only 10.2% were in the left lane.

Similarly, only 29.8% of MRs entered or crossed the intersection when the traffic signal was green (legal – *no traffic violation*). More than half (52.6%) of the MRDs entered or crossed the intersection, when the traffic signal was red (traffic violation - *it includes both passing after signal turned red and leaving early before signal turned green*), and 17.4% entered or crossed when the signal was turning from yellow to green (violation) or red (usually legal).

Table 5.8: Traffic lane use and traffic signal violations of MRDs

Characteristics	**N**	**%**
Traffic lane use		
Middle	358	71.6
Right	90	18.0
Left	51	10.2
Missing	1	0.2
Total	500	100
Traffic signal colour when MR passed		
Red (violation - *it includes both passing after signal turned red and leaving early before signal turned green*)	263	52.6
Green (legal)	149	29.8
Yellow turning Red (usually legal)	47	9.4
Yellow turning Green (violation)	40	8.0
Missing	1	0.2
Total	500	100

A highly significant association was found between MRD age and signal violations [$\chi^2(9)= 26.555$, $p<.002$]. The MRDs aged 18-30 years were more often involved in red and yellow turning green signal violations than other age groups (Table 5.9).

Table 5.9: Association between MRD age and traffic signal violation

		Signal colour when MR passed intersection				
MRD age (years)		**Green**	**Red**	**Yellow turning Green**	**Yellow turning Red**	Total
Under 18	N	54	48	5	10	117
	%	46.2%	41.0%	4.3%	8.5%	100%
18-30	N	23	76	13	9	121
	%	19.0%	62.8%	10.7%	7.4%	100%
31-40	N	40	80	15	17	152
	%	26.3%	52.6%	9.9%	11.2%	100%
41 & over	N	32	59	7	11	109
	%	29.4%	54.1%	6.4%	10.1%	100%
Total	N	149	263	40	47	499
	%	29.9%	52.7%	8.0%	9.4%	100%

5.2.4.2 Traffic Conflicts

Given that more than half of MRDs were involved in signal violations, it was unsurprising that 62.8% of MRs had traffic conflicts with other vehicles and pedestrians (Table 5.10). A 'traffic conflict' has been defined as, an observable situation where two or more road users approach each other in space and time in such a way that a crash may occur, unless one of them applies an emergency manoeuvre such as applying brakes, reducing speed, or changing direction (Amundson & Hyden, 1977; El-Basyouny & Sayed, 2013; Gledec, 1996).

The MR traffic conflicts most commonly involved other motorized vehicles such as motorcycles (18.4%), MRs (10%) and cars (2.4%). About 4% of the MR traffic conflicts involved multiple-motorized vehicles (more than two motorized vehicles involved). MR conflicts were also observed with pedestrians (16.4%) and non-motorized vehicles such as animal carts and bicycles (Table 5.10).

One of the MRs hit the rear of a van, but there was no injury and only the van was damaged. Twenty (*n*=20) near-miss collisions were observed that involved MRs and other motorized vehicles (*n*=15) and pedestrians (*n*=5).

Table 5.10: Traffic conflicts observed between MRs and other vehicles

MR traffic conflicts with other vehicles	N	%
None	185	37.0
Motorized vehicles (include): *Motorcycle 92(18.4%), MR 50(10%) Car 12(2.4%), Van 11(2.2%), AR 11(2.2%) & Truck 4(0.8%)*	180	36.0
Pedestrians	82	16.4
Non-motorized vehicles (*animal carts & bicycle)*	32	6.4
Multiple motorized vehicles *(over two vehicles involved)*	20	4.0
Missing	1	0.2
Total	500	100

5.2.4.3 Driving Distractions

Table 5.11 presents other driving behaviours and practices of MRDs such as use of mobile phone and smoking while driving. Around 3.8% of MRDs were observed using a mobile phone *(talking, texting or any other activity with mobile phone);* less than 1% were smoking while driving. No MRDs wore a helmet.

Table 5.11: Driving distractions of MRDs

Mobile phone use	N	%
No	479	95.80
Yes-talking	8	1.60
Yes-texting	1	0.20
Yes-activity	10	2.00
Others *(smoking)*	2	0.40
Total	500	100

5.2.5 **Regression Model Results**

As outlined earlier, a two-step data analysis approach was adopted in this study. In the second step of the data analysis, a binary logistic regression was formulated with a set of six explanatory variables or predictors *(MRD age, signal colour when MR passed the intersection, total passengers carried by MRs, traffic lane used by MRDs, MR repair and maintenance condition, and time of day),* identified in the descriptive analysis. The aim of the logistic model was to examine the potential contribution of identified human, vehicular and environmental factors to the occurrence of MR traffic conflicts (Yes= 1 and No=0).

Table 5.12 presents the results of the regression analysis. Among the six variables examined, only two variables 'signal colour when MR passed the intersection' and 'time of day' were found to be significantly associated with the traffic conflicts. The odds of traffic conflicts were highest when MRs passed at the red signal (OR: 9.535, 95% CI: 5.789-15.705), compared to the green signal. There was a significant (2.6 times) increase in the odds of a conflict, if the signal was crossed on yellow turning green (which is a violation) (OR: 2.543, 95% CI: 1.216-5.317) or yellow turning red (usually legal) (OR: 2.656, 95% CI: 1.312-5.375).

The odds of traffic conflicts were three times higher between 11am and 5pm (OR: 3.262, 95% CI: 1.443-7.374), and between 9am and 11am (OR: 3.108 95% CI: 1.361-7.100), compared to between 5pm and 7pm. Although it is illegal for MRDs to travel in the middle or right lane, the analysis shows that this behaviour did not significantly increase the odds of a conflict occurring. Similarly, being underage was not found to be directly associated with the likelihood of traffic conflicts, after adjusting for the effects of other variables in the regression model.

Table 5.12: Association of various risk factors with MR traffic conflicts in a binary logistic regression model

Explanatory variables	Categories	Beta	*p*-value	OR	95% CI Lower	95% CI Upper
MRD age (years)	1-17	-.272	.391	.762	.409	1.419
	18-30	.030	.927	1.030	.541	1.964
	31-40	-.143	.633	.867	.481	1.560
	Above 41=0	Reference				
Signal colour when MR crossed the intersection	Red	2.255	.000	9.535	5.789	15.705
	Yellow turning Green	.933	.013	2.543	1.216	5.317
	Yellow turning Red	.977	.007	2.656	1.312	5.375
	Green =0	Reference				
Total passengers carried by MR	7-10	.160	.482	1.173	.752	1.830
	11-15	-.750	.150	.472	.170	1.313
	1-6=0	Reference				
Traffic lane used by MRD	Right	-.088	.830	.916	.409	2.050
	Middle	-.321	.351	.725	.369	1.424
	Left=0	Reference				
MR repair & maintenance condition	Poor	.342	.120	1.408	.915	2.167
	Medium/Good=0	Reference				
Time of day	9am- 11am	1.134	.007	3.108	1.361	7.100
	11:01am- 5pm	1.182	.004	3.262	1.443	7.374
	5:01pm- 7pm	Reference				

5.3 DISCUSSION

Study 2 aimed to address Research Question 3: *What are the characteristics of MRDs that influence the road safety of MRs?* This section discusses the major findings of the current study in terms of five major levels of the MR systems model, general characteristics of MRDs and MRs found in the descriptive analysis, and the outcomes of the regression analysis.

5.3.1 MR Operation on Major Roads

This survey was conducted along major roads in different areas of Lahore. The operation of MRs on major roads in Lahore indicates that they are exposed to diverse and busy traffic conditions that may increase the likelihood of traffic conflicts and road crashes. The findings of the current study support this contention, as MRs were frequently involved in traffic conflicts. Similarly, the crash location data in Study 1B, and crash estimates of Rescue 1122 emergency paramedics (Supplementary Study) also show that MRs were involved in road crashes throughout Lahore. Moreover, operation of MRs on all road types in Lahore suggests that an informal network of MRs has extended across the city, and the government is unable to plan and regulate it.

5.3.2 Underage MRDs

Almost a quarter of MRDs observed in this study appeared to be underage drivers across all survey sites. This shows that traffic monitoring and enforcement is weak in Lahore. Lahore is the provincial capital and second largest city of Pakistan, and police enforcement is higher than elsewhere in Punjab. This suggests that the prevalence of underage MRDs in small cities, towns and villages of Punjab, where minimal or no police enforcement exists, could thus be even higher.

All underage MRDs observed were unlicensed drivers. The illegal operation of underage MRDs under busy traffic conditions in Lahore corresponds to a risky scenario that is likely to increase their involvement in road crashes. However, in the current study, compared to higher aged MRDs, underage drivers were less likely to be involved in signal violations and traffic conflicts. Given that traffic violations and conflicts increase the likelihood of road crashes, the lesser involvement of underage MRDs in these indicates their lower crash risk than older MRDs. This may be due to the fact that as young, less experienced MRDs, with the responsibility of carrying passengers on major roads, they might be more vigilant and careful drivers than their senior fellows. Nevertheless, road crashes result from a complex interaction of human, vehicular and environmental factors, which interact in different ways under various driving situations (Brown, 1990; Evans, 1985; Fuller, 1984; Huang, Ljung, Sandin & Hollnagel, 2004; Stuckey et al., 2007; Ranney, 1994). Therefore, crash risk assciated with underage MR driving will be further assessed in the later studies of the current research.

5.3.3 **Road Safety Behaviours and Practices**

5.3.3.1 Overloading

About half of observed MRs were overloaded with 7 to 15 passengers (including children). Passenger overloading was observed along all survey sites, and throughout the day in Lahore. However, it was more commonly noticed on the GT Road and between 9am and 1pm. This is probably due to the fact that a larger proportion of MRs were observed on the GT Road during 9am-1pm, which includes school, office and business hours, with the maximum mobility of people on the roads.

The literature review and the observations undertaken in the current study suggest that there are two main reasons for overloading of MRs: (1) the MR is an unregulated and unregistered public transport vehicle in Lahore. The absence of regulations and operational parameters for MRs are likely to encourage them to carry extra passengers or loads. (2) Analysis of the survey sites suggest that MRs cover long routes in Lahore *(e.g. Multan Road and GT Road - around 15 km and 11 km long routes, respectively)* and operate along densely populated and congested areas as such as *Shahdra, Begum Kot, River Ravi, Minar-e-Pakistan, Railway Station, Singpura, Baghbanpura, Darogawala, Jalo, Attari*. Most of these areas are characterized as low and middle socioeconomic areas (Shirazi & Kazmi, 2014), where family size is usually large and people cannot afford any other transport mode and they prefer to travel together. An MR is cheaper (15-20 Rupees/trip/person) than other modes, and also offers some flexibility to accommodate extra passengers.

Evidence from other LMICs also indicates that overloading is a common practice in the informal sector (Guillen & Ishida, 2004; Jayatilleke, Poudel, Dharmaratne, Jayatilleke & Jimba, 2015; Kumar, Singh, Ghate, Pal & Wilson, 2016;

Regidor et al., 2009; Sengers & Raven, 2014; Shimazaki & Rahman, 1996). For instance, in a recent study, Kumar et al. (2016) investigated the operational characteristics, roles and contributions of various informal public transport modes *(mini-bus, Tata Magics, Mahindra Gios and other similar vehicles, three-wheeled motorized autorickshaw, non-motarized cycle-rickshaw, Chakdas and Kadukas)* operating in five cities *(Amritsar, Jaipur, Noida, Ahmedabad-Gandhinagar, and Sanand-Viramgam)* of India. It was found that overloading was commonly practised among all informal modes operating across five cities, and on average, informal modes were carrying twice as many passengers as their original seating capacity permitted. The deficiency of formal public transport services, inadequate law enforcement, and the profit-making motives of operators were identified as the major underpinning factors for overloading (Kumar et al., 2016).

The current research did not find a significant association between overloading and traffic conflicts. On account of the extra weight of MR occupants, overloaded MRs are likely to operate at lower speed compared to those which are not overloaded. Similarly, on green signal-phasing, the reaction time of overloaded MRs might be slower than other vehicles, which may prevent collisions with other vehicles. However, previous research has shown that overloading increases the crash risk. For instance, Jayatilleke et al. (2015) investigated the crash contributing factors in road crashes involving for-hire three-wheelers in Kandy, Sri Lanka during 2008-2009. The study found that overloaded three-wheelers were eight times more likely to be involved in road crashes, compared to those which were not overloaded. Similarly, Schmucker, et al. (2011) examined the crash and injury patterns in crashes involving motorized three-wheeled rickshaws *(with seating capacity of three adults or six children)* in Hyderabad, India. Among the crash-involved rickshaws, overloading of over three, four to six and seven to 15 passengers was found in 50%, 36% and 14% cases, respectively. Moreover, overloading increases the potential for multiple casualties in crashes, and several newspapers from across Pakistan have reported multi-casualty crash incidents, where MRs appeared to be overloaded (*The Associated Press of Pakistan,* 2015; *The Dawn*, 2013b, 2015c, 2017; *The Express Tribune*, 2015a; *The Jang*, 2015, 2017; *The People's Daily Online*, 2007).

5.3.3.2 Signal Violations and Traffic Conflicts

This survey was conducted at major signalized intersections in Lahore. Intersections are an important element of the road network, which connect two or more roads to facilitate traffic flow in different directions (Young, Salmon & Lenné, 2013). Conversely, they are also one of the most dangerous parts of the roadway system, as they represent the converging points of traffic and all road users, which increase the likelihood of traffic conflicts and road crashes (Young et al., 2013). In this study, more than half of MRDs crossed the intersection on the red signal and on yellow before the light had turned green. Red signal violation was associated with a ten-fold increase in the odds of a traffic conflict, while leaving when the signal was turning from yellow to red, and yellow to green both increased the odds by about 2.5 times. Most MRDs were noncompliant with traffic signals, resulting in their frequent traffic conflicts with other vehicles.

Frequent involvement of MRDs in signal violations and traffic conflicts shows their risky behaviours, which increase the risk of MR crashes at intersections. Noncompliance with traffic signals results in traffic violations that could lead to traffic conflicts and road crashes (Parker et al., 1992; Papaioannou, 2007; Retting, Ulmer & Williams, 1999). For instance, in Australia, most urban crashes and a large proportion of rural crashes occur at intersections. It was found that in Victoria, Australia, during 2001 to 2005, 58% of bicycle crashes, 47% of car and pedestrian crashes, and 38% of motorcycle crashes occurred at intersections (McLean, Croft, Elazar & Roper, 2010; VicRoads, 2011; Young et al., 2013). In the USA, red light running contributed around 260,000 road crashes every year (Elmitiny, Yan, Radwan, Russo & Nashar, 2010; Retting, Chapline & Williams, 2002). Red light running crashes are more likely to result in injuries, compared to other crash types. It was found that 45% of red light running crashes were injury crashes, compared to 30% of other crash types (Retting, Williams, Preusser & Weinstein 1995; Retting et al., 1999).

In the current study, approximately half of red light running MRDs appeared to be aged less than 30 years, and they were involved in about half of observed traffic conflicts (MRDs aged <18 were less involved and 18-30 were more involved). Age has been found to be a safety factor in other studies. Retting and Williams (1996) compared the demographics and driving history of red light runners, and drivers who had the chance to run a red light at the same intersection, but they did not. The comparison showed that most red light runners were young drivers (<30 years), had a poor driving history, three times more prior multiple speeding violations, and low use of seat-belts, compared to drivers who stopped at a red signal (Retting & Williams, 1996). Moreover, Retting et al. (1999) found that red light runners were much more likely to be driving under the influence of alcohol or drugs, and with suspended, revoked, or invalid driving licences. The demographics and driving profile of red light runners in the current study broadly corresponds with the findings of Retting & Williams (1996) and Retting et al. (1999), if <18 MRDs are excluded.

Because of the site locations, heavy traffic volume and larger exposures of MRs with other vehicles, might have increased the frequency of signal violations and traffic conflicts. Moreover, the focus of observations was the MRDs who were in front and rear traffic queues, and they were more often involved in traffic violations than MRDs in the middle queues. This might have also increased the frequency of their traffic violations. Past research shows that safety at signalised intersections depends on a number of factors such as site layout, traffic volumes, phasing and the timing of the traffic signal, weather and road conditions and the driver's behaviour (Elmitiny et al., 2010; Koll, Bader & Axhausen, 2004; Papaioannou, 2007; Parker, Manstead, Stradling & Reason, 1992). Zhou & Sisiopiku (1997) found that in traffic conflicts analysis, traffic volume and exposure are important factors that affect the frequency of traffic conflicts and road crashes. Red light running rate and crash risk would likely increase at intersections with a high traffic volume (Elmitiny et al., 2010). With a high traffic volume, at the onset of the yellow signal, drivers are likely to be in a following position in the long traffic stream (Elmitiny et al., 2010). Research also showed that crash rates are likely to increase with heavy traffic volume, speeding, more traffic lanes, urban roadway sections, and where there is a narrow shoulder width and reduced median width (Abdel-Aty & Radwan, 2000; Milton & Mannering, 1998).

In this study, about one-third of MR traffic conflicts involved motorcyclists and pedestrians, reflecting their greater exposure and interactions. In MR-motorcycle conflicts, the behaviour and practices of MRDs and motorcyclists were equally important. It was observed that compared to other drivers, MRDs and motorcyclists were mostly non-compliant with traffic signals (leaving early or late exit) resulting in their frequent conflicts. Moreover, all survey sites had a high traffic volume of MRs and motorcycles, probably constituting more than half of all vehicles on the roads along the survey sites. Therefore, in addition to the risky driving behaviours of MRDs and motorcyclists, their large numbers also contributed to their high number of interactions. Given the large number of motorcycles and MRs across Pakistan, and almost similar traffic patterns as observed in Lahore in other large cities of Pakistan, the findings of this study suggest a higher risk of MR-motorcycle conflicts and crashes across the country. The results of earlier studies (Study 1 and Supplementary Study) also support these findings.

In MR-pedestrian conflicts, underpinning factors can be categorized into two major types, ‘behavioural’ and ‘environmental’. Among behavioural factors, the road safety behaviours of MRDs and pedestrians both contributed to their frequent exposures and conflicts. For instance, MRDs violated pedestrians’ right-of-way by leaving early or late, after the onset of green-walking for pedestrians. On the other hand, some pedestrians were observed walking after the onset of the red signal (i.e. red-walkers), resulting in their conflicts with MRs. Signal violations and pedestrian red walking are unsafe and risky behaviours, which increase the likelihood of pedestrian injuries and fatalities (Elmitiny et al., 2010; Gårder, 1989; Parker et al., 1992; Papaioannou, 2007; Retting and Williams, 1996; Retting et al., 1999, 2002). Pedestrian safety is already critical in Pakistan. A recent study that examined the Rescue 1122 crash data from 37 major cities of Punjab, reported a total of 76,737 pedestrian injuries and 1,577 fatalities across Punjab during the last two-year period (July 2013-June 2015) (Tahir, Akbar, Kayani, Al-Ramadhani, Haworth, King & Naseer, 2016). This study also revealed that the largest proportion of these injuries and fatalities were reported in Lahore (Tahir et al., 2016).

There are many environmental factors which are likely to influence the safety of MRDs and pedestrians, including *road engineering, intersection design and geometry, vehicle safety standards, traffic calming measures, and appropriate road safety laws and policies* (Gandhi, & Trivedi, 2007; Gårder, 1989; Retting, Ferguson & McCartt, 2003). In the current study, it was observed that all of the surveyed intersections had pedestrian crossings or zebra-crossings, but none had exclusive pedestrian signals that could completely separate pedestrians from motorized vehicles. The signal timing and phasing also did not appear to be appropriate to ensure the safe movement of all road-users under busy and mixed-traffic conditions. The concept and awareness of the use of zebra-crossings also appeared to be deficient among pedestrians and other road-users. All of these factors are likely to contribute to the high MR-pedestrian exposure and conflicts.

The high involvement of MRDs in signal violations and traffic conflicts was also a consequence of weak traffic control across the survey sites. Traffic police were present at the majority of the survey sites, but most were not actively controlling the traffic. They were standing in concealed spots or on corners of the roads to catch drivers (mainly motorcyclists) to issue traffic tickets. The absence of any vigilant traffic enforcement probably encouraged MRDs to engage in risky behaviours such as red light running. Active enforcement could be a deterrent factor in influencing risky road safety behaviours and practices of MRDs, but due to limited observations (n=12) this variable (i.e. presence/absence of traffic warden on traffic signal) was not examined in the regression analysis. These influences and behaviours will be thoroughly examined in Study 3.

5.3.3.3 Other Road Safety and Traffic Violations

About 4% of MRDs were observed involved in various driver distraction activities such as using handheld mobile phones and smoking while driving. These behaviours would be likely to increase the risk of traffic conflicts and road crashes. However, due to the low frequency of these behaviours, their contribution to traffic conflicts could not be examined in the regression analysis.

None of the observed MRDs wore helmets. The MRDs are required by law to do so, because MRs are classed as motorcycles, and motorcyclists have to wear helmets. However, autorickshaw drivers do not have to wear a helmet, and the lack of any clear rules or guidelines for MR operation in Pakistan, makes the classification of MRs, and hence the helmet requirement for MRDs, ambiguous. On the other hand, helmet wearing rates are very low (around 10%-15%) even among motorcyclist riders in the general driving population (Ahmed, 2007; Hashmi et al., 2012; Hyder et al., 2000; Tahir et al., 2012, 2013).

Motorcycles of MRs need to be registered, yet it was observed that a few MRs (n=7) had no motorcycle registration plate or were displaying a fake plate. Nevertheless, they were operating on major roads in Lahore and were not approached by enforcement authorities. However, due to limited observations, any conclusion about the exact prevalence of the unregistered MRs or MRs with fake number plates cannot be drawn at this stage. More information will be collected in Study 3 of this research.

5.3.4 Vehicle Characteristics

More than 90% of observed MRs were not in good physical condition, and their repair and maintenance seemed to be compromised. Compromised repair and maintenance of most MRs may be a consequence of their long operating times with passenger and goods overloading; irregular maintenance; MRDs' low-earning capacity due to saturation of MRs on all routes; and lack of ownership by drivers, as many MRDs do not own their vehicles (Khawaja, 2011, Siddiqui, 2014; Sarfraz & Hussain, 2010). The socioeconomic characteristics, vehicle maintenance routine and work patterns of MRDs will be thoroughly examined in the subsequent studies.

In addition to compromised safety features, it was observed that many MRs were modified to increase their passenger and loading capacity. Modified MRs were observed across all survey sites in Lahore. The absence of any regulatory mechanism and vehicle fitness criteria for MRs are likely to allow MRDs to make various modifications. The MR design and structural modifications, coupled with their compromised repair and maintenance conditions, may increase mechanical problems in MRs and their involvement in road crashes. The results of Study 1B support these findings, as some single-vehicle crashes (n=17) were reported due to mechanical problems.

5.4 LIMITATIONS OF STUDY 2

It is evident from the results of the current study and previous studies that MRs operate in all major towns of Lahore. However, the data for this study were not collected from all major towns, due to the following survey site selection criteria: (1) MRDs were only observed at sites with signalized approaches; (2) traffic signals were functional (although sometimes signals were off due to load-shedding or being out of order); (3) traffic signals operating automatically (although in some situations traffic wardens switch off the traffic signals for manual control of the traffic); and (4) sites have maximum MR operations.

The age of MRDs was judged from their physical appearance, and given that short observation time, the age groups observed should be considered as an approximation only. This limitation also applies to the observations recorded on the repair and maintenance conditions of MRs. Further, while observing MR overloading, some passengers might have been missed, particularly in situations where there were many small children travelling with a family.

The majority of MRDs were frequently involved in various traffic and road safety violations; however, due to time constraints, it was difficult to observe all MRDs at the same time. Therefore, MRDs at the front and rear ends of queues were mostly observed. There is a likelihood that the percentage of MR traffic conflicts would have been inflated, as this survey was conducted at signalized intersections, where maximum numbers of MRs and other vehicles were operating.

5.5 CHAPTER SUMMARY

This chapter presented the results of an observational survey conducted in Lahore to gain a better understanding of road safety behaviours and practices of MRDs. Survey results show that nearly a quarter of MRDs appeared to be underage drivers, yet they were operating on the major roads and carrying passengers (including children) across the city. More than half of the MRDs were involved in various traffic violations such as red signal violation and leaving before the signal turned green that resulted in their frequent traffic conflicts with other vehicles. Red signal violation was associated with a ten-fold increase in the odds of a traffic conflict, while leaving when the signal was turning from yellow to red and yellow to green both increased the odds by about 2.5 times.

Motorcycle rickshaws had traffic conflicts with various types of motorized (including heavy vehicles) and non-motorized vehicles, and traffic conflicts increase the risk of road crashes. About one-third (34.8%) of MR traffic conflicts involved motorcyclists and pedestrians. This suggests that the vulnerability of other road users has increased with the growing numbers of MRs in Lahore. About half of MRs were overloaded with 7 to 15 passengers, which increases the potential for multiple casualties in road crashes. Overloading was observed throughout the day across all survey sites. Moreover, none of the MRDs wore a helmet, and about 4% were involved in driving distraction activities such as using mobile phone while driving.

This study has addressed Research Question 3: *What are the characteristics of MRDs that influence the road safety of MR?* and it provides real-time observational data to identify some specific road safety behaviours and practices of MRDs that potentially contribute to road crashes. The results of this study support and supplement the Study 1 findings, and it informs Study 3 to further investigate other human, vehicular and environmental factors that contribute to MR-related road trauma in Lahore. The next chapter presents the results of Study 3.

Chapter 6: Study 3: Road Safety Knowledge, Attitudes and Practices of MRDs

Chapter 6 presents the results of Study 3, which specifically addresses Research Question 3: *What are the characteristics of MRDs that influence the road safety of MRs?* The main objective of this study is to gain a comprehensive understanding of the sociodemographic characteristics, work patterns and driving practices of MRDs to better understand the factors underlying their crash involvement and observed behaviours in Study 2.

This chapter is structured into four sections. Section 6.1 describes the study methodology that includes the development of the study questionnaire, study design, pilot testing and data analysis. Sections 6.2 and 6.3 present results and discussion on the main findings. The final section (Section 6.4) presents the limitations of this study and chapter summary. An abstract of this study was presented at the International Conference on Traffic and Transport Psychology (ICTTP) held in Brisbane, Australia in August 2016.

6.1 METHODOLOGY

6.1.1 Development of Survey Questionnaire

The MR systems model provided the framework for developing the questionnaire for Study 3. The survey questionnaire examined some determinants from the first four levels of the MR systems model. Specifically, it examined the majority of determinants under the ‘MR crash, injury and fatality level’ including MR crash characteristics, MRD demographic and socioeconomic characteristics, MRD driving characteristics, and MRD road safety behaviours and practices.

The development of the questionnaire involved an extensive literature review, gathering information and concepts from the findings of Studies 1 and 2. The researcher’s extensive field exposure while observing MRDs in Lahore was particularly important in designing an appropriate survey instrument to study a population, where most study participants were uneducated. An attempt was also made to minimize the limitations of self-reported data such as socially desirable responses, under-reporting and over-reporting of incidents and violations. The survey questionnaire comprised five major sections: sociodemographic characteristics; driving characteristics and work patterns; vehicle characteristics; road safety knowledge, attitude and practices; and road crash experience and traffic violations of MRDs. Altogether the questionnaire consisted of 37 main questions (containing 88 items), asked under five major sections (Appendix D).

6.1.2 Study Design and Sampling Procedure

A cross-sectional survey using a structured questionnaire was conducted in Lahore. Given that MRDs are often busy and it is difficult to engage them, convenience sampling was used to recruit them from various MR terminals or parking stands across Lahore. Being an informal transport mode, MRs do not have fixed terminals, but have established makeshift terminals. About 320 MRDs were approached, and 16 refused to participate in the survey.

Motorcycle rickshaws are particularly concentrated near bus stops and terminals, railways station, educational institutes and markets. They also occupy many pedestrian paths and service lanes. At some places they operate from fixed points such as the Railway Station and RA Bazar, but mostly they operate all along the roads, depending on the number of passengers and MRs on a specific route.

The MRDs mainly operate in two ways: (1) waiting in an MR queue for their turn to load passengers, and (2) operating independently, moving along the road to find passengers. Given that it is difficult to intercept a moving MRD, most participants for this study were recruited from MR queues.

Most survey sites were pre-identified by the researcher, while conducting the observational survey. The site selection criteria included: high number of MRs operating on a particular route; MRDs in queues to load passengers (some not queued were also interviewed, if they agreed to participate); convenience of MRDs and interviewers; and a safe location without disturbing the traffic flow. Only MRDs with at least one year of MR driving experience were recruited.

Motorcycle rickshaw drivers were interviewed on their own MRs, so that before documenting their responses related to various vehicle features (headlights, signals, music system etc.), the overall repair and maintenance condition of vehicle could be observed. This strategy was used to minimize socially desirable responses and supplement the self-report data with some observational data. Moreover, before asking MRDs about their illegal behaviours and driving practices (speeding, red light running, overtaking), the following statement was used to minimize socially desirable responses:

Please remember that no one is perfect in this world. All of us make mistakes (intentional/unintentional) or bend the rules. Therefore, please answer these questions honestly in view of your experience as an MR driver. There is no right or wrong answer.

6.1.3 **Recruitment and Training of Research Assistants**

Three undergraduate students of transportation engineering were recruited from the University of Engineering and Technology (UET), Lahore, to assist with interviewing MRDs. The research assistants were trained on the survey instrument, data collection procedure, accurate recording of responses, safety issues and research ethics by the researcher. Moreover, before commencing the interviews independently, the research assistants attended some interviews with the researcher to fully comprehend the ways to approach MRDs and ask them various questions.

Additionally, throughout the survey process, the researcher remained in the field to ensure smooth, efficient and valid data collection. Before starting the data collection each day, a short meeting was organized to discuss any problems faced while conducting the survey, and how to manage them. Approximately half of the data collection for this study was conducted solely by the researcher.

Given that all research assistants were students of transportation engineering, and were familiar with the terminology commonly used in road safety, the original English version of the questionnaire was used to interview MRDs. However, questions were asked in Urdu or Punjabi languages, depending on the preference of MRDs. Most MRDs were illiterate, therefore interviewers read out the survey questions to them, before documenting their responses.

The survey was conducted in November-December 2015 between 9am and 4pm. During the survey period, the weather was cold, mostly sunny and clear in Lahore. Noise and air pollution levels were quite high in the surveyed areas. Under these conditions, it was a quite challenging task to conduct a road-side survey.

6.1.4 **Pilot testing**

Before undertaking the full-scale survey, a pilot study was conducted to pre-test the reliability and validity of the survey instrument. Twenty (*n*=20) MRDs were interviewed at one location in Lahore (MAO College Sanda Road). Pilot results showed strong evidence of answers affected by social desirability, particularly in responses related to illegal or risky driving behaviours (Sections 3-5 of the questionnaire). Therefore, some questions which were not providing useful information were deleted and some were re-worded. Deterrence is an important concept in traffic psychology and criminology, and is useful in predicting the avoidance or committing of an unlawful behavior (Homel, 1987; Watson, 2004). Therefore, some items regarding the effect of policing (e.g. *I slow down when traffic police/warden is present*, *I violate the rules when traffic warden is not present* etc.) and enforcement (*impose fines without reason* and *impose unnecessary checks*) were added.

The pilot study found that many MRDs were not originally from Lahore, but came for work purposes, so this question was added under the sociodemographic characteristics of MRDs. Similarly, it was observed that many MRs have music systems and modified motorcycle exhaust mufflers known as ‘Dolkhi’. Therefore, questions related to music systems and Dolkhi were also added.

6.1.5 **Data Analysis**

A total of 304 MRDs were interviewed in the full survey, but 300 completed questionnaires were included in the final analysis, due to some missing data. The data were first entered into Excel spreadsheets, coded and cleaned for any inconsistencies. A two-stage data analysis approach was used. First, a descriptive analysis of data was conducted to understand the general sociodemographic and driving characteristics of MRDs and vehicular features of MRs. Second, a binary logistic regression was formulated to examine the potential contribution of various sociodemographic, human and vehicular factors in MR crashes. The binary outcomes ‘MRD involved in a crash’ (Yes=1) and ‘MRD not involved in a crash’ (No=0) was set as the response/dependent variable. A set of explanatory/independent variables were included in the model with the ‘enter’ method.

Road safety knowledge, attitude and practices of MRDs were assessed using a five point Likert Scale: strongly disagree=1, disagree=2, neither agree nor disagree=3, agree=4 and strongly agree=5. Similarly, the frequency of a certain driving violation or behaviour was also assessed using a five point Likert Scale: never=1, rarely=2, sometimes=3, often=4 and always=5. The mean and standard deviations (SD) of all responses were calculated to interpret the results. Moreover, an "Independent Samples T-Test" was applied to compare the means of two independent groups "MRD involved in crashes/crashed-group" and "MRD not involved in crashes/Non-crashed group". The independent samples t-test compared the statistical significance of two groups (crashed and non-crashed group) against the test variables such as MRD road safety behaviours and practices, or traffic violations. Levene's F Test for Equality of Variances was applied (at the alpha value of $p<0.5$) to examine the assumption of homogeneity of variance, and values under "Equal variances not assumed" were used to interpret the t-test results (Sedgwick, 2010). All statistical analysis was performed using SPSS Version 22 software.

6.1.6 **Ethics Considerations**

This study was approved by the QUT Human Research Ethics Committee (approval number 1500000737). Ethical requirements were fulfilled during the survey process. All information regarding study objectives and ethics requirements were shared with MRDs. They were informed that the information would only be used for research purposes. Participation was voluntary, and they did not need to answer any question they were not comfortable with. Only those MRDs who expressed their verbal consent to participate were finally recruited. To recognise their contribution and time, a small cash reward of AU$2 (around 150 Pakistani Rupees) was offered to them at the completion of each interview. This was roughly equivalent to the amount they would earn during the time they took to complete the survey.

6.2 RESULTS

This section presents the results of the full scale survey; the pilot results are not included. The analytical framework of the MR systems model was used to describe the study results under seven sub-headings: survey site characteristics; MRD sociodemographic characteristics; MRD socioeconomic characteristics; MRD driving characteristics and work patterns; vehicular characteristics of MR; road crashes and traffic violations and road safety knowledge, attitudes and practices of MRDs.

6.2.1 **Characteristics of Survey Sites**

This survey was conducted at 18 major operational sites or routes of MRs in different areas of Lahore (Figure 6.1). Motorcycle rickshaw drivers were recruited from various MR terminals or queues, which were irregularly scattered across the survey sites (Figure 6.2).

The largest number of MRDs (*n*= 36) was interviewed at Shalimar Chowk, followed by Railway Station and Saggian Bund Road (*n*= 33) (Table 6.1). These sites are located on major roads, having busy traffic conditions. All survey sites were located in different city areas, and most of them represent highly populated low and middle income areas, where the MR is a major public transport mode for all segments of the society.

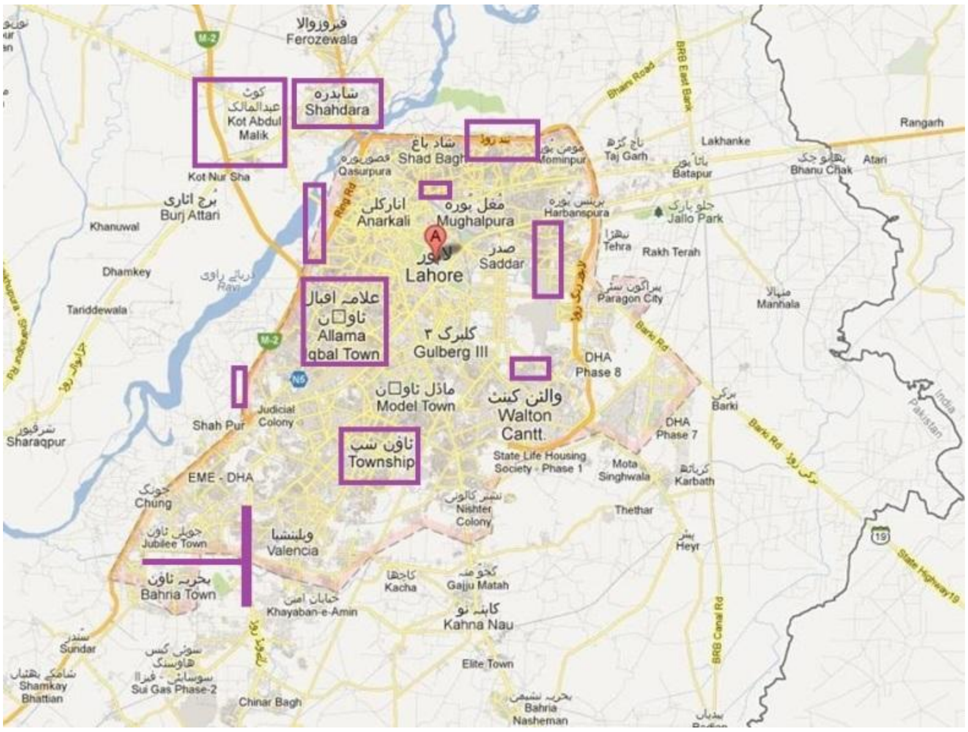

Figure 6.1: Lahore map showing major survey locations and roads
(*Source: Pakimag, 2016*)

Figure 6.2: A typical view of an informal MR terminal at Darbar Station in Lahore
(*Source: Author, 2016*)

Table 6.1: Survey locations in Lahore

No	Survey site	No of MRDs interviewed	%
1	Shalimar Chowk	36	12.0
2	Railway Station	33	11.0
3	Saggian Bund Road	33	11.0
4	Bhatti Chowk	30	10.0
5	Minar-e- Pakistan	25	8.3
6	Singhpura, GT Road	16	5.3
7	Shahdra, Begum Kot	15	5.0
8	Tokar Niaz Baig	14	4.7
9	Akbar Chowk	13	4.3
10	Shahdra, GT Road	13	4.3
11	Batti Chowk	12	4.0
12	Gulshan Ravi	12	4.0
13	Yateem Khana Chowk	12	4.0
14	Larri Adda	11	3.7
15	Scheme More	10	3.3
16	Tokar, Raiwind road	5	1.7
17	Tokar, Bahria Town Road	5	1.7
18	Tokar, Multan Road	5	1.7
	Total	300	100.0

'Chowk' is the Urdu term for an 'intersection'

6.2.2 Sociodemographic Characteristics

Sociodemographic characteristics of MRDs such as their gender, age group, education status, marital status, family members, house ownership, and residential status are presented in Table 6.2. All MRDs (*n*=300) were males and their ages ranged from 10 to 70 years (Mean age=27 years, SD=±11). About one-third of MRDs (36%) were aged 18 to 25 years, and about a quarter (24%) was aged 26 to 35 years. Underage MRDs (under 18 years) comprised 18% of the total participants, and they were divided into three age groups (1-9, 10-13 and 14-17 years) to gain a better understanding of their demographics.

More than half of the MRDs (52.3%) had no formal education, and 19.7% had only primary school education. Over half of the MRDs (58.3%) were married, and over 70% were supporting more than six family members. Nearly two-thirds of the MRDs (62.7%) rented a house, and some (1%) had no house in Lahore, and they were sleeping in their MRs (Table 6.2).

More than 40% of the MRDs were non-locals, temporarily living in Lahore for work purposes. Non-local MRDs were from 22 different districts/cities of Pakistan, including 20 districts/cities of Punjab and one each from the Khyber Pakhtunkhwa (KPK) and Sindh Provinces of Pakistan. With regard to the general health status of MRDs, about half of MRDs (50.6%) reported their health status as 'fair' or 'poor' (Table 6.2).

6.2.3 Socioeconomic Characteristics

Socioeconomic characteristics of MRDs such as their average daily income and take-home income and MR ownership status (rented/owned/leased) are presented in Table 6.3. A high proportion of MRDs (41%) were operating rented vehicles and 36% owned their MRs. Nearly a quarter (23%) had purchased their MRs from a private company on monthly instalments or lease. Among those who had rented MRs, 33.3% of them were paying Pakistan Rupees (PKR) 300 per day; 29.3% were paying PKR 400 per day; and 19.5% were paying PKR 500 per day to the MR owners. Similarly, among MRDs with leased MRs, about three-quarters (75.4%) were paying PKR 1,000 to 5,000 per month, and 21.7% were paying 5,000 to 10,000 PKR per month.

Table 6.2: Sociodemographic characteristics of MRDs

Variable	N	%	Variable	N	%
Age groups (years)			**Non-local MRD permanent residence place**		
1-9	0	0.0	***From province of Punjab, Pakistan***		
10-13	2	0.7	Kasur	29	22.3
14-17	52	17.3	Faisalabad	24	18.5
18-25	108	36.0	Sheikupura	20	15.4
26-35	72	24.0	Gujranwala	8	6.2
36-45	41	13.7	Narrowal	8	6.2
46-55	20	6.7	Okara	8	6.2
56-65	4	1.3	Vehari	7	5.4
>65	1	0.3	Nankana Sahib	4	3.1
Total	300	100	Sahiwal	3	2.3
Marital status			Arif Wala	2	1.5
Single	124	41.3	Bahawalnagar	2	1.5
Married	175	58.3	Khanewal	2	1.5
Divorced/Widowed	1	0.3	Muzaffargarh	2	1.5
Total	300	100	Pakpattan	2	1.5
No of Family members			Toba Tek Singh	2	1.5
1-5	86	28.7	Bahawalpur	1	0.8
6-10	189	63.0	Dera Ghazi Khan	1	0.8
11-15	24	8.0	Lodhran	1	0.8
>20	1	0.3	Sargodha	1	0.8
Total	300	100	Mandi Bahuddin	1	0.8
House ownership			***From other provinces of Pakistan***		
Personal/Owned	109	36.3	Mansahera, KPK	1	0.8
Rented	188	62.7	Tatah, Sindh	1	0.8
No house in Lahore	3	1.0	Total	130	100
Total	300	100	**General health status**		
Residence status			Excellent	1	0.3
Local (from Lahore)	170	56.7	Very Good	23	7.7
Non-local/Outsider	130	43.3	Good	124	41.3
Total	300	100	Fair	106	35.3
Education status			Poor	46	15.3
No formal education	157	52.3	Total	300	100
Primary	59	19.7			
Middle school	50	16.7			
Matriculation	30	10.0			
Higher secondary school	3	1.0			
Bachelors	1	0.3			
Total	300	100			

The average daily gross-income of half of the MRDs (50.7%) was between PKR 500 and 1,100 per day, while the remaining half were earning over PKR 1,100. Similarly, the average daily take-home income of nearly two-thirds of the MRDs

(62%) was between PKR 200 and 600 per day, while the remainder were earning over PKR 600 (Table 6.3).

Table 6.3: Socioeconomic characteristics of MRDs

Variable	N	%	Variable	N	%
Average daily gross-income (PKR)			**Average daily take-home income (PKR)**		
501-600	12	4.0	201-300	9	3.0
601-700	31	10.3	301-400	51	17.0
701-900	64	21.3	401-500	66	22.0
901-1100	45	15.0	501-600	60	20.0
1101-1300	83	27.7	601-700	38	12.7
1301-1500	40	13.3	701-900	50	16.7
1501-1700	20	6.7	901-1100	20	6.7
1701-1900	4	1.3	1101-1300	6	2.0
1901-2100	1	0.3	Total	300	100
Total	300	100	**MR rent/day (PKR)**		
MR ownership status			100	1	0.8
Personal/Owned	108	36.0	200	11	8.9
Rented	123	41.0	250	4	33.0
Leased	69	23.0	300	41	33.3
Total	300	100	350	4	3.3
MR lease/month			400	36	29.3
1000-5000	52	75.4	500	24	19.5
50001-10000	15	21.7	600	1	0.8
10001-15000	1	1.4	800	1	0.8
15001-20000	1	1.4	Total	123	100
Total	69	100			

6.2.4 Driving Characteristics and Work Patterns

Table 6.4 presents some driving characteristics of MRDs such as their MR driving experience and age of starting MR driving. More than half of the MRDs (57.7%) had 1 to 5 years of MR driving experience, and 22.3% had 6 to 10 years. To gain a better understanding of the extent and scale of underage driving in the MR sector, based on the MRD's driving experience, underage MRDs were categorized into 'Current' and 'Past' underage drivers,:

Starting age of MR driving: *Age at which an MRD started driving MR. This age is calculated by subtracting the current age of an MRD (Table 6.3) from his total MR driving experience (Table 6.4).*

Starting age of current underage MRD*: All those MRDs who were still under 18 years are categorized as 'current underage MRDs'. The age at which they started driving MR is their 'starting age'.*

Starting age of past underage MRD*: Past underage MRDs are those who are currently more than 18 years old; however when they started driving an MR, they were underage (<18 years). The age at which they started driving an MR in the past is their 'starting age'.*

Table 6.4: MRDs driving experience and underage driving

Variable	N	%
MRD driving experience (year)		
1-5	173	57.7
6-10	67	22.3
11-15	42	14.0
16-20	16	5.3
>20 (up to 25 years)	2	0.7
Total	300	100
Starting age of current underage MRD (year)		
9	3	5.5
10	1	1.8
11	4	7.3
12	3	5.5
13	16	29.1
14	10	18.2
15	6	15.0
16	12	21.8
Total	55	100
Starting age of past underage MRD (year)		
8	1	1.3
9	1	1.3
10	1	1.3
11	5	6.3
12	4	5.0
13	8	10.0
14	7	8.8
15	8	10.0
16	17	21.3
17	28	35.0
Total	80	100

Table 6.4 shows that among the 55 current underage MRDs, 26 started MR driving when aged 13 or 14 years, and some (n=11) started aged between 9 and 12 years. Similarly, of the 80 past underage MRDs, 45 started MR driving aged 16 or 17 years, and 8 started at the very young age of between 8 and 11 years. This analysis

also indicates that the 'current underage MRDs' could not be 17 years of age, because MRDs with less than one year of MR driving experience were excluded from this study.

Driver Licensing Status and Work Patterns

The driving characteristics of MRDs such as their driver licensing status, work patterns and concept of passenger overloading are presented in Table 6.5. The government has not yet formulated any rules for MRDs to have an MR driving licence, and so they only need to have a motorcycle licence to operate an MR. Therefore, in the current study, MRDs were asked about their motorcycle licensing status. About 92% did not have a motorcycle licence. Among those (*n*=25) who claimed to have a licence, 11 reported that they had an expired licence and eight (*n*=8) had obtained it without passing any theory or practical driving tests. Moreover, 38.7% of MRDs did not even have a national identity card, which is a basic official identity document in Pakistan.

None of MRDs had learned MR driving from any driving school or institute; most (69.3%) were trained by a family member or friend; and around 31% were self-trained. About two-thirds of the MRDs (64%) worked 11 to 15 hours per day; 30.7% worked 6 to 10 hours per day; and a small proportion (4.3%) worked 16 to 20 hours per day. Most MRDs (61.3%) worked seven days per week, and nearly all (98%) had no other job (Table 6.5).

On average, most MRDs (70.3%) were carrying six to seven passengers, and 29.7% were carrying six passengers. More than half of the MRDs (57.7%) considered that carrying over seven passengers constitutes overloading of their MRs, while around 15% reported that carrying over eight passengers constitutes overloading of their MRs (Table 6.5).

Table 6.5: Driver licensing information and work patterns of MRDs

Variable	N	%	Variable	N	%
National identity card			**No of working hours/day**		
Yes	184	61.3	1-5	1	0.3
No	116	38.7	6-10	92	30.7
Total	300	100	11-15	192	64.0
Motorcycle licence			16-20	13	4.3
Yes	25	8.3	>20	2	0.7
No	275	91.7	Total	300	100
Total	300	100	**No of working days/week**		
If yes type of driving licence?			2	1	0.3
Learner/Temporary	4	16	5	8	2.7
Permanent	21	84	6	107	35.7
Total	25	100	7	184	61.3
Status of driving licence?			Total	300	100
Valid	14	56	**Is it your only paid job?**		
Expired	11	44	Yes	294	98
Total	25	100	No	6	2.0
How did you obtain your driving licence?			Total	300	100
Passed theory & practical test	17	68	**Are you only driver of this MR?**		
Paid to someone (e.g. agent) for illegal theory & practical test	8	32	Yes	293	97.7
Total	25	100	No	7	2.3
How did you learn MR driving?			Total	300	100
Self-trained	92	30.7	**Average number of passengers carried by MR**		
Trained by a family member/friend	208	69.3	6	89	29.7
Total	300	100	6-7	211	70.3
			Total	300	100
			How many passengers do you think is overloading of your MR?		
			over 6 passengers	83	27.7
			over 7 passengers	173	57.7
			over 8 passengers	44	14.7
			Total	300	100

6.2.5 **Vehicle Characteristics**

As mentioned earlier, MRs are not registered as such, but are registered as motorcycles. Therefore, in the current study, MRDs were only asked about the registration status of their motorcycles and their registration documents. They were not asked to show or present the registration documents.

More than 90% of MRDs reported that their motorcycles were registered, and they had their registration documents. About 8% reported that their motorcycles were registered, but they did not have their registration documents. However, it was noted that all of these motorcycles had number plates. These MRDs reported that they had lost their registration documents, or did not answer this question. As an informal paratransit mode, no MRDs had vehicle fitness certifications and route permits as required for formal public transport vehicles (Table 6.6).

Nearly three-quarters of MRs (73.3%) were one to five years old, and 16.7% were six to ten years old. Regarding repair and maintenance, most MRDs did not regularly maintain their vehicles. For instance, on responding to the question '*how often do you inspect your MR before driving*', 40% of MRDs reported 'sometimes' and 16% reported 'rarely' or 'never'. Similarly, on responding to the question '*how often do you repair and maintain your MR',* nearly three-quarters of MRDs (70%) reported 'rarely' or 'only when there is a dire need' (Table 6.6).

About a quarter of MRs (24.7%) were modified to carry extra passengers or load or both (Figure 6.3). Similarly, almost one-quarter of MRs (23.7%) had a music system (Figure 6.4), and about 11% had fitted a 'Dolkhi' (a modified motorcycle exhaust muffler) in their MRs.

Table 6.6: Vehicular characteristics of MRs

Variable	N	%	Variable	N	%
Motorcycle registration and documents			**MR design modifications**		
Yes	275	91.7	No	226	75.3
No	25	8.3	Yes to take more passenger	49	16.3
Total	300	100	Yes to take more load & passenger	22	7.3
Vehicle inspection & fitness certification			Yes to take more load	3	1.0
No	300	100	Total	300	100
Total	300	100	**Music system**		
Route permit			Yes	71	23.7
No	299	99.7	No	229	76.3
Do not know	1	0.3	Total	300	100
Total	300	100	**Dolhki (modified muffler)**		
How often do you inspect your MR before riding?			Yes	32	10.7
Never	10	3.3	No	268	89.3
Rarely	38	12.7	Total	300	100
Sometimes	120	40.0	**Age of MR (year)**		
Often	20	6.7	<1	12	4.0
Everyday	112	37.3	1-5	220	73.3
Total	300	100	6-10	50	16.7
How often do you repair & maintain your MR?			11-15	15	5.0
Never	3	1.0	16-20	2	0.7
Rarely or in a dire need	210	70.0	>20	1	0.3
Regularly	87	29.0	Total	300	100
Total	300	100			

Figure 6.3: Modifications in MR design to carry extra passengers and weight
(*Source: Author, 2015*)

Figure 6.4: Front and rear view of music system installed in MR
(*Source: Author, 2016*)

6.2.6 **Traffic Violations and Road Crashes**

To minimize the recall-bias of events, road crashes and traffic violations, questions were asked for the last 12 months period, and these terms were well explained to respondents to ensure an appropriate response. ‘Road accident’ and ‘MR overturned’ questions were asked separately to capture all MR single and multi-vehicle crashes and injury and non-injury crashes. The following definitions were used to inquire about MR road crashes and overturning and MRD traffic violations:

Road Accident: Any incident involving an MR and at least one vehicle (motorized/non-motorized) or pedestrian, occurred on a road, and in which at least one person was injured or died.

MR overturning: Any incident in which an MR overturned (resulted in injuries or no injury), while driving on the road (with or without passengers), for any reason such as speeding, hitting footpath, vehicle shaft broken, brakes failed, overloading of passengers/goods etc.

Offences or traffic violation: Any incident where an MRD was fined due to violation of traffic rules/laws (e.g. signal violation, overloading, driving without a valid driving licence etc.). *Involvement in traffic violations in this document refers to committing a traffic violation.*

6.2.6.1 Traffic Violations

Nearly all MRDs (96%) reported being involved in traffic violations during the last 12 months. More than half of the MRDs (57%) were involved in 11 to 100 traffic violations in a year, and some (7%) were involved in more than 100 traffic violations (Table 6.7). Some of the traffic violation penalties imposed on MRDs by police included: pulled over by police and paid fine, impounding of MRs, and police custody/imprisonment.

Given that the majority of MRDs were frequently involved in traffic violations, it was difficult for them to recall the exact number of their violations during the last one-year period. Accordingly, they only mentioned the estimated range (1-10, 11-50, 51-100 etc.) of their traffic violations, as presented in Table 6.7.

Table 6.7: Road traffic crashes and traffic violations of MRDs

Involved in road crash?	N	%	MRD traffic violation**	N	%
Yes	220	73.3	0	12	4.0
No	80	26.7	1-10	96	32.0
Total	300	100	11-50	120	40.0
MRD at-fault crashes*			51-100	51	17.0
Yes	303	73.2	101-150	10	3.3
No	111	26.8	151-200	4	1.3
Total	414	100	201-250	2	0.7
Road crash attended by Police			251-300	3	1.0
Not attended	354	85.5	> 300	2	0.7
Attended	60	14.5	Total	300	100
Total	414	100			
Number of times MR overturned in a year					
1	71	83.5			
2	7	16.5			
Total	85	100			

***MRD at-fault crashes:** *total based on the total number of crashes reported by 300 MRDs, not the number of participants.*
****MRD traffic violations:** *total number based on the estimated range of traffic violations in the last 12 months*

6.2.6.2 MR Road Crashes

In addition to the large number of traffic violations, nearly three-quarters of MRDs (73.3%) reported being involved in road crashes across Lahore during the past 12 months. A total of 414 road crashes were reported by 300 MRDs over the study period, with the number of crashes per MRD ranging from 1 to 20. More than half of MRDs (58.6%) reported one crash, and about a third (35%) reported two or three crashes (Table 6.7).

The MRDs considered themselves to be at-fault in about three-quarters of MR crashes (73.2%), and only 14.5% of the 414 MR crashes were attended by police. Overturning of MRs (as defined above) was reported in 85 incidents during the 12 months prior to the interview (Table 6.7).

Exploratory analysis showed that a higher proportion (89%) of underage MRDs (10-17 years) were involved in self-reported road crashes, compared to other higher aged MRDs 18-25 (75%), 26-35 (69%) and over 35 (62%) years [$\chi^2(3) = 11.635$, $p<.009$].

6.2.7 **Regression Model Results**

A binary logistic regression model was formulated to examine the potential contribution of the 13 sociodemographic, human and vehicular characteristics/variables *(MRD age, education, residential status, driving experience, training of MR driving, working hours per day, number of traffic violations, passenger overloading, MR ownership status, vehicle age, repair and maintenance routine, design and structural modifications, and MR music system)* to the occurrence of MRDs' self-reported road crashes, with a binary outcome 'Crash-*Yes*=1' and 'Crash-*No*=0'.

The predictors or independent variables were selected based on the general sociodemographic and driving characteristics of MRDs, and vehicular features of MRs found in the descriptive analysis. For instance, 'MRD licensing status' and 'how they obtained the licence' variables were not included in the logistic model, as nearly all MRDs were unlicensed. Similarly, 'MR music system' was included in the model, given that its large size and placement in MRs (Figure 6.4), appeared to constitute a major driving visual obstruction or distraction that was likely to contribute to road crashes. Likewise, the number of MRD traffic violations and working hours/day were included in the model, as past research showed that traffic violations and fatigued driving contribute to road crashes (Connor et al., 2002; Elmitiny et al., 2010; Gårder, 1989; Lim & Chia, 2015; Parker et al., 1992; Papaioannou, 2007; Retting and Williams, 1996; Retting et al., 1999, 2002).

The descriptive analysis showed that over half of MRDs (58.6%) were involved in a single road crash during the one-year study period, while the remaining 42.4% were involved in two or more than two road crashes. Based on this finding, it was hypothesized that a single crash event in a year may not necessarily place the MRD at-fault: it could be the result of several other factors such as other vehicle driver's fault, or vehicular and environmental factors. However, two or over two self-reported crashes would increase the likelihood of the MRD being at-fault. Therefore, to test whether there was any difference between the two groups *(MRD with one crash/year and MRD with more than one crash/year)*, the suitability or applicability of Multinomial Logistic Regression Model – MLRM (instead of the binomial regression logistic model) was considered. Before applying the MLRM, as a first-step, Chi-square tests were performed to examine the association between the two groups of MRDs, and the same set of 13 variables *(*including other sociodemographic variables such as *MRD family size, average take home income and house ownership)* selected initially for the binary logistic model. No significant difference was found between the two groups of MRDs, and except the variable 'MR design modifications', no other variable was found significant in the Chi-square analysis. Accordingly, the hypothesis 'any difference exists between the two groups of MRDs with self-reported crashes' was rejected, and so as the application of the MNLM. The binary logistic regression model was found suitable to answer the research question 'what is the contribution of various risk factors in the occurrence of MR road crashes.

Table 6.8 presents the results of the binomial regression model. Among the 13 explanatory variables examined in the model, five variables 'MRD age (underage MRDs), 'number of traffic violations', 'MR ownership status', 'MR design and structural modifications' and 'MR music system' were found to be significantly associated with self-reported MR road crashes.

Table 6.8: Association of various risk factors with MR road crashes in a binary logistic regression model

Explanatory variables	Categories	Beta	*p*-value	OR	95% CI Lower	95% CI Upper
MRD age (year)	1-17	1.282	.018	3.605	1.246	10.429
	18-27	.185	.554	1.203	.652	2.219
	> 27=0	Reference				
MRD education	Illiterate=1	-.518	.082	.595	.332	1.067
	With some formal education=0	Reference				
MRD residential status	Non-local (not from Lahore)=1	-.187	.547	.830	.452	1.523
	Local (from Lahore)=0	Reference				
No of traffic violations	> 10=1	.682	.029	1.978	1.070	3.655
	≤ 10=0	Reference				
MRD working hours/day	> 10=1	.432	.156	1.541	.847	2.801
	≤ 10=0	Reference				
Passenger overloading	Carrying over 6 passengers	-.129	.697	.879	.460	1.682
	Carrying 6 passengers	Reference				
MRD driving experience (year)	1-5=1	.329	.458	.720	.302	1.716
	> 5=0	Reference				
MR driving training	Self-trained=1	.320	.317	1.377	.736	2.577
	Family/Friend trained=0	Reference				
MR repair & maintenance schedule	Never/Rarely=1	-.436	.174	.646	.345	1.213
	Regularly=0	Reference				
Vehicle age (year)	> 5=1	.422	.203	1.525	.796	2.920
	0-5=0	Reference				
MR ownership status	Rented=1	.719	.018	2.052	1.133	3.718
	Owned/Leased=0	Reference				
MR design modifications	Yes=1	1.504	.001	4.501	1.823	11.118
	No=0	Reference				
MR music system	Yes=1	.753	.049	2.124	1.003	4.498
	No=0	Reference				

Underage MRDs (OR: 3.605, 95% CI: 1.246-10.429) were more likely to be involved in road crashes than higher-aged MRDs. The MRDs with more than 10 traffic violations in a year were more likely to be involved in road crashes (OR: 1.978, 95% CI: 1.070-3.655), compared to those who had 10 traffic violations or less in a year (Table 6.8).

The MRDs driving rented vehicles (OR: 2.052, 95% CI: 1.133-3.718) were more likely to be involved in road crashes, compared to those who owned or leased their vehicles. Similarly, compared to unmodified MRs and MRs without a music system, modified MRs (OR: 4.501, 95% CI: 1.823-11.118), and MRs with music systems (OR: 2.124, 95% CI: 1.003-4.498) were more likely to be involved in road crashes (Table 6.8).

6.2.8 **Road Safety Knowledge, Attitudes and Practices**

Table 6.9 summarizes MRDs' responses on their road safety knowledge, attitudes and practices (KAP), assessed using a five point Likert Scale response (strongly disagree to strongly agree). More than three-quarters of the MRDs (79%) agreed or strongly agreed with the statement '*when traffic warden is not present, I do not stop at red light'.* Similarly, high proportions of MRDs (67%, 55%, 61%, and 54%) agreed with the statements '*I slow down when traffic warden is present', 'cross other vehicle from any side', 'compete with other MRDs to catch passengers,'* and *'flexible to catch passengers from anywhere on the road'*, respectively.

About one-third of the MRDs (34%, 38% and 32%) agreed with the statements '*I do not give way to pedestrians', 'speeding thrills me''* and *'speeding carefully does not cause crashes',* respectively. Similarly, more than a quarter of MRDs (26% and 27%) agreed with the statement*s 'speeding carefully does not cause crashes', 'crashes are caused by the nature' and 'I sound horn often',* respectively.

Nearly half of the MRDs (49% and 48%) believed that they were '*safe and skilled drivers*' and '*mostly compliant with the traffic rules',* respectively. A large proportion of MRDs (60% and 61%) agreed or strongly agreed with the statements '*traffic police impose unnecessary fines and checks'*. Similarly, around three-quarters of the respondents (75% and 77%) agreed or strongly agreed with the statements '*police impose unnecessary fines and checks'*.

Table 6.9: Road safety knowledge, attitude and practices of MRDs

Questionnaire items	Mean	SD	Mean (Non-crashed group)	Mean (Crashed group)	t-test sig
When traffic warden is not present, I don't stop at red light	3.68	.94	3.44	3.77	0.013
I slow down when traffic warden is present	3.89	.79	3.63	3.99	0.002
I cross other vehicles from any side	3.51	.89	3.48	3.52	.672
To catch passengers, I compete with my fellow MRD	3.82	.81	3.71	3.86	.185
I am flexible to pick & drop passengers from anywhere on road	3.97	.86	3.88	4.01	.237
I don't give way to pedestrians	2.91	1.21	2.74	2.98	.086
Speeding thrills me	2.97	1.10	2.78	3.05	.063
Speeding carefully does not cause crashes	2.91	1.09	2.64	3.00	.007
Accidents are caused by the nature	2.96	1.07	2.74	3.05	.026
I sound horn often	2.69	1.16	2.53	2.75	.115
Safe skilled driver	3.57	.99	3.60	3.55	.704
Violate traffic rule at times, but mostly compliant	3.68	1.02	3.58	3.72	.229
Impose fines without any reason/TP	3.45	1.26	3.40	3.46	.692
Impose unnecessary checks/TP	3.50	1.29	3.38	3.35	.303
Impose fines without any reason/P	3.97	1.39	3.96	3.98	.931
Impose unnecessary checks/P	4.00	1.40	3.99	4.01	.899

'TP' stands for 'Traffic Police' and 'P' stands for 'General Police'

The t-test analysis showed that MRDs who reported being involved in road crashes had higher levels of agreement with the following statements: '*when traffic warden is not present, I don't stop at red light*' (p<0.013), '*I slow down when traffic warden is present'* (p<0.002), *'speeding carefully does not cause crashes'* (p<.007), and '*accidents are caused by nature'* (p<.026) (Table 6.9).

6.2.8.1 Risky Behaviours and Practices

Table 6.10 summarises MRDs' responses regarding the frequency (never to always) of their risky behaviours and practices. The reported frequency of risky or illegal parking practices was high (mean > 3.5). The reported frequency of *not knowing traffic rules* was high (mean=3.80), consistent with the reported frequency of *disobeying traffic rules* (mean=3.45). *Disobeying traffic laws when the warden is not looking* and *running away to avoid traffic penalties* were more common among crash-involved MRDs.

Although the reported frequencies of *driving under the influence of alcohol* (mean=1.08) and *taking illegal drugs* were relatively low (mean=1.23), they were significantly more frequent among the MRDs who reported being involved in a crash than those who were not crash-involved. Parking on bus stops and in bazaars were also significantly more commonly reported by crash-involved MRDs. Similarly, MRs *plying/operating on different routes (Some MRDs were operating on fixed routes, while others used to change their routes regularly)* in Lahore were also seemed to be associated (p<.017) with crash involvement.

Among the vehicle-related factors, *driving a faulty vehicle* (p<.001) (Figure 6.5) and *driving a vehicle with a faulty brake system* (p<.010) were significant crash contributing factors and more often reported by crash-involved MRDs.

Table 6.10: Frequency of MRDs traffic and road safety violations

Questionnaire items	Mean	SD	Mean (Non-crashed group)	Mean (Crashed group)	t-test sig
Using mobile phone while driving	2.30	1.34	2.21	2.34	.486
Texting while driving	1.32	.76	1.30	1.33	.791
Eating/Drinking while driving	1.70	1.09	1.55	1.75	.115
Smoking while driving	2.25	1.52	2.18	2.28	.587
Driving too fast for conditions	2.86	.92	2.78	2.90	.311
Traffic conflicts	3.18	.96	3.06	3.23	.188
Inattention while driving	2.82	.94	2.74	2.85	.405
Disobey traffic rules	3.45	.90	3.40	3.47	.532
Not know traffic rules	3.80	1.03	3.71	3.83	.379
Driving while fatigued	3.44	.98	3.50	3.41	.519
Driving under influence of alcohol	1.08	.47	1.01	1.10	.020
Driving taking illegal drug	1.23	.73	1.08	1.29	.004
Causing overcrowding on busy road	3.25	.94	3.11	3.30	.125
Causing high air & noise pollution	3.78	.99	3.63	3.84	.079
Parking on pedestrian pathways	4.02	.67	3.90	4.06	.064
Parking on bus stops	3.72	.79	3.51	3.79	.012
Parking in bazaar	3.64	.86	3.44	3.71	.028
Carrying too many passenger	3.28	.88	3.19	3.31	.251
Plying on fixed routes	3.63	1.07	3.58	3.65	.634
Plying on different routes	3.08	1.04	2.84	3.17	.017
Overcharging	2.24	1.15	2.09	2.29	.150
Driving faulty vehicle	2.43	1.15	2.09	2.55	.001
Driving with faulty headlight in evening	2.28	1.29	2.09	2.35	.122
Driving with faulty brake-system	1.95	1.17	1.69	2.04	.010
Stopping anywhere in middle road to get passenger	3.80	.78	3.76	3.81	.597
Disobey traffic laws when warden is not looking	3.65	.90	3.44	3.73	.009
Run away to avoid traffic penalty	3.22	1.21	2.83	3.36	.001


Figure 6.5: An underage MRD driving MR with no headlight or indicators
(*Source: Author, 2016*)

6.3 DISCUSSION

The main aim of this study was to address Research Question 3: *what are the characteristics of MRDs that influence the road safety of MRs?* This section discusses the major findings of the current study in terms of five major levels of the MR systems model, general characteristics of MRDs and MRs, the outcomes of the regression and t-test analysis, and self-reported road safety attitudes, behaviours and practices of MRDs.

6.3.1 **Young MRDs**

6.3.1.1 Underage MRDs

Underage driving is one of the salient features of the MR sector. This study showed that 18% of MRDs were underage and their ages ranged from 10 to 17 years. The analysis revealed that a larger proportion of underage drivers were involved in self-reported road crashes than higher-aged MRDs. Similarly, the odds of crash involvement for underage MRDs were 2.4 and 3.6 times higher, compared to MRDs aged 18-27 years and over 27 years, respectively.

The increased crash risk of underage MRDs is likely due to factors such as their age and high involvement in self-reported traffic violations. The 'crash-involved MRDs' also reported being more often engaged in illegal and unsafe road safety behaviours such as *when traffic warden is not present, I do not stop at red-signal; and driving faulty vehicle*), which increased the crash risk. Previous research has shown that young drivers are more likely to be involved in risky driving behaviours such as speeding, overtaking, and mobile phone use while driving (Elander, West & French, 1993; Ferguson & Williams, 1998; McKnight & McKnight, 2000; Simons-Morton, Ouimet, Zhang, Klauer, Lee, Wang & Dingus, 2011; Williams, 2003).

Analysis of the 'current' and 'past' underage MRDs revealed that they started MR driving at a very young age. About 60% of current underage MRDs' started MR driving between 11 and 14 years of age. Past research from across the world demonstrates that young teenage drivers are at the highest risk of road crashes and injuries (Bingham, Simons-Morton, Pradhan, Almani, Falk & Albert, 2016; Scott-Parker & Oviedo-Trespalacios, 2017; Simons-Morton, Ehsani, Ouimet, Perlus & Klauer, 2016; Simons-Morton et al., 2011; Simons-Morton, 2002; WHO, 2013, 2015; Williams & Ferguson, 2002). For instance, Williams & Ferguson (2002) found that 16 year old drivers were four times more likely to be involved in road crashes than drivers in their 20s, and the increased risk was not only for young drivers but also for others. The higher crash risk of young drivers is due to the fact that driving a motorized vehicle is a complex demanding task, requiring perceptual, psychomotor and cognitive skills that develop during young adulthood. Therefore, it takes several years to become a skilful driver (Williams & Ferguson, 2002). Being under 18 years of age, all underage MRDs were unlicensed drivers, who were not legally allowed to drive. In the view of current and past research findings, this corresponds to a risky scenario where underage MRDs, passengers and other road users are likely to be at higher risk of road crashes and injuries.

Some underage MRDs did not participate in this study though invited, probably due to fear of being caught by police (though they were informed about the study objectives and its ethics requirements) or suspicion that the research team was from a government agency, collecting data on underage MRDs. Some MRDs, who claimed to be aged 18 or above, might be underage as well, as they know that minimum driver licensing age is 18 years. Nevertheless, considering the limitations of self-reports (under/over-reporting of ages), and the observational survey results, it appeared that underage drivers comprise at least a quarter of the MRDs in Lahore.

Underage driving is not only a hallmark of the MR sector, it is also prevalent among drivers of other transport modes (particularly among motorcycle riders) in Pakistan. For instance, Nadeem et al. (2015) examined the socio-causative factors of road crashes in Multan, Pakistan. The study revealed that about 20% of the participating drivers were under 18. A study in Islamabad, Pakistan found around 17% underage driers or drivers without licences and vehicle registration documents (Hussain, Shu, Sosorburan, Adji, Khan & Raja, 2011). Similarly, Shabiralyani et al. (2015) in a Rescue 1122 crash data-based study showed that of the total 1,609 rickshaw related crashes (both MR and AR but mainly MRs), underage drivers were involved in 245 road crashes in Dera Ghazi Khan, Pakistan during 2010-2014. These studies provide some evidence of the prevalence of underage drivers in the general driving population and their crash involvement in Pakistan. Further studies are needed to evaluate the crash risk associated with underage MRDs and other underage drivers in Pakistan.

6.3.1.2 Young MRDs

More than half (54%) of the interviewed MRDs were young, aged between 10 and 25 years (including 18% underage MRDs). The large presence of young persons in the MR sector in Lahore suggests that this sector has become an important job marketplace for youth.

There are three major potential factors that make the MR sector an attractive job market for youth. **First,** perhaps this is a sector in Pakistan where there are no specific job requirements such as education, skills and experience. Anyone who can ride a motorcycle can become an MRD. Consequently, the MR sector appears to be an ideal choice for uneducated and unskilled youth. **Second**, as opposed to other drivers, there is no strict monitoring and requirement for MRDs to have a driving licence, vehicle registration, fitness certification or route permit. They merely need to buy or rent a motorcycle rickshaw or attach any 70cc or 100cc motorcycle with a cart, and commence working straightaway. **Third**, poverty and unemployment rates are growing in Pakistan. For instance, an economic review showed that around 1.2 billion people were living below the poverty line in 2014, and the country was among the top 43 countries where poverty rates were growing (Yousaf & Ali, 2014). Similarly, based on the Pakistan Labour Force Survey 2014-2015, it was estimated that with an unemployment rate of 8.5%, there were around 5.3 million unemployed people in Pakistan during 2014-2015 (Institute for Policy Reforms Pakistan, 2016). Therefore, considering the current poverty and unemployment situation, the MR sector is providing job opportunities and livelihood to thousands of uneducated/less-educated and low-skilled young people and their families in Lahore and other parts of Pakistan.

6.3.2 **Socioeconomic Status**

The average daily take-home income of nearly two-thirds of the MRDs (62%) was between PKR 200 and 600 per day (roughly AU$ 2-6). These figures suggest (in the local context) that most MRDs have reasonable income levels, given that 13% of Pakistanis were earning around PKR 125-150 per day in 2015 (Hamza, 2015; Rana, 2015). However, the present study also found that over half of MRDs were married, supporting a large family (63% were supporting 6-10 family members), and had a rented house in Lahore. About two-third (64%) of MRDs were operating rented or leased vehicles, and those who had leased MRs, about 97% of them were paying PKR 1,000-10,000 per month in monthly instalments. Moreover, MRDs who were operating rented vehicles had to contribute a minimum of PKR 100 for repair and maintenance of their vehicles. Thus, if we combine all these expenditures with high inflation rates in Pakistan (Moazam & Kemal, 2016), MRDs would barely be ‘making ends meet’. As a result, some MRDs (1%) were sleeping in their MRs.

The literature review and this study suggest that underage MR driving could also be linked with socioeconomic circumstances of a young MRD and his family. The poverty and socioeconomic situation of a family may force them to make a child an MRD, instead of sending him to school. Similarly, for an underage MRD, responsibility for his family is likely to be a compelling force to start MR driving at the very young age of 9 or 10.

The socioeconomic profile of MRDs also shows that 43% were not permanent residents (non-local MRDs) of Lahore (including some from other provinces of Pakistan). Migration of MRDs from different parts of Pakistan to Lahore suggests that people move towards large cities for better job prospects and livelihood opportunities. This also indicates that MR driving has become a livelihood source for families all over Pakistan.

6.3.2.1 General Health Status

In this study, over three-quarters (78%) of MRDs were aged between 10 and 35 years, yet about half reported their general health status as ‘fair’ or ‘poor’. No significant direct association was found between MRDs’ general health status and road crashes. However, during this road-side survey, due to their poor health conditions, many MRDs appeared to be older than their reported age. This may be associated with their low socioeconomic status, irregular eating patterns and working outside for long hours in a polluted environment.

Some MRDs were smoking (Mean=2.25), drank alcohol (Mean=1.08) and used illicit drugs (Mean=1.23) that would also affect their health. Moreover, as mentioned earlier, the government has not provided any designated terminals or parking stands for MRs in Lahore, therefore most MRDs have established their illegal terminals at places that are unclean, smelly and filthy. These working conditions would likely have negative impacts on their health and driving performance.

6.3.3 Driver Licensing and Training

6.3.3.1 Unlicensed MRDs

In this study, 92% of MRDs reported that they did not have a driving licence, and 6% had an expired or illegal licence. Further, if we also consider the limitations of self-reports, this figure could be even more. These findings suggest that nearly all MRDs were unlicensed in Lahore.

The almost complete lack of licensed MRDs in the current study prevented an analysis of the crash risk related to unlicensed MR driving. Therefore, it was not possible to evaluate whether being unlicensed contributed to MRDs’ self-reported road crashes. However, unlicensed driving is clearly a common and normal practice in the MR sector, so it did not appear to be a matter of concern for MRDs. The literature review and observational survey also suggest that police overlook unlicensed MRDs. In this situation, licensing status does not appear to be a significant factor in influencing driving patterns and risky behaviours of MRDs.

Some earlier studies in Pakistan have described the overall situation of the driver licensing system and the prevalence of unlicensed drivers in Lahore, Karachi, Peshawar and Islamabad (Ahmad, 2014; Batool, 2012; Durrani et al., 2012; Qiam, Ahmad, Wazir, Mushtaq & Khan, 2016; Zulfiqar Ali Bhutto Institute of Science &

Technology, 2009). For instance, Durrani et al. (2012) examined the relationship between traffic safety attitudes and ticket-fixing behaviours among the general driving population in Lahore. The study found that around 32% of drivers were unlicensed, and almost the same proportion had received the licence without going through any formal driving test. Further, about 38% did not respond to this question. Similarly, Qiam et al. (2016) in a hospital-based study in Peshawar (capital city of KPK Province, Pakistan), assessed the facial injury severity scale scores and driving safety standards among 115 motorcycle riders injured in road crashes. It was found more than 80% of the participating motorcyclists were unlicensed and not wearing a helmet, when they were involved in road crashes.

6.3.3.2 Driver Training and Experience

About two-thirds (69%) of MRDs reported that in order to learn MR driving, they received informal short training (about one week) from their friends or family members, while 31% did not receive any kind of training.

Some of MRDs mentioned that the MR is an unbalanced and low-powered vehicle, so when it is loaded with passengers, its handle shakes and drags to one side, it is difficult to control without having some experience. Therefore, most MRDs had a brief training session from their senior fellows. However, this training does not seem to be effective in reducing their crash risk, as both groups ‘friend-trained’ and ‘self-trained’ were almost equally involved in road crashes. Similarly, MRD driving experience also did not appear to have any influence on their crash involvement, as both groups (MRDs with ≤ 5 and > 5 years’ driving experience) were equally involved in reported crashes.

The driving experience of MRDs ranged from one year to 25 years. The MRDs with 25 years of driving experience indicate that MR operation started in Lahore across the 1990s; this was confirmed by some old MRDs in interviews. A 25-year reported history (as reported by MRDs who were interviewed in this study) of the MR sector depicts its growing scale and scope in Lahore and Pakistan.

6.3.3.3 Work Patterns

More than two-thirds (68.3%) of MRDs in this study reported that they work between 11 and 20 hours per day for a full week. Similarly, in Study 1B ambulance response time data showed that MRDs operate round the clock across Lahore.

As outlined earlier, MRDs operate without any formal structure for long hours under tough working conditions such as a polluted environment and unhygienic conditions, leading to a fatiguing job that can increase the crash risk. However in this study, no significant direct association was found between MRDs working hours and road crashes. Past research has however demonstrated that driver fatigue is also a major crash contributing factor in Pakistan (Azam, 2013; Azam, Shakoor, Shah, Khan, Shah & Khalil, 2016). For instance, Azam et al., (2016) used Australian Transportation Safety Bureau (ATSB) driver fatigue assessment criteria to compare the proportion of driver fatigue-related crashes reported to the NHMP on the motorways and national highway (N-5) of Pakistan during 2003-2012. The study found that on average fatigue-related crashes accounted for 28% of the total crashes on the motorways, and 10% on the national highway (N-5). Fatigued-related crashes were more often fatal on the motorways than the national highway (N-5) (Azam et al., 2016). However, data analysed in that study did not include MRs, because MRs are not allowed on motorways. They operate along the national highways, but the ATSB driver fatigue assessment criteria used in this study excluded them from the national highways data.

In the current research, Rescue 1122 crash data analysed in Study 1 was mostly collected from the urban centres of 36 districts of Punjab; it did not include MR crashes occurring on the national highways. Fatigue might be a significant factor in MR crashes occurring on the national highways, because the MRDs who operate on the highways cover longer distances to connect two small cities or towns or villages (Malik, 2012; *The Express Tribune*, 2012a, 2013a,b, 2016a). Long travelling distances would likely increase the chances of fatigued driving.

There is another aspect of the long working hours and heavy schedules of MRDs. Given that most MRDs were operating rented or leased vehicles, and supporting a large family, they have to pay a daily rent or monthly lease and support their families, regardless of whether they earn something or not. Therefore, the socioeconomic circumstances of MRDs appear to be a major factor, keeping them on the road for long hours at the expense of their sleep and health. For instance, one MRD who was operating around 20 hours per day in Lahore, on responding to the question *why do you work so long*?, reported:

> *When I stop to take some rest, faces of my children come to my mind and I start again. I hardly sleep three to four hours in a day. I came from a small village of Southern Punjab to earn the livelihood for my children. I do not*

have any house in Lahore, I sleep in my MR.

6.3.4 Traffic Violations and Road Crashes

Almost all MRDs were involved in various types of traffic violations, and about two-thirds (60.3%) were involved in 11-150 violations during the previous year. A significant positive association was found between the number of traffic violations and road crashes. These findings supplement and confirm the results of the observational survey (Study 2), where more than half of MRDs were involved in signal violations. Past studies from across the world also demonstrate a strong association between traffic violations and road crashes (Brown, Ouimet, Eldeb, Tremblay, Vingilis, Nadeau & Bechara, 2016; DeNicola, Aburizaize, Siddique, Khwaja & Carpenter, 2016; Lawton, Parker, Stradling & Manstead, 1997; Parker et al., 1992; Papaioannou, 2007; Retting et al., 1999; Rosenbloom & Perlman, 2016).

Nearly all MRDs were frequently involved in traffic violations, about three-quarters (73.3%) were also involved in road crashes across Lahore during the last one-year period, and a similar proportion reported being at-fault in these crashes. According to the definitions of 'road crashes' and 'MR overturned' used in this study, all (n=414) crashes reported by 300 MRDs were multi-vehicle injury crashes.

The high involvement of MRDs in traffic violations and multi-vehicle injury crashes demonstrates that most do not follow the road rules, and are risky drivers. Their acknowledgment of being at-fault in about three-quarters of self-reported crashes also emphasises their risky behaviours. Crash statistics were self-reports, so there was a likelihood of under-reporting.

This study shows that only 14.5% of MR crashes were reported to police in Lahore during the study period. This is in line with previous research findings that documented a large under-reporting of road crashes in police reported data in Pakistan (Hyder et al., 2000; Ahmed et al., 2015; Ahmed, 2007; Batool et al., 2011; Kayani et al., 2014; Razzak & Luby, 1998; WHO, 2009). Large under-reporting of MR crashes and high involvement of MRDs in self-reported injury crashes suggest that MRDs make an even more sizeable contribution to road trauma across the city.

6.3.5 **Road Safety Knowledge, Attitude and Practices**

6.3.5.1 Red Signal Violation

A high proportion of MRDs (mean=3.68) agreed with the statement *'when traffic warden is not present, I don't stop at red-signal'* and a significant association was found between this behaviour and MRD self-reported crashes. This finding is consistent with the observational survey results, where more than half of MRDs violated the red signal, and a strong association was found between red signal violation and traffic conflicts.

As outlined previously, evidence suggests that red signal violation increases the likelihood of traffic conflicts and road crashes, and it is one of the major crash contributing factors on signalized intersections around the world (Elmitiny et al., 2010; McLean et al., 2010; Parker et al., 1992; Papaioannou, 2007; Retting, Chapline & Williams, 2002; Retting et al, 2002, 2003; Young et al., 2013). It was observed in both Studies 2 and 3 that police presence is a deterrent factor to some extent. However, due to busy traffic conditions and the large numbers of MRs in Lahore, MRDs violate traffic rules even in the presence of police if they have an opportunity.

6.3.5.2 Speeding, Overtaking and other Risky Driving Practices

The MRDs who reported being involved in road crashes had higher levels of agreement with the statement *'I slow down when traffic warden is present'* (*p*=0.001). Similarly, most MRDs also agreed with the statements: *'crossing other vehicle from any side', 'competing with other MRDs to catch passengers', 'flexible to catch passengers from anywhere on the road'*, '*stopping anywhere in the middle of the road to catch passengers*', '*speeding thrills me*', '*speeding carefully does not cause crashes' and 'driving too fast for the conditions'.*

All these self-reported behaviours suggest that MRDs are involved in risky driving practices. Most MRDs in this study were young people (including 18% underage MRDs), so they were more likely to engage in speeding and competing with their fellow MRDs, particularly given competition for work. Risky behaviours and practices of MRDs could also be linked with their socioeconomic and vehicle ownership status. Given that most MRDs operate rented vehicles, they are more likely to engage in speeding and overtaking to get more passengers and increase their trips to enhance their take-home incomes. The results of this study also support this view, as MRDs who were operating rented vehicles were twice as likely to be involved in road crashes, compared to those who owned or leased their MRs.

6.3.5.3 Pedestrian Safety

In the current study, MRDs' self-reported behaviours showed that those MRDs who reported involvement in road crashes more often used illegal terminals or parked across bus-stops and bazaars, as observed in Study 2. These illegal terminals or road-side parking stands are safety hazards and may obstruct pedestrians' mobility, making them more vulnerable to road crashes and injuries. The literature review and findings of Study 1B and Study 2 also support these concerns, and suggest that the large unregulated proliferation of MRs across Lahore is a safety issue for pedestrians.

6.3.5.4 Driving Distractions

The MRDs' self-reported behaviours showed that while driving, they were involved in various driving distractions such as mobile phone usage, eating or drinking and smoking. These results supplement the findings of the observational survey.

Driver distraction refers to a situation, where a secondary activity *(e.g. using mobile phone while driving, eating or drinking, reading while driving etc.)* diverts drivers' attention away from the primary driving task (Bingham, Zakrajsek, Almani, Shope & Sayer, 2015; Ranney, 2008). Experimental simulator-based studies found that reduced situational awareness and reaction times, slow speed adaptation, poor speed and lateral control, increased steering wheel amplitude and frequent hard braking are some of the potential negative impacts of distracted driving (Bingham et al., 2015; Horberry & Edquist, 2008). However, in the current study, no significant association was found between MRDs' driving distractions and road crashes. Nevertheless, compared to the 'non-crashed-group', 'crash-involved MRDs' reported higher mean values for all these behaviours.

6.3.5.5 Compliance with Traffic Rules

More than half of MRDs were often or always involved in '*disobeying the traffic rules'*, '*disobeying traffic rules when traffic warden is not looking'* and '*running away to avoid traffic plenty'*. A highly significant association was also found between road crashes and MRDs behaviours such as '*disobey traffic rules* *when traffic warden is not looking'* (*p*=.009) and '*run-away to avoid traffic plenty'* (*p*=.001).

The MRDs' self-reported responses demonstrate that they are often involved in violation of traffic rules, and these behaviours are likely to become more pronounced in the absence of traffic enforcement. This study also showed that nearly all MRDs were involved in large numbers of traffic violations, so their self-reported traffic violations confirm their self-reported risky behaviours. Both logistic regression and t-test analysis showed a positive association between traffic violations, disobeying the traffic rules, and road crashes. Research from elsewhere also establishes that violation of traffic rules increases crash risk (Elmitiny et al., 2010; McLean et al., 2010; Parker et al., 1992; Papaioannou, 2007; Retting, Chapline & Williams, 2002; Retting et al., 2002, 2003; Young et al., 2013).

6.3.5.6 Road Crashes and Fatalism

A significant association (*p*=.026) was found between the MRDs' perception *'crashes are caused by the nature'* and road crashes. MRDs' perceptions are likely to influence their road safety behaviours and practices. Past research has shown that people with pre-existing ideas or fatalistic beliefs are difficult to change and are more likely to be engaged in risky driving practices, compared to other drivers (Dixey, 1999; Kayani, King & Fleiter, 2011, 2012, 2014; Peltzer & Renner, 2003). For instance, Kayani et al. (2012) explored the association between fatalistic beliefs and risky driving practices and its effects on promoting road safety behaviours in Pakistan. The study found that except for a few participants, most had a strong fatalistic belief that road crashes, injuries, deaths or other losses occur from nature or God, and thus cannot be prevented.

Kayani et al. (2014) also found that fatalistic beliefs not only promote unsafe road safety behaviours, but these kinds of behaviours are also one of the important factors in under-reporting of road crashes in Pakistan. Fatalistic beliefs diminish the role of human error or fault in crash causation, and so those involved do not report a crash to the police. Even where human error is accepted, those involved may pardon the person(s) causing the incident or simply settle the matter between them. In the current study, MRDs with low education levels and high fatalistic beliefs might have not reported or under-reported their crash involvement, making it difficult to assess the exact size of the MR crash problem in Lahore.

6.3.5.7 Drink Driving and Illicit Drug Use

Although it was uncommon, some MRDs reported driving under the influence of alcohol (mean=1.08) or after taking illicit drugs (mean=1.23). Among the drug-users, most were using marijuana and two (n=2) were heroin addicts or injecting drug users. A significant association was found between MRDs driving under the influence of alcohol (p=.020), and using illicit drugs (p=.004) and road crashes. The MRDs driving under the influence of alcohol or illicit drugs present a risky scenario, given that almost all were involved in the large number of traffic violations, and these behaviours are likely to increase the crash risk. Some underage MRDs reported drink driving and illicit drug use, an alarming situation that needs the immediate attention of their parents and government.

As a Muslim country, it is unlawful for the general public to use and sell alcohol in Pakistan (Mir et al., 2012), so MRDs' alcohol use is generally unlawful. Pakistan's national drink driving law prohibits driving under the influence of alcohol. However, there is no random breath testing anywhere in Pakistan, so implementation and enforcement of the drink driving law is ineffective (Batool et al., 2012; Mir et al., 2012: WHO, 2015).

Mir et al. (2012) found some evidence of alcohol and marijuana use among commercial drivers in Pakistan. A survey was conducted with 857 bus and truck drivers in Rawalpindi and Islamabad, Pakistan during 2008. About 10% of truck drivers were driving under the influence of alcohol, and marijuana use was nearly 30% among some groups. A significant association was also found between alcohol and marijuana use and road rage, drivers' at-fault behaviours and road crashes (Mir et al., 2012), so results in the present study may be under-reported.

6.3.5.8 Traffic Law Enforcement

The majority of interviewed MRDs appeared to be displeased with the traffic law enforcement authorities in Lahore. They perceived that traffic police (traffic warden, LTC inspectors and railway police) and general police impose unnecessary fines and checks on them.

In Pakistan, general police and traffic police work independently, although the traffic police are headed by an active Senior Superintendent of Police (SSP). In the large cities of Punjab (Lahore, Rawalpindi, Faisalabad), traffic wardens control the traffic, but in small cities there is less presence of traffic police. In Lahore, along with traffic wardens, around 200 LTC Transport Enforcement Inspectors also regulate and control public transport. Additionally, there are some Railway Police Inspectors, who control traffic across the Railway Station area.

Given the informal status of MRs and large involvement of MRDs in traffic violations, they are potentially a major target for law enforcement authorities in Lahore, increasing their annoyance with authorities. However, many MRDs reported that general police take bribes to ignore illegal MR terminals, and some traffic police and railway police officials are also involved in this practice.

6.3.6 **Vehicle Characteristics**

6.3.6.1 Vehicle Registration

Despite the requirement for motorcycles of MRs to be registered, and for MRDs to carry registration documents, the current study found that 8.3% of MRDs did not have their registration documents, yet all these motorcycles had number plates. These MRDs reported that they had lost their registration documents, and a few did not answer this question.

There is a likelihood that some MRDs might have stolen motorcycles and fake number plates, as reported in some newspaper reports in Karachi (*The Business Recorder*, 2014; *The Dawn*, 2015e; *The Daily Times*, 2013; *The Pakistan Today*, 2012a, 2015b). According to one newspaper report, on average daily around 80 motorcycles were stolen in Karachi during 2014, and some of these bikes were used in making MRs (*The Dawn*, 2015e). One newspaper report claimed that most MR operators in Karachi use stolen bikes, as a stolen motorcycle cost around PKR 10,000-15,000, while a new motorcycle costs between PKR 40,000 and 60,000. A motorcycle rickshaw operator in Karachi acknowledged this:

> *We generally purchase stolen motorcycles and attach a body to make a motorcycle rickshaw*. (*The Pakistan Today*, 2012a)

Newspapers reports also suggest that besides MRs, many other unregistered vehicles operate across Pakistan. For instance, a recent newspaper report claimed that about 320,000 unregistered vehicles were operating in different areas of Punjab Province, and this number is growing (*The Jang*, 2016). Illegitimate operation of unregistered MRs and other vehicles across Punjab indicates the negligence and weak control of the concerned transport and enforcement authorities.

6.3.6.2 Vehicle Safety Standards

Analysis showed that compared to the non-crashed group, crash-involved MRDs were more often involved in driving vehicles with known faults such as a faulty brake system. These findings are consistent with those of Studies 1 and 2 and suggest that repair and maintenance of MRs is often compromised, which increases the likelihood of a road crash.

Motorcycle rickshaws do not have disc brakes, but have ordinary drum brakes. The long hours of use and overloading of passengers and goods put a heavy strain on brake shoes, so they wear out quickly and need replacement. However, some MRDs reported that they do not replace brake shoes in a timely manner, and keep operating with loose foot brakes. Loose foot brakes increase vehicle stopping-time, which increases the likelihood of traffic conflicts, especially in emergency situations (WHO, 2008). Moreover, it was found (from personal communication with two local MR mechanics in Lahore) that MRDs with loose foot brakes are unable to maintain a safe following distance from other vehicles, which also increases the risk of traffic conflicts.

Some MRDs were driving MRs with defective/no headlights (Figure 6.6). No significant direct association was found between MRDs driving with 'faulty headlights' and road crashes; however, 'crash-involved MRDs' reported a higher frequency (mean=2.35) of this risky practice, compared to the 'non-crashed group' (mean=2.09). Moreover, this survey was conducted with MRDs operating during the daytime in Lahore, when generally headlights are not being used. Analysis of MR road crashes which occurred on urban roads and highways during dark-hours would assist in ascertaining the crash risk related to faulty headlights.

6.3.6.3 Design and Structural Modifications

Since the government has not specified national MR engineering and manufacturing standards and regulated the MR manufacturing industry, it was unsurprising to find that about a quarter of MRs were modified to carry extra passengers or load or both (Figure 6.2). Modified MRs were 4.5 times more likely to be involved in road crashes compared to non-modified MRs.

Various MR design and structural modifications include, but are not limited to: two additional seats on the back, elaborate bodies with additional hooks and metal rods, a metallic frame on the roof top to carry load or passengers and MRs converted into loader vehicles. Local modifications of MRs disturb vehicle balance and stability, and these vehicles are more likely to overturn than a balanced vehicle. Eighty-five (n=85) incidents of MR overturning were reported in this study, and the same reason was identified in about half of MR single-vehicle crashes (Study 1B). These findings suggest that locally modified MRs are a safety hazard, and the occupants of these vehicles are likely to be at higher risk of injuries. Crash data-based studies and biomechanical studies on three-wheeled motorised rickshaws from India also support these findings (Chawla et al., 2003; Mohan et al., 1997; Schmucker et al., 2011).

6.3.6.4 Music System

In addition to the design and structural modifications outlined above, nearly a quarter of MRs had music systems and 11% had modified motorcycle mufflers (Dolkhi). Motorcycle rickshaws with music systems were 2.1 times more likely to be involved in road crashes, compared to those without music systems.

The music system of MRs consists of a long wooden-box with five to six speakers (Figure 6.4). It is attached to the MR roof on the top of the passenger seat in such a position that it normally occupies all space between passenger seat and roof, thus completely blocking the driver's rear traffic view.

Most MRs do not have side-view mirrors and many do not even have rear view mirrors. In the absence of side and rear-view mirrors, and with a music system installed, MRDs would be likely to be completely blind to their side and rear traffic flow. Further, under busy and noisy traffic conditions in Lahore, when MRDs play loud music, they may also become deaf to their surrounding environment. Moreover, the MR music system operates with a remote control equal to the size of a simple mobile phone. To switch between different songs, many MRDs keep the remote control in their hands while driving, which may also cause driving distraction. All these factors suggest that MRDs with music system are likely to be blind and deaf to their surrounding traffic environment, increasing the likelihood of traffic conflicts and crashes.

Besides the road safety hazards of the MR music system, it is also important to note that as per the Motor Vehicle Rules 1969 clause A/26, it is unlawful to play music or television in public transport vehicles in Pakistan. It is also culturally inappropriate and unethical to play loud music of your own choice that might be disturbing for others, especially for female passengers. For example, Muhammad (2013) found some commuter dissatisfaction with such conditions:

> *Motorcycle Rickshaw is convenient and easily available, however it is open on all sides and exposed to smoke and dust. Moreover, MR drivers play loud music and there is a gender discrimination, as female do not feel comfortable in sitting with male.* (a female survey participant)

6.3.6.5 Dolkhi

A 'Dolkhi' is a modified motorcycle muffler that produces a loud damaging sound, and it significantly contributes to the air and noise pollution. It was especially observed in MRs with two-stroke 70cc motorcycle engines. In addition to Dolkhis, about 11% MRDs have taken out the baffle from their motorcycle muffler, which also increases noise pollution (Malik, 2012).

Malik (2012) reports that MRs emit noise at a volume of 95 decibels (dB), while Pakistan Motor Vehicle Ordinance 1969 limits noise volume to 85 dB. A noise volume of over 85 dB is harmful for human and the environment; if a person is exposed to it for about eight hours each day, it can cause hearing damage (Naseem, 2012). For instance, a hospital-based study examined the effects of noise pollution on the hearing of public transport drivers in Lahore. The mean age of the drivers was 41 years and more than half (51%) had driven for 8 to 10 years. The study revealed that 65% had a noise-induced hearing loss, and 10% had a disabling hearing loss (Aslam, Aslam, & Batool, 2008), suggesting that air and noise pollution resulting from MRs is not only harmful for other people and the environment, but also for MRDs.

6.3.6.6 Overloading

About three-quarters of MRDs reported that they carried on average six to seven passengers, and a similar proportion perceived that carrying over seven and eight passengers constitutes overloading of their MRs, consistent with the findings of the earlier studies and the literature review of this research.

This study did not find a direct association between MR overloading and road crashes, which is in line with the observational survey results, where overloaded MRs were less likely to be involved in traffic conflicts. As outlined earlier, less involvement of overloaded MRs in traffic conflicts and crashes could be attributed to their slow operating speed while overloaded. This mechanism could be more pronounced in MRs having old 70cc or 100cc motorcycle engines. These findings are consistent with Kumar et al.'s (2016) findings, which, despite overloading and vehicle modification practices, found lower crash rates among informal modes (auto-rickshaws) than formal transport modes in road crashes reported in Jaipur, India during 2013. However, overloaded three-wheelers were more likely to be involved in road crashes than those which were not overloaded (Jayatilleke et al., 2015; Schmucker, et al., 2011).

Overloading is likely to be more dangerous in situations where MRs carry many children. In the observational survey and while travelling across Lahore and other parts of Pakistan, it was noticed that MRs which transport school children are often overloaded, averaging 10 to 15 children. (Figure 6.3 shows an overloaded MR carrying around 15 school children).

6.3.6.7 MR Routes and Schedules

A significant association was found between MR routes *(MRDs operating on different routes)* and road crashes. 'Crash-involved MRDs' were more often operating on different routes, compared to the 'non-crashed group'.

Operating on different or new routes might require some time to adjust to the new operating conditions such as familiarity and knowledge of road rules and signs, road conditions, and enforcement levels in a particular area. Therefore, besides human factors, adjustment time and environmental factors might contribute to crashes involving MRDs, who more often operated on different routes.

The MRDs act as commercial drivers and operate MRs both as a stage-carriage *(operating on long/short route like formal public transport),* and contract-carriage *(individual hire operating on non-fixed routes)* passenger vehicles across Lahore.

Generally, MRs operate as stage-carriages on short and long routes. On the routes, where there is less presence of other public transport modes, MRs operate as the main stage-carriage vehicles, while on other routes they act as a main feeder service across the city. Motorcycle rickshaws which operate as individual contract-carriage vehicles do not have fixed routes and are demand-responsive, similar to taxi services. Contract-carriage MRs operate as school vans, goods carriers and for advertisement display (Figure 2.15).

The MRDs themselves select or decide their routes. The researcher's field experience suggests that MR route selection generally depends on the number of passengers and MRs on a particular route, availability of other public transport modes, and police enforcement level in a particular area. The MRDs can shorten, terminate or change their routes according to the operating circumstances.

6.3.6.8 Air and Noise Pollution

A higher proportion of MRDs (mean=3.78) reported that their MRs contribute to air and noise pollution. The massive growth of MRs over the past two decades is not only associated with numerous road safety problems, but also with environmental issues. For instance, Malik (2012) reported that MRs contribute around 60% of the air pollution in Lahore. The smoke-emitting capacity of MRs is 66.3%, compared to 5%-8% of a four-stroke motorcycle or an autorickshaw. Emissions of MRs go further, to 15% with an over one-year old engine (Malik, 2012).

Findings of the current and previous studies suggest that gross weight of MR body (particularly elaborate bodies), overloading of passengers and goods, MRDs' busy work schedules, and compromised repair and maintenance conditions are likely to cause MRs to emit excessive air and noise emissions. A 70cc or 100cc motorcycle engine is only powered to carry two passengers; however, MRDs seat up to eight passengers, placing a heavy strain on engines, and rendering them unfit in just two or three months (Malik, 2012). Unfit engines emit excessive blackish unburned hydrocarbons, nitrogen oxides and particulate matter detrimental to the environment and public health (Malik, 2012).

In addition to air pollution, MRs are also major contributors to noise pollution in Lahore. For instance, Younes & Ghaffar (2012) examined the spatial pattern of noise pollution in Lahore. The noise levels at almost all the sample sites exceeded the maximum permissible limits and ranged between 91 and 121 dB. Areas such as the walled city, Badami Bagh, Garhi Shahu, Railway Station and Chouburgi Chowk, where most MRs operate, were found to be at the highest noise levels in Lahore. People living in these areas are vulnerable to noise-related health issues such as hearing impairment, hypertension, ischaemic heart disease and sleep disturbance disorders (Younes & Ghaffar, 2012).

6.4 LIMITATIONS OF STUDY 3

This study used self-reported data to examine sociodemographic characteristics, driving practices and road safety knowledge, attitudes and practices of MRDs. The use of self-report questionnaires or measures has several advantages such as being an easy and economical way to collect the data, easily administered to large data samples, and useful in assessing constructs that would generally be difficult to obtain with behavioural or physiological measures such as personality traits (‘extrovert’ or ‘introvert’) (Hoskin, 2012). However, self-report measures also have some limitations, such as social desirability responses, dishonesty, under-reporting or over-reporting. Past research has shown that these kinds of responses are likely to be more pronounced in investigation of illegal behaviours such as drug use (Rosay, Najaka & Herz, 2000; Sloan, Bodapati & Tucker, 2004).

As mentioned earlier, in this study an attempt was made to minimize the limitations of self-reports by piloting the survey and deleting/editing items, where responses were likely to affected by social desirability. However, the current study found that most MRDs were illiterate, and nearly all were involved in large number of traffic violations, so there is a likelihood of under-reporting of MRDs’ actual illegal driving behaviours such as driving under the influence of alcohol and illicit drugs. There might also be cultural and religious reasons for not reporting illicit drug and alcohol use. Moreover, it was a challenging task to conduct a roadside survey with a population that was irregularly scattered across the city and did not have fixed terminals or any legal standing.

Convenience sampling was found to be a suitable approach to survey an unknown large population of MRDs. However, convenience samples have some inherent limitations such as not representing the whole study population, making it difficult to replicate results (Calder, Phillips & Tybout, 1981). Nevertheless, from the literature review, it appeared that MRDs across Pakistan have almost similar sociodemographic and driving characteristics, as identified in this study. Given the current research is the first large scale study in Pakistan which examines the road safety issues associated with MRs, the current study may provide a basis for producing broad generalizations.

6.5 CHAPTER SUMMARY

Study 3 explored the sociodemographic characteristics, driving and work patterns and road safety knowledge, attitude and practices of MRDs. The study found that over half of MRDs were illiterate, married, supporting a large family, had a rented house in Lahore and operated a rented or leased vehicle.

About 18% were underage, and some started MR driving at the very young age of 9 or 10 years. Nearly all MRDs were unlicensed, and involved in various traffic and road safety violations in Lahore during the previous 12 months. Almost three-quarters of MRDs (73.3%) were involved in road crashes across Lahore, and a similar proportion reported being at-fault in these crashes. ‘Underage MR driving’, ‘number of traffic violations’, ‘MRDs operating rented vehicles’, ‘MR structural and design modifications’ and ‘MR music system’, were found to be significant factors in increasing the likelihood of MR crashes.

Most MRDs reported being often involved in various traffic violations such as speeding and overtaking. They also reported using mobile phone and smoking while driving, and a small number had driven under the influence of alcohol or illicit drugs. A significant association was found between road crashes and MRDs self-reported risky behaviours.

Study 3 examined several determinants under the first four levels of the MR systems model, and specifically it addressed Research Question 3: *What are the characteristics of MRDs that influence the road safety of MRs?,* but it also has some implications for Research Question 1: *What is the size of the MR crash problem?*The MRDs’ self-reported sociodemographics, traffic violations, road crashes, at-fault crashes, risky and unsafe behaviours provide a comprehensive understanding of the specific human characteristics and risky behaviours that contribute to MR crashes. All these findings suggest that most MRDs are unsafe drivers and are often involved in various road safety and traffic violations. The results of this study supplement the earlier studies findings, and provide an empirical evidence to validate the concerns raised by the media regarding road safety problems related to MRs across Pakistan. The next chapter presents the results of Study 4.

Chapter 7: Study 4 - MR Road Safety and Transport Policies: A Qualitative Investigation

This chapter presents the results of Study 4. Previous studies examined the Rescue 1122 crash data, assessed the relative frequency of MR crashes, observed the road safety behaviours of MRDs and explored their road safety knowledge, attitude and practices. The current study is a qualitative investigation that addresses Research Question 4 (*What policies and measures could improve the road safety of MR?)* by interviewing key stakeholders to identify policy measures and strategies to address road safety issues related to MRs as identified in the earlier studies.

This chapter is structured into three sections. Section 7.1 presents the methodology and ethics considerations, while Sections 7.2 and 7.3 describe the study results and discuss the main themes, respectively.

7.1 METHODOLOGY

7.1.1 **Qualitative Interviews**

A total of 46 one-on-one semi-structured interviews were conducted with a diverse cohort of participants (Table 7.1) in Lahore. Participants were working in various government and private organizations, including provincial government officials involved in public transport planning, management and operations (Punjab Transport Department, LTC, Transport Engineering & Planning Agency, and Punjab Metro Bus Authority); emergency and rescue service personnel (Rescue 1122); urban and highways traffic enforcement police (Traffic Police, LTC and National Highway & Motorway Police); officials involved in issuing driving licences and inspection of vehicle fitness (traffic police licensing department and Motor Vehicle Examiner); academics and transport and road safety researchers (University of Engineering & Technology, Lahore and NED (Nadirshaw Edulji Dinshaw) University of Engineering & Technology, Karachi); road safety experts, transport engineers, urban transport planners and mechanical engineers (including one automotive engineer) working in the government and private sectors; environmental engineer and experts; journalists involved in road crash reporting; officials of the largest MR manufacturer company in Pakistan and a local MR body manufacturer company; a representative of the MR and AR association in Lahore, and a local politician (member of provincial assembly).

With a few exceptions, the study participants were highly educated, with ten holding Doctor of Philosophy degrees in transportation engineering, mechanical engineering and urban transport planning and management. To ensure a smooth and systematic data collection/interview process, study participants were divided into five major groups: (1) government officials, (2) academics, transportation engineering and road safety professionals/experts, (3) EMS – emergency medical services personnel, (4) urban and highways traffic enforcement police, and (5) other stakeholders (MR and AR association Lahore, MR manufacturing companies, politician and journalists) (Table 7.1).

While visiting various organizations to conduct interviews, the researcher also closely observed the working of organizations such as PTD, LTC, NHMP, Rescue 1122, traffic police, the driver licensing system, and the vehicle inspection system.

Table 7.1: List of the study participants

Group No	Participant category	Participant's affiliation/department	No of persons interviewed	Code used
1	Government officials	Lahore Transport Company (LTC)	5	Official
		Punjab Transport Department (PTD)	3	
		Transport Engineering & Planning Agency (TEPA), Lahore	1	
		Punjab Metro Bus Authority (PMBA)	1	
		Motor Vehicle Examiner, Lahore	1	
	Academics, transportation engineering and road safety experts	University of Engineering and Technology (UET), Lahore	6	Academic & Road Safety Expert
		NED University of Engineering and Technology, Karachi	2	
		Private organizations	3	
3	EMS professionals	Rescue 1122	8	Emergency Medical Technician = EMT
4	Urban and highways traffic enforcement police	Traffic Police, Lahore *(including driving licensing department of traffic police)*	6	Traffic Warden= TW
		National Highway & Motorway Police (NHMP)	4	Senior Patrolling Officer= SPO
		LTC traffic enforcement inspectors	2 *(this number also counted in main LTC government official category)*	Official
5	Other stakeholders	MR manufacturing companies	2	Official
		MR and AR association, Lahore	1	Representative of MR & AR association
		Journalists	2	Journalist
		Local politician	1	Politician

7.1.2 **Sampling and Participant Recruitment**

Study participants were selected on the basis of their expertise and professional experience. Three types of qualitative sampling techniques, ‘purposive’, ‘criterion’ and ‘snowball’, were used to recruit a balanced study sample (Kayani, 2011; Rice & Ezzy, 1999). Purposive Sampling is a commonly used technique in qualitative research, and it is a deliberate selection of study participants who could provide rich and meaningful information about specific research questions (Kayani, 2011; Teddlie & Yu, 2007; Rice & Ezzy, 1999). In Criterion Sampling, certain criteria are used to select the study participants. For example, in selecting the participants from Rescue 1122, only operational staffs were included. Snowball Sampling involves asking initial contacts or study participants to suggest or refer someone else who could provide useful information on the research topic (Kayani, 2011). The sampling or interview process continued until all research questions were fully addressed, and the data saturation *(sampling continued until most information was repeating and no new information was forthcoming)* was achieved (Ezzy 2002; Higginbotham, Connor, & Albrecht, 2001; Patton & Patton, 2002; Tuckett, 2004).

The majority of participants were primarily contacted through their mobile phones to arrange interviews. Given that the researcher has been working with two government departments in Pakistan, his prior contacts helped him to recruit many participants. Some officials were approached personally through their personal secretaries/staff officers; all necessary material (project description/participant information sheet) was provided to them through email or hard copies.

All study participants were interviewed individually by the researcher. The majority of participants were interviewed in their work settings. To ensure an in-depth exploration of the topic, Urdu was the main language of the interviews. Except for five, all interviews were audio-recorded to ensure that all qualitative data was captured. Some officials were hesitant to be recorded, so only notes were taken. Each interview lasted for half an hour to more than one hour. Data collection for this study commenced in November 2015, and was completed in the first week of February 2016.

7.1.3 **Interview Template and Process**

A generic interview guide (Appendix E) was developed for all stakeholders. It consisted of simple and basic questions informed by the literature review, the MR systems model, and earlier studies in this research program. More questions were added as the research progressed, and new themes emerged. In addition, some specific question-sets or templates were also developed, considering the educational and professional background of the interviewees, and the nature of the information required from a participant. For instance, questions related to current and future MR transport policies were asked of the provincial and local public transport department officials, and questions related to traffic violations and driving practices of MRDs were asked of traffic police, NHMP and LTC officials. The interviews were interactive, open-ended questions were asked, and participants were encouraged to share their experiences. A range of probes or prompts were used to achieve the depth of answers in terms of penetration, exploration and description (Legard, Keegan & Ward, 2003).

Most interviews were commenced by asking participants some basic questions such as *how do you see the current road safety situation in Pakistan, and what are the major crash contributing factors in Pakistan*. This was followed by questions addressing the existing public transport situation and the role of transport authorities in Pakistan. Subsequently, questions about MRs and MRDs (the role of MRs in the public transport sector, road safety aspects of MRs and driving practices of MRDs) were discussed. Each interview concluded with participants' recommendations regarding potential transport or road safety policy for MRs, and their future role in the public transport sector in Pakistan.

7.1.4 **Data Analysis**

The recorded interviews in Urdu were transcribed into English, and all relevant information within the scope of the study was identified and captured. To ensure reliability and validity of the transcript, a transcriber with competent English written expression, working with an Emergency Medical Service (EMS), and familiar with this research topic, terminologies, and the dialects of the interviewees, was trained for the transcription process. The first two recordings were transcribed by the researcher to give him a sense of the transcription process and its rudiments. The focus was to systematically manage the coding of various features of interviews by going back and forth between recordings and transcripts (Dressler & Kreuz, 2000; MacLean, Meyer & Estable, 2004; McLellan, MacQueen & Neidig, 2003). The researcher closely supervised the whole transcription process to address the trustworthiness and credibility of the transcript (Dressler & Kreuz, 2000; MacLean, Meyer & Estable, 2004; McLellan, MacQueen & Neidig, 2003).

After transcription, the researcher examined the entire transcript for any inconsistencies. Passages or quotes where there were some doubts were cross-checked against the original recordings to ensure integrity and reliability of the data (Beaton, Bombardier, Guillemin, & Ferraz, 2000; Dressler & Kreuz, 2000; Kayani, 2011; MacLean, Meyer & Estable, 2004; McLellan, MacQueen & Neidig, 2003). Another validity check was made by an independent researcher, who transcribed two randomly selected audio recordings. This translation was compared with the original transcript (translated by transcriber), and the translations were very similar.

Template analysis technique, a type of thematic analysis, was used to analyse the interview data. This involves generating a hierarchical coding list to analyse all data contents. This process maintains a high degree of structure, while analysing the textual data with the flexibility to adapt it to a specific inquiry (Brooks, McCluskey, Turley, & King, 2015). Template analysis is rooted in more structured approaches such as Grounded Theory and Interpretative Phenomenological Analysis (Waring & Wainwright, 2008). The rigour or triangulation of the data (triangulation refers to the objective confirmation and validity of qualitative study findings through the convergence of information from different sources (Carter, Bryant-Lukosius, DiCenso, Blythe & Neville, 2014)) was done through other data sources such as photos taken by the researcher (Figures 7.1-7.2) and statistics quoted by Rescue 1122, LTC, NHMP and officials of MR manufacturing companies.

After reading the whole transcript, important passages and quotes were identified, highlighted and labelled. An initial coding list was developed by assigning descriptive codes to the main themes (Batool et al., 2012; Brooks, McCluskey, Turley & King, 2015; Burnard, Gill, Stewart, Treasure & Chadwick, 2008; King, 2004). A hierarchical coding technique was used to group similar sub-themes under the main themes, and emerging themes were organized into different meaningful clusters. Hierarchical coding is a significant feature of template content analysis, where similar codes can be clustered together to develop more generalized higher-order codes. It gives the flexibility to analyse the data at varying levels of specificity (Batool et al., 2012; Brooks, McCluskey, Turley, & King, 2015; King, 2004). After the coding process, five major themes relevant to this research were identified, and various sub-themes were organized under these major themes to discuss various aspects of road safety problems of MRs, and their potential solutions.

7.1.5 **Ethics Considerations**

This study was approved by the QUT Human Research Ethics Committee (approval number 1500000824). The ethics requirements were fulfilled while conducting this study. Study participants were approached personally, and the purpose of the research was explained to them. If they showed interest in participating in the research, the participant information sheet, consent form and research questions were handed to them. Considering the busy schedules of government officials, a recruitment letter (an overview of this research program) was also enclosed where needed. Given that most participants were highly educated and professionals working in transportation and road safety fields, it was not difficult for them to comprehend the project and provide appropriate feedback. In situations, where participants were not highly qualified or not from a relevant field, an explanation was provided by the researcher. As a Pakistani and well aware of local customs, culture and language, it was quite easy for the researcher to provide any clarification or explanation.

Participation in this study was voluntary and unpaid. Written consent was obtained from participants. The privacy and confidentiality of participants was ensured during and after the research. Participants had the right to not answer any question or withdraw from the study at any time during the interview process. Transcribed anonymous coded data were used to interpret the study findings and themes.

7.2 FINDINGS

Template analysis identified many themes; five major themes were selected and discussed: general road safety situation in Pakistan, road safety characteristics of MRDs, vehicular safety features of MRs, socioeconomic aspects of MR driving, and potential road safety and transport policies for MRs. A table summarising the main themes and sub-themes is given below (Table 7.2).

Table 7.2: Themes (column heading) and sub-themes (column cells) arising from the interviews

General road safety situation in Pakistan	Road safety characteristics of MRDs	Vehicular safety features of MRs	Socioeconomic aspects of MR driving	Potential road safety and transport policies for MRs
Road safety - a low priority in Pakistan	Traffic violations	Stolen motorcycles	Scale of MR manufacturing industry	Current organisational arrangements
Road User Behaviour	Traffic enforcement issues	Air and noise pollution	Socioeconomic scale of MR driving	Current and future MR Policies
Vulnerable road users	Weak enforcement		Socioeconomic Circumstances of MRDs	Stakeholders Recommendations
Driver licensing system in Pakistan	MR Road Crashes			
Vehicle safety inspection system	MR Highway Crashes			

7.2.1 **Road Safety in Pakistan**

All interviews with road safety and other experts began by discussing the general road safety situation in Pakistan, and identifying the major factors that contribute to the low road safety profile of the country. The experts identified many factors that contribute to growing road crashes and injuries in Pakistan, including road safety being a low priority in Pakistan; road user behaviour; vulnerable road users; the driving licensing and vehicle inspection systems in Pakistan. These factors are discussed as sub-themes of the main theme Road Safety in Pakistan.

7.2.1.1 Road safety - a low priority in Pakistan

All participants were concerned that road safety is a low priority area in Pakistan. It was stated that road safety is gaining the attention of governments and other stakeholders globally, however, despite growing numbers of road crashes across the country, road safety does not feature in policy and practice in Pakistan. There is not a single department in the whole country solely responsible for road safety issues.

Road safety situation is alarming in the country. Our government does not have any road safety vision and will. (Road Safety Expert)

The experts mentioned that in terms of road safety, the establishment of the National Road Safety Secretariat (NRSS) in 2006 was the only major effort seen from the government in recent years. However, for financial reasons, the NRSS was dissolved in 2008, and afterwards the Ministry of Communication (MOC) was nominated as a Lead Road Safety Agency (LRSA) in Pakistan. Presently, National Transport Research Centre and NHMP are its executing bodies; however, both these organizations have different functions, transport research and traffic enforcement, respectively. Road safety policy and management is mainly left with police, and public transport departments at the national and provincial levels.

In Pakistan, unfortunately the road safety is in the hands of police, who are not trained for it, therefore we do not see any improvement in this field. (Road Safety Expert)

As well as discussing the poor road safety situation in Pakistan, several experts mentioned that many departments are directly or indirectly involved in public transport planning, policy and management, yet public transport facilities and infrastructure are deficient, unintegrated and inefficient in most parts of the country. Participants stated that short-term strategies and polices are formulated for political gains, and sustainable long-term transport planning and policies are deficient. The majority of the experts identified that political interference, deficient technical and management capacity of the public transport-related organizations, inefficient and misuse of available public resources, and the lack of coordination among various public departments, are the main reasons behind the poor public transport situation, and the weak performance of transport-related organizations.

Our public departments are not functional, there is a great political influence in our institutes, so institutes are weak and ultimately it affects the planning and execution of the projects. (Academic)

Political interference is the most crucial element behind poor performance of our public transport departments, whatever we plan, at the end the decision lies in the hands of a political leader. (Official)

7.2.1.2 Road User Behaviour

Experts expressed the view that road user behaviour is the most critical factor in the increasing numbers of road crashes in Pakistan. It was mentioned that overall there is a lack of a road safety culture in the society, and most road users do not have a road safety sense. With growing urbanization and motorization trends, drivers' patience levels have decreased and most people disregard other road users' 'right-of-way'. Violation of road safety and traffic rules is common and most people exhibit irresponsible behaviour on the road.

> *Road crashes have been increased to a great extent in Pakistan. Not only due to motorization, but also due to other factors such as now we have more people on the road with less patience, tolerance and lacking civic sense, compared to the past. The tolerance and patience level among most road users have been collapsed.* (Academic)

The experts stated that the use of personal safety equipment such as helmets and seat-belts (except on motorways) is very low among drivers, and driving while distracted (e.g. using a mobile phone) is common across Pakistan. Some experts noticed (also observed by the researcher) that many law enforcement officials, who were supposed to be role models for others, do not follow road rules. In this situation, common road users also disregard the rules, thus increasing the likelihood of road crashes.

> *Our roads are like jungle, most people do not follow road rules. Even most enforcement officials do not follow the rules, then what will you expect from a common road user, who is not sensitized with this issue.* (Road Safety Expert)

People with authority and influence consider themselves above the law, and the VIP (Very Important Person) culture is dominant in Pakistan. The experts considered that the most important factor behind the lack of road safety culture is the absence of road safety education at any level. Neither parents nor schools teach children about road safety, and safety culture is also missing at the organizational level. There are only a few people in the country trying to create awareness of road safety; their effort is invisible on the ground. The experts believed that this situation would not improve unless government and all stakeholders take this issue seriously.

In terms of road safety, the most important thing is, when you do not have training or awareness, then how would you know that how to behave on the road? Road safety is a shared responsibility. All stakeholders need to play their effective role. (Road Safety Expert)

7.2.1.3 Vulnerable Road Users

Study participants were deeply concerned about the increasing levels of risk to vulnerable road users (pedestrians, motorcyclists, cyclists) across Pakistan. The experts noted that motorcyclist and pedestrian injuries especially are growing. High motorization and urbanization trends, traffic-mix and violations of road rules were the leading factors identified. They also mentioned that most development projects are constructed without proper consideration of vulnerable road users. They noticed that though road infrastructure is improving across Pakistan, most road projects are designed to facilitate cars, and pedestrians are often ignored in planning. Increasing signal-free corridors in Karachi and Lahore have further worsened this situation.

Most roads are built to accommodate more cars and motorists, and vulnerable road users are nowhere in planning, policy and implementation. Pedestrians' vulnerability has increased after the development of signal-free corridoes in Karachi and Lahore. (Academic & Road Safety Expert)

The experts observed that in recent years, many new road projects, underpasses and flyovers have been constructed in Lahore. However appropriate and sufficient pedestrian facilities are not being provided in these large development projects. In some places, overhead bridges have been constructed but they are not accessible for all pedestrians (the elderly, disabled) and most are ill-maintained, unclean and unsafe. Most pedestrians do not use them, and they have become places for injecting drug-users and beggars (Figure 7.1).

In recent years great infrastructure development has been seen in Lahore. However many of these projects were developed without proper consideration of pedestrians' mobility and needs. Pedestrian facilities are inadequate, inappropriate and ill-maintained across the city. (Academic)

Figure 7.1: Poor condition of a pedestrian overhead bridge at the main Mall Road, Lahore (*Source: Author, 2016*)

It was mentioned that in Lahore illegal parking and road encroachments contribute to road crashes and pedestrian vulnerability. People park their vehicles anywhere on the road, and seasonal vendors block footpaths unchallenged (Figure 7.2), so pedestrians are forced to walk on main roads, and become vulnerable to crashes and injuries.

> *Road encroachment and illegal parking also contribute to road crashes and pedestrians' injuries. In our country, there is no check to park vehicle anywhere on the road, and to run a road-side business.* (Academic & Road Safety Expert)

Figure 7.2: Illegal parking and footpath encroachments in Lahore
(***Source:*** Author, 2016)

7.2.1.4 Driver Licensing System in Pakistan

The driver licensing system was discussed by most study participants. The experts identified many gaps in the existing licensing system, and considered it a major factor in increasing road crashes and the worsening road safety situation. They stated that the current licensing system is inefficient and obsolete, and it is bringing more untrained drivers on the road. Bribery is also practised in the licensing department, and influential people get their licence ‘sitting at home’. Moreover, there is no accountability and check once the licence is issued: after each five years, people merely pay the renewal fee, irrespective of whether they continue violating the road rules.

> *More than 90% road crashes occur due to drivers’ fault, and the main reason is obsolete driving licensing system, where corruption is prevalent and untrained people get the licence sitting at home. Our current system is only giving “licence to kill”.* (Road Safety Expert)

> *In our country, licences are issued without a proper procedure and mechanism, and once the licence is issued, there is no system and monitoring*

mechanism to check driver's driving history and status for the whole life. (Official)

The experts mentioned that in official procedures such as the licensing process, corruption is also prevalent across Pakistan. This was acknowledged by the officials working in the same department, and the situation was even worse in small cities.

Interviewer: *Is this true that we can get the licence by paying bribe, and influential people get the licence without following any official procedures?*

Yes it is fact, and this is more commonly practised in small cities in Pakistan (TW03).

7.2.1.5 Vehicle Safety Inspection System

The experts mentioned that as with the driver licensing system, the existing vehicle inspection system in Pakistan is merely an official formality.

Current vehicle fitness test in Pakistan is merely an official formality, otherwise they do not have trained staff and equipment to check vehicle fitness and emissions levels. (Official)

Our licensing and vehicle inspection systems both are ineffective and obsolete, and they need to be updated as per intentional standards. (Road Safety Expert)

In Punjab, Motor Vehicle Examiners (MVEs) work under the Punjab Transport Department and they have offices in all 36 districts. An official stated that at a district level, the MVE offices consist of only three officials, an MVE, clerk and an office assistant. They issue vehicle fitness certificates, route permits, and regulate all public transport in the district.

The researcher visited the Motor Vehicle Testing (MVT) facility in Lahore; however, the officials were hesitant to provide any information about the testing facility. Therefore, most of the information was collected from drivers and others who were visiting the facility to obtain their vehicle fitness certification, and by observing the process of testing the vehicles. It was observed that due to the lack of an automated system and equipment to examine vehicle mechanical faults and measure vehicle noise and air emissions, the current vehicle inspection system is mainly based on a quick visual inspection and manual check, after which the vehicle is stamped as 'fit' for the next six months.

Road Safety in Pakistan - Theme Conclusion

Study participants' views suggest that road crashes and injuries are growing across the country, and the road safety situation is deteriorating. Some major underpinning factors identified by the experts that contribute to the low road safety profile of Pakistan include: lack of political vision and support, absence of a national road safety policy and dedicated road safety organization, weak performance of public transport organizations, poor road user behaviour, and inefficient driver licensing and vehicle inspection systems.

7.2.2 **MRDs - Road Safety Characteristics**

Road safety characteristics of MRDs and their driving practices were frequently discussed by study participants. The majority of the issues raised by participants were already identified in the previous studies of this research and the literature review. The participants stated that most MRDs are unlicensed, unskilled and untrained drivers, and they have low road safety knowledge and traffic sense. Some participants were from other cities than Lahore, and they had travelled across the country. They were particularly concerned over the large presence of underage and unlicensed MRDs throughout Pakistan.

> *When I see a young guy of 12 to 14 years old driving MR on a major highway carrying eight to ten passengers, I wonder is there any rule of law in our country?* (Road Safety Expert)

> *I think this is the most dangerous innovation on the road, neither the vehicle nor the drivers are safe. Young children who do not know anything about road safety or traffic rules are driving them.* (Academic)

> *I have not seen worst drivers than MRDs, they do not know anything about traffic rules, they drive recklessly on the busy roads and playing havoc with their own and others' lives*. (TW03)

7.2.2.1 Traffic Violations

Traffic enforcement officials (LTC inspectors and traffic wardens) stated that MRDs frequently violate the traffic rules, and they are involved in almost all kinds of traffic and road safety violations. Traffic enforcement officials appeared to be concerned about the growing number of MRs, and their associated traffic problems in Lahore.

Chingchi drivers do not follow any rules, as they do not have licence, route permits or vehicle documents. How many challans (fines/tickets) can we issue to them? We really got sick of them. (TW02)

It is totally an illegal transport, any motorcycle is attached to any cart. Many of MRDs are underage, unlicensed, and even do not have their national identity cards. They do not take care of the stops or rear traffic flow, and just go for the passengers. They are involved in all kinds of traffic violations. (Official)

Chingchis are dangerous, because young children drive them, and it is like a 'vehicle of death'. Challan (fine/ticket) is not a solution for these reckless drivers, the only solution is to get them out from the city (TW04).

Risky driving practices of MRDs such as overtaking and frequent traffic lane changing were particularly noticed by most study participants, especially traffic police officials. Such practices by MRDs disturb the traffic flow, and increase the risk of traffic conflicts and crashes.

Most dangerous thing about Chingchi drivers (MRDs) is that they do not care who is following them, they stop in the middle of the road to pick or drop passengers, which sometimes cause road crashes. (TW05)

I think motorcycle rickshaws are one of the most dangerous public transport vehicles. It is a sort of unplanned invention from a motorbike. The drivers of these vehicles do not know where to park and where to stop. They stop anywhere on the road, when they see the passenger. (Academic)

In Lahore, there are around 200 LTC transport enforcement inspectors and 2,900 traffic wardens. The LTC inspectors regulate public transport vehicles only in Lahore, and they work only in the morning shift in some specific areas. Traffic wardens regulate all kinds of traffic (public and private vehicles) in Lahore, and they work in all major areas of Lahore in three shifts (morning, evening and night).

The LTC and traffic police shared some recent traffic infringement data recorded in Lahore, which shows that MRDs were involved in the highest number of traffic violations of all public transport vehicle drivers.

The LTC recorded total 371,352 traffic violations for all public transport vehicles (Bus, Vans, Coaster/Mazda Truck, 4-stroke Autorickshaw and MR) during *the last four-year period (2012-2015) in Lahore. Motorcycle rickshaws were involved in 145,038 (39.05%) of the traffic violations, compared to 226,314 (60.94%) traffic violations of all other public transport vehicles (Bus, Vans, Coaster/Mazda Truck, 4-stroke Autorickshaw) in Lahore. Further breakdown of data revealed that MRs were involved in 16,326 traffic violations in 2012, 35,995 in 2013, 31,655 in 2014 and the highest number (n= 61,062) was recorded in 2015* (data extracted from LTC documents).

Similarly, traffic police infringement records shows that *rickshaws (both MR and AR) were involved in over 1.4 million (n= 1,458,197) traffic violations in Lahore during the past five-year period (2011-2015). The breakdown of the data indicates that rickshaws were involved in 380,380 traffic violations in 2011, 272,515 in 2012, 264,084 in 2013, 303,381 in 2014 and 237,7837 in 2015* (data extracted from Lahore's traffic police documents).

It is important to note that the LTC recorded separate data for traffic violations of MRs and ARs, while Lahore traffic police recorded them together, similar to the aggregated crash data of Rescue 1122. On responding to the question *what would be the proportion of MR traffic violations in aggregated data of rickshaws?*, the official stated:

> *MR traffic violations would be around 70% to 80% and some of their violations are also recorded under the 'motorcycle' category* (TW05).

7.2.2.2 Traffic Enforcement Issues

While discussing the traffic violations of MRDs, some important enforcement issues emerged. The traffic enforcement officials stated that it is difficult for them to enforce MRDs and record their traffic violations, as there are few officials and large numbers of MRDs. When traffic police issue them a ticket, the MRDs make a plea not to penalize them as they are poor and cannot afford it, and observers curse the traffic police for penalizing poor MRDs.

> *We are in a difficult situation, as these chingchi drivers are poor. When we charge them on any violation, they make a pledge, please let us go, as we are poor, and people around them also curse us that we are Zalim (cruel) people, who catch the poor and leave the rich.* (TW01)

> *These drivers are illiterate, have no licence, do not follow any traffic rules, and*

express pleading behaviour of being poor, when we catch them. (TW03)

These rickshaws are running everywhere in the city. We cannot challan (fine/ticket) all of them, as they are poor and operating rented vehicles. Therefore, they cannot afford to pay fines. (TW04)

The officials stated that the illegal network of MRs has become well-established across Lahore and cannot simply be dealt with via penalties, as fining often results in a worse situation such as protests, burning public property, suicide attempts, and sometimes even fights with the officials.

As far as enforcement is concerned, there is no doubt that illegal MRs are widespread across the city, and MRDs have become a sort of a 'mafia group'. Now the problem is, if we crackdown on them, their numbers are so large that police stations will be full, but these illegal MRs will not finish. The second thing is that law and order situation will become worse, as they do lots of extreme actions such as burning public properties, huge protests, climbing up the electric poles, injured themselves and sometimes even attempt suicide. In a few situations, they even fought with our officials, honestly, it is not easy to deal with these chingchi drivers. (Official).

How can we challan (fine/ticket) them, as they do not have licence, registration documents, and even do not have their national identity cards. Therefore, in this situation only thing we left with is to imprison them, and to avoid that situation, they go for any extreme. (Official)

7.2.2.3 Weak Enforcement

The majority of the study participants believed that the main reason for the extensive informal network of MRs, and the overall poor traffic and road safety situation in Lahore and Pakistan, is weak police enforcement across the country. This issue was discussed with Lahore's traffic police officials. It was found that in Lahore, 3,400 traffic wardens posts are sanctioned, yet only around 2,900 positions are filled. Among the 2,900 traffic wardens, about 700 are office staff *(managing ticketing and licensing record, licence issuance and delivery to the people, making duty rosters for the field staff etc.),* and only around 2,200 traffic wardens serve in the field. Among the field staff, some are permanently deputed with different VIPs for protocol duty, and around 226 are specifically deputed on the Lahore Ring Road. Therefore, presently only around 1700-1800 traffic wardens manage the traffic in the second largest city of Pakistan.

> *Yes it is true that the traffic enforcement is weak in Lahore, but people do not know the actual reasons. We are also human, but our workload is huge, and we are in small numbers.* (TW05)

Besides a huge work-load, another major factor that is likely to severely affect the performance of traffic wardens is their low salary package and no other incentive or work benefits. It was found that the minimum qualification of a traffic warden is a Bachelor's degree, and many are postgraduates. However, they have to work in a low-salary, demanding job. It was stated that traffic wardens are the lowest-paid government employees among all other enforcement officials such as police, LTC and NHMP in the same rank, and with the same qualification.

Moreover, officials mentioned that over 10 years had passed since the establishment of the traffic warden service in Lahore in 2006, yet they have no job structure or career progression. Most are working in the same service scale as when they joined the service. It was noted that this situation was due to political reasons: the service was introduced by a former government, so the current government does not 'own' it. Therefore, traffic wardens appeared to be depressed and demotivated, which is likely to be a main contributing factor in their weak performance, and to contribute to the overall poor traffic and road safety situation in Lahore.

> *Most of us are depressed and disheartened, as we have low salaries and no work benefits. We do not see any career progression, due to the political reasons.* (TW04)

In addition to job-related stresses, there are some environmental factors that may also affect the performance of traffic wardens. As mentioned earlier, it was a quite challenging task for the researcher to conduct road-side surveys in Lahore, due to the high noise, air and dust pollution levels. Traffic wardens stated that they had frequent episodes of headache and respiratory issues due to high vehicular emissions. Severe weather conditions also affect them. For instance, in Lahore during June-July, the average temperature is around 40°C, and sometimes it reaches 45°C. Similarly, in December-February, the temperature drops to less than 10°C. All of these factors are likely to affect their health and work performance.

It is very challenging and difficult to work outside for long hours in a highly polluted environment. We often have episodes of headache and respiratory problems, and severe weather conditions also affect us. (TW03)

7.2.2.4 MR Road Crashes

The experts noticed that due to the large increase in the numbers of MRs in Lahore during the past few years, road crashes and injuries have increased across the city and throughout Pakistan. Similarly, Rescue 1122 emergency paramedics stated that their work load has increased over the years, due to the growing number of MRs and associated road crashes.

Certainly, with the passage of time road crashes have increased in Lahore, and one of the main reasons behind this trend is the growing number of chingchi rickshaws across the city. Nowadays, we remain busy in the whole eight-hour shift, and it was not the case a few years ago. (EMT01)

Rickshaw crashes are increasing in Lahore, for example, we attended around 15 to 20 rickshaw crashes (both MR and AR crashes) per day in 2014, and around 20 to 25 rickshaw crashes per day in 2015. (Official)

Rickshaw crashes (both MR and AR crashes) are increasing at the rate of 20% to 30% every year, as in 2014 we attended a total of 23,974 rickshaw crashes in Punjab, and this number increased to 31,365 rickshaw crashes in 2015 (7,391 more crashes or 31% increase to 2014 figures). Similarly, in Lahore we attended 5,932 rickshaw crashes in 2014, and this figure reached to 8,624 rickshaw crashes in 2015 (2,692 more crashes or 45.38% increase to 2014 figures). Overall, in 2014 rickshaws accounted for 15% and 11% of the total crashes reported in Lahore and the rest of Punjab, respectively. While in 2015, rickshaws were involved in 20.02% and 12.01% of the total crashes reported in Lahore and the rest of Punjab, respectively. (Official, data extracted from Rescue 1122 documents)

As mentioned in Study 1, Rescue 1122 collects aggregated data of MR and AR crashes, under the common category of 'rickshaws'. Responding to the question '*what would be the proportion of MR crashes in rickshaw crashes reported in Lahore and Punjab during 2014-2015?* A Rescue 1122 official stated:

Our field experience suggest that compared to AR drivers, MRDs are more careless drivers, and ARs mostly operate in large cities such as Lahore, Gujranwala and Faisalabad. However, MRs operate everywhere in small cities, towns and villages across Punjab. Therefore, I think in large cities the proportion of MR crashes would be around 70% to 80% and in small cities of Punjab, it would be around 90% to 100%. (Official, data extracted from Rescue 1122 documents)

7.2.2.5 MR Highway Crashes

The National Highways and Motorway Police (NHMP) regulate the traffic on approximately 3,000 kilometres of motorways and highways in Pakistan. Motorcycle rickshaws are not allowed on motorways, but they operate on almost all major highways across Pakistan. The study participants from NHMP revealed that compared to urban roads, MR road crashes occurring on highways are often fatal and result in multiple casualties. They identified many reasons behind fatal MR crashes on the highways: (1) MRDs are uneducated, unlicensed and unskilled drivers; (2) many of them are underage; (3) they are frequently involved in speeding, overtaking, one-way violation and overloading; (4) they operate under mixed traffic conditions on highways where all types of heavy vehicles also operate; (5) they pick and drop passengers anywhere on the road; (6) due to their large numbers and short wait time, they act as a major public transport mode on highways and connect cities, towns and villages; and (7) their vehicles are faulty, unbalanced and easily overturned.

MR crashes on highways are often fatal and involve multiple casualties. I have attended a crash where 15 people died at the scene in a collision between MR and large passenger bus (SPO01)

It was a serious mistake of the government that first allowed these unskilled drivers on the road. Now they have spread everywhere in the country, and have become a safety risk for themselves and other road-users. (Official)

The NHMP officials were particularly concerned about the high proportion of underage MRDs operating on the highways, and the use of MRs as school vans on the highways. The officials noticed that MRs transporting school children are often grossly overloaded, which increases the likelihood of multiple casualties in the case of road crashes. Other experts also highlighted the seriousness of this issue:

A lot of these rickshaws are driven by underage drivers, and these are also used as a school van, which are generally grossly overloaded with innocent children. This is very dangerous on the highways, as crashes on highways are often fatal and result in multiple casualties. (Official)

It is important to mention that during data collection process for this study, it was found that compared to traffic police and general police, the NHMP has a more comprehensive crash data recording and reporting system, covering all major details of a crash including eyewitness and driver statements. Therefore, the NHMP officials were in a better position to identify at-fault drivers in MR crashes occurring on highways. The NHMP officials stated that MRDs who operate on the highways are often involved in speeding, overtaking and overloading that sometimes result in road crashes. They also shared one recent crash report, where an MRD acknowledged his fault:

A collision occurred between a truck, long trailer and MR on a main highway in District Rahim Yar Khan. Two persons were severely injured (MRD and a passenger) and a 50 years old pedestrian, who was standing on the roadside was killed at the scene. The crash occurred due to the negligence of MRD, who entered on the main highway without observing the traffic flow and a truck hit him from the rear. The truck afterwards collided with a long trailer coming from the other side of the road. The MR and long trailer were completely damaged.

This crash report included the statements of the MRD, the two truck and trailer drivers, two eyewitnesses, and the reporting officer. All of them declared that the crash occurred due to the carelessness of the MRD, who stated:

I was driving from Rukan Pur and joined a major highway without observing the traffic flow and due to my negligence, a truck hit me.

The NHMP crash report illustrates that MRDs also operate on highways, and are involved in fatal crashes, including pedestrians, even on a major highway. This issue was also highlighted by other study participants.

Pedestrians are most at risk in Pakistan, and the large growth of MRs has further increased their vulnerabilities. I have noticed that illegal terminals of MRs have occupied many pedestrians' paths across Lahore, which forces *pedestrians to walk on the main roads under busy traffic conditions. This is very dangerous situation and increases the likelihood of pedestrians' injuries and fatalities.* (Academic)

Chingchi drivers often hit pedestrians, I recently attended a crash at the main Bund Road, Lahore, where two chingchi drivers were racing to get passengers, and one of them hit a 65 old pedestrian, who died at the crash scene. (EMT02)

Moreover, traffic enforcement officials (traffic wardens, LTC traffic inspectors, NHMP) and Rescue 1122 emergency paramedics stated that MRDs are not only directly involved in road crashes, but also indirectly involved.

Chingchi rickshaws are dangerous, and just a mass of a metal. When they collide with others, they damage them. I think chingchi rickshaws cause around 10% to 15% indirect crashes, especially they make motorcyclists to fall. Therefore, motorcycle crashes are increasing in Lahore, with the growing number of MRs. (EMT01)

To catch every passenger, chingchi drivers change lane frequently. In doing so, they are not only directly involved in crashes, but also make other vehicles to collide. (EMT03)

7.2.2.6 MRDs - Road Safety Characteristics - Theme Conclusion

The experiences and perceptions of traffic police, LTC, NHMP and Rescue 1122 officials suggest that most MRDs are unlicensed, unskilled and untrained drivers. They are involved in the large number of traffic violations and risky driving practices that increase the likelihood of road crashes. Responses of officials show that MRDs are not only contributing to road trauma on urban roads, but also on the major highways. Further, it was found that MRDs are also an indirect source of road crashes, and large haphazard proliferation of MRs across Pakistan has increased the vulnerabilities of other road users, especially pedestrians and motorcyclists.

7.2.3 Vehicle Safety Features

All study participants (except the representatives of the Pakistan's largest MR manufacturing company, who said that most other companies are producing unsafe MRs), including the MR association representative stated that the MR is an unbalanced and unsafe vehicle. The majority of participants identified similar mechanical and engineering faults in MRs as those already discussed in the previous studies and literature review. The most common faults identified by the experts included, but are not limited to (1) MRs are not rickshaws or passenger vehicles: they are only motorcycles illegally modified into passenger vehicles; (2) an MR is a coupled vehicle - any motorcycle attached to any cart compromises the safety and balance of a vehicle; (3) an MR is open on all sides and unprotected; (4) MRs are unbalanced and overturn easily; (5) MRs have open chains and do not have a proper braking system; their braking system was originally designed only for motorcycles, not for a three-wheeler passenger vehicle; (6) MRs do not have side mirrors, indicators and lights, are completely undetectable to other vehicles in the evening; and (7) there are many local modifications in MR design and structure across Pakistan.

> *It is 100% unsafe vehicle, because total weight of an MR with passengers (6-7 passengers) is about 720 kg on its three wheels. While, a motorcycle is only designed for 160 kg load, so how can you place 720 kg on that engine? Therefore, its handle cannot be stable, which is a biggest flaw. Brakes of MRs are ordinary shoe-brakes, which are not appropriate for a passenger vehicle. These types of ordinary shoe-brakes take some time to stop, which is dangerous especially in emergency situations. Moreover, MRs do not have proper indicators. In night, from the distance it appears that a motorcycle is coming, but once you come close to it, you find a wider thing than a bike, that's why it is extremely dangerous. Motorcycle rickshaws operating in our country are of unique type, and you will never find this kind of vehicle in the rest of the world.* (Automotive Engineer & Road Safety Expert)

> *From engineering point of view, it is completely an unbalanced and unsafe vehicle, and entirely against the principles of road safety*. (Transportation Engineer)

> *I consider MR as one of the most dangerous vehicles on the road. It is just a motorcycle that pulls 7 to 8 people. This is dangerous because it is open from all sides, locally manufactured and unbalanced. In my 15 years of professional experience, I have not seen such a low quality vehicle. I wonder who has allowed them on the road.* (Official)

7.2.3.1 Stolen Motorcycles

From Studies 2 and 3, it is clear that some MRs did not have number plates or motorcycle registration documents, and the literature review also indicated that stolen motorcycles are being used to make MRs in Karachi. In the current study, some study participants (especially police officials) mentioned that stolen motorcycles are also being used to make MRs in Lahore and other cities in Punjab.

> *It is totally an illegal transport vehicle, any motorcycle is attached to any cart. You will find that mostly these rickshaws are prepared from the stolen bikes. There should be a survey on it to find out the extent of this crime.* (Official)

> *In Lahore, a large number of these rickshaws are manufactured from the stolen bikes. The government should crack down on them.* (Official)

7.2.3.2 Air and noise pollution

Besides identifying many road safety problems of MRs, the study participants were also concerned over the detrimental effects of MRs on the environment. They identified that MRs are powered by a low-capacity 70cc/100cc engine that does not have the capacity to handle the gross weight of passengers and a metal cart for a long time. Therefore, MRs emit excessive emissions soon after they are operational.

> *Motorcycle Rickshaws are one of the major sources of air and noise pollution in Lahore and other large cities of Pakistan. Actually, MRs use 70cc/100cc motorcycle engine that is only powered to carry maximum two-riders. When you place 7-8 passengers and also carry a metal-cart with a low capacity engine, then what will be the outcome? Definitely, it will emit excessive emissions.* (Automotive Engineer)

> *Air and noise pollution from MRs is significant and it is detrimental to the human and the environment. If we really care for our environment, then MRs should be banned in the city.* (Environmental Engineer)

Traffic wardens were particularly distressed about the growing numbers of MRs, and their increasing contribution to air and noise pollution in Lahore.

> *Motorcycle Rickshaws are the biggest nuisance for us. They are in large numbers, open their silencers (muffler) and cause unbearable air and noise pollution. Literally they have turned us mad, and are a real headache for us. I*

request Environmental Protection department to find out any solution for them. Government should send them out from the city. (TW03)

7.2.3.3 Vehicular Safety Features - Theme Conclusion

Engineering experts suggested that the MR is an unbalanced, unprotected and unsafe vehicle. It is locally manufactured and lacks safety features, posing a safety risk to other road users. Besides identifying numerous road safety issues, the experts believed that MRs also damage the environment.

7.2.4 MR Driving - Socioeconomic Aspects

7.2.4.1 Scale of MR Manufacturing Industry

The LTC records showed that there is an extensive MR manufacturing network in Lahore and across Punjab. There were 46 MR body manufacturing companies, and 22 motorcycle manufacturing companies in Lahore alone in 2013 (Figures 2.3-2.4, information extracted from the LTC documents).

The officials of the Pakistan's largest MR manufacturing company (PQL) stated that they produced around 36,000 MR units in 2014, and their average monthly production was about 2,500 to 3,000 MR units. The PQL has a Pakistan-wide (including Federally Administered Tribal Areas - FATA) sales and distribution network. A local unregistered small MR body manufacturing company at the Bund Road Lahore is producing around 100 MR body units every month (statement of the company's sales representative, who was interviewed in this study).

Given that PQL started producing MRs in 1994, and currently has a Pakistan-wide network, and the large numbers of MR-associated companies across Lahore, there is clearly an extensive MR industry. A similar situation is anticipated in other provinces (Sindh, KPK and Baluchistan) of Pakistan.

7.2.4.2 Socioeconomic Scale of MR Driving

The PQL records show that they have around 300 employees at their production unit, 7,000 vendors, 400 sales-dealers, 4,500 service dealers, 1,000 spare-parts dealer and approximately 25,000 customers across Pakistan. Thus about 38,200 people are directly involved in the MR business of only one manufacturing company. Further, if each of the 38,200 individuals is supporting on average six members of his family, over 0.2 million people obtain their livelihood from just one MR company (stated by PQL official).

These figures do not include the number of MRDs operating across Pakistan. If there are around one million MRDs, and each is supporting a family unit of six members, around seven million people directly gain their livelihood from the MR driving sector. Further, there are many others (local mechanics and welders, second-hand MR sales dealers) directly or indirectly involved in this business. This situation provides an overall view of the extended socioeconomic network associated with the MR driving profession in Pakistan.

7.2.4.3 Socioeconomic Circumstances of MRDs

Study 3 revealed that most MRDs operate rented vehicles, have a rented house, support large families and work long hours to barely make ends meet. It was also found that most MRDs are uneducated, and many are underage, also linked with their low-socioeconomic status. The extent of the MRDs' socioeconomic hardships, and the severity and sensitivity of this issue can be gleaned from the experience of the enforcement officials in Lahore:

> *Recently we caught a very young 10-12 year child, who was driving the MR on the main GT Road Lahore (GT Road is a four lane major road in Lahore), and his mother used to accompany him always. When we tried to issue infringement ticket to that guy, his mother started crying and made a big issue. She said, I am a widow, I do not have anyone else to earn except this boy. I have taken loan to buy this MR on instalments, if you impound our MR, who will run our house?* (Official)

All study participants repeatedly emphasised that while devising any policy measures for MRs, it is crucial for government to consider the socioeconomic aspects of MR driving and the sensitivity of this issue. Most were of the opinion that imposition of a ban on MRs would not solve the problem; in fact it might create various other issues such as socioeconomic, transport and security-related problems:

Socioeconomic issues: *thousands of MRDs will be jobless, and in that situation MRDs and their families will be at the stake of their life, like in Karachi, where MRDs are attempting suicides.* (Official)

Transport-related issues: *Currently, MRs are the largest informal public transport mode in Pakistan, and they are providing transportation to a large population (especially to poor people) across the country. In the absence of MRs, there will not* *be any public transport available for the general public that will create mobility and transport related issues across Pakistan.* (Official)

Security issues: *there will be several law and order and security related issues across the country such as protests, damage to the public properties, suicide attempts, increase in crime etc.* (Official)

> *We agree that MR is an unsafe vehicle, MRDs are unskilled drivers and they are involved in many road crashes, and MRs are also polluting our environment. However, government must think about their children before taking any decision.* (Representative of MR and AR association)

> *This is a very sensitive issue that needs to be addressed properly, otherwise it can result in severe socioeconomic, transport and security related consequences.* (Official)

7.2.4.4 Socioeconomic Aspects of MR driving - Theme Conclusion

Official records and stakeholders' views suggest that the MR manufacturing and MR driving network is very large, and extends across Pakistan. The officials believed that millions of the people are directly or indirectly associated with the MR business, with significant socioeconomic implications. Therefore, this matter should be handled carefully, considering all underpinning factors and the prevailing situation across the country.

7.2.5 MR - Road Safety and Transport Policies

This theme presents the government's current and future strategies or policies with regard to the operation of MRs in Lahore and Punjab. It also outlines the recommendations proposed by various stakeholders to address transport and road safety issues associated with MRs in Pakistan.

7.2.5.1 Current Organisational Arrangements

The Punjab Tranport Department (PTD) and Lahore Tranport Company (LTC) are the two principal departments directly involved in public transport planning, policy, management and operations in Punjab and Lahore, respectively. In addition, there are some other public departments such as the Tranport Engineering and Planning Agency - TEPA, Punjab Metrobus Authority - PMA, Punjab Masstransit Authority, Urban Unit and City government, all directly/indirectly involved in public tranport planning, management and operations.

Punjab Transport Department (PTD)

The PTD was established in 1987 and is the main public tranport regulatory authority at the provincial level in Punjab. The PTD has the following mandate and functions (Transport Department, 2016):

- Implementation of government policies for the provision of efficient affordable, and comfortable public transport facilities across Punjab.
- Preparation and implementation of public tranport development plans.
- Initiation of special public transport initiatives like subsidies to promote environment friendly transport across the province.
- Fixation and regulation of public transport fares.

The headquarters of the PTD is located in Lahore, and it has offices in all 36 districts of Punjab. The Motor Vehicle Examiners (MVE) also work under the PTD. As part of the Lahore Urban Transport Master Plan (LUTMP) developed by JICA in 2012, a technical wing of the PTD, the Transport Planning Unit (TPU) was established in Lahore in 2011. The aim was to develop a team of dedicated transport planners and engineers to promote effective and sustainable public tranport planning and management in the province. Before TPU, there were 14 different provincial and local government departments in Punjab that were involved in public tranport planning, which resulted in haphazard planning and management of public transport (Transport Planning Unit, 2016).

Lahore Transport Company (LTC)

The LTC is an associated department of the PTD established in 2009 in response to the growing public tranport problems in Lahore, and deficient technical capacity of the PTD. The LTC is mandated to plan and facilitate a high quality, safe, efficient, affordable and sustainable public transport specifically for Lahore city (LTC, 2015), while the TPU is responsible for transport planning in all 36 districts of Punjab. Both the TPU and LTC have a team of transport planners and tranportation engineers.

7.2.5.2 Current and Future MR Policies

As part of this study, interviews were conducted with the lead management, planning and operational team of the PTD, TPU and LTC. As far as Punjab Province is concerned, it was found that currently the PTD does not have any workable transport or road safety policy for MRs, and MRs are not included in their ongoing public transport projects across the province. The PTD has apparently left this issue with the LTC, which is only mandated to plan for Lahore. As the main provincial transport regulatory authority, the PTD is well aware of the extended informal network of MRs across Punjab, and the associated transport and road safety issues. However, it also understands the situation of existing public transport facilities and infrastructure across Punjab. Presently it appears the PTD is not ready to take up this issue as a priority.

> *We know the extent of an informal network of MRs and unskilled MRDs across the province, but the existing public tranport facilities are not sufficient to cover the whole population. This prevents us to take any severe actions.* (Official)

Over the past two decades, the Punjab-wide growth of MRs and unregistered MR manufacturing companies shows the neglect of the PTD and related departments.

> *There was no concept of planning in the Transport Department, before the establishment of the Transport Planning Unit in Lahore in 2011.* (Official)

> *There are only six authorized MR manufacturing companies in Pakistan, the rest all are illegal, and producing unsafe MRs, and it is due the negligence and the failure of the Transport Department.* (Official)

> *If we also include the number of outskirts of Lahore, in 2013 the number of MRs were around 55,000 in Lahore and would be between 100,000 and 150,000 in the rest of Punjab, and new MRs are consistently coming on the road. I think it's the responsibility of our administrative department to control it, as now this illegal MR industry has been proliferated in the whole Punjab and most manufacturing is from outside of Lahore, at least they should not allow new manufacturing of MRs. If they control the new manufacturing, old MRs will automatically be phased out from the city.* (Official)

On the other hand, the LTC team is trying to improve the public transport situation in Lahore, recently taking some initiatives such as transport surveys to re-align old bus routes and the provision of online bus route information; introduction of new buses; offering subsidies and incentives to encourage private operators to improve the quality and quantity of public transport; launching Pakistan's first public transportation smart phone application (called “bus da pata”) for journey planning; construction of some new bus stop waiting areas; and introduction of student and elderly green cards for concessional fares. All these initiatives suggest that LTC is trying to improve public transport infrastructure and facilities. However, challenges for public transport remain:

> *What loss we are bearing that we do not have enough buses to cater all passengers and maintain an efficient-headway, so passengers do not wait not for the buses. Whatever illegal transport is available, they just travel on that.* (Official)

> *We have lost our 8 or 9 well-established bus routes in Lahore, due to the large proliferation of MRs across the city. The bus operators are here to make profit, if they will not make any business, they have to quit, as government cannot subsidize them completely.* (Official)

Regarding MR transport or road safety policy, it appeared that the LTC has taken this issue seriously, and is trying to find a solution. However, it appeared that matters are sometimes outside LTC control, and it is unable to fully implement planned strategies, mainly due to political influences.

> *Motorcycle rickshaw is an unauthorized, unbalanced and unsafe vehicle, it should not run as a public transport vehicle in Lahore. However, when we try to take any initiative against MRs and accelerate our efforts, a strong reaction comes from the public representatives. They say until you provide them any alternative, do not disturb them, as it is a source of livelihood for thousands of families.* (Official)

> *Transport department have also made some efforts to ban MRs in Lahore, but after a few attempts, they had to roll back, due to political pressure.* (Official)

> *I think government has not developed any strategy to provide any alternative to thousands of MRDs, who are operating across the city. They are struggling to find any suitable solution for this problem.* (Official)

In this situation, the main strategy of the LTC is currently to gradually ‘phase out’ *(‘phasing out’ refers to the gradual removal of MRs from Lahore)* MRs from Lahore by increasing public transport facilities in the city. However, this strategy does not seem to be effective as some working in the same department do not agree with this policy:

I am personally against this 'phasing out strategy' as it is against the human basic right, you cannot stop anyone earning his livelihood. Let people decide, 'give them choices'. People are forced to use this kind of dangerous illegal vehicle, as they do not have any other option. You need to improve your services, why you ban anyone? You make 100,000 policies that we will phase out them, you cannot do that either with the enforcement or any phasing out policy. (Official)

To conclude, interviews with PTD, TPU and LTC officials suggest that currently, the government has no workable transport or road safety policy for MRs in Lahore and Punjab. They are well aware of the transport, road safety and public health hazards associated with MRs; however, the extensive socioeconomic circle of the MR sector, political pressure constrains planning, policy and implementation processes of the transport organizations.

The next section presents the recommendations proposed by various stakeholders with regard to transport and road safety policies for MR.

7.2.5.3 MR Transport and Road Safety Policies - Stakeholders Recommendations

This study involved interviews with a diverse range of stakeholders. All aspects of MR road safety were discussed and many potential solutions and strategies were proposed by different stakeholders. However, most stakeholders proposed similar strategies or policy measures, so the synthesis of all major recommendations is outlined here.

Given the poor road safety profile of MRDs and compromised safety features of MRs, some participants proposed complete ban on MR operation, especially in Lahore.

From the road safety and public health perspective, MRs should be banned in Pakistan, especially in Lahore. Both vehicle and drivers are dangerous and unsafe, and should not be allowed on the road. (Road Safety Expert)

On the other hand, socioeconomic aspects of the MR sector, and the gap-filler role of MRs in the public transport sector were also acknowledged by stakeholders.

Therefore, they suggested that in the present situation, MRs should not be banned anywhere in Pakistan, and should continue operations under well-defined structures and systems as outlined below.

(1) A national ‘MR task force’ (MRTF) should be formulated that might include provincial transport department’s planning managers and road safety experts, a Motor Vehicle Examiner, a member of Pakistan Standards and Quality Control Authority (PSQCA), an environmental engineer, representatives of the Pakistan’s largest MR manufacturing company and MR association in Karachi. Comprehensive MR transport and road safety policies should be formulated by incorporating the feedback of all stakeholders. This policy should be implemented both at the national and provincial levels simultaneously.

(2) The MRTF should formulate nationally standardized manufacturing and engineering standards for MRs. All unregistered MR manufacturing companies across Pakistan should be banned, and only authorized companies should be allowed to manufacture MRs as per vehicular safety standards set by the MRTF. MRs should be assembled and manufactured in one company as a single unit. MR coupling (joining any body and motorcycle) and any kind of design modification should be prohibited. MR passenger and loading capacity should be well-defined, and overloading should not be allowed.

(3) Motorcycle rickshaws should operate under a well-organized system that may be called the ‘Chingchi/MR Transport System’, which should have a stringent organizational and management structure, so that all issues related to MR operation and safety can be addressed systematically. Moreover, MRs should run as a feeder service in large cities such as Karachi and Lahore, and their routes, stops, fares and other parameters should be established and enforced by the concerned authorities.

(4) A separate lane could be provided to MRs on urban roads and highways; they should not be mixed with other traffic. Moreover, no unregistered MR should be allowed to operate, and there should be a strong check on stolen motorcycles being used as MRs. A survey should be conducted in Lahore to assess the number of stolen motorcycles used in MRs.

(5) All MRDs should be licensed and trained in basic traffic and road safety

rules. Underage MR driving should be discouraged, and no underage MRD should be allowed to drive on urban roads or highways. A Pakistan-wide road safety awareness campaign could be launched for MRDs.

7.3 DISCUSSION

This qualitative study aimed to address Research Question 4: *What policies and measures could improve the road safety of MR?*. This discussion section discusses the study major findings, described under the five major themes *(Road safety in Pakistan; MRDs - road safety characteristics; MRs – vehicle safety features; MR driving – socioeconomic aspects and MR road safety and transport policies).* The discussion is also based on experiences and observations of the researcher while conducting this study, and the five main levels of the MR systems model, especially the fifth level – Policy environment: external influences (local, national and international public policies).

7.3.1 **Road Safety in Pakistan**

The experts expressed concern about the growing number of road crashes and poor road safety situation in Pakistan. They identified many factors which contribute to the low road safety profile of the country, and some of these factors included, but are not limited to: lack of political will and vision; absence of national and provincial road safety policies and any dedicated road safety organization; overlapping of functions and deficient coordination among public transport organizations; motorization and urbanization trends; mix traffic conditions; poor driving licensing system; unskilled and uneducated drivers; a lack of road safety and traffic sense among road users; weak police enforcement and out-dated traffic management system; a lack of infrastructure and facilities for vulnerable road users (particularly pedestrians); encroachments and other road-side hazards; no road safety audits and black spot programs; absence of vehicle fitness standards and testing facilities; under-reporting of road crashes and non-existence of centralized crash data recording and reporting system. Major road safety issues identified in this study are in line with Batool et al.’s (2012) findings, which highlighted the main institutional and executional issues, physical and operational issues, driver’s attitudes and behaviour problems, and crash data collection issues in Pakistan.

The experts were of the view that the road safety situation in Pakistan cannot be improved unless government takes this issue seriously, and works on all identified factors/gaps, especially with regard to MRs. Two main areas (the driver licensing and vehicle inspection systems) that are directly related to road safety of MRs are discussed below.

7.3.1.1 Driver Licensing System

The experts identified several gaps in the current driver licensing system in Pakistan, and considered it a major contributor to increasing road crashes across the country. The experts noted that the existing licensing system is not well-designed to test traffic and road safety knowledge, driver's behaviour and the driving skills of novice drivers, and therefore it is bringing more low-skilled drivers on the road. The experts further added that drivers with low knowledge and skills are mainly responsible for the increasing number of road crashes and injuries. It was also mentioned by some participants that influential people obtain a licence through illegal means, and corruption is prevalent in different official processes. These findings are consistent with a previous qualitative study (Batool et al., 2012).

The current licensing system is mainly managed by traffic police in Pakistan. This research provided an opportunity to the researcher to closely observe the working of the driver licensing system in Lahore. It was found that the current licensing system has improved in some aspects such as the introduction of a computerized licensing system since 2011, streamlined processes which are less time-consuming and hassle-free, establishment of six licensing service centres in different areas of Lahore (before 2011 there was only one licensing centre), and a more transparent system compared to the past (Ahmad, 2014).

Despite some improvements in the overall system, the licensing process remains almost the same conventional two-stage process: a 'Learner' and 'Permanent' licence. The learner licence is issued without any theory or practical test, regardless of whether a person knows how to drive or not (Ahmad, 2014). The learner licence is issued for six weeks; afterwards one can apply for a permanent driving licence that involves an easy and short oral road signs test and a driving test. In the oral road signs test, four or five short simple questions generally are asked from the candidate by showing him/her different road signs. This is followed by a short driving test. The researcher formed the view that anyone who can move the car forward or backward for less than half a kilometre can easily pass this driving test, and obtain a permanent licence.

Moreover, once the licence is issued, presently there is no system to check the driver's driving history, or impose severe penalties to deter repeat traffic offenders. Drivers can violate road rules for years, and renew their licences simply by paying the nominal fee. These deficiencies in the current licensing system are probably producing low-skilled drivers, who are mainly responsible for growing road crashes and the overall poor road safety situation across Pakistan. Therefore, the experts proposed updating the existing licensing system to international standards; this will be discussed in the next chapter.

7.3.1.2 Vehicle Inspection System

The experts identified many gaps in the current vehicle fitness and inspection system (VFIS) in Pakistan. They stated that the existing VFIS is inefficient and obsolete, and does not ensure the fitness and safety of vehicles on the road. Therefore, updating the system was suggested.

Regarding the current VFIS system, an official policy document entitled "Modernization of the Trucking Sector in Pakistan – Trucking Policy" prepared by Engineering Development Board of Pakistan, states (EDB, 2015):

> *The current motor vehicle examination and fitness certification system in Pakistan is no more than an 'eye-wash', serving no meaningful function, except a 'rubber-stamp' formality. The MVEs are neither trained nor equipped for vehicle testing and certification. The system, equipment and knowledge which are required for examining and certifying vehicles do not exist.* (EDB, Trucking Policy, pp. 33-34)

Similarly, a development planning study "Project for Automotive Industry Development Policy in Pakistan" conducted by JICA, mentioned that the existing VFIS in Pakistan does not fulfil its objectives, as facilities are not fully equipped and maintained, and inspection is mainly visual. Moreover, despite high technological advancement in the automobile industry globally in the past few decades, rules pertaining to VFIS in Pakistan have not been updated since the 1980s (JICA, 2011).

It is important to ensure the safety of vehicles on the road, as unfit vehicles are more frequently involved in road crashes, accounting for approximately 45% of total road crashes in Pakistan (JICA, 2011). Besides posing road safety hazards, unfit vehicles are detrimental to the environment, as they emit excessive air and noise pollution (EDB, 2015; JICA, 2011).

In Pakistan, motorized vehicles are categorized into two main types ‘commercial or public service vehicles’ and ‘private vehicles’. According to Pakistan Motor Vehicle Rules 1969, only commercial or public service vehicles are required to go through the VFIS every six months (JICA, 2011). However, due to weak enforcement, not even all public service vehicles comply with these rules, and currently only around 30% to 40% of public service vehicles obtain fitness certification (JICA, 2011). Private vehicles, which constitute over 80% of total vehicles across Pakistan, are not required to go through a vehicle fitness test (JICA, 2011; EDB, 2015).

Given that the MR is not registered as a public transport vehicle, it also avoids vehicle fitness and emissions testing requirements. Consequently, as identified in Study 3, the absence of any regulatory mechanism and vehicle fitness requirement is likely to be a major factor in the compromised safety features of most MRs.

7.3.2 **MRDs – Road Safety Characteristics**

The responses of experts and officials suggest that most MRDs are unskilled and risky drivers. Rescue 1122 recent (2014-2015) and past (2011-2013) crash data, and traffic violations records of the LTC and traffic police, also support the experts’ opinion regarding the low road safety profile of MRDs. Rescue 1122 recent road crash data (2014-2015) shows that in terms of frequency of vehicles involved in traffic collisions in Lahore and the rest of the Punjab, rickshaws (both MR and AR) were in second position after motorcycles during 2014-2015. Rescue 1122 and NHMP crash records also provide empirical evidence to validate/substantiate newspaper crash reports and media concerns regarding increasing numbers of MR road crashes throughout Pakistan.

7.3.3 **Traffic Enforcement Issues**

The responses of the traffic enforcement officials suggested that monitoring and control of MRs have become challenging in Lahore, and MRDs cannot simply be controlled with traffic penalties. On humanitarian and socioeconomic grounds, it is very difficult for enforcement authorities to impose stringent penalties and checks.

7.3.3.1 Weak Traffic Enforcement

Concerning weak traffic enforcement in Lahore, discussion with traffic wardens identified job-related stresses and environmental factors that are likely to affect their performance. Experts' opinions and traffic wardens' perspectives suggested that traffic enforcement in Lahore may improve if issues related to the employment conditions of traffic wardens are addressed appropriately, for instance, (1) introducing service structural reforms and a regular career progression system for traffic wardens, and enhancing their salaries as per pay packages of other enforcement agencies such as the general police, LTC and NHMP; (2) hiring of new staff in accordance with the current vehicle population in Lahore to ensure effective monitoring and control of traffic; and (3) introduction of an integrated traffic management system in Lahore, and training of traffic police in best-practice traffic management and road safety policing concepts. These two areas will be discussed in the next chapter.

The health impacts of air and noise pollution on traffic warden health can be further assessed from a recent study conducted in Lahore to examine exposure to traffic-related Polycyclic Aromatic Hydrocarbons (PAHs) among traffic wardens, rickshaw drivers and shopkeepers working along roads, with a control group for comparison (Kamal, Qamar, Gulfraz, Anwar & Malik, 2015). The study found that compared to the control group, the concentration of 1-OHP (1-hydroxypyrene, a biomarker to measure PAH exposure) was significantly higher among the traffic wardens, and rickshaw drivers were the second most affected group. Other biomarkers that measured oxidative stresses were also higher among these two groups. Further, due to the higher time spent by traffic wardens (around 8.72 hours per day for 6 days per week) under busy traffic conditions, they had frequent headache and respiratory symptoms (Kamal et al., 2015).

To reduce the health impacts of air pollution and environmental factors among traffic wardens and the general public in Pakistan, two kinds of initiatives may be useful.

(1) Organizational/personal level: given that all traffic wardens attend the same basic law enforcement and traffic management training course, all are probably capable in traffic management and control. Therefore, at the organizational level, exposure of field staff to air pollution and other environmental factors could be reduced by regular rotation of field and office staff.

Personal exposure to air pollutants can be reduced by wearing proper personal protective equipment such as a facemask or respirator. However, the efficacy of a facemask or respirator to remove pollutants from inhaled air largely depends on the respirator type and quality of the adsorbent material used in it, and surrounding environmental conditions (Laumbach, Meng & Kipen, 2015). For instance, in the USA, the National Institutes for Occupational Safety and Health (NIOSH) certifies a ‘protection factor’ of ‘10’ to a respirator having a quality adsorbent material and a proper face-seal (Bollinger, 2004; Laumbach et al., 2015). These types of respirators when properly worn following the ‘fit-tested’ standards are likely to reduce the concentration of the air pollutant inside the facemask to ≤10% of the concentration outside the facemask (Bollinger, 2004; Laumbach et al., 2015). It was observed by the researcher that in Lahore, despite high air pollution levels, the use of personal protective equipment (facemask or respirator, sunglasses etc.) among traffic enforcement officials is low. Use of personal protective equipment can be improved, by awareness, training and strict implementation of organizational SOPs (standard operating procedures).

(2) Governmental level: a serious effort is required to address this important public health challenge. Long term planning, legislation and stringent enforcement are required to reduce environmental impacts resulting from vehicular emission in Pakistan. In this regard, Pakistan may follow the examples of neighbouring countries such as Iran, China and India (Atash, 2007; Singh, 2014; Yang, Wang, Shao & Muncrief, 2015).

Iran implemented a ten-year air pollution control master plan in Tehran in 2000, and successful vehicle emission control programs are also running in Beijing, China since 1999 (Atash, 2007; Yang et al., 2015). Both these programs include a range of initiatives such as improving new vehicle manufacturing and emission standards; removing old vehicles from the roads; adopting better fuel quality standards (China 5/V and Beijing 6/VI emission standards) and alternative fuel vehicles (hybrid, electric or solar powered); in-use vehicle emission control; improving vehicle inspection standards; adopting better traffic management systems; and, in Tehran, training and awareness of traffic enforcement officials and the general public regarding the negative impacts of air pollution, and correct ways of driving to reduce fuel consumption and air pollution (Atash, 2007; Khajevandi, 2005; Yang et al., 2015).

The emissions of MRs and ARs could be reduced by converting them on electric or solar batteries. For instance, around 100,000 battery operated e-rickshaws are operating in Delhi, India, which are ecofriendly transport mode, compared to traditional ARs (Singh, 2014).

7.3.4 **Government Current and Future MR Transport or Road Safety Policy**

Interviews with PTD, TPU and LTC officials suggested that currently, government has no effective transport or road safety policy for MR in Lahore and the rest of Punjab. It appeared that the PTD mainly relies on the LTC to address this issue; however, the LTC is only responsible for the public transport planning and regulation of Lahore district itself.

As far as Lahore is concerned, the LTC is primarily working on an MR ‘phase out’ policy, which, as outlined in earlier sections, will be ineffective for the following reasons. **First,** current public transport facilities are insufficient to cater for the population. For instance, there are total 60 bus routes in Lahore, of which 15 have been cancelled due to overlapping with the Metro Bus route. Of the remaining 45 bus routes, only 25 routes are operational, on which around 400 buses are operating across Lahore. Similarly, there are total 53 van routes in Lahore, of these only 36 routes are operational, on which around 1,400 passenger vans are operating (LTC official, interviewed in November 2015).

Second, the current fleet of the LTC is decreasing instead of increasing: it previously had a fleet of around 650 buses in 2010-2011, and planned to introduce 2,000 new buses by June 2012, but this did not happen (LTC, 2015). Some private operators withdrew their buses from nine major well-established bus routes in Lahore. It is important to mention that the LTC does not own any public transport (bus or van). It invites private operators to run buses or vans on different routes. The LTC only regulates their operation and fares, and provides some subsidy to bus operators (not to van operators) to cover small business losses. However, private operators are withdrawing their buses, as they are losing business to growing competition from MRs, and new operators are not entering the market.

Because of their large numbers, MRs are more frequent compared to the LTC-regulated public transport modes (bus and van). The average MR headway *(minimum passing time between two vehicles in a transit system)* is less than five minutes across the city. On busy MR routes such as GT Road and Bund Road, sometimes 5 to 10 MRs are seen in just one minute. Conversely, due to lower numbers of buses, the headway of an LTC bus is around 10 to 15 minute in peak-hours, and 15 to 30 minutes in off-peak hours (LTC, 2015). Hence people prefer to travel by MR than wait for public transport. Motorcycle rickshaws also operate round the clock, while the LTC fleet operates between 5am and 11pm. Moreover, an MR is cheaper than all other public transport mode, making them an attractive transport option.

Third, the MR 'phase out' policy of LTC appears to be ineffectual, given that the number of MRs and illegal MR manufacturing companies are growing across Lahore and Punjab, and new transport projects such as the Orange Line Metro Train Project (OLMTP), and identification of new operators to operate buses on current non-operational routes, will take some time. The OLMTP is the first mass-transit train project in Pakistan, and will cover around 27 kilometres in Lahore. The project started in 2015, and is scheduled to be completed by 2017. However, this project became controversial at its start, and on 27 January 2016, the Lahore High Court issued a stay order against construction work for this project within 200 feet of the historical buildings along its route (*The Express Tribune*, 2016). The petitioners (many civil society activists) raised the following concerns: (1) the project was conceived and initiated without properly planning; (2) before construction, electricity, water and gas lines were not shifted to appropriate places; (3) no proper traffic management plan and alternative routes were provided, so thousands of people are suffering due to time wastage in traffic jams on a daily basis: even ambulances remained stuck in traffic jams for hours; (4) since the commencement of this project, around 26 people died in traffic crashes and occupational-related incidents due to the poor occupational health and safety arrangements in this project; (5) Lahore's architectural heritage is at risk due to the many historical buildings of the city affected (UNESCO, The United Nations Educational, Scientific and Cultural Organization, also raised this concern); and (6) government is diverting funds from other important sectors (health and education) for this project (*The Express Tribune*, 2016). This project is still underway and may be completed by 2018.

This situation indicates that currently LTC faces two main problems in terms of implementing its MR ‘phase out’ policy. On the one hand, the numbers of MRs are increasing because their administrative department (i.e. the PTD) which is supposed to control informal operation and illegal production of MRs across the province, is not taking this issue seriously. On the other hand, public transport facilities are deficient in meeting the transportation needs of the large population of Lahore, and political pressure is also increasing for the socioeconomic reasons outlined previously.

Finally, the LTC MR ‘phase out’ policy does not seem feasible, as there is internal disagreement about the policy, on the basis that it is against basic human rights to deprive someone from earning a livelihood. Some officials believed that no policy can phase out MRs until government provides better alternatives. To conclude, the current situation clearly indicates that presently government has no definitive road safety or transport policy for MRs in Lahore and the rest of Punjab. Agencies appeared to be in a ‘wait-and-see’ situation, struggling to find appropriate solutions for this growing transport, road safety and socioeconomic challenge.

7.4 CHAPTER SUMMARY

Study 4 involved interviews of the key stakeholders to identify policy measures and strategies to address transport and road safety issues related to MRs. Rescue 1122 and NHMP crash data, infringement records of the LTC and traffic police, and perspectives of the experts suggested that most MRDs are unskilled and risky drivers, who are making a sizeable contribution to road trauma across Pakistan. Engineering experts identified many mechanical and engineering defects in MRs, which demonstrates that MR lacks safety features and they are unstable and unsafe vehicles.

Interviews with transport department officials showed that currently there is an absence of any workable transport or road safety policy for MRs. It appeared that the PTD is relying on the LTC to tackle this issue, but the LTC is only mandated to regulate and plan for public transport operating in Lahore. The LTC is primarily relying on an MR phase out policy, which would be impossible in Lahore at present. Stakeholders suggested that MRs should not be banned anywhere in Pakistan, but they should operate under a well-defined structure and system. It was proposed to formulate transport and road safety policies for MRs, and MR manufacturing standards and fitness criteria need to be developed and implemented. These policies would require that all MRDs should be licensed and no underage MRDs should be allowed to drive MRs on urban roads or highways across Pakistan.

In addition to proposing policy measures and recommendations for MRs, this study also identified some organizational gaps in the operations of transport-related organizations, traffic police, the driver licensing and vehicle safety inspection systems in Pakistan, which will be further discussed in the next chapter. The next chapter presents the discussion and concluding recommendations to address the road safety issues of MRs.

Chapter 8: Discussion and Conclusions

The overall aim of this doctoral program was to examine the road safety aspects of MRs. The detailed discussion of the findings of the four studies conducted within this research program has been presented in the previous chapters. This chapter synthesises the research major findings in relation to the MR system model and research questions, and recommends policy measures to address the identified road safety issues of MRs. This chapter also outlines the strengths and limitations of the overall research program, and proposes directions for future research. An overview of the current research is given at the beginning of this chapter to remind the reader about the research background and design.

8.1 RESEARCH BACKGROUND AND DESIGN

The literature review identified several gaps related to research, planning, policy, management and operations of MRs in Pakistan. It was found that the road safety and public health issues of MRs were not well-documented in Pakistan, although newspaper reports indicated that MRs are contributing to road crashes, injuries and fatalities across the country. Moreover, it was noted that extensive growth of MRs over the past two decades has led to a country-wide network, which has become a livelihood source for thousands of families. All of these factors provided the impetus to undertake this research program, which examined the following research questions:

1. What is the size of the MR crash problem?
2. What are the characteristics of MR crashes?
3. What are the characteristics of MRDs that influence the road safety of MRs?
4. What policies and measures could improve the road safety of MRs?

The OLV-use systems model was adapted to develop the MR systems model, which offered five comprehensive levels to examine the factors which influence the road safety of MRs. Using the five major levels of the MR systems model, an inclusive analytical framework was constructed (Table 3.2), and four main studies were conducted to address research aims and questions:

Study 1: Analysis of Rescue 1122 road crash data

Study 2: Observations of road safety behaviours and practices of MRDs

Study 3: Survey of road safety knowledge, attitude and practices of MRDs

Study 4: Identification of road safety and transport policy measures for MR.

8.2 REVIEW OF RESEARCH FINDINGS

This section outlines the major findings of the current research in relation to the five main levels of the MR systems model, and four research questions addressed in this research program.

8.2.1 **Research Question 1:** What is the size of the MR crash problem?

Research Question 1 was examined under the first level (MR crashes, injuries and fatalities) and sub-level (MR crash characteristics – *crash trends and scale of MR crash problem)* of the MR system model. This research question was addressed mainly by Study 1 and the Supplementary Study, while Studies 3 and 4 made minor contributions.

Study 1A showed that during 2011-2012, rickshaws (MR and AR) were involved in 17.20% and 9.02% of the total crashes attended by Rescue 1122 across Lahore and the rest of Punjab, respectively. This revealed that after motorcycles and cars, rickshaws were the third major vehicle type involved in road crashes across Punjab in the two-year study period. Rickshaw crashes were reported from all 36 districts of Punjab, which indicates the province-wide distribution and prevalence of MR and AR crashes. Responses from a survey of Rescue 1122 emergency paramedics suggested that more than 80% of rickshaw crashes they attended involved MRs, and less than 20% involved ARs. These estimates are consistent with sources cited in the literature review, which indicated that ARs operate only in large districts of Punjab, while MRs operate in large and smaller centres across the province, so they are a higher proportion of rickshaw crashes.

More recent data (2014-2015) suggests that rickshaw crashes are increasing across Punjab. For instance, Rescue 1122 attended 261,263 road crashes across Punjab in 2015, where rickshaws (MR and AR) were involved in 31,365 or 12.01% of the total crashes, approximately an 80% increase on 2011 figures. The data revealed that rickshaws were the second highest vehicle type (after motorcycles) involved in collisions in Lahore and the rest of Punjab during 2014-2015, while they were the third highest (after motorcycles and cars) in 2011-2012. These figures, together with the emergency paramedics' estimates, suggest that MRDs make a sizeable and growing contribution to road crashes, injuries and fatalities across Lahore and Punjab.

Moreover, in Study 3 nearly three-quarters of MRDs reported being involved in road crashes in Lahore during the one-year of study period. Similarly, in Study 4, the NHMP officials stated that MRDs not only contribute to road crashes on urban roads, but also on major highways across Pakistan, and crashes on the highways are more likely to be fatal and/or multi-casualty incidents. Additionally, countrywide unregulated operation of MRs and high under-reporting of road crashes (Ahmed, 2007; Ahmed et al., 2015; Batool et al,, 2012; Bhatti, et al., 2011; Ghaffar et al., 2004; Hyder et al., 2000; Kayani et al., 2014; Razzak & Luby, 1998), also imply a significant under-reporting of MR crashes.

8.2.2 **Research Question 2:** What are the characteristics of MR crashes?

Research Question 2 related to the first main level (MR crashes, injuries and fatalities) and sub-level (MR crash characteristics – *crash trends, crash types, vehicle involved, crash contributing factors, casualty characteristics, injury severity, injury type etc.)* of the MR system model. Study 1 and the Supplementary Study mainly addressed this research question, while remaining studies provided some additional information.

The analysis of the MR crash data showed that MR crashes were reported in all major towns and on all road types in Lahore, demonstrating that MRDs are significant contributors to road trauma across the city. The ambulance response time data indicated that MRs operate around the clock in Lahore, which reflects their central paratransit role in the city's public transport sector.

About 84% of MR crashes were multi-vehicle crashes involving both motorized (including heavy vehicles) and non-motorized vehicles, because in Lahore, MRs operate on all road types in mixed traffic conditions, which increases the likelihood of multi-vehicle crashes. Previous research has demonstrated that exposure to different vehicles under heterogeneous traffic conditions affects the crash risk, rates and severity (Donnelly-Swift & Kelly, 2015; Kim et al., 2007). However, in MR crashes, no significant association was found between crash type and crash severity, and about three-quarters of single and multi-vehicle crashes were of moderate injury severity.

Nearly half (45%) of single-vehicle crashes occurred due to overturning of MRs. Similarly, in Study 3, 85 incidents of MR overturning were reported by MRDs in Lahore over the previous 12 months. The causation of overturning was not investigated in this research, but frequent overturning of MRs in single-vehicle crashes shows that their balance and equilibrium are inappropriate to vehicle safety standards. This is likely to be due to the fact that MRs are locally modified, with a turning radius of only 7.7 feet, when it should be a minimum of 12 to 14 feet for a balanced three-wheeled vehicle (*The Express Tribune*, 2012a). Schmucker et al.'s (2011) data and simulation-based and biomechanical studies (Chawla et al., 2003; Gawade, Mukherjee & Mohan, 2005; Mohan et al., 1997) from India also support these findings. However, MRs and three-wheeled motorised rickshaws have different vehicle safety features, and therefore future research is imperative to assess the safety and crashworthiness levels of MRs.

In all three datasets analysed in Study 1, there was a higher proportion of males involved in road crashes, compared to females. Similarly, people aged 11-40 years were most commonly involved in both rickshaw and MR crashes, comprising more than half of the total casualties recorded in these crashes. Males and young people are over-represented in crash data around the world (WHO, 2009, 2013, 2015). Likewise, in Pakistan, for sociocultural and economic reasons, a higher proportion of young males than females are in paid employment and in education, and they are socially more active than females (Pakistan Bureau of Statistics, 2016; Sathar, Kamran, Sadiq & Hussain, 2016). Those aged between 10 and 39 years comprise more than half (55.3%) of the general population (including about 33% in age group 10-24 years) in Pakistan (Pakistan Bureau of Statistics, 2016; Sathar et al., 2016), also increasing the likelihood of young and middle-aged people being more involved in road crashes.

Among road users, MRDs, motorcycle riders, passengers and pedestrians were the most common casualties in MR crashes, and motorcyclists and pedestrians were involved in about two-thirds (66%) of multi-vehicle crashes. This shows that the vulnerable road users such as motorcyclists and pedestrians were frequently involved in MR crashes. Past research from Pakistan and other parts of the world has also shown that motorcyclists and pedestrians are largely represented in the crash data globally (Ahmed, 2007; Batool et al., 2012; Ghaffar et al., 2004: Hashmi et al., 2012; Jafar et al., 2013; Saleem, Haider, Khan & Saleem, 2015; Shabiralyani et al., 2015; Tahir et al, 2012, 2013; WHO, 2009, 2013, 2015). In MR crashes, the higher interaction of MRs and motorcycles is due to their large numbers in Lahore, and more importantly, their risky driving behaviours and practices such as signal violations and speeding. In Study 2, it was observed that both MRDs and motorcyclists were frequently involved in various traffic violations such as leaving early before the signal turned green that increased the likelihood of their traffic conflicts.

In MR-pedestrian collisions, there are several human behavioural and environmental factors that are likely to increase the risk of their traffic conflicts and crashes: (1) growing numbers of MRs and their illegal parking stands across Lahore. In Studies 2 and 3, it was noticed that MRs have occupied many pedestrian pathways, service lanes and major portions of the roads in Lahore, which likely to obstruct pedestrian mobility on the road and expose pedestrians to traffic; (2) risky road safety behaviours of MRDs such as neglecting the right-of-way of pedestrians was an important factor in frequent MR-pedestrian collisions. In this respect, the behaviour of pedestrians was also important, as in Study 2 it was observed by the researcher that some pedestrians do not comply with road rules at crossings, increasing their vulnerability to crashes and injuries; (3) environmental factors may contribute to MR-pedestrian collisions such as mixed-traffic conditions, improper signal phasing, and absence of pedestrian signals in Lahore, where pedestrians and other road users are not separated by time and space; there is a lack of appropriate infrastructure and facilities for pedestrians, such as absence of overhead bridges and underpasses along the major road projects in Lahore; the construction of signal-free corridors in Lahore and Karachi further creates problems for pedestrians and makes it difficult to cross the road under busy traffic conditions; (4) and a lack of awareness among pedestrians regarding safety issues. Tahir et al. (2016) also identified similar factors for the increasing vulnerability of pedestrians in Pakistan, while analysing the Rescue 1122 crash data from 37 major cities of Punjab.

The lack of protection provided by the MR for the driver and passengers also contributes to injury in crashes. Given that MRDs are mounted on the forward motorcycle section of MRs, they are as unprotected and unsafe as motorcycle riders, while MR passengers are more vulnerable to injury, because MRs are open at the sides. In particular, MR rear-seat passengers are potentially vulnerable in rear-end collisions. In this research, it was not possible to investigate the relationship between crash impact point (rear, front, angular) and resulting injury outcomes for MR occupants. An increased risk of fatal injuries and poorer Glasgow Coma Scores were found for front-seat passengers of motorized three-wheeled rickshaws in India (Schmucker et al., 2011). However, as already mentioned, Indian rickshaws and MRs have different vehicle features, and passenger seating capacity and positions, therefore the crash and injury patterns among the occupants of MRs need further exploration.

8.2.3 **Research Question 3:** What are the characteristics of MRDs that influence the road safety of MRs?

Research Question 3 was examined under the first four main levels (*MR crashes, injuries and fatalities, immediate physical work environment, external physical work environment and organizational environment and policy environment*) and sub-levels (*MRD demographics & socioeconomic profile, MRD driving characteristics, MRD road safety behaviours and practices, Vehicle-MR, Road infrastructure & environment and MRD work patterns)* of the MR system model. This research question is primarily addressed by Study 3, but all other studies contributed.

8.2.3.1 Demographics and Socioeconomic Characteristics

Young and Underage MRDs

The MR sector is dominated by young and underage drivers, as over half (54%) of the MRDs interviewed in Lahore were young people aged between 10 and 25 years. The growing poverty and unemployment rates in Pakistan (IPRP, 2016; Yousaf & Ali, 2014), flexibility of job conditions in the MR sector, and weak or absence of regulations and enforcement appeared to be the major factors attracting young MRDs to enter this sector.

Underage driving is one of the significant features of the MR sector. Nearly a quarter of MRDs appeared to be underage drivers in the observational survey, and 18% in Study 3. Some started MR driving at the very young age of nine or ten years, which clearly indicates the extent and scale of underage driving in the MR sector. The prevalence of underage MRDs would probably be higher in smaller centres across Pakistan than in Lahore, because there is less or no police enforcement in these centres.

The Study 3 survey results showed that compared to higher-aged MRDs, a larger proportion of underage drivers reported being road crashes, and their odds of crash involvement were higher (2.4 and 3.6 times higher than MRDs aged 18-27 years and over 27 years, respectively). However in Study 2, underage drivers were less frequently observed violating the traffic signal or in traffic conflicts than older MRDs, and the regression analysis did not show a significant association between underage MR driving and traffic conflicts. These conflicting results suggest that the higher involvement of underage MRDs in road crashes in Study 3 may have reflected more honest reporting, rather than necessarily more risky driving. The real crash risk related to underage MR driving needs to be further examined in Pakistan.

Underage driving is also prevalent among the general driving population in Pakistan (Ali et al., 2010; Durrani et al., 2012; Hussain et al., 2011; Nadeem et al., 2015; Shabiralyani et al., 2015). However, the current research and newspaper reports indicate that the MR sector has the largest cohort of underage public vehicle drivers in Pakistan. The presence of underage motorcycle riders among the general population suggests that some might become MRDs. In order to control underage driving in the MR sector, underage drivers in the general driving population also need to be monitored.

Socioeconomic Characteristics

Study 3 revealed that the average daily take-home income of nearly two-thirds of MRDs was between PKR 200 and 600. The analysis of various socioeconomic factors and other related characteristics of MRDs suggested that they live in difficult social circumstances, in particular those supporting large families.

Newspaper and media reports indicated that that the socioeconomic conditions of MRDs are likely to be the main factor affecting their involvement in risky driving practices such as speeding and passenger overloading, to increase their trips and incomes. However, in the current research no significant association was found between MRDs’ socioeconomic status (income), overloading, traffic violations and road crashes. Further research is required to better understand these determinants.

The socioeconomic profile of MRDs also revealed that almost half MRDs were not permanent residents of Lahore, showing that MR driving has become a livelihood source for families across Pakistan. This highlights the importance of evidence to developing policies and procedures for MR-related road safety issues in Pakistan.

8.2.3.2 Driving Characteristics and Work Patterns

Unlicensed MRDs

Nearly all MRDs who participated in Study 3 were unlicensed drivers. The large presence of unlicensed MRDs, notwithstanding that levels of enforcement are higher in Lahore, suggests an even poorer situation in other parts of Pakistan. The literature review also indicates that MRDs are the largest group of unlicensed commercial drivers across Lahore and Pakistan.

The following factors are likely to promote unlicensed MR driving: (1) the deficiency of formal public transportation across Pakistan, and the easy availability, low-fares and door-to-door services of MRs, are likely to convince authorities to allow unlicensed MRDs to operate. The responses of traffic enforcement officials also showed that they recognize this reality, so they generally disregard the licensing requirement for MRDs; (2) the socioeconomic circumstances of MRDs and their families are likely to be a significant factor for an MRD to start as an underage and unlicensed driver. More than half of MRDs were operating rented or leased vehicles, supporting a large family and had a rented house in Lahore. Consequently, they may not be able to afford to pay the licensing fee or lose their essential earnings, while going through theory and practical driving tests and other official procedures; (3) more than half of MRDs had no formal education and about half were from places outside of Lahore. Therefore, they might be ignorant of traffic rules and the licensing procedures and regulations. Their self-reported illegal risky behaviours and higher involvement in traffic violations in the LTC and traffic police data also support this view; (4) the extensive and common practice of unlicensed driving in the MR sector, and the prevalence of unlicensed drivers within the general driving population in Pakistan (Ahmad, 2014; Batool, 2012; Durrani et al. 2012; Hussain et al., 2011; Qiam et al., 2016) are likely to be encouraging factors for MRDs to go unlicensed.

Given that almost all MRDs in Study 3 were unlicensed, the crash risk related to unlicensed MR driving could not be evaluated. The literature review reveals that the characteristics of unlicensed drivers and the level of their crash risk have not been investigated in Pakistan. Some previous studies however, have described the overall situation of the driver licensing system and the prevalence of unlicensed drivers in cross-sectional surveys (Ahmad, 2014; Batool, 2012; Durrani et al. 2012; Hussain et al., 2011; Qiam et al., 2016). Future studies with comparison groups (licensed and unlicensed drivers) from MRDs and the general driving population are imperative to investigate the influence of licensing on driver behaviour and driving patterns.

Work Patterns

More than two-thirds (68.3%) of MRDs reported working between 11 and 20 hours per day for a full week. This shows that most MRDs have heavy work schedules that likely increase the risk of being fatigued while driving. Estimates suggest that fatigue-related crashes account for 2% to 23% of all reported crashes around the world (Azam et al., 2016; Horne & Reyner, 1995; Maycock, 1996). Driver fatigue is one of the major crash contributing factors in highway crashes in Pakistan (Azam, 2013; Azam et al., 2016).

In the current research, no significant association was found between self-reported fatigued driving and road crashes. This may correspond to the fact that the data for Study 3 were collected from MRDs operating in various urban areas of Lahore. These drivers were operating under busy and noisy mixed-traffic conditions during daylight hours. Given that MRs do not have permanent fixed stops, they stop frequently over short distances to pick up and drop off passengers. Short-transits, busy and noisy traffic conditions and the presence of passengers might keep them alert. Moreover, in Study 3, most MRDs were interviewed while they were in queues, which also provided them some opportunity to relax or take a short nap. These factors are likely to reduce the involvement of MRDs in fatigue-related crashes in urban settings; it might be a contributing factor on highways.

Driver Training and Experience

Study 3 did not find a significant association between MRDs' short informal training and MR driving experience and road crashes. Both groups of MRDs *(friend-trained vs self-trained and < 5 years of MR driving experience vs >5 years of MR driving experience)* were almost equally involved in self-reported road crashes. On the other hand, a significant association was found between underage MR driving and road crashes. This is probably due to the fact that being an underage MRD does not necessarily mean less or more experience, as analysis of the 'current' and 'past' underage MRDs showed that some started MR driving at the age of 9 or 10. Therefore, a 17 year old underage MRD who started MR driving at 10 years, would have 7 years' experience, although still being underage.

As mentioned previously, MRDs work in an environment where most do not follow traffic and road safety rules. Regardless of their driving experience and short informal training, limited monitoring and unregulated operation are likely to allow them to disregard the basic requirements of public vehicle drivers, and more often to engage in risky behaviours. Necessary regulations, enforcement and awareness are required to influence MRDs to improve their road safety performance, which will be further discussed in the recommendations section.

8.2.3.3 Road Safety Behaviours and Practices

Traffic Violations and Road Crashes

In the observational survey, more than half of MRDs were involved in red-light running and leaving before the signal turned green resulting in frequent traffic conflicts with other vehicles. Red signal violation was found to be a highly significant factor in increasing the likelihood of traffic conflicts. Further, more than half of MRs were overloaded with 7 to 15 passengers and no MRD wore a helmet.

Frequent involvement of MRDs in signal violations and traffic conflicts does not only demonstrate behavioural issues, but it may also reflect a knowledge gap, given that the majority of MRDs were poorly educated and were driving without a licence (so therefore had not passed a road rules knowledge test).

Study 3 found that nearly all MRDs were involved in the large number of traffic violations; about three-quarters reported being involved in road crashes, and a similar proportion reported being at-fault in these crashes during the past 12 months. Risky road safety behaviours and practices of MRDs such as underage driving, traffic violations, MR structural and design modifications and MR music system, were significant factors in increasing the likelihood of MR crashes. A significant association was also found between road crashes and MRDs' self-reported behaviours and practices such as *when traffic warden is not present, I do not stop at red-signal; road crashes are caused by nature; driving faulty vehicles; and driving a vehicle with faulty brake system.*

Rescue 1122 emergency paramedics perceived that compared to other drivers, MRDs were more often involved in speeding, careless driving, traffic signal violations, overloading and underage driving in Lahore during 2014. The LTC traffic infringement records showed that MRDs were involved in 39% of the traffic violations from 2012 to 2015 in Lahore, the highest number of recorded violations from any group of public vehicle drivers during the study period. Similarly, traffic police traffic violations data revealed that rickshaws (mostly MRs) were involved in over 1.4 million traffic violations in Lahore during 2011-2015.

The high involvement of MRDs in self-reported road crashes and illegal and unsafe road safety behaviours, frequent violations of traffic rules, experiences of LTC, traffic police, NHMP, Rescue 1122 paramedics, and opinion of other stakeholders suggest that most MRDs are risky drivers, who are making a significant contribution to road trauma on urban roads as well as on highways across Pakistan.

8.2.4 **Research Question 4:** What policies and measures could improve the road safety of MR?

Research Question 4 was examined under the fifth main level (Policy environment: external influences - *relevant local, national & international public policy*) and sub-level (Public policies in Pakistan - *Road safety and transport policies, Vehicle inspection system, Driver licensing system, Driver behaviour related legislation, Road crash data surveillance & management system, MR crash surveillance system, MR vehicle registration system, MR road safety and transport policy, Enforcement and control on MR operation)* of the MR system model. This research question was mainly addressed by Study 4, while Study 3 provided some additional information.

Study 4 involved interviews of key stakeholders to identify policy measures to address road safety issues related to MRs. In addition to recommending policy measures for MRs, this study also identified some gaps and suggested measures for governmental organizations that will be discussed in the following sections.

8.3 RECOMMENDED POLICY MEASURES FOR MR

This research was a good opportunity for the researcher to not only examine the road safety implications of MRs, but also to better understand the working of various government departments associated with traffic policy and procedures. This research process helped to identify organizational gaps in planning, policy, management and operations of some of these departments that are likely to contribute to the overall poor traffic and road safety situation in Lahore and Pakistan.

The identified organizational gaps or factors are directly or indirectly related to the road safety of MRs, and without improving these determinants, the road safety issues of MRs cannot be fully addressed. Therefore, based on the current research findings and the researcher's personal observations and experiences in this research program, two types of recommendations are proposed: 'specific' and 'general'. The specific recommendations relate to road safety and transport policies for MRs, while the general recommendations seek to reduce the overall burden of road trauma in Pakistan.

8.3.1 MR Road Safety and Transport Policies

The perspective of transport department officials was that the government has no workable transport and road safety policies for MRs, and they are struggling to find an appropriate solution for this problem. Therefore, it was proposed by experts to regulate MRs under comprehensive transport and road safety policies. These policies should be evidence-based and formulated by incorporating the feedback of all stakeholders (an MR Task Force), outlined in the previous chapter. Evidence enables policy makers to make appropriate decisions for road safety, using scientifically-based evidence in all phases of policy development (Filtness, Thomas, Talbot, Quigley, Papadimitriou, Yannis & Weijermars, 2016).

Standardized MR transport and road safety policies could be implemented across Pakistan, and the Motor Vehicle Ordinance 1969 needs to be amended accordingly. However, merely regulating and enforcing MR policies might not solve the issue, unless practical actions are initiated to improve overall transport and road safety situation at the local and national levels, as discussed below.

8.3.2 MR Registration Scheme

The literature review and the current research showed that MRs have operated across Pakistan for the past two decades, and their numbers are increasing, yet they are unregistered and their exact number is unknown to the authorities. This research demonstrates that the government does not have strong control and monitoring over the manufacturing of MRs, as many unregistered companies are operating across

Punjab and Pakistan. For instance, Figures 2.8 and 2.9 show that there are 46 MR body manufacturing companies (according to officials, many unregistered), and 22 motorcycle manufacturing companies across Lahore, and a similar situation exists in Karachi and other parts of the country (Hasan & Raza, 2015). Moreover, from Studies 2 and 3, some MRDs did not have a motorcycle registration number plate or documents. The literature review and officials in Study 4 revealed that some MRs are constructed using stolen motorcycles.

A comprehensive survey of MRs and registered and unregistered MR manufacturing companies could be conducted in all four provinces of Pakistan. This data need to be registered with the provincial motor vehicle registration authorities and transport departments. All new MRs could be registered under the category of 'MR', not as motorcycles. No unregistered MR could be allowed to operate, and there should be a strong check on stolen bikes being used in MRs. Motorcycle rickshaws could also be regulated to display number plates on both the front and rear of the vehicle to aid enforcement.

8.3.3 **MR Transport System**

The crash location data (Study 1B) showed that MRs operate in all major towns and on all road types (major, arterial and collector roads) in Lahore. In Study 3, the responses of MRDs suggested that they do not have fixed routes and decide their routes according to the operating circumstances. Study 4 revealed that the large informal growth of MRs across different routes in Lahore is causing problems for the LTC-regulated public transport services. The LTC is losing its profitable bus and van routes, and new operators are unwilling to operate due to the saturation of MRs. Further, the literature review and stakeholders' views in Study 4 indicate that a similar situation exists in other large cities of Pakistan.

It was proposed that MRs could run under a well-organized system that may be called the 'MR/Chingchi Transport System', which should have an appropriate organizational set-up and management structure in all cities of Pakistan, so that all issues related to MR operation and safety could be addressed systematically.

Large urban centres such as Lahore and Karachi need integrated multimodal transport services (bus rapid transit – BRT, subways, tram system etc.) along with feeder modes. Introduction of the BRT on one route in Lahore, and ongoing Orange Line Metro Train Project (OLMTP) are good initiatives. However, both these projects will cover around 500,000 commuters per day, less than 5% of Lahore's population (*Medill Reports Chicago*, 2016). Even after the introduction of more BRT routes and OLMTP lines, first- and last-mile is always a problem, especially in the narrow and congested areas, where large vehicles cannot access. Therefore, MRs could operate as a feeder service in the large cities, and their routes, fares and other operational parameters should be well-defined, regulated and enforced.

During data collection phases, it was noticed that MRs and ARs have established illegal terminals or stands across Lahore. These illegal terminals are haphazard and block major portions of pedestrian paths and roads. Therefore, they are likely to compromise the safety of pedestrians and other road users. Frequent involvement of pedestrians in traffic conflicts and road crashes (Studies 1B and 2), experiences and records of Rescue 1122, traffic police, LTC and NHMP also support these observations.

The government could regulate both MR and AR services in Lahore and Pakistan. Regulation of the paratransit transport sector could limit their numbers to specific areas and allocate them designated terminals/parks in Lahore, similar to the 'three-wheelers parks' in Sri Lanka (Gopallawa & Weerasekera, 2014; Jayatilleke et al., 2015). This may assist to decrease MR and AR-related traffic and road safety problems, and equalise availability of transport services in all areas of Lahore and Pakistan. In this regard, traffic surveys would be helpful to assess passengers' travel demands and to identify suitable places for MR/AR terminals.

8.3.4 MR Modifications and Manufacturing Standards

In Study 3, about a quarter of MRs were modified to carry extra passengers and load, and a significant association was found between MR design modifications and road crashes. Similarly, almost one-quarter of MRs had a music system, and MRs with music systems were twice as likely to be involved in road crashes, compared to MRs without music systems. The engineering experts in Study 4 mentioned that due to local modifications and manufacturing, most MRs are unstable and unsafe, and more likely to overturn and be involved in crashes. Newspaper reports and the LTC records also showed that many locally modified MRs operate all over Pakistan, and various unregistered MR manufacturing companies produce their own local brands. Local coupling of MRs, joining any motorcycle with any cart, and second-hand motorcycles and carts, are also common.

Local design and structural modifications are likely to disturb the balance and stability features of MRs. In Study 1B, about half the single-vehicle crashes occurred due to overturning of MRs, and 85 incidents were reported in Study 3. Past research has also shown that most of the for-hire three-wheelers operating in the LMICs are unstable vehicles, as they do not have modern vehicle safety features such as antilock braking systems, seat-belts, and air-bags (Jayatilleke et al., 2015; Mohan et al., 1997; Peden, 2004). The users of unsafe three-wheelers are at higher risk of crashes, injuries and fatalities, compared to other vehicle users (Dharmaratne & Ameratunga, 2004; Dharmaratne & Stevenson, 2006; Farooqui, 2004; Jayatilleke et al., 2015; Mohan et al., 1997). From this perspective, locally modified MRs with ordinary drum brakes and unstable vehicle safety features are also less safe vehicles.

Engineering and manufacturing standards for MRs need to be formulated and implemented across Pakistan. This could be supported by regulations such as only allowing authorized companies to manufacture MRs in accordance with approved national standards. Motorcycle rickshaw coupling and all other kinds of design and structural modifications could be prohibited. There could also be standardized specifications for the size of MR tyres, height of the MR body, seat designs, brakes and body balance. Moreover, music systems in MRs could be banned.

8.3.5 Overloading and Safety Implications for MR Passengers

An MR has a limited seating capacity of six passengers, including the driver. However, in Study 2, more than half of MRs were overloaded, and in Study 3 about three-quarters of MRDs reported that carrying over seven and eight passengers constitutes the overloading of their MRs. The field experiences of the researcher, traffic enforcement officials and experts also suggest that overloading is commonly practised by MRDs.

Overloading appears to be a serious safety concern, particularly where MRs are grossly overloaded with school children (e.g. Figure 6.3). Past research related to the safety of three-wheelers showed that overloading increases the risk of crash involvement and multi-casualty incidents (de Silva, Nellihala & Fernando, 2014; Dandona, Anil Kumar & Dandona, 2005; Jayatilleke et al., 2015: Schmucker et al., 2011; Somasundaraswaran & Richard, 2006: Whitfield & Jones, 1995). Evidence from this research and other LMICs (Ames et al., 2014; Cervero, 2000; Cervero & Golub, 2007; Guillen & Ishida, 2004; Jayatilleke et al., 2015; Mateo-Babiano et al., 2011, 2013; Regidor et al., 2009; Sengers & Raven, 2014; Schmucker et al., 2011; Shimazaki & Rahman, 1996) suggest that gaps in public transport facilities, absence or weak law enforcement, and extra income generation motives are some of the main reasons of overloading among the informal sector.

To address this significant safety issue, the passenger and loading capacities of MRs need to be defined, and then overloading could be banned. Specifically, MRs overloaded with school children should be monitored. However, while devising MR manufacturing and loading standards, it should be noted that the MR is primarily a transport option for poor people, and currently it is the only widely available transport mode across the country. Therefore, limiting MR seating capacity might affect the mobility of those people who cannot afford other transport modes. Thus, policies need to be evidence-based, but suited to local circumstances. In his comprehensive policy reviews, Imran (2009, 2010) concluded that the majority of transport policies failed in Pakistan, because they were not well-contextualised and suited to local conditions.

8.3.6 MR Vehicle Safety and Emissions Standards

Study 1B showed that some MR crashes occurred due to mechanical defects, and Rescue 1122 paramedics also observed more vehicular defects in MRs than in other vehicles in Lahore during 2014. Similarly, around 91% of the observed MRs in Study 2 were not in good physical condition, and 70% of MRDs in Study 3 reported that they 'rarely' maintain their vehicles. A significant association was found between 'driving a faulty MR' and self-reported MR crashes. The engineering experts in the qualitative study identified many mechanical and engineering defects in MRs.

Given the compromised fitness of most MRs, usage of low capacity 70cc/ 100cc motorcycle engines, Dolkhi (a modified motorcycle exhaust muffler that causes air and noise pollution) and the presence of some two-stroke 70cc MRs, MRs were also considered to be significant sources of air and noise pollution in Lahore and other parts of Pakistan. It was argued that the absence of any regulations and vehicle inspection requirement for MRs allows them to operate without concern for the safety and emissions of their vehicles. Two-stroke MRs and ARs have been banned since 2005, and are supposed to have been phased out from five major cities (Lahore, Multan, Gujranwala, Faisalabad and Rawalpindi) of Punjab by 2007;

however, the Punjab Transport Department and other related departments could not effectively enforce this ban (Aziz, 2015; Malik, 2012).

In order to improve the safety of MRs and minimize their negative environmental impacts, MR vehicle safety and emissions standards could be formulated, implemented and examined periodically like other public transport vehicles in Pakistan. However, this cannot be fully achieved with the existing vehicle inspection system in Pakistan, as discussed earlier. Some measures to improve the current vehicle inspection system are presented in the general recommendations section that could help to improve the safety and fitness of MRs.

The government may also consider a country-wide free ‘MR repair and maintenance program’ to improve the fitness of existing MRs. Two-stroke 70cc MRs, ARs and Dolkhis, which are a huge source of air and noise pollution, need to be banned in the whole country. As outlined earlier, switching of existing MRs and ARs on alternative fuels (solar or batteries) and introduction of e-rickshaws in Pakistan, like in India (Singh, 2014), could also assist to reduce vehicular emissions.

8.3.7 **MR and Motorcycle Lanes**

Vehicle registration records of the Lahore Excise and Taxation Department and the LTC statistics indicated that motorcycles constituted more than three-quarters of all vehicles registered in Lahore from 2010 to 2015. Study 1B and observational survey showed that MRs operate in the mixed-traffic conditions in Lahore, and they had traffic conflicts and collisions with various types of motorized (including heavy vehicles) and non-motorized vehicles. About half of MR traffic conflicts and collisions involved motorcycles. Newspaper crash reports and experiences of NHMP officials suggested that MRs are not only involved in road crashes on unban roads, but also on national highways, which are often fatal and multi-casualty incidents. Past research from Pakistan and elsewhere also showed that motorcycle-related crashes and injuries are over-represented in the crash data globally, and they pose a serious road safety and public health issue (Ahmed, 2007; Ghaffar et al., 2004: Hashmi et al., 2012; Jafar et al., 2013; Jamali, 2008; Tahir et al., 2012; Tahir et al., 2013; Tahir, Akbar, Al Ramadhani, Haworth, King & Naseer, 2016; WHO, 2009, 2013, 2015)

Given the large numbers of MRs and motorcycles in Pakistan and their higher involvement in road crashes, an option is to provide a separate lane for both vehicles (or motorcycles alone) on urban roads and highways across the country. This could assist in reducing MR and motorcycle-related road crashes, and improve the overall road safety situation in Pakistan. In Malaysia, where motorcyclists accounted for about 60% of the total road fatalities, the introduction of exclusive motorcycle lanes proved to be a cost-effective solution in reducing crash risk, rates and severity of crashes (Radin Umar, 2006; Radin Umar, Mackay & Hills, 1995). Evaluation studies revealed that exclusive motorcycle lanes in Malaysia resulted in an average decrease of around 39% in motorcycle crashes, and a highly significant drop of 600% in motorcyclist fatalities (Radin Umar, 2006; Radin Umar et al., 1995). Moreover, the cost: benefit ratio of an exclusive motorcycle lane ranged between 3.3 and 5.22, showing that the provision of separate motorcycle lanes was a highly cost-effective countermeasure to reduce motorcycle-related crashes and fatalities in a country with a large number of motorcycles (Radin Umar, 2006; Radin Umar et al., 1995).

8.3.8 MRDs Road Safety Behaviours and Practices

Nearly all Lahore MRDs were unlicensed, and they were frequently involved in various traffic and road safety violations. A significant association was found between road crashes and MRDs self-reported risky behaviours. Moreover, road safety and transportation engineering experts and traffic enforcement officials identified many risky road safety practices of MRDs that increase the likelihood of crashes. All these findings suggest that MRDs have a poor road safety profile and most are unsafe drivers.

The complexity and range of MRD safety measures implies that an integrated approach and multi-level locally-suited interventions are more likely than one-off or one-size-fits-all interventions to be effective in improving the road safety characteristics of MRDs. Regulation, enforcement, education and awareness components need to work together to reduce the burden of road trauma resulting from the risky and illegal behaviours of MRDs. Comprehensive and clear legislation pertaining to MRD licensing, underage driving, driving under the influence of alcohol or drugs, and other unsafe behaviours and operational parameters is a necessary element of such an approach.

Currently, MRDs are legally required to hold a motorcycle licence, but very few comply. After regulating MRs, MRDs could be licensed as public vehicle drivers under a specific MR category, and their theory and driving tests conducted accordingly. Given that MRDs are low-income workers, the government could give them a subsidy on the licensing fee or an incentive to encourage them to be licensed. Similarly, more than half MRDs in this research were operating rented or leased vehicles, and were daily-wage workers, who might not be able to afford to lose a day's income in official procedures. To cover this group, traffic police could arrange mobile driver licensing camps in Lahore, as they do for some other groups. Licensing MRDs might not directly improve road safety; however, this process would bring them under a formal monitoring system, which could be a spur to improve their road safety behaviours. Higher compliance with licensing laws assists in improving driver and road safety management (Watson, 2003).

The social marketing campaigns combined with enforcement could be useful in improving MRDs road safety behaviours and practices and increasing their compliance to be licensed. For example, advertising to convince MRDs that it is safer to stay in the left lane or that visibility is important, so have good side and rear mirrors. Or to advertise that there will be licence checks next month, so get your licence before then? Or perhaps advertising directed at MR passengers to get them to ask MRDs to slow down, when they often involve in speeding and overtaking. Some other aspects of the driver licensing system are discussed under the general recommendations.

After necessary legislation, enforcement is key to prevention of unlicensed and underage driving, overloading and other risky behaviours of MRDs. Vigilant and vigorous traffic enforcement is an effective tool to change driver behaviour (Boniface & Horn, 2016). Effective traffic enforcement does not necessarily mean penalizing drivers: it should be a balanced combination of general and specific deterrence (Boniface & Horn, 2016).

General deterrence is an intervention (legislation, policy or practice) to persuade the general public that certain actions or behaviours are unacceptable, so that they avoid committing an offence due to the perceived risk of detection and the certainty, severity and swiftness of the punishment. Specific deterrence is an action against a specific individual to change his or her future tendency to offend (Ferris, Mazerolle, King, Bates, Bennett & Devaney, 2013). In road safety policing, a successful example of general and specific deterrence is a countrywide program of Random Breath Testing (RBT) in Australia to control drink driving and alcohol-related road crashes. Evidence suggests that the RBT program resulted in the long term reduction in drink driving and alcohol-related road crashes in Australia (Baldock & White, 1997; Ferris et al., 2013; Homel et al., 1988). Deterrence concepts can also be used to reduce the incidence of various risky behaviours of MRDs, however familiarity of police with these concepts is necessary, as discussed in the following section. Moreover, since MRDs are daily-wage workers, and most are supporting large families, the severity and swiftness of punishment and enforcement would need to be applied in accordance with their socioeconomic circumstances. An effective deterrence approach requires a thorough understanding of the target population to achieve road safety objectives (Boniface & Horn, 2016; Ferris et al., 2013).

The ultimate goal of enforcement should be to change the driver's behaviours, which can be better achieved by combining enforcement with education and awareness in the community (Boniface & Horn, 2016). This would involve sensitising MRDs to the consequences of various risky behaviours and the overall impacts of road trauma on society. They would be encouraged to promote safe driving behaviours and road safety. In this regard, a nationwide targeted campaign for MRDs to educate them on basic road rules and road safety principles would be helpful. Traffic police, LTC inspectors and NHMP patrolling officers can play an important role in educating MRDs and promoting their safety. Moreover, after the establishment of the proposed 'MR Transport System' across Pakistan, a program such as 'Safest MRD of the Month' with a small monetary benefit, could be initiated to promote a road safety culture in the MR sector.

8.3.9 Underage MRDs – a Road Safety Issue or Social Dilemma

The current research suggests that the MR sector has the largest cohort of underage public vehicle drivers in Pakistan. A significant association was found between MR underage driving and road crashes, but the lack of a relationship between underage driving and observed traffic conflicts suggests that the crash risk finding may have reflected more honest responding by underage drivers. The experts proposed banning underage driving in the MR sector. From the road safety perspective, banning might be an appropriate policy to decrease crashes related to underage MR driving, but such a policy could have socio-economic consequences.

The literature review and this research show that thousands of underage MRDs operate across Pakistan. It appears that the socioeconomic circumstances of the family and a child's own survival are likely to be the main factors that force a youth to start work at very young age. Therefore, banning underage MRDs might push such families and children into deeper poverty and risk their survival. This situation may force these children to work in other low-paid child labour sectors such as motorcycle mechanics, tailoring, or dishwashing, or even to engage in criminal activities. Many children are deprived of educational and other healthy life opportunities in such occupations, and thus lead a stressful life (Kiani, 2010; Siddiqi & Patrinos, 1995).

In an LMIC such as Pakistan, where the population is large and the government is unable to provide an enabling environment to the masses, road safety should not be viewed in isolation: prevailing social dynamics should also be taken into account. The current situation demands a careful analysis of the problem and finding appropriate solutions to achieve road safety, while maintaining the integrity and social fabric of the society.

8.3.10 **Financial implications**

The recommendations made earlier (a comprehensive survey of MRs and unregistered MR manufacturing companies in all four provinces of Pakistan; formulation and implementation of engineering and manufacturing standards for MRs; a country-wide free 'MR repair and maintenance program; provision of a separate lane for motorcyclist on urban roads and highways across the country; subsidy to MRDs on the licensing fee etc.) have financial implications. It is assumed that most of these initiatives could be managed and financed by the concerned departments. For instance, the transport department has infrastructure in all districts across the four provinces of Pakistan which would allow it to conduct the survey of MRs and unregistered MR manufacturing companies at the district level all over Pakistan. The LTC conducted such a survey in Lahore in 2013. The Engineering Development Board (EDB) is the apex body in Pakistan for the development, standardization and certification of vehicle manufacturing standards. It can develop and implement MR engineering and manufacturing standards across Pakistan. Similarly, the National Highway Authority and the Communication and Works Department are the road infrastructure development authorities at the national and provincial levels in Pakistan, which can undertake the motorcycle separate lane project. For an initiative such as the country-wide free MR repair and maintenance program, public-private partnership can be solicited, and MR manufacturing companies which are operating across Pakistan may be invited to assist government in this respect. One such campaign has been successfully undertaken in Multan, Pakistan, where Rescue 1122 officials conducted a survey of road safety practices of motorcycle riders, and during the interview time, Atlas Honda (the largest manufacturer and seller of motorcycles in Pakistan) provided free repair and maintenance to the motorcycles of survey participants (Hashmi et al., 2012). Such collaborations and initiatives promote safety and community awareness, which is crucial to promote road safety culture in Pakistan.

8.4 GENERAL RECOMMENDATIONS

The review of Decade of Action for Road Safety 2011-2020 suggests that the recommended policy measures for MRs would be of limited effectiveness, unless there is some major improvement seen in the following areas in Pakistan.

8.4.1 **Road Safety - A National Priority**

Previous research has consistently demonstrated that the burden of road crashes and injuries is growing across the country, yet road safety is a neglected area in Pakistan (Ahmed, 2007; Batool et al., 2012; Bhatti & Ahmed, 2014; Ghaffar et al., 2004; Hyder et al., 2006; Kayani, et al., 2014; Shabiralyani et al,. 2015; Soori et al., 2011; Tahir et al,. 2012, 2013, 2016). The WHO 2015 Global Status Report on Road Safety also showed the absence of any national road safety strategy, fatality reduction targets and funding for a road safety agency in Pakistan. Systematic reviews by Hyder et al. (2006) and Imran (2009, 2010) revealed that Pakistan has never had an approved transport policy, and any transport policies implemented in Pakistan during the last few decades have been unsuccessful. Bhatti & Ahmed's (2014) review suggested that the establishment of the National Road Safety Agency (LRSA) in Pakistan in 2005-2006 could have been successful, if this initiative had been sustained and given full political and financial support. The LRSA began well; it drafted the first National Road Safety Plan in 2007, reviewed road safety legislation, ensured multi-sectoral collaboration at the national and provincial levels, and collected crash data from some parts of the country to assess the overall road safety situation. Unfortunately, the LRSA was dissolved soon after its establishment, and currently there is no dedicated LRSA in Pakistan (Bhatti & Ahmed, 2014). The current research findings are consistent with earlier studies (Ahmed, 2007; Batool et al., 2012; Bhatti & Ahmed, 2014; Ghaffar et al., 2004; Hyder et al., 2006; Kayani, et al., 2014; Shabiralyani et al., 2015; Soori et al., 2011; Tahir et al., 2012, 2013, 2016), and highlight the lack of transport and road safety planning, policy and practice in Pakistan.

Pakistan, especially Punjab, has attracted some large foreign donors during the last few decades. In recent years, there has been extensive road infrastructure development in Lahore including the construction of include 3-5 lane wide roads, overhead bridges and signal-free corridors. With the assistance of Turkey, the first Bus Rapid Transit (BRT) system was introduced on one route in Lahore in 2013, and since 2016 the Orange Line Metro Train project (funded by China) has been under construction and is expected to be completed by 2018. The recent China-Pakistan Economic Corridor (CPEC) is one of the largest development projects in Pakistan that will connect China, Pakistan, Iran, Afghanistan, India, Central Asian Republic, and the region. It includes enhancement of geographical linkages through development of road, rail and air transportation system (China-Pakistan Economic Corridor, 2017). Since 2016, the Asian Development Bank has been providing technical assistance to Pakistan to establish a road safety management system across the country. This appears to be a comprehensive road safety project that includes all five pillars of Decade of Action for Road Safety. However, past experiences suggest that implementation of planned activities and political and financial sustainability of this initiate may remain important issues.

Following the guidelines of WHO (2004) and the Decade of Action for Road Safety 2011-2020, an independent, dedicated and fully supported LRSA need to be established in Pakistan. National road safety and transport policies should be formulated and implemented. The work of the first LRSA team may be useful in this respect. The policies should include both short-term and long-term crash reduction and injury prevention goals or targets.

Since road safety is everyone's responsibility, a holistic 'Safe System Approach' needs to be adopted. Organizations responsible for planning, enforcement, infrastructure development, drivers' licensing, vehicle registration, research, industry, media and community should work together. The sustainability of actions and collaborations are the keys to achieve the desired goals.

In the LMICs, Non-Governmental Organizations (NGOs) can also play an important role in improving road safety (Ali & Adnan, 2012). In this respect, establishment of the Road Traffic Injury Research and Prevention Centre (RTIR & PC) in Karachi, Pakistan in 2007 was one of the successful initiatives (Ali & Adnan, 2012; Razzak, Shamim, Mehmood, Hussain, Ali & Jooma, 2012). The RTIR & PC has developed a crash surveillance system, and collects data from five major public and private hospitals in Karachi (Ali & Adnan, 2012; Razzak et al., 2012; Saqib, Sheeraz & Farooqui, 2010). It conducts injury prevention research to inform relevant stakeholders and government agencies to initiate various road safety measures. Based on this evidence, the RTIR & PC has proposed some cost-effective solutions to public authorities, and some actions have been taken. Post-implementation studies showed a significant decrease in fatalities and crash severity at the treatment areas (Ali & Adnan, 2012; Saqib et al., 2010). The work of RTIR & PC should be sustained and supported by the government to replicate it in other large cities in Pakistan.

8.4.2 Improving Collaboration and Coordination

Current and past research identifies that the lack of coordination and collaboration among various government organizations is one of the major reasons for the deficient transport planning and poor transport situation in Pakistan (ADB, 2015; Batool et al., 2012; Hisam, 2006; Ghaffar et al., 2004; Imran, 2009). There are many transport-related departments in Lahore and Punjab, and it was noted by the experts (Study 4) and the researcher that effective communication, coordination, and collaboration are missing between these departments. Most of these departments work in isolation, resulting in deficient planning, overlapping of effort, and wastage of public resources.

A similar situation was also observed among various traffic enforcement agencies (e.g. general police, traffic police, LTC traffic enforcement squad, Railway traffic police and NHMP) and other related departments (e.g. driving licensing system, vehicle inspection system and motor vehicle registration authority). It was surprising to find that the same job is performed by two or more organizations. For example, in addition to traffic police, which is the main driver licensing authority in Pakistan, the NHMP also issues driving licences in a few cities, and has planned to extend these services to the whole of country (NHMP, 2016). Similarly, in Lahore, in addition to the traffic police, the LTC and railway traffic police also control the traffic. The LTC is mandated to control and manage public transport vehicles, while the traffic police also have the same function. Moreover, the experts noticed (as did some government officials) that unnecessary political and bureaucratic interference in official matters delays the processes and affects the performance of public departments.

Motorcycle rickshaws are an ideal example of the above-mentioned organizational gaps and unnecessary political inference in public departments. Over two decades have passed, yet MRs operate without any transport or road safety policy. Transport departments and other regulatory authorities are present, but none regulate or monitor MRs. The current research demonstrates that MRDs make a significant contribution to road trauma across Pakistan, and MRs are also detrimental for the environment. However, given the extended socioeconomic network associated with the MR sector, presently, there is a great political pressure against imposing any checks or regulating this country-wide informal network. This research clearly shows the weak performance of transport and related organizations in Pakistan.

The absence of a research culture is another important factor behind the weak performance of public organizations. The experts mentioned that generally public policies are not research-based and are short-term, to achieve political gains. Sustainable evidence-based planning and vision is lacking among transport and other public organizations in Pakistan. It was noted by the experts and researcher while working with government departments in Pakistan that most organizations are unfamiliar with the significance of research in organizational development, and they do not have the appropriate capacity and technical expertise to collect, analyse and use data in evidence-based planning and practice. Some organizations which collect data often do not use it themselves, and discourage others from accessing and using this data. Without a reference from an authority figure, it is challenging in Pakistan to obtain data from any government department.

Public departments should be strengthened in Pakistan, and their research, planning, policy and operational capacity need to be enhanced. The inter/intra-departmental and multi-sectoral coordination among various government departments could be improved. Overlapping of work and unnecessary political interference need to be avoided, and organizations should have a clear vision, objectives and an implementation framework to improve their performance and achieve organizational goals. Public policies need to be integrated across public departments and at various levels of the government to achieve better outcomes.

8.4.3 Addressing Traffic Enforcement Issues

Study 4 identified some factors underpinning the weak performance of the traffic police in Lahore. It was discussed that their performance may improve by addressing their service structure-related issues and increasing their number in accordance with the current vehicle population in Lahore.

Another important issue related to weak traffic enforcement was identified (by some experts and noticed by the researcher while conducting observational survey): that traffic police are not fully aware of and trained in modern traffic management and road safety policing concepts. Instead of active traffic control, the prime focus of police seemed to be to increase their traffic infringement revenues. It appeared that their performance is evaluated based on the amount of infringement revenues they generate, rather than their effect on road safety.

To improve the overall traffic and road safety situation in Lahore and Pakistan, it is imperative to train traffic police and general police in modern best practice traffic management and road safety policing concepts such as understanding driver behaviours and traffic psychology; deterrence measures for repeat offenders; knowledge about the safe system approach; training in road crash prevention and reporting, crash scene investigation and use of crash and infringement data in research and evidence-based practice; use of emerging traffic enforcement technologies such as the use of speed cameras for speed management, detection of driving under the influence of alcohol and drugs, and application of alcohol interlocks, to avoid the five fatal crash risk factors *(speeding, drink/drug driving, not wearing a seat-belt or helmet, fatigued driving and distracted driving such as mobile phone use while driving).* They could work with the community, media and other stakeholders to improve traffic enforcement and road safety outcomes.

Regarding training and professional development of police, international collaborations and technical assistance could also be solicited. For example, the Global Road Safety Partnership (GRSP) is a non-profit international organization which aims to promote road safety globally, particularly in the LMICs. One of the objectives of the GRSP is to train and enhance the technical capacity of police, to improve traffic enforcement and road safety policing in the LMICs. In recent years, under the 'Transport Corridor Europe-Caucasus-Asia program' (TRACECA), the GRSP has organized training workshops for police in Ethiopia, Ghana, Thailand, Indonesia, Colombia, Vietnam and Brazil (Global Road Safety Partnership, 2016).

8.4.4 **Driver Licensing and Vehicle Inspection Systems**

8.4.4.1 Driver Licensing System

The majority of the experts in Study 4 emphasized that in Pakistan, existing driver licensing and vehicle inspection systems are inefficient and outdated, and they need to be updated as per international standards. Given the significance of these two systems in relation to the current research, the researcher closely observed the structure and working of these two systems. As identified by the experts and previous studies (Ahmad, 2014; Batool et al, 2012; EDB, 2015; JICA, 2011), it was noticed that the current driver licensing and vehicle inspection systems are merely official formalities, as they are not producing an efficient skill-based driving licensing system or ensuring the roadworthiness of vehicles. Under these current systems, even if all MRDs were licensed and all MRs were certified as fit vehicles, there might not be a significant reduction in road trauma resulting from the risky driving practices of MRDs and unsafe MRs. It is vital to revamp both these systems. Introduction of a Graduated Driver Licensing (GDL) system and improving the standards of current vehicle inspection system would be helpful in this regard.

The GDL system is a three-stage licensing process (learner, provisional and open licence) that aims to train novice drivers under the low-risk driving environment, and then gradually expose them to more complex driving situations (Bates, Allen, Armstrong, Watson, King, & Davey, 2014). The research demonstrates that the GDL system is effective in reducing crash risk and road crashes, especially among young drivers (Bates et al., 2014; Fell, Jones, Romano & Voas, 2011; Masten, Foss & Marshall, 2011; Neyens, Donmez & Boyle, 2008; Williams, Chaudhary, Tefft & Tison, 2010). For instance, in the USA after the introduction of the GDL systems, the crash risk for the youngest novice licensed drivers was reduced to 20% to 40% (Bates et al., 2014; Shope, 2007). Research showed that even with a basic type of the GDL system, the fatal crash risk was reduced among 16 and 17 year old drivers, compared to somewhat older drivers, while more comprehensive GDL systems result in even greater reduction of road crashes (Bates et al., 2014; Fell et al., 2011). However, given the different sociocultural environment and road users' behaviours in Pakistan, the GDL system introduced in the HICs might not be suitable here. Therefore, further research is needed to identify gaps in the existing licensing system and assess the applicability and feasibility of the GDL system in Pakistan.

To improve the licensing system in Pakistan, there is also a need to ensure the uniformity of licensing standards across the country. For instance, currently both traffic police and NHMP issue driving licences in Pakistan, and they have a more or less similar two-stage driving licensing structure - learner and permanent licence. Though compared to traffic police, the NHMP has an improved licensing system and more stringent theoretical and driving tests criteria, it may not make much difference in terms of driving skills, which are usually acquired as part of an efficient GDL system (Bates et al., 2014; Masten, Foss & Marshall, 2011; Neyens, Donmez & Boyle, 2008; Williams, Chaudhary, Tefft & Tison, 2010). Therefore, it is important to adopt the GDL as well as national driving licensing standards to ensure uniformity in licence issuing criteria and practice.

The transparency of the service delivery system is also a crucial factor in the success of any system. Therefore, appropriate strategies and policies sould be adopted to make the system corruption-free. A successful anti-corruption strategy can be developed by identifying gaps in the existing system, and investigating the factors which persuade people to engage in anti-social behaviours.

The restructuring of the licensing system could be coupled with improvement in traffic enforcement and road safety policing by introducing structural, policy, legislative and operational reforms. The experts noticed that presently, once the licence is issued, there is no system to monitor the driving history of a driver. Consequently, people do not feel any pressure to obey traffic rules.

To promote responsible driving behaviours and road safety for all road users, it is crucial to improve enforcement and adopt an efficient monitoring system such as a 'Demerit Points System' (DPS), successfully implemented in many counties around the world. For instance, the DPS is a national program and an integral part of the road safety law in Australia. It includes demerits points on the driver's licence for certain driving violations, and imposition of penalties such as ‘on the spot heavy fines’, court imposed penalties and instant loss of the licence for serious traffic violations (Road Safety Committee Report, 1994). However, the context of Pakistan is entirely different from that of a HIC such as Australia. Given the sociocultural differences and economic disparities, stringent monitoring and heavy penalties may not be suitable in Pakistan, where the majority of the population is poor. A DPS also requires an efficient data recording and management system and related enforcement that would be difficult to achieve in Pakistan. This research presents the overview of best practices that have assisted improvement in road safety globally, but the applicability of these interventions needs to be assessed in the local context.

8.4.4.2 Vehicle Inspection System

A Vehicle Inspection System (VIS) serves as an audit of a vehicle to improve its roadworthiness by removing vehicular defects (Asander, 1993; Paine, 2000). Although the literature did not provide any conclusive evidence regarding the effectiveness of VISs in reducing road crashes, they appear to be effective in reducing the number of defective vehicles on the road (Paine, 2000; National Highway Traffic Safety Administration, 1989; Rechnitzer, Haworth & Kowadlo, 2000). In the current research, some single-vehicle MR crashes were attributed to vehicle defects, and engineering experts also identified many vehicular defects in MRs.

There are many different kinds of VISs that operate globally, ranging from a low-quality and high-cost system to an efficient and cost-effective system (Paine, 2000). An efficient VIS contributes to road safety by improving the fitness of vehicles. It is fully equipped with specialized equipment to identify vehicular defects and trained staff to carry out these inspections vigilantly (Asander, 1993; Paine, 2000). The system should also have instruments to check vehicular air and noise emissions to reduce their negative environmental impacts. Moreover, besides periodic mandatory inspections, random road-side inspections could be conducted, otherwise the vehicles would be neglected until just before the periodic inspection (Asander, 1993; Paine, 2000). Periodic vehicle inspections supplemented with surprise road-side inspections keep a consistent check on drivers to maintain roadworthiness of their vehicles (Asander, 1993; Paine, 2000).

Private vehicles, which comprise over 80% of the total vehicles in Pakistan, currently do not require any vehicle fitness test (Pakistan Bureau of Statistics, 2015; PEDB, 2015). Motorcycle rickshaws, as an informal transport mode, are also exempted from any safety inspection. An improved VIS supplemented with road-side inspections, and covering private vehicles (including MRs), could improve vehicle roadworthiness and overall road safety.

8.5 STRENGTHS AND LIMITATIONS OF THE RESEARCH

8.5.1 Research Strengths

Apart from the anticipated outcomes of the current research identified at its commencement, a number of additional potential strengths emerged as it progressed. Some of these are outlined in this section.

8.5.1.1 Research Plan, Methodology and Framework

A systematic approach was adopted in this research program to examine road safety aspects of MRs. The project involved a range of research methodologies such as retrospective analysis of the crash data, quantitative surveys, observational survey and a qualitative study. Multiple research methodologies and data analysis approaches assisted in gaining a comprehensive understanding of the various road safety characteristics of MRDs and MRs that contribute to road crashes.

Given the considerable underreporting of road crashes in police crash records, Rescue 1122 crash data were analysed to understand the characteristics of MR crashes. Rescue 1122 crash data comprised large datasets collected from the whole of Punjab, which provided information about the demographics of casualties, the prevalence and distribution of crashes across all districts of Punjab, injury and crash severity, collision types, crash contributing factors, road users involved in road crashes, temporal characteristics of crashes, and crash locations of MR crashes. On the other hand, police crash records in Pakistan provide limited information about fatal crashes and fatalities.

The literature review suggested that there is a scarcity of injury or crash severity modelling-based studies in Pakistan that could identify specific crash or injury contributing factors. The current research used various logistic regression modelling approaches to identify different sociodemographic, human, vehicular and environmental factors that are likely to influence the safety of MRs. Identification and better understanding of crash risk factors is important to develop appropriate policies and enforcement strategies to reduce the burden of road crashes.

The Stuckey et al. (2007) systems model was adapted to develop an MR systems model, which provided a strong theoretical foundation for this research program. The selected model offered five comprehensive investigation levels to identify various sociodemographic, human behaviour, vehicular, environmental and policy related factors that affect the safety of MRs. In contrast, traditional road safety models primarily focus on the driver's behaviour and errors, and used driver's fault and hierarchical-based approaches, which may not fully capture various environmental and situational factors that influence the safety of drivers and vehicles (Brown, 1990; Evans, 1985; Fuller, 1984; Huang, Ljung, Sandin, & Hollnagel, 2004; Michon, 1989; Näätänen, & Summala, 1974; Taylor, 1964). Analytical framework used in this research could be used in future studies.

Except for part of the survey with MRDs (Study 3), all data collection for this research was conducted solely by the researcher. This approach assisted to better understand the road safety issues of MRs, and the general road safety situation in Pakistan. In particular, long exposure periods while observing and conducting interviews with MRDs were useful in identifying potential risk factors that contribute to road crashes, and issues related to traffic enforcement, road safety policing and environmental conditions.

8.5.1.2 Bridging the Knowledge Gap

Given that road safety issues related to MRs are not well-documented in Pakistan, there was limited scientific literature on this subject. Newspaper and media reports were only the major source of information regarding road crashes, transport policy, operations and socioeconomic issues related to MRs. Although news reports provided some useful up-to-date information, the scientific authenticity of some of these reports could not be validated. The knowledge gap highlighted the need for a comprehensive scientific inquiry, and the current research has attempted this inquiry. The empirical findings of this research provide scientific evidence to verify concerns raised in the media regarding road safety and public health hazards associated with the growing numbers of MRs across Pakistan.

8.5.1.3 Transport, Road Safety, Public Health and Social Issue

This research was undertaken to examine the road safety aspects of MRs. As research progressed, it was found that it is not merely a transport, road safety or public health issue in Pakistan: it is also an important socioeconomic issue that has become a challenge for local and national governments. This research thus addresses significant national transport, road safety, public health and social issues.

This research has also identified some organizational gaps between various governmental departments or systems. The research findings could inform government's road safety and transport policies for MRs, and also offer opportunities for other stakeholders to improve public transport planning, policy, management and operations, driver licensing system, vehicle inspection system, traffic enforcement, road safety policing, and Rescue 1122 crash data collection and management systems in Pakistan.

The findings could also be useful for MR manufacturing companies and other related stakeholders to improve MR engineering and manufacturing standards, and plan their business strategies in accordance with the government's future policy for MRs. Moreover, this research has attempted to measure the scale of the MR sector in Pakistan, and outlined some major socioeconomic issues associated with the sector. Thus, the current research provides a balanced approach and opportunity for all stakeholders to determine the potential role of MRs in Pakistan.

8.5.2 **Research Limitations**

The specific limitations of the four main studies conducted within this research program have been presented in their respective chapters. This section outlines some major limitations of the overall program of research.

The Rescue 1122 data analysed in Study 1A were aggregated such that crashes involving MRs and ARs were recorded together under the category of 'Rickshaws'. Therefore, it was not possible to draw any conclusion about the exact proportion of MR and AR road crashes reported in Lahore and Punjab during 2011-2014. To address this limitation, a survey of emergency paramedics was conducted, which assisted to determine the burden of MR-related road trauma across Lahore and Punjab.

The MR crash data analysed in Study 1B also had some limitations: crash contributing factors and road users involved in crashes were not well-defined or clearly documented. The Emergency Response Form (ERF) used by Rescue 1122 paramedics had limited space and variables. Consequently, it could not capture all the relevant information of a road crash such as sociodemographic characteristics and licensing status of the driver, and environmental factors such as road and weather conditions. Injury classification criteria used in Rescue 1122 also do not correspond to the accepted international classification, so in the analysed data, limited information was available about crash severity and injury severity. Moreover, emergency paramedics generally did not document the exact locations of MR crashes attended by Rescue 1122 across Lahore in 2014. Therefore, Study 1B could not provide a comprehensive understanding of the characteristics and patterns of MR crashes. Accordingly, the later studies of this research program addressed these limitations by identifying the specific human, vehicular and environmental risk factors that contribute to MR crashes. Previous studies have also noted the limitations in secondary datasets such as ambulance and police records, and medical reports in Pakistan (Bhatti et al., 2011; Razzak & Laflamme, 2005).

In addition to limitations identified in the ERFs, it was also noticed that Rescue 1122 emergency paramedics were not fully trained in efficient utilization of the available space in the ERF, and accurately recording the information. They need to be sensitized about the significance of accurate crash data in injury prevention, and to be better trained in data collection and recording processes.

There is a likelihood of under/over-reporting in paramedics’ crash estimates in the Supplementary Study, and in some of the observations recorded in Study 2 such as the apparent age of MRDs, physical conditions of MRs, and the total number of passengers travelling in MRs.

Study 3 used self-report data to investigate the sociodemographic characteristics, driving practices and illegal and risky road safety behaviours of MRDs. The self-report data have some inherent limitations such as social desirability responses, dishonesty, under-reporting or over-reporting which is more pronounced while investigating illegal behaviours (Rosay et al., 2000; Sloan et al., 2004). More than half of MRDs had no formal education and nearly all of them were frequently involved in traffic violations in Lahore. This suggests that MRDs would likely to under-report their risky and illegal behaviour such as speeding, overtaking, and overloading.

There was limited previous research on this subject, so the program of research was exploratory and aimed to be comprehensive in breadth, rather than an in-depth focus on a narrow part of the problem. The lack of denominator (exposure) data prevented the use of many risk modelling techniques.

Given the large scope of this research program (four main studies, one supplementary study and Study 1 had two sub-studies), survey of MR commuters or passenger survey was not conducted, though planned initially. However, the findings of this research and the literature review suggest that the MR is primarily a transport mode for poor or low-income people. Moreover, due to deficient public transport across Pakistan, MRs are the only available option for the general public, so a commuters' survey was not prioritized.

8.6 GLOBAL IMPLICATIONS

Road crashes and injuries pose a significant public health, social and development challenge to countries around the world. This issue is more serious in the LMICs, where over 90% of the world's road fatalities occur (WHO, 2015). The higher rates of road crashes and fatalities in the LMICs are mainly attributed to unsafe transport systems and lack of comprehensive road safety policies and practice (Mohan, 2008; WHO, 2015). Pakistan is one of those LMICs, where public transport and road safety has never been a priority for the government (Ahmed, 2007; Batool et al., 2012; Bhatti & Ahmed, 2014; Ghaffar et al., 2004; Hyder et al., 2006; Kayani et al., 2014; Shabiralyani et al., 2015; Soori et al., 2011; Tahir et al., 2012, 2013). Consequently, the current public transport system in Pakistan is failing to serve the rapidly growing population, and various informal locally modified vehicles are filling this gap. These locally developed vehicles serve a large population; however, they also pose many road safety and public health challenges, and MRs are one such example in Pakistan.

The current research gives a comprehensive understanding of the safety, planning, policy, operational and socioeconomic issues related to MRs, which might have implications for other LMICs, where various types of paratransit modes (informal/formal) operate. In addition to investigating the road safety aspects of an informal public transport mode, this research identifies some organizational gaps which potentially contribute to weak performance of public organizations in the LMICs. Therefore, the study of MRs could assist other LMICs to plan and regulate similar types of paratransit modes, and strengthen their public departments to improve their overall transport and road safety situation.

8.7 FUTURE RESEARCH

Comprehensive and accurate data is required to fully understand the characteristics of road crashes, and identify all crash risk factors. An efficient crash database requires systematic data collection, coding, processing and analysis (WHO, 2010). The Rescue 1122 crash data analysed in Study 1 had some limitations as outlined earlier. Therefore, future research could explore MR crash characteristics with more comprehensive datasets. In this regard, Rescue 1122 currently has the largest road crash database, as well as the organizational capacity to improve its crash data collection. Based on the limitations identified in this research, recommendations will be shared with Rescue 1122 management to improve their crash data collection and management system, which would be helpful for future research related to MR and other vehicle crashes.

In addition to the Rescue 1122 data, the NHMP crash-records can be used to understand the patterns and characteristics of MR crashes occurring on the major highways across Pakistan. The NHMP patrols around 2,219 kilometres of highways across all four provinces of Pakistan (NHMP, 2015), and MRs operate on many highways.

The current research has examined the road safety aspects of MRs from a public health and injury prevention perspective, so it mainly identified the human behavioural factors that contribute to MR crashes. Future research may focus on the engineering and mechanical aspects of MRs, to identify any engineering solutions to make these types of vehicles safer and more environmentally friendly. Safer and better quality paratransit modes can bridge the gap between formal and informal transport sectors. This is particularly important for LMICs such as Pakistan and India, where population is large and public resources are scarce, to provide adequate transport facilities to the masses.

More work is needed to investigate if factors found to be prevalent in this research contribute to crash risk (e.g. overloading, underage driving, unlicensed driving, vehicle characteristics), and by what mechanism. Safety implications for passengers also need to be explored.

As outlined previously, to promote safe driving behaviours and vehicle safety features, the local adaptation and suitability of the GDL system, a demerit points scheme and an upgraded vehicle inspection system need to be assessed for Pakistan. Similarly, for better traffic enforcement and management and road safety outcomes, introduction of an integrated traffic management system in Lahore and Karachi could be evaluated. Moreover, existing traffic enforcement and road safety policies, legislation and practices could be reviewed to identify better policies, legislation and measures.

8.8 CONCLUDING REMARKS

The current research demonstrates that MRDs make a significant contribution to road crashes, injuries and fatalities across Pakistan. Nearly all MRDs were unlicensed, and about a quarter were underage. Almost all MRDs reported being involved in the large number of traffic and road safety violations. About three-quarters of MRDs were involved in self-reported MR crashes in Lahore, and nearly the same proportion acknowledged being at-fault in these crashes.

The engineering experts identified many vehicular defects in MRs such as MRs being unbalanced and overturning easily; open at the sides and lacking protection; having ordinary drum brakes and open chains, no side-mirrors or indicators; poor coupling; and unsafe modifications in design and structure. These factors suggest that MRs have low levels of vehicle safety, and MRs are also considered to be a major source of air and noise pollution in Lahore and elsewhere.

Motorcycle rickshaws are unregulated and unregistered and are not managed by any feasible government transport or road safety policy. Their extensive growth over the last two decades indicates that they are the largest informal public transport mode in Pakistan, providing mobility services to millions of people across the country. Thousands of people earn their livelihood and support their families from this sector.

Although the current research establishes that MRDs have a poor road safety profile and the MRs lack safety features, banning MRs does not appear feasible under the current circumstances. Therefore, the MR system could be regularized and operate under a well-defined transport policy and system. A range of policy measures and strategies are proposed to address transport and road safety problems related to MRs. This research also has implications for transport-related organizations, Rescue 1122, traffic enforcement departments, and driver licensing and vehicle inspections systems. Improvement in these systems may improve the overall road safety situation across Pakistan. The findings of this research could also assist other LMICs to regulate and manage their informal transport sectors.

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Appendices

Appendix A: Rescue 1122 data and forms

Table A1.1: Emergencies attended by Rescue 1122 across Punjab, 2004- 07 March 2016

District	Road Crashes	Medical	Fire	Building Collapse	Crime Incident	Drowning	Blast/ Explosion	Misc	Casualties Rescued
Lahore	333141	328836	20323	1277	19089	760	360	29632	740424
Rawalpindi	52020	49459	5403	119	3525	169	94	6142	127717
Faisalabad	135988	138005	8734	1015	20853	535	97	31006	350144
Multan	79210	153664	5053	245	7692	226	39	12155	294337
Gujranawala	87605	81905	5154	382	8943	433	198	20708	208889
Bahawalpur	38142	74722	1924	49	3704	235	15	14640	135871
Sargodha	31296	54139	2070	121	3739	112	18	6218	96002
D.G. Khan	29607	77680	1918	291	4746	283	43	12864	159644
Sahiwal	39635	53701	2121	207	6140	347	13	12448	132563
Sialkot	46247	26304	3508	174	3115	500	25	8158	97902
Rahim Yar Khan	35287	59262	1705	156	2539	298	30	8113	152994
Murree	4450	22350	421	14	322	40	3	4079	36054
Jhang	23453	52070	1101	172	3955	142	23	12746	148883
Khanewal	25038	30899	953	92	3795	144	4	9518	81646
Rajanpur	10602	24865	664	72	1561	93	8	8463	111226
Muzaffargarh	14178	30842	461	128	1783	135	11	6883	92268
Gujrat	21499	11273	940	80	1487	214	16	3649	55026
Bahawalnagar	14370	26413	669	98	2463	77	17	5774	51877
Attock	7778	26131	560	50	982	133	16	5152	43047
Jehlum	10413	10310	558	30	610	116	3	1778	31330
Toba Tek Singh	13491	19507	472	61	2117	68	4	4892	47620
Pakpattan	13979	19940	405	52	2353	136	5	7282	56268
Mianwali	8734	14860	526	49	2055	209	2	3108	32605
Kasur	20309	18249	691	155	1804	123	9	4274	93898
Vehari	12962	17991	713	69	1684	102	5	2712	43135
Chakwal	7726	6709	487	16	589	61	4	2448	19835
Okara	17357	20636	729	130	3004	233	21	4343	60022
Hafizabad	12476	11939	885	117	1475	171	7	3365	54458
Sheikhupura	28787	26630	1244	145	3072	237	10	6657	76753
Lodhran	14154	26744	593	53	2124	116	1	5028	55190
Nankana Sahib	9589	10053	711	122	1311	110	4	2516	30942
Khushab	9544	13938	406	50	1209	54	1	2922	33106
M.B. Din	10163	6150	532	56	978	200	3	2418	33077
Narowal	10341	18077	793	102	1386	99	49	4237	43664
Layyah	9937	13923	439	59	959	79	12	3631	65368
Bhakkar	7802	17253	493	56	1217	83	6	5411	35959
Chiniot	9067	4640	286	43	731	47	3	1449	24875
Total	1256377	1600069	74645	6107	129111	7120	1179	286819	3954619

Source: *Rescue 1122, 2016*

Figure A1.1: Rescue 1122 Emergency Call Form

EMERGENCY CALL FORM

Emergency Call #:.................... Sr. #:.................... Date:.................... Call Time: ....

Caller's Detail:....................

Nature of Emergency:....................

Place of Incident:....................

....

Name of CTWO:.................... Sign:....................

Ambulance #:....................

Time out:....................

Response Time:....................

Shifted to:....................

Time in:....................

Meter out:.................... Meter in:.................... Total Mileage:....................

Name of WO:.................... Sign:....................

EMT:.................... EMT:.................... Driver:....................

Remarks & Action Proposed by EO (Operations)

....

....

....

....

....

Sign. of EO (Operations)....................

District Emergency Officer

Figure A1.2: Rescue 1122 Emergency Response Form

RESCUE 1122 EMERGENCY RESPONSE FORM

Form # 17399 EC # ______ COD # ______ EV # ______ Date ______

Time out: ______ In ______ Kms Covered ______

Millage out: ______ In ______ Response Time ______

Name: [redacted] Sex F ☐ M ☐ Age ______

Address: [redacted] Contact No. [redacted]

Emergency Area: ______

Cause of Emergency: R.T.A. ☐ Fire ☐ Fall ☐ Violence ☐ Explosion ☐ Building Collapse ☐

Suicide: Poisoning ☐ Strangulation ☐ Medical Emergencies ☐ Train Accident ☐ Other (s) ______

No. of Victims: One ☐ Two ☐ More ☐ None ☐

Place of Emgergency: Road ☐ Work ☐ Home ☐ School ☐ Other (s) ☐

Time since onset of Emergency: ______ Education: Illiterate ☐ Primary ☐ Matric ☐ Higher ☐ P.G. ☐ Other (s)

Severity of injury sustained & outcom: Only First Aid → (Mild) Hospitalized → Moderate ☐ Critical ☐ Dead ☐

Type of Vehicle invloved: Motor Cycle ☐ Bicycle ☐ Rickshaw ☐ M/Rickshaw ☐ Car ☐ Bus ☐ Truck ☐

Driver of victim vehicle / Age: ______ Education: ______ Licenced Yes ☐ No ☐

Other(s) ______ Accident with Vehicle / Object (Clarity) ______

HOW / WHY Emergency took place? ______

DETAIL OF FIRST TREATMENT

VITALS		TREATMENT	MEDICINES	QTY.
Pulse				
BP				
Temp.				
R.R.				
Conscious Level				

Type of injury: S.T. Inj. Cut Fracture Single Multiple Head Spinal Chest Abdominal

Burn: Others: ______

Shifted to: ______ CMO (Emergency Deptt.) ______

EMTs ______ Driver ______ CWO ______

Station House Incharge / Statioon Co-ordinater ______

Emergency Officer (Operations) ______

(i) Items received from victim: ______

(ii) Victim / Attendent, suggestions & comments: ______

Table A1.2: Monthly trends of road crashes attended by Rescue 1122 in Punjab, 2011- 2012

	Rickshaw		**Motorcycle**		**Car**		**Van**		**Truck**		**Bus**		**Other**	
2011	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Jan	1205	6.90	6283	6.96	1960	7.88	640	7.76	297	7.41	149	4.22	1139	6.81
Feb	1291	7.40	6319	7.00	1930	7.76	478	5.79	264	6.58	182	5.16	1076	6.43
Mar	1483	8.50	7235	8.01	2265	9.10	694	8.41	234	5.84	229	6.49	1142	6.83
Apr	1344	7.70	6910	7.65	2103	8.45	667	8.08	232	5.79	170	4.82	1281	7.66
May	1341	7.68	7174	7.94	2101	8.44	632	7.66	284	7.08	244	6.92	1690	10.11
Jun	1422	8.15	7765	8.60	2012	8.09	732	8.87	358	8.93	261	7.40	1204	7.20
Jul	1477	8.46	7638	8.46	2262	9.09	818	9.92	397	9.90	335	9.50	1592	9.52
Aug	1407	8.06	8454	9.36	2118	8.51	554	6.72	366	9.13	352	9.98	1408	8.42
Sep	1828	10.47	8108	8.98	1855	7.46	692	8.39	331	8.25	390	11.05	1318	7.88
Oct	1523	8.72	8358	9.25	2231	8.97	699	8.47	394	9.83	293	8.30	1778	10.63
Nov	1698	9.73	8532	9.45	2209	8.88	781	9.47	457	11.40	340	9.64	1528	9.14
Dec	1437	8.23	7539	8.35	1836	7.38	863	10.46	396	9.88	583	16.52	1566	9.36
Total	17456	100	90315	100	24882	100	8250	100	4010	100	3528	100	16722	100
2012														
Jan	1229	6.45	8364	8.57	1882	7.89	756	8.55	400	7.52	415	10.64	1570	7.18
Feb	1474	7.73	7876	8.07	2196	9.21	836	9.46	443	8.33	335	8.59	1653	7.56
Mar	1640	8.60	7860	8.05	2166	9.08	790	8.94	458	8.61	436	11.18	2191	10.02
Apr	1622	8.51	7799	7.99	2076	8.70	618	6.99	447	8.41	423	10.85	1883	8.61
May	1492	7.83	7622	7.81	2236	9.37	895	10.13	475	8.93	291	7.46	2032	9.29
Jun	1508	7.91	8126	8.33	2125	8.91	883	9.99	412	7.75	323	8.28	1804	8.25
Jul	1540	8.08	8347	8.55	2212	9.27	724	8.19	516	9.70	354	9.08	1790	8.19
Aug	1677	8.80	9859	10.10	2433	10.20	871	9.86	481	9.04	315	8.08	1859	8.50
Sep	1587	8.32	8080	8.28	2295	9.62	693	7.84	402	7.56	308	7.90	1661	7.60
Oct	1856	9.74	9106	9.33	2340	9.81	876	9.91	506	9.51	361	9.26	1486	6.80
Nov	1316	6.90	8939	9.16	1574	6.60	773	8.75	396	7.45	310	7.95	1475	6.75
Dec	2123	11.14	5604	5.74	317	1.33	122	1.38	382	7.18	29	0.74	2464	11.27
Total	19064	100	97582	100	23852	100	8837	100	5318	100	3900	100	16676	100

Table A1.3: Comparison of road crashes reported in Lahore and rest of Punjab, 2011- 2012

		Rickshaw		Motorcycle		Car		Van		Truck		Bus		Other	
	District	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
1	LHR	12215	33.45	56246	17.29	23562	32.73	5172	21.96	4136	19.16	1064	9.06	6992	12.95
2	RWP	196	0.54	11177	3.44	3886	5.40	2093	8.89	231	1.07	155	1.32	1611	2.98
3	FSD	4347	11.90	22081	6.79	7853	10.91	2972	12.62	1838	8.52	988	8.41	4479	8.29
4	MTN	1321	3.62	20481	6.30	2284	3.17	747	3.17	798	3.70	392	3.34	3048	5.64
5	GUJ	2018	5.53	20910	6.43	4800	6.67	1563	6.64	1849	8.57	1476	12.56	3716	6.88
6	SGD	1715	4.70	6911	2.12	1466	2.04	342	1.45	487	2.26	357	3.04	965	1.79
7	DGK	629	1.72	10519	3.23	1082	1.50	575	2.44	435	2.02	219	1.86	1134	2.10
8	RYK	286	0.78	10169	3.13	3569	4.96	206	0.87	372	1.72	256	2.18	1788	3.31
9	BWP	827	2.26	11439	3.52	1554	2.16	351	1.49	573	2.65	356	3.03	2796	5.18
10	SWL	616	1.69	11061	3.40	1594	2.21	394	1.67	644	2.98	485	4.13	752	1.39
11	SKT	1141	3.12	15279	4.70	1017	1.41	577	2.45	471	2.18	237	2.02	3154	5.84
12	MRE	50	0.14	6391	1.96	788	1.09	444	1.89	479	2.22	235	2.00	1858	3.44
13	ATK	385	1.05	2552	0.78	774	1.08	359	1.52	188	0.87	53	0.45	578	1.07
14	RJP	165	0.45	3975	1.22	318	0.44	166	0.70	270	1.25	154	1.31	722	1.34
15	JLM	192	0.53	4564	1.40	1114	1.55	351	1.49	411	1.90	125	1.06	1019	1.89
16	KNWL	667	1.83	8930	2.75	1368	1.90	310	1.32	858	3.98	336	2.86	1066	1.97
17	MZGH	827	2.26	5255	1.62	772	1.07	416	1.77	489	2.27	442	3.76	892	1.65
18	BWNG	266	0.73	6458	1.99	635	0.88	127	0.54	296	1.37	175	1.49	1050	1.94
19	JHNG	1522	4.17	5417	1.67	1636	2.27	961	4.08	1668	7.73	807	6.87	2855	5.29
20	GRT	546	1.50	7669	2.36	1865	2.59	641	2.72	714	3.31	513	4.37	888	1.64
21	KSR	895	2.45	7498	2.31	591	0.82	331	1.41	398	1.84	235	2.00	1080	2.00
22	TTS	170	0.47	3874	1.19	705	0.98	284	1.21	203	0.94	169	1.44	490	0.91
23	MIA	184	0.50	3953	1.22	475	0.66	323	1.37	207	0.96	118	1.00	511	0.95
24	PKTN	262	0.72	6354	1.95	629	0.87	103	0.44	163	0.76	111	0.94	1193	2.21
25	BHK	469	1.28	3736	1.15	320	0.44	272	1.16	253	1.17	208	1.77	1248	2.31
26	CHK	157	0.43	2895	0.89	314	0.44	183	0.78	130	0.60	95	0.81	113	0.21
27	HAF	353	0.97	5444	1.67	726	1.01	446	1.89	229	1.06	98	0.83	1112	2.06
28	KHU	451	1.23	3629	1.12	706	0.98	308	1.31	334	1.55	163	1.39	758	1.40
29	LAY	376	1.03	3372	1.04	447	0.62	186	0.79	194	0.90	91	0.77	397	0.74
30	LODH	333	0.91	6436	1.98	954	1.33	446	1.89	296	1.37	117	1.00	1597	2.96
31	MBD	274	0.75	4974	1.53	635	0.88	228	0.97	260	1.20	232	1.97	850	1.57
32	NKS	332	0.91	2975	0.91	290	0.40	256	1.09	164	0.76	123	1.05	189	0.35
33	NARW	188	0.51	4595	1.41	313	0.43	247	1.05	103	0.48	100	0.85	672	1.24
34	OKA	445	1.22	4981	1.53	762	1.06	263	1.12	450	2.08	301	2.56	844	1.56
35	SHP	1435	3.93	7258	2.23	1264	1.76	716	3.04	720	3.34	620	5.28	1341	2.48
36	VEH	265	0.73	5821	1.79	912	1.27	190	0.81	273	1.26	142	1.21	1151	2.13
	Total	36520	100	325279	100	71980	100	23549	100	21584	100	11748	100	54009	100

Table A1.4: Monthly trends of road crashes attended by Rescue 1122 in Punjab, July 2013-June 2014

	Rickshaw		Motorcycle		Car		Van		Truck		Bus		Other	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Jul-13	1640	14.30	12063	8.09	1607	7.56	858	28.51	494	2.42	182	3.44	1923	7.63
Aug-13	808	7.05	13729	9.20	1713	8.06	179	5.95	1570	7.68	336	6.35	1947	7.73
Sep-13	838	7.31	12500	8.38	1682	7.91	168	5.58	1633	7.99	407	7.69	1863	7.39
Oct-13	1083	9.44	14153	9.49	2178	10.24	211	7.01	1883	9.22	457	8.64	2062	8.18
Nov-13	863	7.52	10719	7.19	1644	7.73	172	5.72	1719	8.41	470	8.88	1856	7.36
Dec-13	866	7.55	11018	7.39	1804	8.48	188	6.25	1838	8.99	560	10.58	1923	7.63
Jan-14	888	7.74	11419	7.65	1837	8.64	233	7.74	1904	9.32	482	9.11	2004	7.95
Feb-14	821	7.16	10583	7.09	1588	7.47	179	5.95	1695	8.29	412	7.79	1762	6.99
Mar-14	907	7.91	13042	8.74	1850	8.70	197	6.55	1960	9.59	425	8.03	1982	7.86
Apr-14	918	8.00	13191	8.84	1822	8.57	216	7.18	1878	9.19	452	8.54	2058	8.17
May-14	873	7.61	13278	8.90	1738	8.17	202	6.71	1857	9.09	518	9.79	3468	13.76
Jun-14	964	8.41	13488	9.04	1802	8.47	206	6.85	2003	9.80	591	11.17	2354	9.34
Total	11469	100	149183	100	21265	100	3009	100	20434	100	5292	100	25202	100

Table A1.5: Comparison of road crashes attended by Rescue 1122 in Lahore and the rest of Punjab, July 2013-June 2014

		Rickshaw		**Motorcycle**		**Car**		**Van**		**Truck**		**Bus**		**Other**	
	City	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
1	LHR	2385	20.80	26265	17.73	4424	20.96	335	11.23	5355	26.39	439	8.35	2802	11.12
2	RWP	961	8.38	4764	3.22	1239	5.87	127	4.26	229	1.13	156	2.97	1747	6.93
3	FSD	1638	14.28	11422	7.71	2082	9.86	405	13.58	2602	12.82	727	13.83	2413	9.57
4	MTN	301	2.62	9492	6.41	844	4.00	58	1.94	943	4.65	120	2.28	1375	5.46
5	GUJ	980	8.54	11124	7.51	1624	7.69	217	7.27	1481	7.30	535	10.18	1799	7.14
6	SGD	207	1.80	3246	2.19	619	2.93	86	2.88	562	2.77	99	1.88	524	2.08
7	DGK	265	2.31	4544	3.07	488	2.31	70	2.35	472	2.33	106	2.02	379	1.50
8	RYK	83	0.72	6637	4.48	792	3.75	86	2.88	486	2.39	106	2.02	1255	4.98
9	BWP	185	1.61	4626	3.12	610	2.89	56	1.88	509	2.51	173	3.29	845	3.35
10	SWL	81	0.71	4686	3.16	419	1.99	112	3.75	305	1.50	134	2.55	489	1.94
11	SKT	458	3.99	6118	4.13	615	2.91	111	3.72	700	3.45	95	1.81	1713	6.80
12	MRE	92	0.80	342	0.23	208	0.99	43	1.44	9	0.04	39	0.74	36	0.14
13	ATK	115	1.00	1128	0.76	256	1.21	15	0.50	195	0.96	40	0.76	230	0.91
14	RJP	99	0.86	2050	1.38	130	0.62	61	2.04	236	1.16	174	3.31	85	0.34
15	JLM	113	0.99	1632	1.10	323	1.53	30	1.01	115	0.57	123	2.34	199	0.79
16	KNWL	184	1.60	5083	3.43	690	3.27	108	3.62	599	2.95	234	4.45	1141	4.53
17	MZGH	170	1.48	2232	1.51	277	1.31	76	2.55	282	1.39	69	1.31	484	1.92
18	BWNG	54	0.47	2529	1.71	236	1.12	48	1.61	200	0.99	65	1.24	665	2.64
19	JHNG	849	7.40	2634	1.78	803	3.80	105	3.52	1248	6.15	180	3.42	1420	5.63
20	GRT	291	2.54	3845	2.60	734	3.48	93	3.12	370	1.82	231	4.39	447	1.77
21	KSR	134	1.17	3106	2.10	233	1.10	80	2.68	335	1.65	112	2.13	521	2.07
22	TTS	33	0.29	1795	1.21	233	1.10	26	0.87	169	0.83	30	0.57	182	0.72
23	MIA	94	0.82	1320	0.89	129	0.61	36	1.21	68	0.34	48	0.91	159	0.63
24	PKTN	62	0.54	2241	1.51	182	0.86	33	1.11	104	0.51	90	1.71	299	1.19
25	BHK	65	0.57	1257	0.85	124	0.59	44	1.48	202	1.00	35	0.67	277	1.10
26	CHK	73	0.64	993	0.67	91	0.43	13	0.44	81	0.40	17	0.32	38	0.15
27	HAF	117	1.02	2335	1.58	227	1.08	27	0.91	233	1.15	79	1.50	386	1.53
28	KHU	181	1.58	1511	1.02	216	1.02	61	2.04	262	1.29	79	1.50	280	1.11
29	LAY	22	0.19	1499	1.01	76	0.36	17	0.57	69	0.34	21	0.40	49	0.19
30	LODH	155	1.35	2152	1.45	264	1.25	20	0.67	189	0.93	49	0.93	425	1.69
31	MBD	141	1.23	2112	1.43	234	1.11	19	0.64	164	0.81	47	0.89	343	1.36
32	NKS	24	0.21	1102	0.74	60	0.28	22	0.74	63	0.31	23	0.44	153	0.61
33	NARW	91	0.79	1847	1.25	116	0.55	34	1.14	119	0.59	23	0.44	282	1.12
34	OKA	121	1.06	2695	1.82	423	2.00	85	2.85	369	1.82	189	3.60	558	2.21
35	SHP	557	4.86	5376	3.63	738	3.50	172	5.77	756	3.73	513	9.76	600	2.38
36	VEH	88	0.77	2381	1.61	347	1.64	52	1.74	212	1.04	57	1.08	602	2.39
	Total	11469	100	148121	100	21106	100	2983	100	20293	100	5257	100	25202	100

Table A1.6: Road users and injury types in MR crashes reported in Lahore, 2014

	Injury types																			
	Head		**Cut/abrasions**		**Upper & lower limb injury**		**Fractures (single & multiple)**		**Face**		**Foot**		**Others**		**None**		**Unclear & missing**		**Total**	
Road users	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Pedestrian	12	15.79	14	8.33	17	11.56	13	13.40	10	19.61	2	7.41	11	19.64	0	0.00	7	6.80	86	7.47
MRD	15	19.74	41	24.40	37	25.17	19	19.59	11	21.57	8	29.63	14	25.00	323	75.82	59	57.28	527	45.79
Passenger	22	28.95	61	36.31	34	23.13	27	27.84	6	11.76	6	22.22	12	21.43	0	0.00	13	12.62	181	15.73
Car driver	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	47	11.03	1	0.97	48	4.17
Truck driver	0	0.00	0	0.00	1	0.68	1	1.03	1	1.96	0	0.00	0	0.00	20	4.69	0	0.00	23	2.00
Motorcycle rider	22	28.95	37	22.02	42	28.57	33	34.02	16	31.37	9	33.33	10	17.86	10	2.35	17	16.50	196	17.03
Motorcycle pillion rider	4	5.26	11	6.55	12	8.16	3	3.09	3	5.88	0	0.00	6	10.71	0	0.00	2	1.94	41	3.56
Bicyclist	0	0.00	2	1.19	3	2.04	1	1.03	2	3.92	2	7.41	1	1.79	0	0.00	3	2.91	14	1.22
Autorickshaw driver	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.79	7	1.64	0	0.00	8	0.70
Van driver	1	1.32	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	1.17	0	0.00	6	0.52
Unclear	0	0.00	1	0.60	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.97	2	0.17
Animal cart driver	0	0.00	1	0.60	1	0.68	0	0.00	2	3.92	0	0.00	1	1.79	0	0.00	0	0.00	5	0.43
Other (Crane operator & ambulance, tractor & bus driver)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	14	3.29	0	0.00	14	1.22
Total	76	100	168	100	147	100	97	100	51	100	27	100	56	100	426	100	103	100	1151	100

Table A1.7: MR crash locations in Lahore

Codes of different roads in Lahore

Road type	**code**
Major Road (e.g. Jail road, Mall road, Ferozepur road etc.)	1
Arterial roads (e.g. shadman road from Jail road, sanda road etc.)	2
Collector roads (e.g. roads inside Iqbal town, johar twon, sabzazar scheme etc.)	3

Codes of towns in Lahore

Town	**Code**
Ravi Town	1
Shalimar Town	2
Wahgah Town	3
Aziz Bhatti Town	4
Data Ganj Bakhsh Town	5
Gulberg Town	6
Samanabad Town	7
Iqbal Town	8
Nishter Town	9
Lahore Cantt	10
other	11

Crash location	No. of road crashes	Towns (codes)	Road Types (codes)
1. Abdul malik	4	.8	1
2. Atari	2	.4	1
3. Awari town	1	.2	1
4. Band road	5	1.0	1
5. Bara dari road	1	.2	2
6. Barki pind	1	.2	3
7. Begum kot	11	2.2	2
8. Bhatti chowk	3	.6	2
9. Boy shah	1	.2	3
10. Canal road	4	.8	1

11. Chamda mandi	1	.2	2
12. choti patki	2	.4	2
13. Chuburgi	3	.6	1
14. Darogawala	2	.4	1
15. Darbar	4	.8	1
16. DCO office	1	.2	1
17. DHA	1	.2	1
18. Domoria pull	2	.4	2
19. Ferozepur road	3	.6	1
20. front of RSH	1	.2	1
21. Gamay shah	1	.2	1
22. Ghazi road	3	.6	1
23. Glaxay town	1	.2	2
24. Green town	6	1.2	1
25. Hafiz town	1	.2	2
26. Hamdard chowk	4	.8	2
27. Imamia colony	1	.2	2
28. Bus stop 28	4	.8	1
29. Javaid nagar stop	2	.4	3
30. Kahna	3	.6	1
31. Kot Abdul Malik	5	1.0	3
32. Lady Wallington hospital	2	.4	1
33. Lakshmi chowk	1	.2	1
34. Lalik chowk	1	.2	2
35. Lari adda	3	.6	2

36. Malipura	2	.4	1
37. Manawa wala	1	.2	2
38. MAO college	1	.2	1
39. Masti gate	1	.2	1
40. Mughalpura	2	.4	2
41. Multan road	2	.4	2
42. Nicolas road	1	.2	1
43. Nizampura	2	.4	2
44. Peco road	2	.4	2
45. Peer maki chowk	1	.2	1
46. Qasoori chowk	2	.4	1
47. RA bazar	3	.6	2
48. Railway station	1	.2	2
49. Rana town	5	1.0	2
50. Ravi chowk	4	.8	3
51. Ravi pull	3	.6	1
52. Rehmanpura	1	.2	1
53. Ring road	2	.4	3
54. RS 9	1	.2	1
55. RS 11	12	2.4	2
56. Sanda road	2	.4	1
57. Sanda band road	2	.4	2
58. Scheme more	2	.4	1
59. Services hopsital	1	.2	2
60. Shadbagh	1	.2	1

61. Shahalam chowk	3	.6	3
62. Shahdra	7	1.4	2
63. Shamnagar road	1	.2	1
64. Sherakot chowk	6	1.2	3
65. Taj company	5	1.0	1
66. Taxali chowk	4	.8	3
67. tyre market	4	.8	1
68. unclear	38	7.6	2
69. Missing	1	.2	
70. Yousaf park	3	.6	
71. Quaid-Azam interchange ring road	1	.2	3
72. Lakhodahar ring road	2	.4	1
73. Bagbanpura	3	.6	2
74. Rizwan garden	1	.2	2
75. Mahmood boti gol chakar	2	.4	3
76. Nahkhuda chowk, misri shah	1	.2	2
77. UET Gate no 2	1	.2	2
78. Gari Shahu pull	1	.2	1
79. Bhati chowk	1	.2	2
80. Rachna town	2	.4	1
81. Chakian stop GT road	1	.2	2
82. opposite Shahdra police station	1	.2	2
83. Rustam Sohrab factory stop	2	.4	1
84. Degree college Shahdra	1	.2	2
85. Ravi flour Band road	1	.2	1

86. Jamal pipe factory, Rana town	4	.8	1
87. Bank stop, Band road	2	.4	3
88. Gourmet bakery, kahna	1	.2	3
89. Packages factory gate 1	1	.2	1
90. Soye asaal	1	.2	1
91. PSO pump Ghazi chowk	1	.2	2
92. Khyaban-e-Iqbal, Walton road	1	.2	2
93. Koree stop, Walton	1	.2	1
94. Pattik mandi	1	.2	3
95. Opposite Chidren hospital	1	.2	2
96. Shukat Khanam hospital signal	1	.2	1
97. defence morr	1	.2	1
98. Toyota showroom Walton	1	.2	2
99. HBL bank Kanchi	2	.4	2
100. Bhekaywala chowk	1	.2	1
101. Madyan stop Model town	1	.2	2
102. Ghass mandi China chowk	1	.2	2
103. Salamatpura stop	2	.4	2
104. Basi mor, Ahmad town	1	.2	3
105. Manawa bank stop	1	.2	3
106. Near public school, aik moria pull	1	.2	2
107. sufi soap factory	4	.8	3
108. Tia musa stop, Taxali gate	1	.2	1
109. chatta colony, Begum kot	1	.2	1
110. gulfshan town, sheikupura road	4	.8	3

111. Shahdra morr	7	1.4	1
112. Nasir hospital, Rana town	1	.2	1
113. Chatta colony stop, Begum kot	1	.2	1
114. Kot Shahab deen park, Shahdra	2	.4	2
115. Taj company chowk, under ring road	1	.2	3
116. Yadgar pull	1	.2	2
117. Shimlah pahari	1	.2	1
118. Kadaknala stop, Multan road	2	.4	2
119. Shell pump near toll plaza, Rana town	1	.2	1
120. PSO pump, Begum kot	2	.4	1
121. Ferozwala	2	.4	1
122. Khokhar road, Band road	1	.2	1
123. Metro station, Shahdra	1	.2	3
124. Shell pump,Shahdra morr	1	.2	1
125. Old Ravi pull naka	1	.2	1
126. Hassan marriage hall, Shahdra	1	.2	2
127. Dhair pind, Shahdra	1	.2	2
128. Ravi toll plaza	3	.6	2
129. Lal havely, PSO pump faroqabad Badami bagh	1	.2	2
130. Women degree college, Shahdra	4	.8	1
131. Dosaco chowk, kot abdul malik	1	.2	1
132. Bhati wali gali, Ichra	1	.2	2
133. Fortress bridge, Fortress stadium	1	.2	3
134. Liberty chowk	1	.2	2
135. Shadman chowk	1	.2	2

136. Sadabahar shadi hall, Ghazi road	1	.2	2
137. DHA morr	2	.4	2
138. Packages gate no 3	2	.4	2
139. Chungi amar sadu stop	1	.2	2
140. Bank stop, ferozepur road	6	1.2	2
141. Main bazar, chungi amar sadu	1	.2	2
142. Azam chowk	1	.2	1
143. Workshop stop, Youhanaabad	1	.2	1
144. Ali Murtaza factory	1	.2	2
145. Old Ravi pull	6	1.2	1
146. Awal khair stop, Garanwala road	1	.2	2
147. Javeed park, kala khatai road	1	.2	1
148. Rachna town	1	.2	2
149. 25 no stop, Badami bagh	1	.2	1
150. Undrepass (between Ravi chowk & old Ravi chowk)	1	.2	2
151. Learners college, kot shahabdin	1	.2	3
152. Begum kot chowk	5	1.0	3
153. Farukh abad	1	.2	1
154. Imamia colony main stop	2	.4	1
155. Baba kulfi wala, shahalam chowk	2	.4	2
156. Shalamar chowk	1	.2	2
157. Daily Pakistan office, Jail road	1	.2	2
158. Jail road to Mall road	1	.2	1
159. Chabacha phatak,canal road	1	.2	1
160. Omar hospital, jail road	1	.2	1

161. Campus pull signal	1	.2	1
162. near Mall road	1	.2	1
163. Shama chowk	1	.2	2
164. W- block, DHA	1	.2	1
165. Walton signal	1	.2	3
166. Ittefaq hospital, metro bus stop	1	.2	1
167. Kanchi stop	1	.2	1
168. Kot lakphat station	1	.2	1
169. Bismillah chowk, joday pull	2	.4	1
170. Patik IT tower	2	.4	3
171. Ichra bazar	1	.2	3
172. Halay college	1	.2	1
173. Al Rehman garden, Shariqpur road	3	.6	1
174. jia musa stop	1	.2	2
175. Pipe stop, Green town	1	.2	3
176. Attari darbar	1	.2	3
177. D-block,DHA	1	.2	2
178. Glaxo town, Shalamar town	1	.2	2
179. Kacha road, kacha pind	1	.2	2
180. Gajumata	1	.2	2
181. Zahor Elahi road intersection	1	.2	2
182. Dosaku chowk, skp road	1	.2	2
183. Startech CNG, Thokar	1	.2	1
184. opposite Govt high school. Ferozwala kachary	1	.2	2
185. Shahdra railway station	1	.2	1

186.Kot Abdul malik toll plaza	3	.6	1
187.Noori bori darbar	1	.2	1
188.Sharaqpur road	1	.2	2
189.Skyway bus station	1	.2	1
190.Total pump, Gulshan ravi	1	.2	2
191.Gulshan ravi	2	.4	1
192.Sanda police station, shamnagar road	1	.2	3
193.Sherakot police station	1	.2	3
194.Chota Sanda	1	.2	1
195.PSO sherakot	1	.2	2
196.Wandala road	1	.2	1
197.Sagian pull	2	.4	3
198.Shahi fort road	1	.2	1
199.Awan town	1	.2	2
200.Al hafiz town, Malgzar colony	1	.2	1
201.Kasoori chowk, academy road	1	.2	2
202.Jaffry pulli, canal road	1	.2	3
203.Shah de kohi, canal road	1	.2	3
204.Chungi dogage, gujar colony	1	.2	3
205.Nori pori stop,kot abdul malik	1	.2	3
206.Marbara morr,25 no stop, Shahdra	3	.6	2
207.Balkmay pind,kala khatai road	1	.2	2
208.Latif chowk,wandah road	1	.2	1
209.Timber market, ravi road	1	.2	2
210.Shahdra town	1	.2	2

211. Baradari road	1	.2	2
212. FC college underpass	2	.4	2
213. Ferozwala kachary	2	.4	1
214. Karol village, kala khatai road	2	.4	2
215. 25 no stop, Allah Ho darbar	1	.2	2
216. Kala Shah Kaku	1	.2	2
217. So moria pull, Rachna town	1	.2	1
218. Mahmood boti	1	.2	2
219. 32 chowk	3	.6	1
220. Ferozwala stop, rachna town	1	.2	1
221. Meraj park stop	1	.2	2
222. kala khatai morr	1	.2	2
223. haji kot,kala khatai road	1	.2	2
224. Kala khatai morr	2	.4	2
225. Police checkpoint,begum kot	1	.2	2
226. Barkat town,kala khatai road	1	.2	2
227. Geo shadi hall	1	.2	2
228. Ghareeb nagar, Shahdra	1	.2	2
229. Yousaf park	1	.2	2
230. Power station phattak no 5, ring road	1	.2	2
231. kot noor shah, faizpur interchange	1	.2	2
232. Polka factory khajoorwale	1	.2	1
233. Gourmet bakery, 25 no stop	1	.2	2
234. Kashmir park stop, rachna town	1	.2	2
235. Peer naseer, harbanspura	1	.2	2

236.Akhri mint gate, darogwala	1	.2	2
237.Sunday bazar, green town	1	.2	2
238.Ayesha mart, peco road	1	.2	2
239.Phatyan wali pully	1	.2	2
240.Manawawala police station	1	.2	2
241.Ring road service road	1	.2	2
242.Bada sanda stop	1	.2	2
243.Nawaz Sharif mill, band road	1	.2	1
244.Chabacha phatak, canal road	1	.2	1
245.Khadak nala tyre shop	1	.2	2
246.Arabian delight, ferozepur road	1	.2	1
247.Mall to jail road	2	.4	1
248.Kalma chowk	1	.2	2
249.Jinnah towards campus	1	.2	1
250.FC to central station	1	.2	2
251.Mall road bridge	1	.2	2
252.Central point towrads firdous market	1	.2	2
253.Raiwand road, khybane Jinnah chowk	1	.2	2
254.Total pump, dharmpura	1	.2	2
255.Sodiwal, Multan road	1	.2	2
256.Canal to jail road	1	.2	1
257.front gate canal view society	1	.2	1
258.Jinnah underpass (upper part) to thokar	1	.2	3
259.Raiwind road, ghalib morr	2	.4	2
260.Ferozepur road underpass	1	.2	2

261.W-block 44/A street, Attari	1	.2	2
262.Close to Firdous market	1	.2	2
263.Muslim town morr	1	.2	2
264.Doctor hospital underpass	1	.2	1
265.Campus pull signal	1	.2	1
266.Backhay wala morr	1	.2	1
267.Malipura shell pump, band road	2	.4	2
268.Bhatti chowk	1	.2	1
269.Raheem marriage hall, band road	2	.4	2
270.New khan bus station, band road	1	.2	1
271.32- chowk,metro stop ravi road	1	.2	1
272.opp Mian Munshi hospital,band road	1	.2	1
273.Zakria Shah darbar, sharaqpur road	1	.2	1
274.Corporation chowk, chota sanda	1	.2	2
275.Begum kot chowk	1	.2	3
276.Noori bori pori darbar	1	.2	2
277.Double roads, gulshan ravi	1	.2	3
278.Sabzazar police station	1	.2	2
279.Multan road, mandi stop	1	.2	2
Total	500	100.0	

Appendix B: Supplementary Study - Emergency Paramedics’ Perceptions of Relative Involvement of MRs in Road Crashes

INTRODUCTION

Study 1A revealed that rickshaws (both MR and AR) were involved in 47,989 road crashes in Punjab during three years (2011-2012 and July 2013-June 2014). However, aggregated datasets analysed in Study 1A did not distinguish between road crashes involving MRs and ARs, so it was not possible to draw any conclusions about the relative proportions of road crashes for these two types of vehicles. It was not feasible to ask Rescue 1122 to make an exact count of crashes involving MR and AR, due to a large databank for the last 11 years (2004-2015), lack of support staff and time constraints. Therefore, a small Supplementary Study was undertaken to assess the relative frequency of road crashes involving MRs and ARs. This Study also identifies some human, vehicular and environmental factors that resulted in MR crashes in Lahore during 2014. The Supplementary Study specifically addresses Research Question 1 *(What is the size of the MR crash problem?),* and it also has some implications for Research Question 3 *(What are the characteristics of MRDs that influence the road safety of MRs?).*

Emergency paramedics of Rescue 1122 Lahore District were invited to participate in this study. Given that the Rescue 1122 ambulance service was initiated from Lahore in 2004, and later extended to all 36 districts of Punjab by 2010, the emergency paramedics of Rescue 1122 Lahore are more experienced in attending road crashes, compared to other paramedics in the rest of the Punjab. Therefore, they were in a better position to assess the relative frequency of MR and AR crashes. It is important to note that ARs are a formal and regulated mode, while MRs are an informal and unregulated paratransit mode in Lahore and other parts of Pakistan (LTC, 2015).

METHODOLOGY

A questionnaire-based survey was conducted with the emergency paramedics. Rescue 1122 has 13 rescue stations in different areas of Lahore (Figure B1). All rescue stations in Lahore offer emergency ambulance (except the LOS Station), fire and rescue services to the local community around the clock. Around 150 emergency paramedics work at these rescue stations in three shifts (morning, evening and night). The emergency paramedics were approached (personally by the researcher) at 11 rescue stations across Lahore. Two rescue stations were excluded from the survey, because one of them (LOS Station) as already mentioned, does not offer ambulance services, while another (Central Station) is located at the Ferozepur Road, where MRs have not been permitted to operate since 2013. All emergency paramedics who worked with Rescue 1122 in Lahore during 2014 were included in this study.

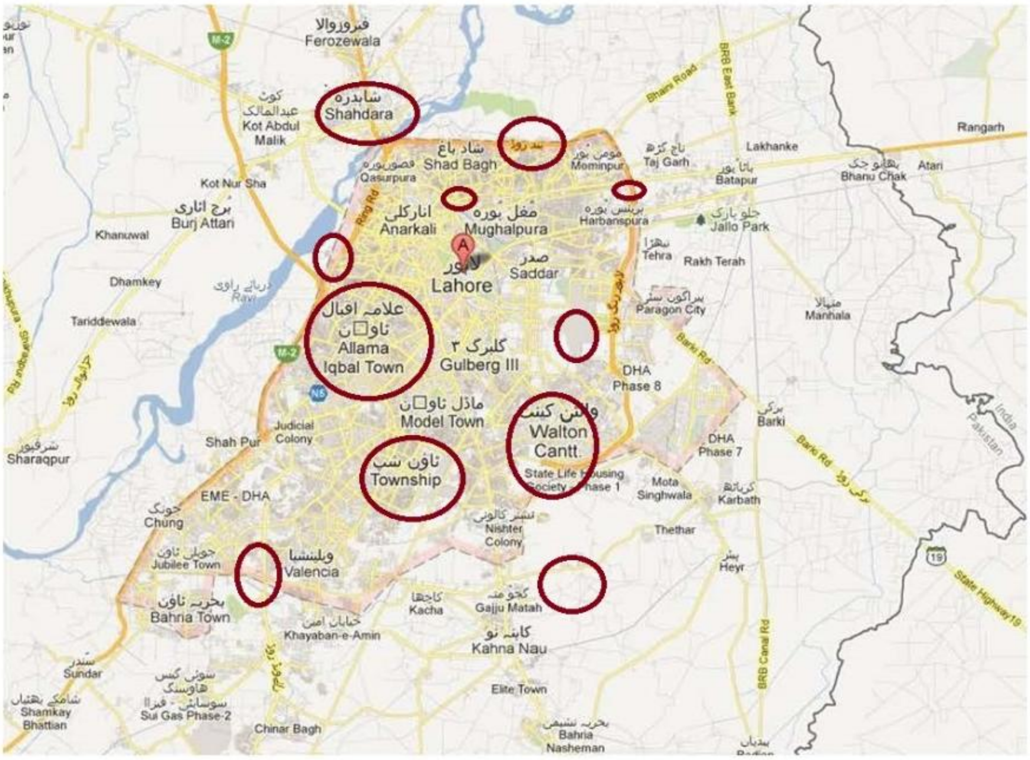

Figure B1: Lahore map showing Rescue 1122 ambulance stations

*(**Source:** Pakimag, 2016)*

Survey Questionnaire

The survey questionnaire was self-administered, and consisted of seven main questions; the last question had 14 sub-items or responses (Appendix 2A). The questions related to the experiences of the paramedics while attending road crashes across Lahore in 2014 *(What percentage of MRs/ARs were involved in road crashes you attended in 2014? What would be the percentage of road crashes which occurred due to the fault of MRD?).*

In the last question (number 7) of the questionnaire, based on the paramedics' perceptions, a comparison was made between MRDs and all other drivers *(all motorised and non-motorised vehicles drivers involved in MR crashes in Lahore in*

2014), using a 5-point Likert Scale type responses *(never, less than half of the time, about half of the time, more than half of the time and always).* The aim of this comparison was to assess (based on the paramedics' perceptions) how often MRDs were involved in a certain traffic violation *(speeding by MRD/other drivers, overloading by MRD/other drivers, red-signal violation by MRD/other drivers)*, which contributed to road crashes in Lahore during 2014.

The survey questionnaire was first developed in English then translated into the Urdu for easy comprehension by the emergency paramedics. A total of 130 questionnaires were distributed, and 109 were returned, resulting in a response rate of 84 percent. All completed questionnaires (*n*=109) were included in the final data analysis.

Data Analysis

The data were entered into Excel spreadsheets and then coded and cleaned for any inconsistencies. Given a small study sample size (*n*=109), responses of the emergency paramedics in percentages (1-10%, 11-20%, 21-30% etc.), the bivariate or multivariate analysis was not found to be an appropriate approach for the data analysis. Therefore, univariate descriptive analysis was conducted and 'Mean', 'Mode' and 'Standard Deviation' were calculated for all responses and histograms were developed to present the study results. The mean and the standard deviation provide useful information about the nature of the measurements related to various variables in isolation (Washington, Karlaftis, & Mannering, 2010). All data analysis was conducted with SPSS software, version 22.0 (IBM *SPSS Statistics* for Windows, Version 22.0).

Ethics Considerations

This study was approved by the QUT Human Research Ethics Committee (approval number of 1500000209). The survey questionnaire was anonymous and participation was voluntary and informed. All necessary information was provided to the emergency paramedics, and given their busy work schedule, they were asked to complete the questionnaire at their convenience. Written permission from the Director General of Rescue 1122 was also obtained before approaching the paramedics.

RESULTS

This section presents the results of the survey. It is important to note that these results are based on the experiences and estimates/perceptions of the Rescue 1122 paramedics, while attending MR and AR crashes across Lahore in 2014.

Survey Participants Characteristics

Table B1 shows the total number of the emergency paramedics working at different rescue stations in Lahore, and the number who participated in this survey. The largest number of the survey participants were from Yadgar Station (21.1%), followed by Saggian Station (16.5%) and Shahdra Station (12.8%). About 80% of the emergency paramedics had working experience of 6 to 10 years, and 5.5% had more than 10 years' working experience (with maximum 11 years' experience) with Rescue 1122 Lahore.

Table B1: Survey participants from different rescue stations in Lahore

No	Rescue Station	Total paramedics	No of participants	%
1	Yadgar Station	24	23	21.1
2	Saggian, Bund Road	20	18	16.5
3	Shahdra, GT Road	16	14	12.8
4	Tokar Niaz Baig	16	12	11.0
5	Singpura, GT Road	12	11	10.1
6	Defence Housing Authority (DHA)	12	10	9.2
7	Township Station	12	9	8.3
8	Lohari Station	6	4	3.7
9	Nadeeem Chowk, Lahore Cantonment	12	3	2.8
10	Qainchi, Walton Road	12	3	2.8
11	Moon Market, Allama Iqbal Town	8	2	1.8
	Total	150	109	100

Emergency Paramedics Work Experience (years)
Mean: 7.06, Mode:7, SD: ±1.817, Range: 3-11 years

Paramedics Work Experience (years)	No of paramedics	%
1-5	16	14.7
6-10	87	79.8
>10	06	5.5
Total	109	100

Paramedics' Estimated Proportion of MR and AR Crashes

Figure B2 shows the relative proportion of the MR and AR crashes reported by the emergency paramedics, based on their experiences while attending rickshaw (both MR and AR) crashes across Lahore in 2014.

Nearly half of the emergency paramedics (47%) reported that MRs were involved in 81-100% of the rickshaw crashes they attended, while 57.8% reported that ARs were involved in only 1-20% of the rickshaw crashes they attended. The mode for proportion of crashes involving MRs was 81-90% (36 participants), while the mode for proportion of crashes involving ARs was 1-10% (37 participants), with both distributions being highly skewed.

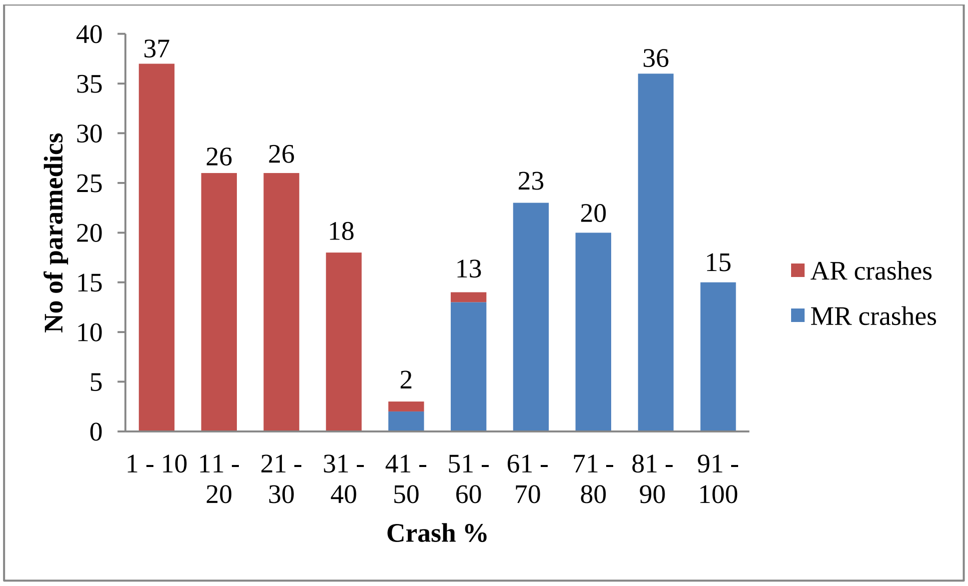

Figure B2: Paramedics estimated proportion of MR and AR crashes in Lahore, 2014

Underage and Unlicensed MRDs

Figures B3 and B4 present paramedics' estimates regarding the proportions of underage and unlicensed MRDs in MR crashes they attended across Lahore in 2014. Almost half (48.62%) of the paramedics indicated that between 41% and 60% of MRDs were underage, while approximately 40% estimated that between 81% and 100% of MRDs were unlicensed drivers.

Similarly, the mode for perceived proportion of underage MRDs was 41-50% (31 participants), and most of the sample (73 participants) selected categories between 31% and 60%. The mode for perceived proportion of unlicensed drivers was much higher, at 81-90% (26 participants).

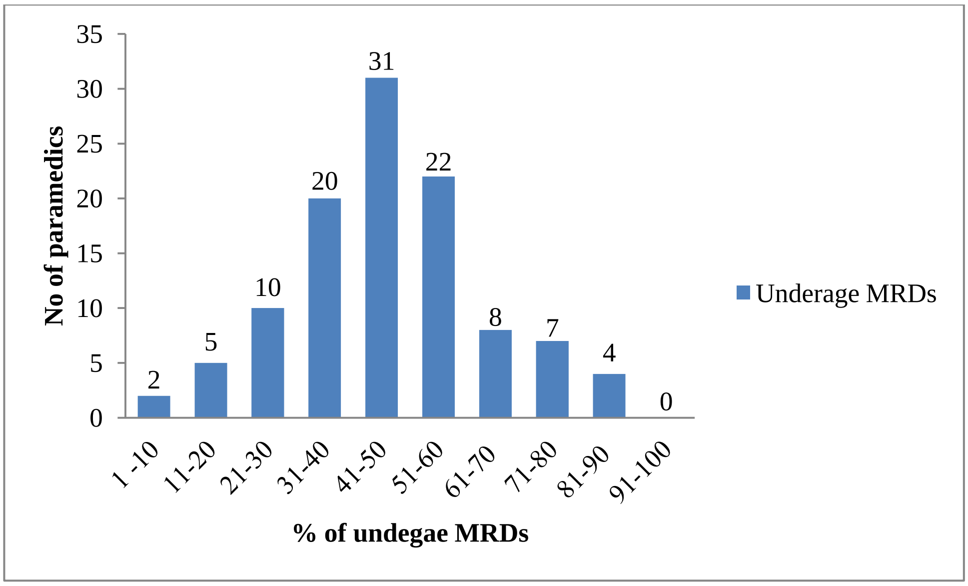

Figure B3: Estimated proportion of underage MRDs in Lahore, 2014

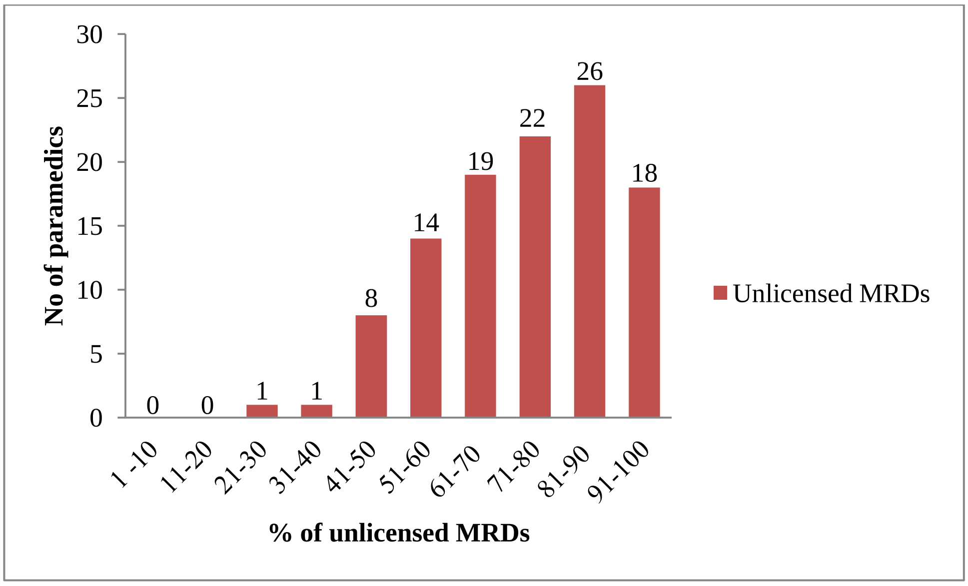

Figure B4: Estimated proportion of unlicensed MRDs in Lahore, 2014

MRDs at-Fault Crashes

Figure B5 shows paramedics' estimates regarding the proportion of MRDs at-fault in MR crashes they attended across Lahore in 2014. About 40% of paramedics attributed fault in around 81-100% of road crashes to the MRDs. Similarly, the mode for perceived proportion of MRDs at-fault was 81-90% (28 participants).

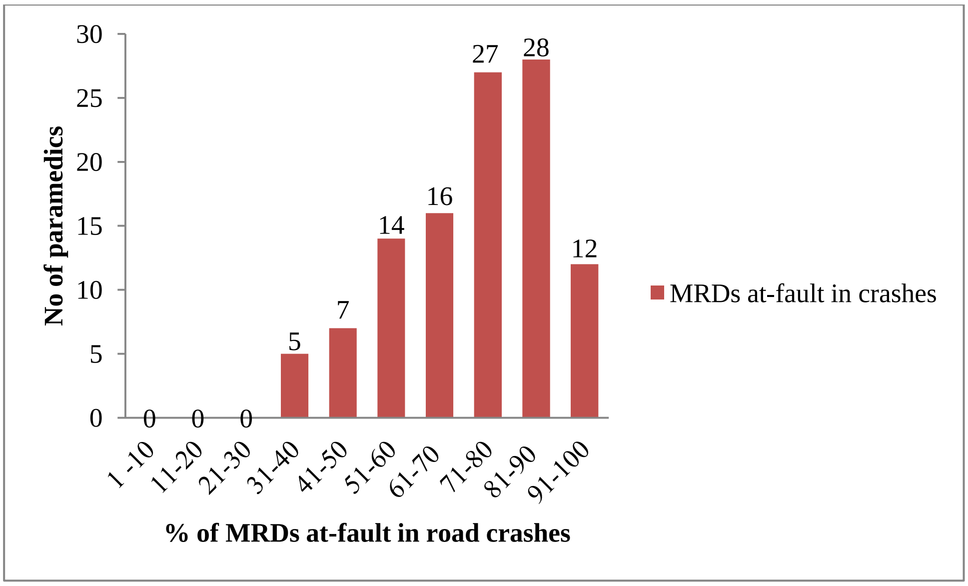

Figure B5: Estimated proportion of MRDs at-fault in road crashes in Lahore, 2014

Crash Contributing Factors

Table B6 presents a comparison of MRDs/MRs with other drivers/vehicles (motorised and non-motorised vehicles) on various human and vehicular factors that likely resulted in MR crashes. This comparison is based on the experiences and estimates of the emergency paramedics. Besides human and vehicular factors, paramedic' estimates are also given for some environmental factors (road and weather conditions) that might have contributed to MR road crashes. It is important to mention that the environmental factors estimates are only related to MRs, not to other vehicles.

Around 89% of the paramedics estimated that MRD speeding (Mode: 4) was a contributing factor in more than half or in all MR crashes they attended. Conversely, over two-thirds of the paramedics (67%) believed that other drivers were less likely to be involved in speeding (Mode: 2). Similarly, most paramedics perceived that reckless driving (Mode: 4), 'disobeying traffic signal' (Mode: 4), underage driving (Mode: 4) and overloading (Mode: 4) were more common among MRDs, compared to other drivers. Moreover, most paramedics perceived that vehicular mechanical defects were more common among MRs (Mode: 4), compared to other vehicles (Mode: 2).

Table B6: Contributing factors in MR crashes attended by emergency paramedics in Lahore, 2014 (emergency paramedics estimates)

Questionnaire items	Never(1)	<Half of time(2)	Half of time(3)	>Half of time(4)	Always(5)	Mean (SD)	Mode(Range)
Speeding by MRD	1(.9%)	3(2.8%)	8(7.3%)	63(57.8%)	34(31.2%)	4.16(.748)	4(1-5)
Speeding by other drivers	3(2.8%)	73(67%)	30(27.5%)	3(2.8%)	0	2.30(.569)	2(1-4)
Reckless driving by MRD	3(2.8%)	8(7.3%)	53(48.6%)	45(41.3%)	0	4.28(.721)	4(2-5)
Reckless driving by other drivers	1(.9%)	78(71.6%)	24(22%)	6(5.5%)	0	2.32(.591)	2(1-4)
Disobey traffic signal by MRD	1(.9%)	17(15.6%)	27(24.8%)	50(45.9%)	14(12.8%)	3.54(.938)	4(1-5)
Disobey traffic signal by other drivers	1(.9%)	80(73.4%)	21(19.3%)	6(5.5%)	1(.9%)	2.32(.637)	2(1-5)
Underage MRD	17(15.6%)	24(22%)	62(56.9%)	6(5.5%)	0	3.52(.823)	4(2-5)
Underage other drivers	8(7.3%)	69(63.3%)	24(22%)	8(7.3%)	0	2.29(.711)	2(1-4)
Overloading by MRD	0	7(6.4%)	22(20.2%)	40(36.7%)	40(36.7%)	4.04(.912)	4(2-5)
Overloading by other drivers	4(3.7%)	68(62.4%)	24(22%)	11(10.1%)	2(1.8%)	2.44(.799)	2(1-5)
Defects in MR	1(.9)	18(16.5%)	34(31.2%)	39(35.8%)	17(15.6%)	3.49(.978)	4(1-5)
Defects in other vehicles	6(5.5%)	87(79.8%)	13(11.9%)	2(1.8%)	1(.9%)	2.13(.563)	2(1-5)
Bad road condition	35(32.1%)	50(45.9%)	11(10.1%)	8(7.3%)	5(4.6%)	2.06(1.065)	2(1-5)
Poor weather conditions	23(21.1%)	79(72.5%)	6(5.5%)	1(.9)	0	1.86(.535)	2(1-4)

DISCUSSION

Relative Frequency/Proportion of MR and AR Crashes

Study 1A showed that rickshaws (both MR and AR) were involved in 47,989 road crashes in Punjab during 2011-2012 and July 2013-June 2014. Emergency paramedics' estimates suggest that the mode for the proportion of crashes involving MRs was 81-90%, and the mode for the proportion of crashes involving ARs was 1-10%. Therefore, it can be assumed that majority of the MR/AR crashes in Study 1A were MR crashes. These crash estimates show that compared to AR crashes, the burden of MR crashes is significantly higher across Lahore and the rest of Punjab, and MRDs are making a substantial contribution to road crashes, injuries and fatalities across the province.

The literature review indicates that MRs operate on urban roads as well as on highways across Pakistan. Given this situation, if we replicate paramedics' estimates to the whole Pakistan, the burden of MR crashes appears to be significant across the country.

Underage and Unlicensed MRDs

Estimates of the emergency paramedics suggest a wide prevalence of underage and a high proportion of unlicensed MRDs across Lahore. Emergency paramedics' estimates likely to be accurate, since police data is incomplete. Studies 2 and 3 of the current research program provide further validation of the paramedics' estimates.

MRDs at-Fault and Crash Contributing Factors

Emergency paramedics attributed MRD fault in most MR crashes they attended in Lahore during 2014. Moreover, comparison (based on paramedics' estimates) of MRDs with other drivers suggest that MRDs were more likely to be involved in various risky and illegal driving behaviours and practices such as speeding, reckless driving, signal violations, and overloading. Furthermore, the majority of paramedics reported more mechanical defects in MRs, compared to other motorised vehicles.

Emergency paramedics' perceptions suggest that most MRDs are risky drivers and often engage in various unsafe and illegal driving practices. Moreover, frequent mechanical defects noted in MRs suggest that MRs are unsafe vehicles, and the findings of Study 1B also support these results. Unsafe driving practices of MRDs combined with their unsafe vehicles, are likely to increase the risk of crashes, injuries and fatalities.

Study Limitations

The Supplementary Study assessed the relative frequency of MR and AR crashes, and it also identified some human and vehicular factors that potentially contributed to MR crashes. However, the findings of this study are based on the estimates, observations and experiences of the emergency paramedics while attending MR crashes across Lahore in 2014. Though this survey was conducted in April-May 2015 (only 4-5 months after the study period), the paramedics' estimates are likely to be over or under-estimates, due to the likelihood of recall-biased responses. Further, given that ARs mostly operate in large districts of Punjab, and MRs operate in the whole province, there is a likelihood that MR crash frequencies/ proportions for the small districts of Punjab would be under-estimations. In small districts of Punjab, where only MRs operate, MR crashes could be 100%.

Moreover, considering the large scope of the current research program, in this survey only emergency paramedics of Rescue 1122 Lahore were included. Nevertheless, Rescue 1122 Lahore paramedics are more experienced and have attended more MR crashes compared to other paramedics in the rest of Punjab. Therefore, their observations and estimates are useful to understand the size of MR crash problem in Lahore and the rest of Punjab.

Summary

The Supplementary Study involved a survey of Rescue 1122 emergency paramedics to assess the relative involvement of MRs in road crashes. About half of emergency paramedics estimated that MRs were involved in more than 80% of rickshaw crashes, and ARs were involved in less than 20% of rickshaw crashes they attended across Lahore in 2014. Accordingly, it was estimated that most MR/AR crashes reported in Lahore and the rest of Punjab during 2011-2014 were MR crashes. The estimated large proportion of MR crashes in Punjab indicates the extent of MR crash problem and related road trauma across the province.

Emergency paramedics' estimates also suggest that there is a wide prevalence of underage MRDs and a high proportion of unlicensed MRDs in Lahore. They also attributed fault to MRDs in most of the crashes they attended during the study period. Further, they perceived that MRDs were more often involved in risky driving practices, compared to other drivers. Additionally, paramedics observed more mechanical defects in MRs, compared to other vehicles.

Underage and unlicensed driving; most at-fault in reported crashes; risky behaviours such as speeding, reckless driving and signal violations; and more mechanical defects noticed in MRs, suggest that most MRDs are unsafe drivers and MRs lack safety features.

The Supplementary Study has two important implications for this research program: first, it has addressed two significant limitations of Study 1: (1) it provides estimates of MR/AR crashes to address the limitations of aggregated data in Study 1A; (2) it identifies some human and vehicular crash contributing factors to address the limitation of Study 1B, where crash contributing factors were not well-defined and documented. Second, this study offered some input to Research Questions 1 *(What is the size of the MR crash problem?)* and 3 *(What are the characteristics of MRDs that influence the road safety of MRs?).* Moreover, this study provides some useful information to inform the subsequent studies of the current research.

Appendix B(A): Survey questionnaire of Supplementary Study

Emergency Paramedics' Perceptions of Relative Involvement of MRs in Road Crashes

QUT Ethics Approval Number 1500000209

Questionnaire No: …………   Date:………………………………

RS No: ……………………………..   Location of RS:

1. What is your working experience as an Emergency Paramedic at Rescue 1122 Lahore.

   …………………………….. (years)

Please think about the rickshaws crashes (both Motorcycle Rickshaws and Auto-Rickshaws) you attended in 2014 and answer the following questions:

2. What percentage (%) involved Motorcycle Rickshaw (MRs)?

   …………………………….. (approximately)

3. What percentage (%) involved Auto-rickshaws (ARs)?

   …………………………….. (approximately)

The next questions relate to MR drivers only (not AR drivers).

4. What percentage (%) of MR drivers were under the age of 18 years in road crashes which you attended in 2014?

   …………………………….. (approximately)

5. What percentage (%) of MR drivers were without driving licence in road crashes which you attended in 2014?

   …………………………….. (approximately)

6. In MR road crashes which you attended in 2014, what would the percentage (%) of the road crashes which occurred due to the fault of MR Driver?

   …………………………….. (approximately)

7. How often do you think that the following factors contributed to the MR crashes that you attended in 2014? (Please tick/cross one box per line.)

		Never	**Less than half of the time**	**About half of the time**	**More than half of the time**	**Always**
		1	2	3	4	5
1	Speeding by MR driver					
2	Speeding by other driver					
3	Reckless driving by MR driver					
4	Reckless driving by other driver					
5	Disobey traffic light/signal by MR driver					
6	Disobey traffic light/signal by other driver					
7	Underage (under the age of 18 years) MR driver					
8	Underage (under the age of 18 years) other driver					
9	Overloading by MR driver					
10	Overloading by other driver					
11	Defects in MR					
12	Defects in other vehicle					
13	Bad road conditions					
14	Poor weather conditions					

Participant Information and Consent Form for Supplement Study

Emergency Paramedics' Perceptions of Relative Involvement of MRs in Road Crashes

QUT Ethics Approval Number 1500000209

RESEARCH TEAM

Principal Researcher:	Muhammed Navid Tahir, PhD student, QUT
Associate Researcher:	Prof Narelle Haworth (Principal Supervisor), QUT Dr Mark King (Associate Supervisor), QUT Prof Simon Washington (Associate Supervisor), QUT
	Faculty of Health, Queensland University of Technology (QUT)

DESCRIPTION

This project is being undertaken as part of PhD study for Muhammed Navid Tahir. The purpose of this project is to make an assessment of frequency of road traffic crashes involving Motorcycle Rickshaws and Auto-Rickshaws in Lahore, Pakistan. You are invited to participate in this project because you are working as an Emergency Medical Technician (EMT) at Rescue 1122 Lahore and your participation can give us the valuable information to explore this topic.

PARTICIPATION

Your Participation will involve completing an anonymous questionnaire that consists of 5 questions that will take approximately 5-10 minutes of your time that is convenient for you.
Your participation in this project is entirely voluntary. Your decision to participate or not participate will in no way impact upon your current or future relationship with QUT/ Researcher. If you do agree to participate you can withdraw from the project at any time without comment or penalty. Any identifiable information already obtained from you will be destroyed. However as the questionnaire is anonymous once it has been submitted it will not be possible to withdraw. Please respond carefully to the questions and remember there are no rights or wrong answers and this information will only be used for research purposes. It is expected that non-identifiable data collected in this project may be used in future research projects.

Research team would be happy to provide you feedback (in the form of email) on this project, if you are interested in it (please tick option below).

☐ Yes, I am interested to have feedback

☐ No, I am not interested

EXPECTED BENEFITS

It is expected that this project will not directly benefit you. However, it may benefit you indirectly by enhancing the knowledge on this subject that could help the community generally.

RISKS

There are no risks associated with this project except to spare some time for completing this short survey questionnaire.

PRIVACY AND CONFIDENTIALITY

Please note that all comments and responses are anonymous and will be treated confidentially unless required by law. Moreover, we will not ask you any identifiable information such as your name, full date of birth etc.

Any data collected as part of this project will be stored securely as a non-identifiable data in accordance with QUT's Management of research data policy. The data collected or stored in this project may be used as comparative data in future projects or stored on an open access database for secondary analysis.

CONSENT TO PARTICIPATE

If you agree to all above-said information and willingly want to participate in this research then we may assume that you have fully understood the risks/benefits of this research and you have provided us your informed consent.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

If you have any questions or require further information please contact one of the research team members below.

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(Level 2, K block, QUT Kelvin Grove campus)
Kelvin Grove QLD 4059, AUSTRALIA
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CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Unit on [+61 7] 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Unit is not connected with the research project and can facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information.

Appendix C: Survey forms for Study 2

FORM A: SITE DETAILS FORM

Study 3: Observations of Road Safety Behaviours and Practices of Motorcycle Rickshaw Drivers in Lahore, Pakistan

QUT Ethics Approval Number 1500000144

Survey form No: ______________________________

Site No: ______________________________

Site name: ______________________________

Address (street/road name/bus stop and nearest intersection):

____________________ ______________________________________

Total no of signalized approaches on this site: ________________

Number of traffic lanes on each approach________________

Date: ________/________/________

Day of the week: ______________________________

Time: Commence: ______________ am/pm

Time: Complete: ______________ am/pm

Traffic warden present: ☐ Yes ☐ No

Road Type: ☐ Major Roads ☐ Arterial Roads ☐ Local/Residential

Weather conditions:
☐ Sunny
☐ Cloudy
☐ Rain
☐ Other (please specify) ______________________

Total number of MRDs observed at this site (for all approaches): ______________

FORM B: MOTORCYCLE RICKSHAW (MR) CHARACTERISTICS & MRD CHARACTERISTICS & DRIVING OFFENCES

Study 2: Observations of Road Safety Behaviours and Practices of Motorcycle Rickshaw Drivers in Lahore, Pakistan

QUT Ethics Approval Number 1500000144

Form No: ________ Site No: ________ Approach No: ________
Time: __________ (am/pm)

1. Motorcycle Rickshaw (MR) Characteristics

MR condition	**Any No. Plate Displayed**	**No of Passengers (including driver)**
1. ☐ Poor 2. ☐ Medium 3. ☐ Good 4. ☐ Missed out 5. ☐ Others (plz specify)	1. ☐ Yes 2. ☐ No 3. ☐ Missed out 4. ☐ Others (plz specify)	Passenger type / Number: Adults: ___ School age children: ___ Pre-school children: ___ Total: ___ **Goods carried?** 1. ☐ A lot 2. ☐ Moderate 3. ☐ Little 4. ☐ None

Passenger type	Number
Adults	
School age children	
Pre-school children	
Total	

2. Motorcycle Rickshaw Driver (MRD) Characteristics and Driving Offences

Age of MRD (years)	**Mobile Phone use**	**Traffic Lane use**
1. ☐ Possibly under 18 2. ☐ Clearly under 18 3. ☐ 18-30 4. ☐ 31-40 5. ☐ 41-50 6. ☐ 51-60 7. ☐ Over 60 8. ☐ Missed out 9. ☐ Others (plz specify)	1. ☐ No 2. ☐ Yes- Talking 3. ☐ Yes- Text messaging 4. ☐ Yes- Activity 5. ☐ Missed out 6. ☐ Others (plz specify)	1. ☐ Left 2. ☐ Right 3. ☐ Middle lane(s) 4. ☐ Missed out 5. ☐ Others (plz specify)
Signal colour when MR passed the intersection 1. ☐ Green 2. ☐ Red 3. ☐ Yellow (turning Green) 4. ☐ Yellow (turning Red) 5. ☐ Missed out 6. ☐ Others (plz specify)	**Jumping the Red Light/Movement prior to violation** 1. ☐ No 2. ☐ Yes, leaving too early 3. ☐ Yes, leaving after light turned Red 3. ☐ Missed out 4. ☐ Others (plz specify)	**Conflict observed** 1. ☐ No 2. ☐ With pedestrian 3. ☐ With motorized vehicle 4. ☐ With non-motorized vehicle 5. ☐ Missed out 6. ☐ Others

Appendix D: Survey questionnaire for Study 3

SURVEY FOR STUDY 3
Road Safety Knowledge, Attitude and Practices of Motorcycle Rickshaw Drivers (MRDs) in Lahore, Pakistan
QUT Ethics Approval Number 1500000737

Survey No: ……………… **Date:** ……………………………… **Study Location/Area:** ……………………………………………

INFORMATION ABOUT YOU

1. **Age (years):** …………………….

2. **Marital Status:** ☐ Single ☐ Married ☐ Divorced/Widowed

3. **Number of household members (family to support):** …………………….

4. **House:** ☐ Personal/Owned ☐ Rented

5. **Local** (from Lahore) ☐ **Outsider** (from any other city) ☐

6. **Education Level:**
   - ☐ No formal education
   - ☐ Primary school
   - ☐ Middle school
   - ☐ High school
   - ☐ Higher secondary school
   - ☐ Bachelor level
   - ☐ Master or higher

7. **Average daily total income from MR (in Pakistani Rupees)?**
   - ☐ 1-100
   - ☐ 101- 200
   - ☐ 201-300
   - ☐ 301-400
   - ☐ 401-500
   - ☐ 501-600
   - ☐ 601-700
   - ☐ Over 700 (please specify……………………………………………………………………………)

8. **Average daily take-home income from MR (in Pakistani Rupees)?**
   - ☐ 1-100
   - ☐ 101- 200

☐ 201-300
☐ 301-400
☐ 401-500
☐ 501-600
☐ 601-700
☐ Over 700 (please specify…………………………………………………………………………)

9. **Motorcycle Rickshaw (MR):** ☐ Personal/Owned
☐ Hired/Rented on daily wages
☐ Leased from Private Company/ Bank

If Hired/Rented then:
How much do you pay as a daily rent?
☐ 1-100
☐ 101- 200
☐ 201-300
☐ 301-400
☐ 401-500
☐ Over 500 (please specify…………………………………………………………………………)

If Leased from Private company/ Bank then:
How much do you pay to Private Company/ Bank per month? **…………………….** RS/Month

10. **How many years have you been driving an MR?** **…………………….** Years

11. **How would you rate your general health status?**
☐ Excellent
☐ Very good
☐ Good
☐ Fair
☐ Poor
☐ Other (please specify)……..)

INFORMATION ABOUT YOUR VEHICLE AND DRIVING PRACTICES

12. **How did you learn to drive an MR?**
☐ Self-trained
☐ Trained by a family member/friend
☐ Driving School
☐ Others (please specify…………………………………………………………………………)

13. **Is your Motorcycle registered with Motor Registration Authority?**
☐ Yes ☐ No ☐ Do not know

14. **Do you have vehicle inspection and fitness certification for your MR?**

☐ Yes ☐ No ☐ Do not know

If yes then is it: ☐ Valid/Current ☐ Expired ☐ Do not know

15. Do you have route permit for your MR?

☐ Yes ☐ No ☐ Do not know

16. Do you have your National Identity Card?

☐ Yes ☐ No

17. Do you have a motorcycle driving licence?

☐ Yes ☐ No

If Yes then:
Type of driving license? ☐ Learner/Temporary ☐ Permanent

Status of driving license? ☐ Valid/Current ☐ Expired ☐ Do not know

How did you obtain your driving license?
☐ Passed theory and practical test
☐ Paid to someone (e.g. agent) for illegal theory & practical test certificate
☐ Others (please specify…………………………………………………………………………)

18. How many hours per day do you drive the MR? …………………… Hours/Day

19. How many days per week do you drive the MR (No of days/week)? ……………………. Days/week

20. Is it your only paid job? ☐ Yes ☐ No

If No then how many hours per week do you work on other paid jobs?
…………………… Hours/Week

21. Are you the only driver of this MR? ☐ Yes ☐ No ☐ Do not know

If No, then how many drivers (besides you) are driving this MR?
…………………….

22. How old is your MR? .... (years)

23. How often do you inspect/check (i.e. Brakes, lights, mirror etc.) your MR before riding?

☐ Never
☐ Rarely
☐ Sometimes

☐ Often
☐ Everyday

24. How often do you repair and maintain your MR?

☐ Never
☐ Only when there is a dire need
☐ Regularly

25. If you are driving a rented MR then who is responsible for its repair and maintenance?

☐ MR Driver
☐ MR Owner
☐ Both (MR Owner & MRD) to some extent
☐ Do not know

26. What is average number of passengers you carry?

…………………………………………….

27. How many passengers do you think is overloading of your MR?

☐ Carrying more than 6 passengers
☐ Carrying more than 7 passengers
☐ Carrying more than 8 passengers
☐ Others (please specify…………………………………………………………………………)

28. Have your MR been modified?

☐ No
☐ Yes to take more passengers
☐ Yes to take more loads
☐ Yes to display advertising
☐ Yes to take more school children
☐ Others (please specify…………………………………………………………………………)

29. Do you have music system install in your MR? ☐ Yes ☐ No

30. Do you have modified Silencer or "Dolhki" fitted in your MR? ☐ Yes ☐ No

INFORMATION ABOUT YOUR ROAD SAFETY KNOWLEDGE, ATTITUDE AND PRACTICES

31. To what extent do you agree or disagree with the following statements?

Please remember that no one is perfect in this world. All of us make mistakes (intentional/unintentional) or bend the rules. Therefore, please answer these questions honestly in view of your experience as an MR driver.	**Strongly Disagree**	**Disagree**	**Neither Agree or Disagree**	**Agree**	**Strongly Agree**
When traffic warden is not present, sometimes I do not stop at red light	1	2	3	4	5
I slow down when traffic warden is present	1	2	3	4	5
I cross other vehicles from any side	1	2	3	4	5

To catch passengers, I compete with my fellow MR drivers	1	2	3	4	5
I am flexible to pick & drop passengers from anywhere on the road	1	2	3	4	5
Pedestrians often come in my way, but I do not stop for them	1	2	3	4	5
Speeding thrills me	1	2	3	4	5
Speeding carefully does not cause crashes	1	2	3	4	5
Road crashes are caused by the nature	1	2	3	4	5
I sound horn often	1	2	3	4	5
What are your perceptions about yourself as an MR driver					
Safe skilled driver	1	2	3	4	5
Violate the traffic rules at times, but mostly compliant	1	2	3	4	5
Your perceptions (as an MR driver) about traffic police	1	2	3	4	5
Impose fines without any reasons	1	2	3	4	5
Impose unnecessary checks	1	2	3	4	5
What are your perceptions about other (e.g. Police, Lahore Transport Authorities, district authorities, Lahore development Authority etc.) government authorities					
Impose fines without any reasons	1	2	3	4	5
Impose unnecessary checks	1	2	3	4	5

32. How often do you do each of the following?

Please remember that no one is perfect in this world. All of us make mistakes (intentional/unintentional) or bend the rules. Therefore, please answer these questions honestly in view of your experience as an MR driver.	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Using a mobile phone to answer a call while driving (in motion)	1	2	3	4	5
Using a mobile phone to read or reply a text message/SMS while driving	1	2	3	4	5
Eating or drinking while driving (in motion)	1	2	3	4	5
Smoking while driving	1	2	3	4	5
Driving too fast for the conditions	1	2	3	4	5
Causing traffic conflicts with other vehicles	1	2	3	4	5
Inattention/lack of concentration while driving	1	2	3	4	5
Disobey traffic rules (e.g. do not give way/do not keep left)	1	2	3	4	5
Not know traffic rules (e.g. do not know where to turn, cannot read or understand the traffic instructions/signs etc.)	1	2	3	4	5
Continue driving while fatigued/tired	1	2	3	4	5
Driving under the influence of alcohol	1	2	3	4	5

Please remember that no one is perfect in this world. All of us make mistakes (intentional/unintentional) or bend the rules. Therefore, please answer these questions honestly in view of your experience as an MR driver.	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Driving after taking illegal drugs	1	2	3	4	5
Cause overcrowding on the busy road	1	2	3	4	5
Causing high air & noise pollution	1	2	3	4	5
Parking on pedestrian pathways/footpath	1	2	3	4	5
Parking on bus stops	1	2	3	4	5
Parking in bazaar/markets	1	2	3	4	5
Carrying too many passengers	1	2	3	4	5
Plying on fixed routes	1	2	3	4	5
Plying on different routes	1	2	3	4	5
Charging more than normal rates	1	2	3	4	5
Driving faulty vehicle	1	2	3	4	5
Driving with faulty head lights in evening	1	2	3	4	5
Driving with faulty brake-system	1	2	3	4	5
Stopping anywhere in the middle of road to get the passenger	1	2	3	4	5
Disobey traffic law when traffic warden is not looking	1	2	3	4	5
Run away to avoid penalty of traffic violation	1	2	3	4	5

INFORMATION ABOUT ROAD ACCIDENTS AND OFFENCES

Road Accident: Any incident involving an MR and at least one road vehicle (motorized/non-motorized) or pedestrian, occurring on a road open to public circulation, and in which at least one person is injured or killed. Intentional acts (murder, suicide) and natural disasters are excluded.

MR overturning: Any incident in which an MR is overturned (resulted in injuries or no injury), while driving on the road (with or without passengers), due to any reason such as speeding, hitting footpath, wheel of MR came off, vehicle-shaft broken, brakes failed, overloading of passengers/goods etc.

Offences: Any incident where an MRD was fined due to violation of traffic rules/laws (e.g. signal violation, speeding, overloading, driving without having a valid driving licence etc.).

33. Have you been involved in any road accident as an MR driver in the last one year?

☐ Yes ☐ No ☐ Do not know

If yes then:

34. How many times have you been involved in road accident(s) as an MR driver in the last one year?

…………………………………………..

How many of these accidents did police attend the scene?
………………………………………….

How many of these accidents occurred due to your fault?
………………………………………….

35. How many times have you been penalized due to violation of traffic rules as an MR driver, in the last one year?

…………………………………………..

36. Which of the following have you experienced in the last one year as a result of MR driving?
(can select multiple)

☐ Being pulled over at the side of the road by traffic police/police
☐ Paid fine
☐ Impounding of MR
☐ Police took away my licence
☐ Police took away my motorcycle registration documents
☐ Police custody/ imprisonment
☐ Others (please specify………………………………………………………………………………)
☐ All of the above

37. How many times your MR has been turned-over while carrying passengers in last one year?

………………………………………….

Participant Information and Consent Form for Study 3

Road Safety Knowledge, Attitude and Practices of MRDs in Lahore, Pakistan

QUT Ethics Approval Number 1500000737

RESEARCH TEAM

Principal Researcher:	Muhammed Navid Tahir	PhD student
Associate Researchers:	Prof Narelle Haworth	Principal Supervisor
	Dr Mark King	Associate Supervisor
	Prof Simon Washington	Associate Supervisor
	Centre for Accident Research and Road Safety - Queensland (CARRS-Q)	
	Faculty of Health, Queensland University of Technology (QUT)	

DESCRIPTION

This project is being undertaken as part of a PhD study for Muhammed Navid Tahir.

The purpose of this project is to explore the Road Safety Knowledge, Attitude and Practices (KAPs) of Motorcycle Rickshaw Drivers (MRDs) in Lahore, Pakistan.

You are invited to participate in this project because you are an active MRD and your participation can give us the valuable information to explore this topic.

PARTICIPATION

Your participation will involve completing a verbally administrated anonymous survey that consist of 30 questions (including some Likert scale answers- strongly agree-strongly disagree) that will take approximately 30-35 minutes of your time.

Questions will include: your basic demographics (e.g. age, education, monthly income etc.); information about your vehicle and driving practices (e.g. driving license, vehicle registration, route permit etc.); information about your road safety attitude and practices (to what extent do you agree or disagree to the statements regarding various driving violations) and your knowledge about road crashes and how often you were involved in road accident(s).

If you think that discussing your driving behaviours or recalling a past crash experience may cause you some discomfort, then you may prefer to not participate in this study.

Please respond carefully to the questions and remember there are no rights or wrong answers and this information will only be used for research purposes, so please reply as honestly as possible.

Your participation in this project is entirely voluntary. If you agree to participate you do not need to answer any question(s) you are uncomfortable answering. Your decision to participate or not participate will in no way impact upon your current or future relationship with QUT or the researcher. If you do agree to participate, you can withdraw from the project at any time without comment or penalty. However as the survey is anonymous once it has been submitted it will not be possible to withdraw.

EXPECTED BENEFITS

It is expected that this project will not directly benefit you. However, it may benefit you indirectly by enhancing the knowledge on this subject that could help the community generally.

To recognise your contribution and time, we will offer you a small cash reward of (2 AUS$= about 160 Pakistani Rupees) after the completion of this survey.

RISKS

There are minimal risks associated with your participation in this project such as:

1. Disclosure of any illegal behaviour (e.g. speeding, illegal parking, signal violations etc.) will not place you at risk of prosecution or legal penalty, because this information is anonymous in nature and it will only be used for research purposes. The information will be kept confidential and only research team would have access to this information. Moreover, laws in Pakistan also do not allow use of such information for any legal purpose. Therefore, you will not be placed at risk in terms of any disclosure of illegal behaviours. Please also note that you do not need to answer any question, which may cause you any kind of discomfort.

2. Some questions may cause you discomfort (e.g. such as those that ask you about your past crash experience etc.), in this situation as already mentioned you have full right to not answering that question or you may even withdraw from the survey at any time in such a situation.

PRIVACY AND CONFIDENTIALITY

Please note that all comments and responses are anonymous and will be treated confidentially unless required by law. Moreover, we will not ask you any identifiable information such as your name, full date of birth etc.

Any data collected as part of this project will be stored securely as a non-identifiable data in accordance with QUT's Management of research data policy. The data collected or stored in this project may be used as comparative data in future projects or stored on an open access database for secondary analysis.

CONSENT TO PARTICIPATE

If you agree to all above-said information and willingly want to participate in this research then we may assume that you have fully understood the risks/benefits of this research and you have provided us your informed consent.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

If you have any questions or require further information please contact one of the researchers listed below.

Muhammed Navid Tahir	+61 7 3138 84775	muhammednavid.tahir@hdr.qut.edu.au
Narelle Haworth	+61 7 3138 8417	n.haworth@qut.edu.au

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Advisory Team on +61 7 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Advisory Team is not connected with the research project and can facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information.

Appendix E: Generic interview guide for Study 4

Identification of Policies and Measures to Improve Road Safety Aspects of Motorcycle Rickshaws in Pakistan

QUT Ethics Approval Number **1500000824**

Sheet No:……………… Date:……………………………...
Study Location:…………………

1. How do you see the current road safety situation in Pakistan?

   If road safety situation is worsening in the country:

2. What are major factors behind worsening road safety situation in Pakistan?
3. How do you see public transport situation in Pakistan in the following context:
   a) Do we have proper infrastructure and public transport facilities in the country?
   b) Does government has right vision and planning for sustainable public transport facilities in the country?
   c) Do you think the transport organizations (e.g. Transport department, Lahore Transport Company etc.) are playing their effective role in transport planning and management?
4. What is your viewpoint regarding road safety aspects of Motorcycle Rickshaw (MR)?
5. What is your perception regarding the existing legal status of MRs in Pakistan?
6. What is your understanding regarding Government's current transport and road safety polices related to operation of MRs?
7. How do you see the role of MRs in public transport sector in Pakistan?
8. What should be the future of MRs in Pakistan?
9. What are your suggestions to improve the road safety aspects of MRs?

Participant Information Sheet and Consent Form for Study 4
Identification of Policies and Measures to Improve Road Safety Aspects of Motorcycle Rickshaws in Pakistan
QUT Ethics Approval Number 1500000824

RESEARCH TEAM

Principal Researcher:	Muhammed Navid Tahir	PhD student
Associate Researchers:	Prof Narelle Haworth	Principal Supervisor
	Dr Mark King	Associate Supervisor
	Prof Simon Washington	Associate Supervisor

Centre for Accident Research & Road Safety, Queensland (CARRS-Q)
Faculty of Health, Queensland University of Technology (QUT)

DESCRIPTION

This project is being undertaken as part of a PhD study for Muhammed Navid Tahir.

The purpose of this research project is to discuss the road safety aspects of Motorcycle Rickshaws (MRs). This research is very important because currently MRs are the largest informal/unregulated public transport mode in the country, however they are operating without any transport and road safety policy.

Findings of Study 1 (of this PhD program) show that rickshaws were involved in nearly 52,000 road crashes in Punjab, Pakistan between 2011-2013. Study results also indicate the frequent involvement of Motorcycle Rickshaw Drivers (MRDs) in speeding, reckless driving, underage and unlicensed driving and endangering the safety of pedestrians and other road users. Therefore, this research program aims to undertake a thorough exploration of this subject, so that appropriate policy and safety measures regarding MRs could be identified and recommended to government.

As part of the project, we are recruiting people from concerned Government/Private departments/organizations to discuss the subject matter. Your participation would provide us valuable information about this topic.

PARTICIPATION

Your participation will involve participating in a semi-structured interview that will take approximately 15-20 minutes of your time. The interview will be audio-recorded, however if you would not like to be audio-recorded, only notes will be taken. Participation in this project is voluntary. If you do agree to participate you can withdraw from participation at any time during the interview process without comment or penalty. You do not have to answer any question that you do not want to. Your decision to participate will in no way impact upon your current or future relationship with QUT or the interviewer.

EXPECTED BENEFITS

It is expected that this project will not benefit you directly; however, it may benefit the community through advancing knowledge about the topic and which, in turn, may improve transport/road user issues related to MRs.

RISKS

There are no risks beyond normal day-to-day living associated with your participation in this project. However, although the interview questions are very simple and non-threatening, some questions may cause some discomfort or even conflict with government policy. In such a situation you have the right to not answer that question, and you may even withdraw from the study at any time during the interview process.

PRIVACY AND CONFIDENTIALITY

Your responses will be confidential and made anonymous once transcribed. Your name is not required for any of the responses. In the case of a recorded interview, the recording will be destroyed after the contents have been transcribed. The audio-recording or notes will not be used for any other purpose except for research. Only the research team will have access to the audio recording/notes. Your name will not be mentioned in the published study/thesis, you will only be mentioned as panelists/participants of the study. The study findings will only be reported according to themes and issues. Please note that non-identified information gained in this study may be used in future research for comparative purposes.

CONSENT TO PARTICIPATE

We would like to ask you to please sign a written consent form (enclosed) to confirm your agreement to participate.

QUESTIONS / FURTHER INFORMATION ABOUT THE PROJECT

We would like to share the study findings with you, if you would like to have such feedback. If you would like to have copy of this report please contact the researcher using the details below or include your preferred contact details in the consent form (attached). Any contact details provided for feedback purposes would be stored securely and separately from the research data and disposed of, once the feedback is provided. If you have any questions or require further information please contact one of the researchers listed below.

Muhammed Navid Tahir	muhammednavid.tahir@hdr.qut.edu.au
Narelle Haworth	n.haworth@qut.edu.au

CONCERNS / COMPLAINTS REGARDING THE CONDUCT OF THE PROJECT

QUT is committed to research integrity and the ethical conduct of research projects. However, if you do have any concerns or complaints about the ethical conduct of the project you may contact the QUT Research Ethics Advisory Team on +61 7 3138 5123 or email ethicscontact@qut.edu.au. The QUT Research Ethics Advisory Team is not connected with the research project and can facilitate a resolution to your concern in an impartial manner.

Thank you for helping with this research project. Please keep this sheet for your information

Consent Form

By signing below, you are indicating that you:

- Have read and understood the information document regarding this project.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions you can contact the research team.
- Understand that you are free to withdraw at any time, without comment or penalty.
- Understand that you can contact the Research Ethics Advisory Team on +61 7 3138 5123 or email ethicscontact@qut.edu.au if you have concerns about the ethical conduct of the project.
- Understand that you have option to choose if the interview will be audio-recorded or only notes taken.
- Understand that non-identifiable data collected in this project may be used as comparative data in future projects.
- Understand you can have feedback on the findings of this study.
- (If you would like to receive the feedback, please add your preferred contact details (email or postal) in the section below.
- Agree to participate in the project.

Please tick the relevant box below:

☐ I **agree** for the interview to be audio-recorded.

Name--

Signature---

Date--

Thank you for your time and cooperation.