



## Effectiveness of Road Safety Audit Implementation (An Analysis on Surkhet – Jumla Road, Nepal)

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**Abstract:** Road traffic crashes result in the deaths of approximately 1.19 million people around the world each year and leave between 20 and 50 million people with non-fatal injuries. More than half of all road traffic deaths occur among vulnerable road users, such as pedestrians, cyclists and motorcyclists. Road traffic injuries are the leading cause of death for children and young adults aged 5–29. Yet two thirds of road traffic fatalities occur among people of working age (18–59 years). Nine in 10 fatalities on the roads occur in low- and middle-income countries, even though these countries have around 60% of the world's vehicles. A safe and efficient road network for the transportation of people and goods is a prerequisite to support the overall development of every country. United Nations General Assembly resolution 74/299 (2020) proclaimed Second Decade of Action for Road Safety for 2021–2030. As per recorded data road fatalities in Nepal is 2320 which is 5.8 per 10000 registered vehicle and 7.8 per 100000 populations and along Surkhet-Jumla road, total accident no. 127, fatality 33-person, serious injury 223 in 2022-2023 FY.

Surkhet – Jumla road section seen to be critical in safety aspect due to narrow road width and sharp curves. The Department of Roads (DoR) under the Ministry of Physical Infrastructure and Transport has undertaken the task of upgrading the Strategic Road Network in Mid-western regions of Nepal under donor funded project namely Road Sector Development Project (RSDP) and RSDP AF with a vision to provide strategic transport connection to district headquarters. Once a road is built, making changes or fixing errors becomes expensive. There will be huge economic loss due to a road crash and requires proper consideration from decision-makers to be more focused on proper road safety intervention to reduce the road traffic crashes. To avoid such additional expenditures, an independent review of detailed designs and road safety audits are necessary to ensure that the constructed road does not pose risks.

Given the ongoing commitment of DoR to build safer roads, the agency undertook the Road Safety Audit (RSA) Study for roads under both RSDP and RSDP AF of this highway to improve the overall road safety. It also intends to identify any critical safety aspect in the road design elements for corrective actions. Road crash costing is very crucial for decision-makers for economic analysis of the road projects which will give decision-makers an idea about the importance of road safety intervention. DoR took intervention to improve the safety aspect of the highway considering the recommendations of RSA through six contracts.

This paper aims to evaluate the effectiveness and benefits of intervention on road safety along Surkhet-Jumla Road after the 8 years of intervention. For this, different literatures are reviewed and required data/texts are extracted to analyse the situation. From the analysis it was found that the condition of road safety after intervention is improved to some extent and some development indicators are also improved during this period considering the intervention on road safety is triggering factor for improvement on development indicators.

**Keywords:** Road Safety Audit, Road Crash Cost, Safety Benefits, Effectiveness of Road safety measures

### 1.0 Introduction

#### 1.1 Background

A safe and efficient road network for the transportation of people and goods is a prerequisite to support the overall development of every country. Road accidents have become a matter of serious concern in Nepal. Every passing year adds to the number of those injured or perished in road mishaps. Lack of road discipline, inadequate knowledge about road safety measures, driving under the influence of alcohol, disregard for traffic signs while driving and poor condition of roads factors contribute to road accidents. According to the WHO, 1.19 million road traffic deaths in 2021; this corresponds to a rate of 15 road traffic deaths per 100000 population and road traffic injuries are the leading cause of death for children and young adults aged 5-29 years. And, more than half of all road traffic deaths are among vulnerable road users: pedestrians, cyclists and motorcyclists. In Nepal, two-wheeler accidents account for over two-thirds of the injuries and fatalities that happen as a result of road accidents alarmingly, the data show that road accidents are killing a large number of people in their most economically productive years. Equally worrisome is the loss of productivity of those who are left disabled or bed-ridden? The good news is that with awareness and little but concrete effort, road



accidents are entirely preventable. Making our roads safe to travel is a shared responsibility of all stakeholders concerned. One important but overlooked aspect that can make travel much safer is making public transportation prompt, reliable and hassle-free. The quest towards safer roads demands the use of the latest technology, appropriate processes, and the capacity to use them for the effective provisioning of safer roads. One of the most important processes to put to widespread use is the road safety audit process. The principal purpose of a Road Safety Audit is to identify likely safety hazards within the design or construction as they could affect road users by changing road user behaviour or by changing the outcome of an incident involving an errant vehicle. As a key element of the Safe System, road infrastructure must be designed to enable equitable access and accommodate the mobility needs of all road users including pedestrians, bicyclists, riders of two and three wheelers, users of public transport, as well as drivers of motor vehicles. High quality technical standards for design and construction are key components for safe road infrastructure that is intuitive to use as well as forgiving [1].

### 1.2 Road Safety Audit (RSA)[9]

A road safety audit is “a formal and detailed examination of a road project by an independent and qualified team of auditors that leads to a report that lists any potential safety concerns in the project.” Road safety audit is a “low cost, high benefit” process. Road safety audit offers great value to road authorities. Principle of Road Safety Audit is “*Prevention is better than cure*”. The main objective of road safety audit is to minimize the risk of crashes occurring on an existing road/a new road project and to minimize the severity of any crashes that do occur or are likely to occur. Benefit of RSA may be:

- Throwing away costs and reconstruction costs to correct safety deficiencies identified
- Lifecycle costs are reduced since safer designs often carry lower maintenance costs
- Societal costs of collisions are reduced by safer roads and fewer, less-severe crashes.
- Liability claims, a component of both agency and societal costs, are reduced.
- May help produce designs that reduce the number and severity of crashes
- May reduce costs by identifying safety issues and correcting them before projects are built
- Promote awareness of safe design practices
- Integrate multimodal safety concerns
- Consider human factors in all facets of design

### 1.3 Information about Surkhet – Jumla Road

RSA for Karnali Highway was carried out as per the Road Safety Audit Manual 1997 (Revision 2022) and manual on Road Safety Audit (IRC: SP: 88-2019). During the road safety audit following information were simultaneously collected [10]:

#### Bangesimal – Tallo Dungeshwar Link

This link of Karnali Highway (H13) starts 6+000 km from Surkhet at Bangesimal, passes through Hurre, Baddichaur, Kalyan and Upallo Syaule to Tallo Dungeshwar. It caters mainly to the traffic to Kalikot and Jumla. Although a new track to Dailekh has been made from Tallo Dungeshwar, the existing Dailekh – Surkhet link over Guranse will continue to be the major traffic carrier to the district centre. As a result, along Bangesimal – Upallo Syaule, the AADT was 734 vehicles in 2012 which was about 20% of the saturation traffic. Considering the terrain and the pavement width, the design speed as per NRS 2045 is 50 kmph for up to Kalyan and 30 kmph thereafter. However, there is little provision to encourage the drivers to follow the design speed. On the other hand, vehicles could not intercept many curves if they attempt to drive close to the design speed.

#### Tallo Dungeshwar – Khidkijyula Link

From Tallo Dungeshwar (63+000) at 580 msl the 63.5 km section to Khidkijyula climbs up to 772 msl along Karnali Highway (H13). The AADT of 161 vehicles in 2012 and doubled mainly due to construction related traffic. During RSDP, some portions of the section were already sealed and majority of the structures have been constructed. Once a road is built, people move closer to the road for easy access and economic opportunities. In absence of strict ROW and building line enforcement, vehicle-vehicle and vehicle-pedestrian conflicts were obvious together with traffic congestion. This can be seen at Suba Chheda, Nauli, Paltada, Rakam and all small hamlets on the way.

#### Khidkijyula – Jumla Link

The 28.7 km section from Khidkijyula (126+000) to Manma, the road climbs up 982 m higher. This together with steep terrain naturally requires a lot of sharp climbs and tight horizontal curves. From Manma to Ranchuli the height difference is not much but the hard rock cliffs along the alignment might have required to



compromise on the width. This has severe consequences on the sight distance. From Nagma to Jumla the alignment is rather flat.

All the above three sections have their own safety problems. Khidkijyula - Manma section has a number of tight switchbacks where steering safely is difficult even for experienced drivers. Visibility at some of the curves is not enough even for 20 kmph cruising speed. Additionally, gradients exceeding NRS limit is a major safety concern along Manma – Ranchuli section.

From Nagma to Jumla, the general alignment is rather flat leading to the misconception to motorists to freely drive beyond the speed limit and carelessly drive at high cruising speeds. However, a sharp horizontal kink, which is plenty as per the design, might take the drivers by surprise and result in a serious accident. Provisions of walking path and school signs needs to be made to segregate and guide the pedestrian and vehicular traffic before the road is opened for normal traffic. While investigating the reasons of a couple of recent work zone accidents on the Manma-Jumla road, the RSA team found that the novice drivers were unaware of the site conditions and overestimated the mechanical capacity of their vehicles.

## **2.0 Literature Review**

### **2.1 Road Safety Strategy of Nepal for Resilient and Sustainable Development**

For Safer Roads and mobility, we should adopt Road safety audits, Black spot analysis, Traffic calming measures, Road furniture to improve safety, Safe Pedestrian crossing, Traffic signals, Work zone safety, Intentional arrangement for road safety audit, Guidelines for safe road design, Road maintenance, Pedestrianized zones, Parking and loading zone etc. Designing and building safer road infrastructure for every road user group is the responsibility of road authorities, and road safety audit has a key role to play. A recent World Bank Group study estimated that Nepal will require an additional investment of US\$879 million over the coming decade, to systematically address its road safety challenges, to enable it to achieve the Sustainable Development Goal (SDG) 3.6 target of halving its national road crash fatalities. Systematic and large-scale initiatives are needed annually to ensure their proper sequencing and successful delivery. Improving road safety in Nepal is vital to national health, well-being and economic growth. As evidenced by the World Bank, reducing road fatalities and injuries will enable Nepal to achieve substantial increases in economic growth and national income [4].

### **2.2 Delivering Road Safety and Initiatives to 2030**

To meet the SDG Targets 3.6 and 11.2 call for a halving of global road deaths and universal access to safe transport in cities and settlements, respectively (UN 2015). It is Recommended priorities for improved road safety over the coming decade will include: promoting shifts to more sustainable and safer transport modes; improved reporting on sustainability outcomes by businesses and enterprises of all sizes; enhanced vehicle safety; safer transport for children; more stringent safety requirements for vehicles and transport services procurement; safe speed management in cities; infrastructure safety; and potential safety gains from new technologies. Estimated population welfare gains from achieving a 50 percent fatality reduction in the countries assessed over this period were equivalent to 6 percent to 32 percent of GDP. More effective, efficient, and scaled-up initiatives are required to emulate the performance trajectories of high-income countries that define good road safety practice and provide a blueprint for action [5].

Accidents result in considerable economic and health challenges. Road geometry aspects like radius, grade, sightlines, and setback distances, as well as the presence or absence of dividers pavement conditions, the state of vehicles, and the characteristics of road users further influence crash dynamics. The standard emphasizes that road alignment should ensure a sight distance equivalent to either the overtaking or stopping sight distance for multilane roads and at least double the stopping sight distance for single-lane highways. Designing these roads presents significant challenges, particularly in hilly regions, as they must navigate challenging terrains. Among the various pillars or themes identified in the road safety action plan, safer road infrastructure stands out as a major intervention toward achieving improvements in the road safety scenario. It is crucial to incorporate road safety interventions during the design phase, and the road design team must take responsibility for detailing the schedule of road safety structures, irrespective of whether an RSA is conducted or not. This is vital for future road projects mandated at the federal, provincial, and local levels [14].

### **2.3 Determinants and Economic Burden of road traffic accidents in Nepal**

According to the findings of an analysis of the data and an examination of the factors that determine road traffic accidents based on a comprehensive set of characteristics, it has been concluded that there is a positive relation between drunk driving and road accidents. On the other hand, poor road conditions and improper driving skills are the two primary causes of road traffic accidents [6].

The sum of the direct medical and non-medical, productivity loss and pain, grief and suffering costs resulted in a total economic burden of approximately USD 122.88 million in 2017. The total direct costs that



included the costs of medical and non-medical costs were estimated at USD 13.0 million and represented 10.58% of the total costs of Road Traffic Injuries in Nepal. The direct non-medical costs that include vehicle damage were responsible for 9.36% whereas direct medical costs accounted for only 1.22% of the total costs of RTIs [7].

#### **2.4 Road safety assessment of high-risk strategic road network in Nepal**

Three potential investment plans have been prepared for consideration with the most comprehensive showing that by investing NPR 25.4 billion (USD\$200 million), the number of fatalities and serious injuries on the assessed strategic road network could be reduced by up to 60%, saving around 57,734 fatalities and serious injuries over 20 years. The overall benefit to cost ratio would be \$3 of benefit for every \$1 spent. iRAP and local partners have undertaken a number of assessments since 2014 and an estimated USD682.44 million of road investment has been made safer informed by iRAP assessments. According to the iRAP Vaccines for Roads Big Data Tool, achieving >75% of travel on 3-star or better roads for all road users in Nepal by 2030 stands to save 2,041 fatalities a year with an economic benefit of USD7.4 billion [8].

#### **2.5 Road Transport Safety and Axle Load Control in Nepal**

Development of road infrastructure has been instrumental in propelling economic progress, generating employment opportunities, and enhancing the overall quality of life for the citizens. Despite witnessing growth in the road network, there remains an urgent need for further investments in this sector to address the growing demands and challenges posed by the country's evolving transportation needs because road injuries pose a significant public health challenge, leading to a high number of preventable fatalities and disabilities. These accidents impose substantial social and economic costs, including sudden deaths, injuries, disabilities, and loss of income. The economic impact of road traffic injuries in Nepal amounts to approximately 1.52% of the country's gross national product, highlighting the increasing financial burden caused by accidents [11].

Existing Road Traffic Accident reporting and recording system by the Traffic Police needs to improve and must be implemented with the application of ICT. The accident recording can be eased by the application of mobile devices which are connected to the central database system. The initiation to establish the Road Accident Information Management System (RA-IMS) should be taken by DoTM. Motor Vehicle and Transport Management Act-1993 (MVTMA-1993) states that the road transport safety is prime concern of Department of Transport Management (DoTM). DoTM has to play key role of regulator and responsible for overall management of the road transport service sector. DoTM needs to manage and facilitate safe, effective and reliable road transport services by managing and controlling the vehicle fleet, driver's licensing, route permit, fare fixation, axle load control and minimize the road traffic accidents and making adequate provision of compensation of road accident including regulating the insurance for road traffic accidents [12].

#### **2.6 United Nations Second Decade of Action for Road Safety**

United Nations General Assembly resolution 74/299 (2020) proclaimed Second Decade of Action for Road Safety for 2021 – 2030. The goal of the Second Decade is to achieve (at least) a 50% reduction in road traffic deaths and injuries by 2030. A gradual decline in global road traffic deaths and injuries of approximately 7% per year will lead to an achievement of the 50% target in the number of deaths within 10 years. More than 90% of global road traffic deaths presently occur in low-income and middle-income countries like Nepal. On top of the enormous human suffering caused, the economic costs of road crashes keep many millions of people in poverty, with the economic losses estimated to range between 2% and 5% of GDP in these countries.

#### **2.7 Road safety situation in Nepal**

Nepal is a land locked and mountainous country. With no suitable lakes or rivers for transport use and depends on its air routes and its road network for the transport of people and goods. But the mountainous terrain creates a significant challenge to the provision of a cost-effective and safe road transport network. Presently totaling about 100,000 km, much of Nepal's national road network was built quickly to minimal standards to provide connectivity to remote parts of the country. However, the increase in the road network without due attention to engineering, enforcement, and education has added to a rising trend in traffic casualties in recent years [2].

Annual road fatalities in Nepal have more than quadrupled since the mid-1990. The World Health Organization estimates that the fatality rate for 2019 was 16.3 (per 100,000 people) and fatality rate of 40 deaths per 10,000 registered vehicles. But as per recorded data road fatalities in Nepal is 2320 in 2022-2023 FY which is 5.8 per 10000 registered vehicle and 7.8 per 100000 populations [3]. Road crashes in Nepal are the leading cause of death among children and young adults (aged 5-29 years); and the annual economic loss from road crashes is estimated to be about 1.5% of Nepal's GDP.



In Nepal, major portion of vehicle composition is of two wheelers (72.24%) and involvement of two wheelers in accident is the highest 39.23% on average, heavy vehicles (Trucks and Buses) about 12/12% and that of car is 28.29% on average with highest rate in an urban area. Peak traffic hours in Nepal are from 9:00AM to 7:00PM and accident rate at that time is also high. Also, driver’s negligence is the major cause (72.32%) of accident followed by over speed (14.66%) [13].

Despite the global commitment to improve road safety, Nepal has yet to make significant progress in this area. Among the various pillars or themes identified in the road safety action plan, safer road infrastructure stands out as a major intervention toward achieving improvements in the road safety scenario. A fully empowered and resourced National Road Safety Council is essential for the effectiveness of road safety activities in the country. Once a road is built, making changes or fixing errors becomes expensive. To avoid such additional expenditures, an independent review of detailed designs and road safety audits is necessary to ensure that the constructed road does not pose risks [14].

There is increasing trend of road traffic accidents, vehicle collisions, and injuries in Nepal over the past ten years especially among two-wheelers and four-wheelers like a car, bus, and auto. The common predisposing factors for road traffic accidents were negligence of drivers, over speeding based on analysis of available data. This urges the necessity of regulating vehicle density for the limited road in dense cities and more emphasis need to be given to better public vehicles. Additionally, road safety measures need to be kept in priority by governing bodies to maintain road and road lights and riders must consider vehicle speeds and caution in residency areas and accident-prone roads [15].

### 3.0 Road Accident Cost and Benefits

Road crash costing is very crucial for decision-makers for economic analysis of the road projects which will give decision-makers an idea about the importance of road safety intervention. There will be huge economic loss due to a road crash and requires proper consideration from decision-makers to be more focused on proper road safety intervention to reduce the road traffic crashes. The total crash cost may be divided into three components, viz. Human Cost, Vehicle Damage Cost and Administrative Cost. Human Cost components, which comprises for all kind of injuries (minor, major or fatal) share a major portion of the total crash cost which is further subcategorized into three components: Cost associated with Loss of Productivity/Lost Output, Cost associated with Quality of Life, Medical Costs [16].

#### 3.1 Computation of National Road Accident Costs [12]

1. Estimation of value of statistical life for fatal accident = 60 x GDP per capita
2. Estimation of value of statistical life for serious injury = 12 x GDP per capita
3. Estimation of property damage costs = Cost of net vehicle damage (Average vehicle repair cost - (custom duties + sales tax + salvage value) + insurance excess + survey fee + lost business
4. Medical costs = total hospital costs (Beds, treatment, insurance, families of victim)
5. Administration costs = i. 0.2% of total resource cost for Fatal Accident, ii. 4.0% of total resource cost for Serious Injury Accident, iii. 14 % of total resource cost for Minor Injury Accident, and iv. 10 % of total resource cost for property damage only Accident
6. Human Costs = 20% of the total cost of each type of accident.

**Total Accident Cost = Total of 1 + 2 + 3 + 4 + 5 + 6**

#### 3.2 Cost and Benefit of Road Safety [19]

Analyses in Norway and Sweden – both of which are comparatively safe countries – suggest that fatality reductions of about 50 % can be realized by applying cost effective measures. It is reasonable to believe that benefits of a similar magnitude can be attained in many European countries.

Road Safety Measures	Estimated reduction of the number of road users killed or seriously injured		
	Benefit cost ratio	Killed	Seriously injured
Speed enforcement	1.49	7.2	21.3
Speed cameras	2.11	1.6	3.5
Section control (coordinated)	1.58	0.9	2.2
Feedback sign for speed	2.35	1.4	2.5
Drink driving enforcement	1.80	22.1	44.3
Seat belt enforcement	2.44	5.7	17.5
Inspection of heavy vehicles	1.41	0.6	1.1
Rest hour enforcement	1.45	1.1	1.9



Bicycle helmet law	1.02	1.3	2.4
Pedestrian reflective devices	3.49	5.6	11.8
Accompanied driving	1.25	3.0	16.9
Elderly driver retraining	1.85	0.2	1.0

Table 1: Cost effective road safety measures in Norway [19]

### 3.3 Crash Cost Review

Higher Road Safety is a driver for economic growth. Speed limits and reliable enforcement technology in combination lead to a reduction of accidents [20]. The total cost of road crashes in Kathmandu Valley for the fiscal year 2020 was calculated a NRs. 1.827 billion. Among various components of crash cost, the total cost of lost output share 46.28 %, Vehicle damage cost shares 36.27 %, Medical cost shares 2.16 %, Administrative cost shares 6.01 % and Quality of life shares 9.25 % respectively [18].

Cost components	Fatal Crash (NRs.)	Injury Crash (NRs.)
Lost output	6,105,664	5,206
Medical Cost	10,798	9,151
Vehicle Damage	107,018	128,421
Administrative Cost	14,889	25,887
Quality of Life	1,221,133	1,041
<b>Average cost per Casualty Crash</b>	<b>7,459,501</b>	<b>169,706</b>

Table 2: Average cost for fatal and injury crash[16]

Cost components	Total Cost (NRs.)	Proportion (%)
Lost output	845,956,172	46.28
Medical Cost	39,588,838	2.16
Vehicle Damage	663,056,510	36.27
Administrative Cost	109,882,473	6.01
Quality of Life	169,191,234	9.25
<b>Total</b>	<b>1,827,675,227</b>	<b>100</b>

Table 3: Road traffic Crash Cost of Nepal [16]

Severity	Base 2016 crash Costs
Fatality	\$ 10,635,263
Major Injury	\$ 715,846
Minor Injury	\$ 109,365
Property Damage Only	\$ 7,954

Table 4: Crash Costs for Highway FEWA [22]

Cost Components	Fatal	Serious Injury	Moderate Injury	Minor Injury	Property Damage Only
Medical Care	22,254	17,464	3,823	2,051	68
Future Earnings	1,053,152	23,563	7,786	3,876	319
Public Services	1,275	314	204	133	29
Property Losses	11,901	4,683	3,980	3,008	1,257
Subtotal Loss	1,088,592	46,025	15,793	9,067	1,672
Quality of Life	2,093,660	113,992	25,566	10,647	244
Total	3,182,252	160,016	41,359	19,714	1,916

Table 5: Costs per Police Reported Crash Victim in Michigan (1997 dollars) [21]

### 3.4 Development Indicators of Karnali Region

Transportation was always a hassle in Karnali due to the poor road connectivity, causing the hike in food prices up to 4 times the national average during 2012-2013. The literacy rate of the total population in Karnali province aged 5 years and above is 76.1 percent in 2021 census. The male literacy rate is 83.3 percent while female literacy rate is 69.4 percent for this province [23]. Some development indicators of Karnali region are improved as indicate below:



Development Indicators	Year 2012-2013 [24] [26] [28] [29]	Year 2022-2023 [25] [27] [29]
Adult Literacy	32.50	76.1%
Life Expectancy	50.50	67.03
GDP per capita	USD 475	USD 964
Human Development Index	0.350	0.538
Multidimensional Poverty Index	0.286	0.169
Poverty (%)	52.9	39.5%
Gross Domestic Product	21.70 billion NRs.	197.99 billion NRs.
Infant Mortality Rate	47 per Thousand	27 per Thousand
Maternal Mortality	33 in the year	17 in the year
Employed people	58.56% Male & 41.44% Female	24.80 to Population Ratio
Unemployed people	95,700 persons	9.70 to Population Ratio
Wholesale price of Jumla Apple	NRs.26.93/kg in 2010 [31]	NRs 40/kg in 2015 [32]

Table 6: Some Development Indicators of Karnali region

Market	Pre-Road	Post-Road
Surkhet	-0.2	0.5
Dailekh	0.4	0.8
Kalikot	-5.6	0.1
Jumla	-3.3	-2.6

Table 7: Price Volatility before and after road connectivity [30]

Market	Dry Season	Monsoon
Surkhet	1.2	1.3
Kalikot	8.0	13.5
Jumla	16.6	21.6
Mugu	39.0	52.0

Table 8: Transport price from Nepalgunj to Jumla 2010 [30]

### 3.5 Data and Analysis

#### Traffic Data along Karnali Highway

Traffic in PCU	2011/12	2012/13	2014/15	2015/16	2016/17	2018/19	2020/21	2021/22	2022/23
AADT Total	400	492	791	585	783	3052	1359	1129	2855
AADT excluding Motorcycle	339	377	650	531	421	2218	832	609	1574

Table 9: AADT of Surkhet North [17]

Traffic in PCU	2011/12	2012/13	2014/15	2015/16	2016/17	2018/19	2020/21	2021/22	2022/23
AADT Total	295	311	327	312	155	186	797	698	524
AADT excluding Motorcycle	266	283	303	287	151	166	594	572	456

Table 10: AADT in PCU and PCU Excluding 2/3 wheelers at Khulalu south Kalikot [17]

#### Road Accident Data

Following table presents 10 years accident data along Karnali Highway:

- Road Accident number
- Death in the Accident
- Injury in the accident



		Total Accident data along Karnali Highway with in 10 years																																	
SN	Highway	Category of Vehicle	2013-14			2014-15			2015-16			2016-17			2017-18			2018-19			2019-20			2020-21			2022-23			2023-24			Total		
			Accident No.	Death	Injured	Accident No.	Death	Injured	Accident No.	Death	Injured	Accident No.	Death	Injured	Accident No.	Death	Injured	Accident No.	Death	Injured	Accident No.	Death	Injured	Accident No.	Death	Injured	Accident No.	Death	Injured	Accident No.	Death	Injured			
1	Karnali Highway (Surkhet-Daijlekh, Kalikot-Jumla-Mugu)	Truck, Tanker	1	1	1	4	3	2	2	2	1	2	3	2	2	3	1	10	5	12	6	1	8	16	3	13	12	6	12	10	1	8	80	31	67
2		Tipper	1	0	2	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	0	0	0	4	0	1	9	4	8
3		Dozer, Excavator	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0	0	5	3	0
4		Bus	2	3	3	5	24	5	6	7	6	4	7	4	4	5	3	5	4	14	9	5	19	7	2	5	12	5	43	8	0	7	77	103	210
5		Micro Bus	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	2	5	1	9	8	2	13	11	0	14	17	0	21	54	4	82	
6		Car, Jeep	1	2	1	1	2	3	0	0	0	1	1	0	3	3	0	5	5	8	4	2	8	22	3	36	23	10	60	22	5	24	107	39	164
7		Tractor	3	4	1	9	9	2	6	6	5	4	6	1	8	10	4	8	8	6	5	2	3	13	4	13	13	4	17	10	0	5	94	55	69
8		Auto Riksha	0	0	0	0	0	0	0	0	0	1	1	0	1	3	0	1	1	0	0	0	0	8	0	19	13	2	24	9	3	17	47	13	91
9		Motoecycle	2	2	0	3	3	1	3	3	1	1	1	0	2	2	1	9	4	6	8	2	7	36	3	16	42	5	50	37	2	38	186	31	175
10		Others	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	1	4	1	3	7
<b>Total</b>			<b>11</b>	<b>13</b>	<b>8</b>	<b>24</b>	<b>44</b>	<b>15</b>	<b>19</b>	<b>20</b>	<b>13</b>	<b>13</b>	<b>19</b>	<b>7</b>	<b>20</b>	<b>26</b>	<b>9</b>	<b>40</b>	<b>27</b>	<b>48</b>	<b>38</b>	<b>14</b>	<b>54</b>	<b>112</b>	<b>19</b>	<b>118</b>	<b>127</b>	<b>33</b>	<b>223</b>	<b>118</b>	<b>12</b>	<b>125</b>	<b>660</b>	<b>286</b>	<b>873</b>

Table 11: Accident Data along Karnali Highway [18]

Accident Data	2013/14 to 2017/18- 5 Year	2018/19 to 2023/24- 5 Year	Increased/Decreased
No. of accident	87	435	+400%
No. of Death	122	105	-14%
No. of injury	52	568	+992%
Average Ratio of death on accident 0.76		0.31	-45%

Table 12: Accident Data and analysis along Karnali Highway [18]

The final report of road safety audit recommended some activities to improve the overall road safety for the roads under RSDP-I, RSDP-II and based on the recommendations Department of Roads with financial support from IDA funding namely RSDP and RSDP AF procurement of works was done through 6 contracts incorporating the following activities along the Karnali Highway. This was the major intervention on road safety at that time in Nepal. Total investment along the Karnali Highway on road safety after receiving the road safety audit recommendations on fiscal year 2017/18 is about NRs. 2.50 billion with following activities of road safety measures at hazardous locations. Target of the investment was to meet the 50% reduction of fatality as per National Road Safety Action Plan 2013-2020. Though target is not meet, road safety intervention resulted reduction of fatality along the Karnali Highway.

Surkhet - Manma – Jumla Road, Road Safety Works	
S. No.	Work items
1	Gabion/Steel beam barrier
2	Retro-reflective paint and sticker
3	Delineator posts
4	Rumble strips
5	Traffic Sign Posts
6	Thermoplastic road marking
7	Nose Cutting for improving visibility
8	Otta seal paving on shoulders
9	Construction of bus-bay and Footpath

Table 13: Activities of Road Safety Intervention along Karnali Highway [10]

From the chart/table above, it can be seen that from FY 2013-14 to 2017-18 no. of death is greater than no. of accident but after that no. of accident increased and no. of death remains decreased/stable after the implementation of RSA recommendations. From data presented number of accidents increased by 400% and no. of death decreased by 14% after intervention on road safety. Also, average death ratio over accident decreased by 45% for the period of 2018/19 to 2023/24 with respect to the period of 2013/14 to 2017/18. From the data it can be said that due to implementation of road safety measures driver's attention of driving built up resulting



decreased severity of the accident and became effective to save valuable/productive lives. So, road safety audits are necessary to ensure that the constructed road does not pose risks.

#### 4.0 Conclusion and Recommendations

##### Conclusion:

From the literature review and available data analysis of Karnali region, it can be expressed that there is improvement in the social life of the people to some extent and development indicators of the region like literacy, HDI, Life expectancy, poverty, per capita income etc. are improved directly or indirectly due to the improvement in road safety. Law enforcement on road safety is also highly beneficial to save lives and reduce serious injury. There was about 2.5 billion Nepalese Rupees investment for road safety to fulfill the RSA recommendations due to which road fatality is decreased by 14% within 5 years. Considering the road safety intervention cost and crash cost (like Human Cost, Vehicle Damage Cost and Administrative Cost) during the study period, it can be said that there is saving in social/economic cost due to the implementation of road safety audit recommendations. The overall benefit to cost ratio would be \$3 of benefit for every \$1 spent on road safety. Also, implementation of RSA recommendations became effective to build up driver's attention of driving with decreased severity of the accident and is effective to save valuable/productive lives. Improving road safety in Nepal is vital to national health, well-being and economic growth.

##### Recommendations:

- Investigate accident black spots for all road length and construct appropriate countermeasures.
- Highway has narrow carriageway, the pavement shoulders on either side should be sealed.
- At the location of sharp-curves the nose should be cut and the pavement should be widened.
- Removing hazardous locations by identifying them, investigating appropriate treatments.
- Reinstate of damaged road safety infrastructures with road safety measures is must.
- Engineering solution, Education and law enforcement programs to be adapted for road safety.
- Road authorities must guarantee adequate levels of safety on existing roads.
- Road safety audit recommendation must be implemented for better road safety.

#### 5.0 References

- [1]. The Rising Nepal news Editorial. Making Roads Safe: 03 Oct 2023
- [2]. Sanjaya Kumar Shrestha. A presentation on Road safety situation in Nepal: DoR 2012
- [3]. Kailash Timalsena. Ways to reduce road accidents [<https://ekantipur.com/en/opinion/2024/03/21>]
- [4]. Saroj Kumar Pradhan. Road Safety Strategy of Nepal for Resilient and Sustainable Development: 2015
- [5]. Delivering-Road-Safety-in-Nepal-Leadership-Priorities-and-Initiatives-to-2030: World Bank Report 2020
- [6]. Raju Bhai Manandhar. Determinants of road traffic accidents in Nepal: 2022
- [7]. Amrit Banstola, Jesse Kigozi, Pelham Barton<sup>2</sup> and Julie Mytton. Economic Burden of Road Traffic Injuries in Nepal: International Journal of Environmental Research and Public Health, 25 June 2020
- [8]. iRAP. Road safety assessment using iRAP targets part of high-risk strategic road network in Nepal - General, News, Star rating for designs May 10, 2022
- [9]. RDV Systems. The Benefits of Road Safety Audit Analysis. A Deep Dive Into The Benefits of Road Safety Audit Analysis and Opportunities,
- [10]. DoR, Road Safety Audit: Road Sector Development Project-AP-H629-NP 2014
- [11]. Om Prakash Giri<sup>1</sup>, Janani Selvam, Padma Bahadur Shahi, Bharat Ram Dhungana. Road Transport and Safety Protocols in Nepal and India: Section A-Research paper, Eur. Chem. Bull. 2023,12(10), 12680-12696
- [12]. Katahira & Engineers International in association with Full Bright Consultancy (Pvt.) Ltd, Road Transport Safety and Axle Load Control Study in Nepal: Part A: Road Transport Safety, road accident information management system, DoR, NIRTTP, May 2015
- [13]. Krishna Nath Ojha. Road safety status and some initiatives in Nepal, DOI: <https://doi.org/10.5935/jetia.v7i27.713>, 15th Feb 2021
- [14]. Hemant Tiwari, Sanjay Luitel. Road-infrastructure-safety paper: <https://doi.org/10.46610/JoRAIS.2023.v08i03.00321> <sup>st</sup> Dec 2023
- [15]. Alok Atreya, Dhan Bahadur Shrestha, Pravash Budhathoki, Samata Nepal. Epidemiology of Road Traffic Accidents in Nepal from 2009/10 to 2019/20: A 10 Year Study, DOI: <https://doi.org/10.33314/jnhrc.v19i2.3432>



- [16]. Samikshya Rizal, Hemant Tiwari. Analysis of Road Traffic Crash Costin Kathmandu Valley, conference Proceeding 2nd International Conference on Integrated Transport for Sustainable Mobility, February 2023
- [17]. Government of Nepal, ministry of physical infrastructure and transport, department of roads, planning and design branch, highway management information system (hmis) unit, Traffic Count and Vehicle Classification, [https://ssrn.dor.gov.np/traffic\\_controller](https://ssrn.dor.gov.np/traffic_controller)
- [18]. Karnali Province Traffic Police Office, Surkhet. Accident Data along Karnali Highway 2023/2024
- [19]. European Commission, Directorate-General Transport and Energy. Costbenefitanalysis of road safety: SafetyNet 16/10/2009
- [20]. Julia Strenge. The Benefits of Road Safety in Smart Mobility,Reduction of Traffic Accidents with Enforcement Technology, VITRONIC, 2023
- [21]. Victoria Transport Policy Institute. Transportation Cost and Benefit Analysis II – Safety and Health Costs ([www.vtpi.org](http://www.vtpi.org)), 4 October 2021
- [22]. Tim Harmon, Geni Bahar, and Frank Gross. Crash Costs for Highway Safety Analysis, FEWA, January 2018
- [23]. Suman Kharel and Prajwal Man Pradhan. Human Development Indices and Governance Interrelationship: Evidence from Nepal, 24 Dec. 2023
- [24]. Government of Nepal National Planning Commission. Assessment of Karnali Employment Program. May 2012
- [25]. Karnali Province, Vulnerability indicators, Emergency response Preparedness Report, June 2021
- [26]. Government of Nepal, National Planning Commission. Multidimensional Poverty Index, analysis towards action, 2018
- [27]. Government of Nepal Ministry of Finance Singh Durbar, Kathmandu. Karnali's economic growth Nepal, FY 2022/23
- [28]. DSV Advisors. Karnali Basin Area, <https://karnaliconservation.org/karnali-basin-area/>
- [29]. Krishna Prasad Gautam & Tripti Shahi. The Kathmandu Post, Deprived of timely care, <https://kathmandupost.com/health/2023/05/04>, Published at: May 4, 2023
- [30]. World Food Programme Nepal. More than roads: using markets to feed the hungry in Nepal, JULY 2010
- [31]. P.N. Atreya and A. Kafle. Production practice, market and value chain study of organic apple of Jumla, The Journal of Agriculture and Environment Vol:17, Jun.2016
- [32]. SNV Impact that matters. In Jumla, apples keep poverty away 07/12/2015, <https://www.snv.org/update/jumla-apples-keep-poverty-away>