
**TRIBHUVAN UNIVERSITY**

**INSTITUTE OF ENGINEERING**

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**THESIS NO: T05/071**

# A Study on Impacts of Road Infrastructures on Regional Economy of Developing Nation: A Case Study of Nepal

**by**

**Hari Prasad Subedi**

**A THESIS**

**SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING IN**

**PARTIAL FULFULLMENT OF THE REQUIREMENTS FOR THE DEGREE OF**

**MASTER OF SCIENCE IN TRANSPORTATION ENGINEERING**

**DEPARTMENT OF CIVIL ENGINEERING**

**LALITPUR, NEPAL**

**FEBRUARY, 2017**

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The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a thesis entitled **"A Study on Impacts of Road Infrastructures on Regional Economy of Developing Nation: A Case Study of Nepal"** submitted by **Hari Prasad Subedi (071/MST/255)** in partial fulfillment of the requirements for the degree of Master of Science in Transportation Engineering.

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## ABSTRACT

Road Infrastructure is a backbone of national economy. It causes socioeconomic development of the nation. A proper planning is required for road infrastructure development. Proper planning requires the inventory of roads, population and other socioeconomic parameters. As the economic growth of any nation is related to the transport infrastructure, transport infrastructure is also called the "infrastructure of infrastructure". Most of the agricultural products in developing nationsare manufactured in rural areas and they need to be transported to the urban areas for consumption. The huge resource of water power, mines, agricultural products are produced in rural areas, which need to be transported to urban areas for power production, manufacturing of products, consumptions etc.Establishment of better connectivity between rural and urban area requires road infrastructures. The study on impact of road infrastructure on regional economy of developing nation is the main objective of this research. Nepal has been taken for case study. The GDP per capita of any nation is dependent on the infrastructures available in the nation. More the roadinfrastructures more will be the economical transactions and more will be the GDP. This research utilizes the principles of multiple regression and correlation to study the relationship of road density with GDP per capita and establishes best fit regression equations. Regression analysis is carried out using MS-Excel and XL-stat software. The independent variables taken here are road density per 100 sq. km and road density per 1000 population. The research also try to analyze the impact of pavement type on GDP per capita, so the variables are extended for bituminous, gravel and earthen type roads as well. It is found from the analysis that the GDP per capita largely depends upon road density of bituminous and graveled road than that of earthen roads.



*Keywords*: Road infrastructures, GDP per capita, road density, regional economy, road pavement.

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Hari Prasad Subedi
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## LIST OF ABBREVIATIONS

| | |
|---|---|
| BT | Bituminous Road |
| CBS | Central Bureau of Statistics |
| C.I. | Confidence Interval |
| DDC | District Development Committee |
| DoLIDAR | Department of Local Infrastructure and Agricultural Roads |
| DoR | Department of Roads |
| ER | Earthen Road |
| GDP | Gross Domestic Product |
| GIS | Geographical Information System |
| GR | Gravel Road |
| HDI | Human Development Index |
| IOE | Institute of Engineering |
| Km | Kilometer |
| LRN | Local Road Network |
| m | metre |
| No. | Number |
| NPC | National Planning Commission |
| NRs | Nepali Rupees |
| Pop | Population |
| Sq | Square |
| SRN | Strategic Road Network |
| TU | Tribhuvan University |
| U.S. | United States |
| USD | United States Dollar |
| VDC | Village Development Committee |
| WB | World Bank |
| % | Percentage |
| $ | Dollar |

# CHAPTER ONE:INTRODUCTION

## 1.1 Background

Everyone moves from one place to another. The history of movement is as old as the history of this planet. Any movement requires some infrastructureswhich people used for transportation. The facilities/ infrastructures which they use in their trip is simply the fixed facility, a very important element of transportation system.Transportation system as a whole is composed of various elements[1]. Transport facilitiesare the important one. The transport facilities are provided for the purpose of assuring an economically viable, environmentally suitable and socially acceptable transportation system. The facilities include physical components of any highway, railway, airway or waterway. The road stretch for highways, tracks for railways, runways for airways, ports for waterways are typical physical components in the transportation system and they are called Transport Infrastructures. The infrastructures thus influence on various sectors in the society. A society is simply a mass of people living together with similar or different lifestyles. The population distribution is the key characteristics of any society. The settlement and migration processes are related to availability of infrastructures. Transport infrastructures are the most important of them. Thus, the economic development of any society is directly related to the amount of transportation facilities available. The transportation medium may be air, land or water. But the land transportation is much more suitable for the country like Nepal. The land transport mainly consists of railway and highway (roadway). Since Nepal contains a large amount of roadways than railways, the economic development and settlement patterns are much more affected by the provision of road infrastructures. So only the impact of road infrastructure on economy of Nepal has been taken for this research process.

As compared to the urban region, some facilities are not available in rural regions. For example, the provision of health, education and employment facilities may not be available on the rural regions and people need to make trip to fulfill these demands. So the migration and settlement of rural to urban is inevitable both for short term and long term reasons (Tacoli, 1998). “Proper rural-urban linkages are important for poverty

[1] Transportation system includes facilities, moving entities and control system.

reduction and sustainable rural development and urbanization. The living standards and employment opportunities both can be improved by the provision of strong rural- urban linkages. Domestic trade and the adequacy and efficiency of infrastructure are the backbone of mutually beneficial rural-urban relationships and of the success of the relationship between urban and rural areas". (Tacoli, 1998; Tacoli, 1998; Tacoli, 2003; Rosenthal, 2000)

This linkage and the inter dependencies of rural, suburban and urban for the opportunities is possible only by the provision of road infrastructures. Provision of road infrastructure in any country certainly increases the economical activities. This research has been undertaken to establish the relation of transport infrastructure and economical parameter such as GDP taking the examples of districts of Nepal.

Transport facilities help in developing access with the rural-urban linkages. Road accessibility can reduce isolation, stimulate crop production and marketing activities, encourage public services and help to transfer technology. Road building has been seen to bring about notable enthusiasm and visible changes in rural life. It brings out a lot of economic activities in rural and urban area. Thus, Road infrastructure has been considered as the "infrastructure for infrastructure".

### 1.2 Introduction

Nepal is a landlocked country lies between The Republic of China and India. It covers almost about 0.01% of the world area and about 0.3% of Asia area. The diverse cultural, religion and social lifestyles of people make this country a unique. Topographically, Nepal is classified into three regions: a plane southern part as a Terai region, the steep northern part as a Mountainous region and Hilly region with mild slope. About 17% of the land lies in terai region, 15% in mountainous region remaining 68% in hilly region.

Total population of the country is more than 28.17 million with GDP of 19.77 millionUS$(as of March 2016, source: http://www.worldbank.org/en/country/nepal). The population is about 45% in terai and remaining in hilly and mountaneous region. Population density is 198.9 people per square kilometer as of March 2016 (Source: http://countrymeters.info/en/Nepal as of 31st March 2016). The capital city of Nepal is Kathmandu and the major cities are Kathmandu, Pokhara, Biratnagar, Dharan, Nepalgunj etc. They are also the market centers for their localities.

Nepal is now entered into the federal system[2] with proposed 7 states.The boundaries of 7 states are almost clearly defined in Constitution of Nepal 2015. The distribution of physical infrastructures in these federal states is not uniform. The population distribution, geographical area, economical activities are different. So, it is also necessary to study and analyzethe present status of population distribution, transport distribution in these states. The figure below (downloaded from (www.ekantipur.com)) shows the 7 federal states as marked in Constitution of Nepal 2015.


Figure1.1.: Map of Nepal with seven states

On the other hand, diversityin climatic condition withina very small area is a unique characteristic of the country. The geographical, topographical and climatic variations sometimes are the problems for the infrastructure development within the nation.

The infrastructure developmentcauses the migration of people. The infrastructure development is directly related to the amount of road length. When looking to the back, the populations in urban regions were not of so high as there were not sufficient transport facilities. But due to the transport infrastructures, the population has been increased in the urban region leading to more economical activities. This research papertries to find out

[2] Constitution of Nepal 2072 is made after successful *Janaandolan* leading to end of monarchy system and start of democratic federal system.

the pattern of increase in economical activity (in terms of GDP per capita) with roaddensity of bituminous, gravel and earthen road in graphical formats and will prepare a mathematical modelusing various statistical tools.

### 1.3 Identification of Research problem

It is required for any policy makers to understand the relationship between transport infrastructure and the transport demand. Generally the transport demand is related to the social need. The social need, on the other hand is directly related with the population distribution and economic activities. The exact relationship of economic activity and transport infrastructure is thus very important. While making policies and programs for any region, one should know the road length data and its relation with GDP.

Gap in supply and demand of transport infrastructures causes a lot of problems to people. Economic activities are also related to the land use pattern of any region. It is related with socioeconomic factors, employment opportunities, available services etc. which is mostly related with the availability of transport infrastructures. With the availability of different opportunities, people try to agglomerate in those strips, where more facilities areavailable, so the land value increases and economic activities are changed.

Lack of sufficient researches in field of transport economy and planning is another problem that exists today in Nepal. Nepal is now entered into Federalism and seven different states are identified by the Constitution of Nepal 2015. So, it is required to study and analyze the present status of transport and economical characteristics in these states, finding the problems and solve that problem by doing research to establish the relationship between economical activities and road length. It is also required to search the data related to population distribution, road length and economic status of the area for future research and planning works.

### 1.4 Research Questions

Based on the problem that was identified, following research questions are made:

- What is the relation between road length and economy of developing nation?
- What is the impact of pavement type on regional economy of developing nation?

## 1.5 Objectives of Research

The main objective of this research is to analyze and understand the impact of road infrastructure on economy of developing nation.The specific objectives of the research are:

- To assess the impact of road density in GDP per capita.
- To express the impact of pavement types on regional economy of developing nation.

Note that the interest of this thesis is not only to establish a causal relationship between road infrastructure and various economic variables. Instead, this thesis will be used for regression forProjection,the interest is to obtain the best fit possible regression equation on 95% of confidence level. This research aim to take districts of Nepal in consideration and try to make relation of GDP with type of pavement: Earthen, Gravel, Bituminous.

## 1.6 Composition of the Report

This report comprises of six chapters. Chapter one briefly explains about background and introduction of research. This chapter also includes various processes of research formulation such as identification of research problem, generation of research questions and research objectives. Chapter two explains about the literature reviews which include relation of transport with population distribution and land use patterns, road and economy and previous studies etc. Chapter three contains the methodologies that are applied during the research process. This chapter briefly explains how the data are collected and how the analysis has been done. Chapter four contains data collection for the research and Chapter five includes data analysis, result and validation part. Chapter six contains conclusions, recommendations, limitations and possible furtherresearches.

# CHAPTER TWO: LITERATURE REVIEW

Literature review is an ongoing process in research. Document collection is the first step in literature review. The documents are collected from various articles, journals, papers etc. Books are also referred for various literatures. Internet is mostly used as it is easy to access and various references can be obtained from that.

## 2.1 Transport and Population

Transport and population are dependent to each other. Transport infrastructure brings economic development thereby creating opportunities for employment, business, health, education services etc. Therefore transportation is said to be the backbone of national economy. There are some theses related to transport infrastructure and land use patterns in different cities of United States, Japan etc. The society is generally recognized as a group of people. Therefore the distribution of population is just the reflection of society nature.

According to the study of (Zhenau, 2014), the public transportation infrastructure played a vital role in stimulating and facilitating regional economic growth even after the maturity of the systems after the 1990s in the U.S. northeast mega region. The positive effects of public transportation infrastructure were found under both the partial equilibrium assessment and the general equilibrium assessment. In terms of the modal comparison, highway infrastructure was found to play a dominant role in contributing to regional economic growth at the national level, the state level and the metropolitan level. The regional impact of public passengerrail and transit varies among different geographic scales and locations, but it is significant. A higher impact was found at both the metropolitan level and the regional state level. After considering spatial spillover effects, the dissertation confirms that public passenger rail and transit infrastructure in the northeast mega region play a substantial impact on regional economic growth. The regional impact is stronger than public airports' but significantly smaller than highways'. The impact of public airport infrastructure was found much larger at the national level rather than only in the northeast state level or the northeast metropolitan level (Zhenau, 2014).

According to (M.Burdina, 2004) the effect of transportation is very much important for business location decisions and impact of transportation on employment growth. The ordinary least-squares model was used in that study to evaluate the impact of transportation on employment rate of the study region. The transportation factors were significant for total and manufacturing employment in the Upper Great Plains. Second, the results of the estimated logit model for new manufacturing establishments showed that influence of transportation differs for companies with less than 50 employees and companies with more than 50, and finally, factors which have been associated with total employment in the county were different from those associated with manufacturing employment.(M.Burdina, 2004).

"At the municipal level, the coordination between land use planning and transportation is easiest due to factors such as the number of people being smaller and less bureaucracy. Furthermore, the notion is presented that transportation planning is one of the most mathematically justified areas of planning. This follows along with the area of population distribution and its mathematical basis. For his part, Levy (2006) also brings up a good point about populations. Showing the distinction between the western world and the third world, he explains that, in many Third World nations population increases have been and are still happening. These population booms can occur in urban areas since they are still developing and growing. Also the rural populations are also a factor when rural to urban migration is concerned"(Levy, 2006).

Relation between transport facility and land use is also important. The population of rural regions is also need to be taken into account as the future populations that migrate to urban regions are those of rural areas (Levy, 2006).

### 2.2 Road and Economy

Physical infrastructure is often indicated as a key input to economic growth both in developed and developing countries (Roberts et al, 2006).

The study carried out by LulitAkiluTerefe (Ethiopia) on 'Impact of Road on Rural Poverty Evidence Form Fifteen Rural Villages in Ethiopia'concluded that better road access would contribute to economic growth by reducing transport cost, travel time and

vehicle operating costs. Roads can increase rural households' access to agricultural inputs and product markets. It also facilitates utilization of existing socio-economic services such as education and health which enhances the human capital accumulation of the poor. Moreover, roads play a vital role to enhance productivity by fostering technology and information flows. In addition, roads create employment opportunities for the local people through facilitation of small businesses and industries in the long run while providing temporary employment opportunities through road construction works. (TerefeL. A).

"Road plays vital role in economical development of countries especially developing countries. The approach adopted is empirical in that selected variables on existing road networks are directly compared or correlated with a country's income. As pointed out by Owen (2), comparisons of income and road infrastructure are not meant to imply that a road by itself is capable of developing a country or region, but that it is a necessary element in the development process"(Queiroz C. et al, 1992).

According to World Bank Report (2006), physical isolation is a strong contributor to poverty. Populations without reliable access to social and economic services are poorer than those with reliable access (World Bank, 2006). The interaction among drivers of spatial development is as shown in figure(World Development Report, 2009)

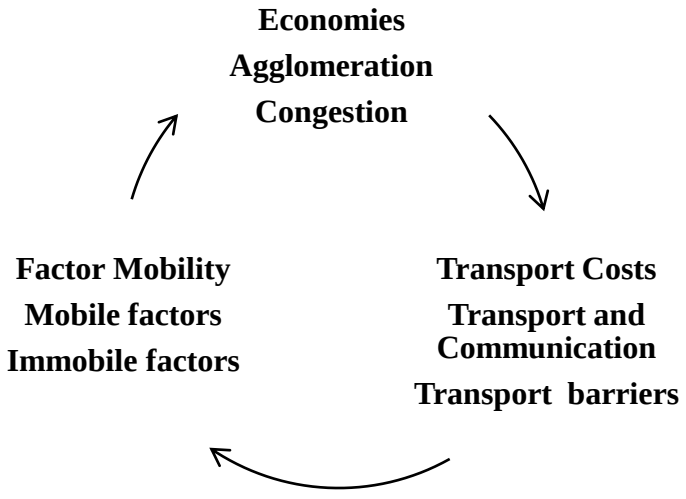


Figure 2.1: Interaction among drivers of spatial development

## 2.3 Previous studies

Growth model of Barro (1990) implies a simple “reduced form” relationship between income per capita and infrastructure stocks per capita.(Canning D.).

Kocherlakota and Yi (1996, 1997) used a related approach to study the relationship between shocks to public capital and subsequent changes in GDP in the United States and the United Kingdom over the last 100 years and an approach was built upon their methodology. (Canning D.).Khandker and Koolwal(2011) examines the impact of rural roads in the long run by using household level panel data from Bangladesh between 1997and 2005. They estimate the benefit of road projects on consumption expenditure before and after the project in control and treatment villages (Terefe L.A.).

Other studies by Mu and Dominique(2007); Khandker et al(2006); Stifel et al(2012) and Wondemu and John(2010) are also found significant impact of roads on poverty reduction and economic growth using impact evaluation techniques and panel data estimation by taking specific road projects.(TerefeL. A. )

A research done by Dhakal S.(2016) had made a regression analysis regarding relation of GDP with Road density per area and road density per population taking 9 districts of Nepal. In his report, he has mentioned in chapter "Conclusion and Recommendations" that, it is advised to perform future researches taking road and GDP data of all districts. This report aims to use all the available data of most of the districts of Nepal.

World Bank Development Report, 2009 has also specified three spatial dimensions which are supposed to affect on economy of any region: density, distance and division.

## 2.4 Road Network in Nepal

The 42 km all weather gravel road between Amlekhganj to Bhimphedi was thefirst road of its kind constructed in 1929 outside the Kathmandu valley. Rapid development of road construction has been started only after the advent of democracy in 1950. The 115 km long road between Thankot (Kathmandu) andBhainse (Makawanpur) was constructed in 1957. The national network of road in Nepal is either of SRN or LRN. SRN includes national highway and feeder roads while LRN includes urban roads, district roads and rural roads (Sitaula T.P).

Table 2.1: Comparative chart of SRN with their influenced population and density

| Year | Descriptions | Length | | | Total | Influenced pop. (no.per km) | Densitiy km/100sqkm |
|---|---|---|---|---|---|---|---|
| | | BT | GR | ER | | | |
| 1998 | 9th five year plan | 2905 | 1656 | 179 | 4740 | 3901 * | 3.22 |
| 2000 | | 2974 | 1649 | 171 | 4794 | 3857 * | 3.26 |
| 2002 | 10th five year plan | 3029 | 1664 | 168 | 4861 | 4763 ** | 3.3 |
| 2004 | | 3495 | 883 | 614 | 4992 | 4636 ** | 3.39 |
| 2006/7 | | 4258 | 2062 | 3079 | 9399 | 2463 ** | 6.39 |

(Sitaula T.P)

Population census 1991 *

Population census 2001 **

## 2.5 Settlement planning in developed countries

"Rural-urban transformations are related with economic development, poverty reduction and disparities in living standards. These disparities cause economic activities in the region. The living standards mean availability of basic and sophisticated things for human beings" (World Bank Development Report, 2009).

In many developed countries, in its early stage of developing, proper land use planning is required to carry out for spatial development. The geographical accessibility is the main criterion for planning purposes. The various studies show that instead of linking a very small settlement by the road link, it may be a better idea to transfer the settlement to urban region or to road side. This idea may be financially and economically sound. As we know, linking each and every people with proper transportation medium is the main responsibility of any nation. Since, the prime objective of any developing nation is to linkeach and every society by road infrastructure so as to achieve a rapid economic growth thus by increasing GDP of that nation.

## 2.6 Impact of road in Nepal

Better access to roads could have a considerable role on economic growth in the country especially for countries which have very low initial road density and even more so for the land locked countries(LulitAkliluTerefe). For the transportation of materials, manpowers, equipmentsetc from one place to other for the purpose of any development, construction etc. requires road infrastructures. For example: construction of hydropower in any locality first requires road accessibility.

In this thesis impact of pavement type bituminous, gravel and earthen to economic growth is also studied and compared herewith.

## CHAPTER THREE: METHODOLOGY

Proper planning is necessary to make the research work effective and efficient. The process as a whole follows the standard method of research. Starting from the formulation of research problem up to the final preparation of research report, many activities are performed. The most time consuming activities are data collection and analysis part. The analysis was started after the data collection. The results are validated and are presented to experts for the feedback. After their feedback the final research report was presented and submitted. Various steps followed in Research work are expressed through flow diagram as follows:

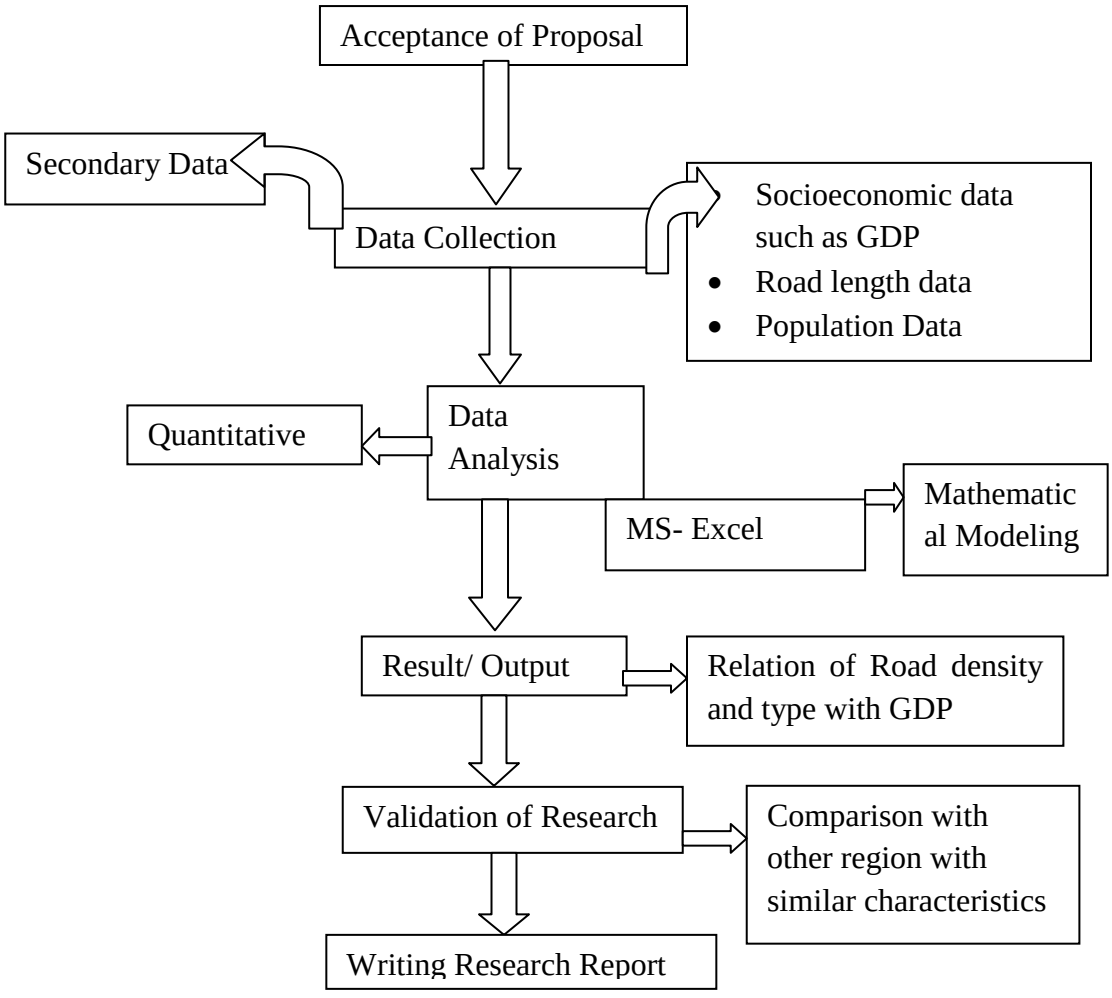


Figure 3.1: Flow diagram for Research Work

### 3.1 Study Area

Nepal was entered into federalism and the constitution of Nepal had clearly identified seven different states. The states are divided based on their geographical location and population considering cultural and religion status. The classification of states considered the geography of districts. Almost individual district is put in different states except Nawalparasi and Rukum. The research has useddistricts of Nepal as study area.

### 3.2 Data Collection

Data collection is the key step in any research. The data used in this research are of secondary type.

The secondary data are collected using following devices:

1. Review of literatures from library and internets and data collection from previous studies
2. Data collection from journals, articles and newspapers
3. Collection of road data and GDP data of developing and developed countries
4. Collection of road data of Nepal from DoR, DoLIDAR, DDC, VDC, Municipality and ward offices
5. Collection of population data of Nepal from CBS, DDC, VDC, Municipality office and ward offices
6. Collection of socioeconomic data of Nepal (Human Development Index, HDI, Per capita income), population density datafrom CBS, NPC
7. Use of google earth and google maps for some data collection

### 3.3 Data Analysis

The data collected from secondary sources are quantitatively analyzed and a relationship between the road densities with GDP is established using mathematical modeling. The least square method is used to find the relation for Nepal. The data of road density, GDPand Population of different districts are correlated using MS- Excel to establish a result using regression equation.

### 3.4 Research Tools

Various tools are used for data collection, analysis and presentation purpose. Used of laptop/desktop for internet surfing was done so as to perform literature reviews. Use of IOE library, TU library and other librarieswere done for searching of previous studies, thesis on related topic. The data thus obtained areanalyzed using MS- Excel 2007 and XL-STAT software. Use of MS- Project and Primavera software is done for scheduling and planning of research work. Extensive use of MS- Word is performed for report preparation.

### 3.5 Output and Validation

The result after the data analysis was validated by comparing the results with other similar district or region. The final outcome was presented in presence of experts for the validation. The output is presented in the form of graph plotted between road densities with GDP.

# CHAPTER FOUR: DATA COLLECTION

## 4.1 Data Collection

Based on the objectives of the research, data collection process is carried out. Most of the data are secondary type. The demographic and socioeconomic data are collected from different reliable sources. The GDP data of districts of Nepal are obtained from Nepal Human Development Report, 2014, UNDP and demographic and socioeconomic data of Nepal are downloaded from website of National Planning Commission(url: www.npc.gov.np) and Central Bureau of Statistics (url: www.cbs.gov.np). The data thus collected are reliable as these are downloaded from reliable sources.

Following tables show the data collected during research process:

### 4.1.1 Population and GDP data

The population and GDP data are obtained from CBS and Nepal Human Development Report, UNDP and are tabulated as follows:

Table 4.1: Socioeconomic data consisting of population and GDP of districts of Nepal

| State | S.N | Name of District | Area, km2 | Population, 2011[3] | Growth rate (%): 2001-2011[4] | GDP (Value Added, Million Rs.), 2014[5] |
|---|---|---|---|---|---|---|
| State No. 1 | 1 | Taplejung | 3,646 | 127,461 | -5.4 | 6,802.80 |
| | 2 | Panchthar | 1,241 | 191,817 | -5.1 | 8,413.50 |
| | 3 | Ilam | 1,703 | 290,254 | 2.6 | 14,852.20 |
| | 4 | Sankhuwasabha | 3,480 | 158,742 | -0.3 | 7,687.80 |
| | 5 | Terhathum | 679 | 101,577 | -10.2 | 5,850.40 |
| | 6 | Dhankuta | 891 | 163,412 | -1.8 | 8,335.40 |
| | 7 | Bhojpur | 1,507 | 182,459 | -10.1 | 7,383.70 |
| | 8 | Khotang | 1,591 | 206,312 | -10.8 | 9,476.50 |
| | 9 | Solukhumbu | 3,312 | 105,886 | -1.7 | 7,947.90 |

[3] Source: Central Bureau of Statistics (CBS)
[4] Source: Central Bureau of Statistics (CBS)
[5] Source: National Planning Commission Report

| State | S.N | Name of District | Area, km2 | Population, 2011[3] | Growth rate (%): 2001-2011[4] | GDP (Value Added, Million Rs.), 2014[5] |
|---|---|---|---|---|---|---|
| | 10 | Okhaldhunga | 1,074 | 147,984 | -5.6 | 5,748.30 |
| | 11 | Udayapur | 2,063 | 317,532 | 10.4 | 11,841.70 |
| | 12 | Jhapa | 1,606 | 812,650 | 18.1 | 40,370.20 |
| | 13 | Morang | 1,855 | 965,370 | 14.5 | 49,026.10 |
| | 14 | Sunsari | 1,257 | 763,487 | 22 | 34,261.10 |
| | | | **25,905** | **4,534,943** | | **217,997.60** |
| State No. 2 | 1 | Saptari | 1,363 | 639,284 | 12.1 | 20,822.90 |
| | 2 | Siraha | 1,188 | 637,328 | 11.3 | 17,784.30 |
| | 3 | Dhanusa | 1,180 | 754,777 | 12.4 | 28,727.10 |
| | 4 | Mahottari | 1,002 | 627,580 | 13.4 | 17,283.90 |
| | 5 | Sarlahi | 1,259 | 769,729 | 21.1 | 25,341.10 |
| | 6 | Rautahat | 1,126 | 686,722 | 26 | 21,193.00 |
| | 7 | Bara | 1,190 | 687,708 | 23 | 41,527.00 |
| | 8 | Parsa | 1,353 | 601,017 | 20.9 | 30,004.60 |
| | | | **9,661** | **5,404,145** | | **202,683.90** |
| State No.3 | 1 | Dolakha | 2,191 | 186,557 | -8.7 | 6,991.90 |
| | 2 | Ramechhap | 1,546 | 202,646 | -4.6 | 7,835.80 |
| | 3 | Sindhuli | 2,491 | 296,192 | 5.9 | 9,884.10 |
| | 4 | Kavrepalanchok | 1,396 | 381,937 | -1 | 21,777.60 |
| | 5 | Sindhupalchok | 2,542 | 287,798 | -5.9 | 12,976.40 |
| | 6 | Rasuwa | 1,544 | 43,300 | -3.2 | 2,677.40 |
| | 7 | Nuwakot | 1,121 | 277,471 | -3.8 | 12,266.70 |
| | 8 | Dhading | 1,926 | 336,067 | -0.8 | 13,391.60 |
| | 9 | Chitawan | 2,218 | 579,984 | 22.9 | 36,270.90 |
| | 10 | Makwanpur | 2,426 | 420,477 | 7.1 | 24,156.70 |
| | 11 | Bhaktapur | 119 | 304,651 | 35.1 | 17,142.00 |
| | 12 | Lalitpur | 385 | 468,132 | 38.6 | 36,179.00 |
| | 13 | Kathmandu | 395 | 1,744,240 | 61.2 | 320,170.50 |
| | | | **20,300** | **5,529,452** | | **521,720.60** |
| ate N o. | 1 | Gorkha | 3,610 | 271,061 | -5.9 | 11,419.70 |

| State | S.N | Name of District | Area, km2 | Population, 2011[3] | Growth rate (%): 2001-2011[4] | GDP (Value Added, Million Rs.), 2014[5] |
|---|---|---|---|---|---|---|
| | 2 | Lamjung | 1,692 | 167,724 | -5.3 | 8,057.90 |
| | 3 | Tanahu | 1,546 | 323,288 | 2.6 | 14,006.50 |
| | 4 | Kaski | 2,017 | 492,098 | 29.3 | 31,244.70 |
| | 5 | Manang | 2,246 | 6,538 | -31.8 | 845 |
| | 6 | Mustang | 3,573 | 13,452 | -10.2 | 1,055.00 |
| | 7 | Parbat | 494 | 146,590 | -7.1 | 6,004.50 |
| | 8 | Syangja | 1,164 | 289,148 | -8.9 | 14,179.90 |
| | 9 | Myagdi | 2,297 | 113,641 | -0.7 | 4,721.80 |
| | 10 | Baglung | 1,784 | 268,613 | -0.1 | 9,397.10 |
| | 11 | Nawalparasi (East of SustaBardaghat)[6] | 1,081 | 321,754 | 14.3 | 15,070.10 |
| | | | **21,504** | **2,413,907** | | **116,002.20** |
| State No. 5 | 1 | Nawalparasi (West of SustaBardaghat) | 1,081 | 321,754 | 14.3 | 15,070.10 |
| | 2 | Rupandehi | 1,360 | 880,196 | 24.2 | 40,138.80 |
| | 3 | Kapilbastu | 1,738 | 571,936 | 18.7 | 23,002.80 |
| | 4 | Palpa | 1,373 | 261,180 | -2.7 | 10,373.80 |
| | 5 | Arghakhanchi | 1193 | 197,632 | -5.2 | 7,198.20 |
| | 6 | Gulmi | 1,149 | 280,160 | -5.6 | 8,418.20 |
| | 7 | Rukum (Eastern Part)[7] | 1,439 | 104,284 | 10.7 | 3,297.30 |
| | 8 | Rolpa | 1,879 | 224,506 | 6.9 | 5,779.00 |
| | 9 | Pyuthan | 1,309 | 228,102 | 7.4 | 6,191.90 |
| | 10 | Dang | 2,955 | 552,583 | 19.5 | 25,240.20 |
| | 11 | Banke | 2,337 | 491,313 | 27.3 | 22,619.60 |
| | 12 | Bardiya | 2,025 | 426,576 | 11.5 | 18,787.40 |

[6]Nawalparasi has been splited into two states (4 and 5). So the features of the districts are assumed to be equally distributed in both the states.

[7]Rukum has been splited into two states (5 and 6). So the features of the districts are assumed to be equally distributed in both the states.

| State | S.N | Name of District | Area, km2 | Population, 2011[3] | Growth rate (%): 2001-2011[4] | GDP (Value Added, Million Rs.), 2014[5] |
|---|---|---|---|---|---|---|
| | | | **19,837.50** | **4,540,222** | | **186,117.30** |
| State No. 6 | 1 | Rukum (Eastern Part) | 1,439 | 104,284 | 10.7 | 3,297.30 |
| | 2 | Salyan | 1,462 | 242,444 | 13.6 | 7,703.80 |
| | 3 | Dolpa | 7,889 | 36,700 | 24.2 | 1,558.50 |
| | 4 | Jumla | 2,531 | 108,921 | 21.8 | 4,474.90 |
| | 5 | Mugu | 3,535 | 55,286 | 25.8 | 1,955.10 |
| | 6 | Humla | 5,655 | 50,858 | 25.3 | 1,649.20 |
| | 7 | Kalikot | 1,741 | 136,948 | 29.7 | 3,227.90 |
| | 8 | Jajarkot | 2,230 | 171,304 | 27 | 4,255.40 |
| | 9 | Dailekh | 1,502 | 261,770 | 16.2 | 7,266.70 |
| | 10 | Surkhet | 2,451 | 350,804 | 21.6 | 12,925.00 |
| | | | **30,435** | **1,519,319** | | **48,313.80** |
| State No. 7 | 1 | Bajura | 2,188 | 134,912 | 24 | 2,851.50 |
| | 2 | Bajhang | 3,422 | 195,159 | 16.8 | 3,816.60 |
| | 3 | Doti | 2,025 | 211,746 | 2.3 | 6,590.60 |
| | 4 | Achham | 1,680 | 257,477 | 11.3 | 5,513.80 |
| | 5 | Darchula | 2,322 | 133,274 | 9.2 | 3,397.20 |
| | 6 | Baitadi | 1,519 | 250,898 | 7 | 5,821.30 |
| | 7 | Dadeldhura | 1,538 | 142,094 | 12.6 | 4,392.40 |
| | 8 | Kanchanpur | 1,610 | 451,248 | 19.4 | 17,140.60 |
| | 9 | Kailali | 3,235 | 775,709 | 25.8 | 29,569.90 |
| | | | **19,539** | **2,552,517** | | **79,093.90** |
| | | | **147,181.00** | **26,494,504** | | **1,371,929.3** |

### 4.1.2 Road Inventory data

The road data are downloaded from the website of DoLIDAR and DoR. The LRN data are extracted from website of DoLIDAR and SRN data are extracted from website of DoR. The road data are tabulated as follows.

Table 4.2: Road Inventory data of Nepal (district-wise)

| | S.N | Name of District | SRN[8] | | | | LRN[9] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | BT | GR | ER | Total | BT | GR | ER | Total |
| State No. 1 | 1 | Taplejung | 29.50 | - | 17.00 | **46.50** | - | - | 76.38 | **76.38** |
| | 2 | Panchthar | 91.86 | - | 124.40 | **216.26** | - | - | 427.00 | **427.00** |
| | 3 | Ilam | 115.95 | 17.40 | 127.10 | **260.45** | - | - | 920.00 | **920.00** |
| | 4 | Sankhuwasabha | 47.70 | 25.00 | 62.00 | **134.70** | - | - | 158.99 | **158.99** |
| | 5 | Terhathum | 33.07 | - | 94.60 | **127.67** | - | - | 339.24 | **339.24** |
| | 6 | Dhankuta | 80.18 | 45.50 | 9.00 | **134.68** | 1.70 | 4.00 | 347.70 | **353.40** |
| | 7 | Bhojpur | - | 7.50 | 108.50 | **116.00** | - | - | 253.42 | **253.42** |
| | 8 | Khotang | 13.00 | - | 183.76 | **196.76** | - | - | 141.55 | **141.55** |
| | 9 | Solukhumbu | - | - | 37.20 | **37.20** | - | - | 20.67 | **20.67** |
| | 10 | Okhaldhunga | 9.00 | 6.00 | 56.70 | **71.70** | - | - | 84.26 | **84.26** |
| | 11 | Udayapur | 90.86 | 42.00 | 112.50 | **245.36** | 0.81 | 16.79 | 106.52 | **124.12** |
| | 12 | Jhapa | 139.92 | 39.68 | 17.00 | **196.60** | 45.66 | 687.78 | 208.19 | **941.63** |
| | 13 | Morang | 150.52 | 25.50 | 40.20 | **216.22** | 22.36 | 859.72 | 230.70 | **1,112.78** |
| | 14 | Sunsari | 115.03 | 66.00 | 10.00 | **191.03** | - | - | 342.40 | **342.40** |
| State No. 2 | 1 | Saptari | 135.00 | 65.50 | 46.00 | **246.50** | - | 42.50 | 214.26 | **256.76** |
| | 2 | Siraha | 111.93 | 19.00 | 14.00 | **144.93** | - | 92.20 | 357.50 | **449.70** |
| | 3 | Dhanusa | 104.14 | 47.50 | 43.50 | **195.14** | - | 38.06 | 610.44 | **648.50** |
| | 4 | Mahottari | 99.79 | 59.00 | 26.50 | **185.29** | 2.44 | 228.92 | 52.21 | **283.57** |
| | 5 | Sarlahi | 58.22 | 85.20 | 38.00 | **181.42** | - | 97.24 | 194.07 | **291.31** |

[8] SRN including UR, 2013/14 (Source: dor.gov.np)
[9] LRN, 2014/15 (Source: dolidar.gov.np)

| | S.N | Name of District | SRN[8] | | | | LRN[9] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | BT | GR | ER | Total | BT | GR | ER | Total |
| | 6 | Rautahat | 71.83 | 9.00 | 7.00 | **87.83** | - | 250.87 | 314.48 | **565.35** |
| | 7 | Bara | 83.34 | 68.00 | 16.00 | **167.34** | - | 182.64 | 349.59 | **532.23** |
| | 8 | Parsa | 37.82 | 13.00 | 2.00 | **52.82** | 7.95 | 239.89 | 130.50 | **378.34** |
| State No.3 | 1 | Dolakha | 106.68 | 10.00 | 20.00 | **136.68** | 0.50 | 79.78 | 376.48 | **456.76** |
| | 2 | Ramechhap | 44.00 | - | 33.00 | **77.00** | - | - | 608.20 | **608.20** |
| | 3 | Sindhuli | 73.50 | 27.80 | 221.50 | **322.80** | - | - | 395.21 | **395.21** |
| | 4 | Kavrepalanchok | 130.48 | 54.34 | 4.30 | **189.12** | 23.30 | 193.70 | 1,172.70 | **1,389.70** |
| | 5 | Sindhupalchok | 121.15 | 6.00 | 69.10 | **196.25** | 1.30 | 0.20 | 1,794.60 | **1,796.10** |
| | 6 | Rasuwa | 40.50 | - | 25.70 | **66.20** | - | - | 132.92 | **132.92** |
| | 7 | Nuwakot | 104.71 | 11.00 | 25.00 | **140.71** | - | 26.75 | 782.55 | **809.30** |
| | 8 | Dhading | 114.88 | 20.00 | 38.20 | **173.08** | - | - | 844.30 | **844.30** |
| | 9 | Chitawan | 158.45 | 56.50 | 37.00 | **251.95** | 122.05 | 1,169.52 | 180.36 | **1,471.93** |
| | 10 | Makwanpur | 193.67 | 100.77 | 40.70 | **335.14** | - | 40.50 | 268.20 | **308.70** |
| | 11 | Bhaktapur | 90.85 | 19.84 | 7.00 | **117.69** | 22.98 | 40.42 | 107.65 | **171.05** |
| | 12 | Lalitpur | 129.26 | 25.54 | 33.20 | **188.00** | 27.91 | 57.29 | 160.30 | **245.50** |
| | 13 | Kathmandu | 259.19 | 11.50 | 37.16 | **307.85** | 91.25 | 113.62 | 298.85 | **503.72** |
| State No. 4 | 1 | Gorkha | 26.84 | 40.50 | 109.90 | **177.24** | - | - | 2,366.31 | **2,366.31** |
| | 2 | Lamjung | 19.17 | 1.00 | 51.87 | **72.04** | - | - | 412.25 | **412.25** |
| | 3 | Tanahu | 128.49 | - | 33.00 | **161.49** | - | 37.21 | 972.78 | **1,009.99** |
| | 4 | Kaski | 114.46 | 5.00 | 20.50 | **139.96** | 2.70 | 25.06 | 794.25 | **822.01** |
| | 5 | Manang | - | - | 30.00 | **30.00** | - | - | 3.20 | **3.20** |
| | 6 | Mustang | - | - | 181.00 | **181.00** | - | - | - | **-** |
| | 7 | Parbat | 37.11 | - | 48.50 | **85.61** | 0.65 | - | 245.83 | **246.48** |

| | S.N | Name of District | SRN[8] | | | | LRN[9] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | BT | GR | ER | Total | BT | GR | ER | Total |
| | 8 | Syangja | 97.94 | 2.00 | 57.00 | **156.94** | - | - | 680.00 | **680.00** |
| | 9 | Myagdi | - | 10.00 | 21.00 | **31.00** | - | - | 319.01 | **319.01** |
| | 10 | Baglung | 9.71 | 2.42 | 142.00 | **154.13** | - | - | 272.02 | **272.02** |
| | 11 | Nawalparasi (East of SustaBardaghat) | 77.44 | 10.00 | 14.50 | **101.94** | 62.59 | 307.80 | 159.76 | **530.15** |
| State No. 5 | 1 | Nawalparasi (West of SustaBardaghat) | 77.44 | 10.00 | 14.50 | **101.94** | 62.59 | 307.80 | 159.76 | **530.15** |
| | 2 | Rupandehi | 137.69 | 12.50 | 13.50 | **163.69** | 71.88 | 426.09 | 19.11 | **517.08** |
| | 3 | Kapilbastu | 150.97 | 43.00 | 29.00 | **222.97** | 0.42 | 286.08 | 247.33 | **533.83** |
| | 4 | Palpa | 108.59 | - | 91.00 | **199.59** | - | - | 898.91 | **898.91** |
| | 5 | Arghakhanchi | 60.91 | 1.00 | 109.00 | **170.91** | - | - | 191.43 | **191.43** |
| | 6 | Gulmi | 44.54 | - | 82.50 | **127.04** | - | - | 590.47 | **590.47** |
| | 7 | Rukum (Eastern Part) | - | 10.00 | 82.70 | **92.70** | - | - | 30.50 | **30.50** |
| | 8 | Rolpa | 38.41 | 84.00 | 34.00 | **156.41** | - | 6.14 | 208.37 | **214.51** |
| | 9 | Pyuthan | 85.43 | - | 75.00 | **160.43** | - | - | 146.10 | **146.10** |
| | 10 | Dang | 174.22 | 136.00 | 56.00 | **366.22** | - | 79.71 | 381.72 | **461.43** |
| | 11 | Banke | 178.81 | 13.50 | 34.10 | **226.41** | 6.72 | 221.75 | 90.11 | **318.58** |
| | 12 | Bardiya | 132.49 | 49.93 | 29.00 | **211.42** | - | 284.82 | 59.48 | **344.30** |
| State No. 6 | 1 | Rukum (Eastern Part) | - | 10.00 | 82.70 | **92.70** | - | - | 30.50 | **30.50** |
| | 2 | Salyan | 46.16 | 68.50 | 61.00 | **175.66** | 3.70 | 23.07 | 163.45 | **190.22** |
| | 3 | Dolpa | - | - | - | **-** | - | - | - | **-** |
| | 4 | Jumla | - | - | 85.00 | **85.00** | - | - | 69.20 | **69.20** |

| | S.N | Name of District | SRN[8] | | | | LRN[9] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | BT | GR | ER | Total | BT | GR | ER | Total |
| | 5 | Mugu | - | - | - | **-** | - | - | 16.58 | **16.58** |
| | 6 | Humla | - | - | 40.00 | **40.00** | - | - | - | **-** |
| | 7 | Kalikot | - | - | 77.00 | **77.00** | - | - | - | **-** |
| | 8 | Jajarkot | - | - | 118.00 | **118.00** | - | - | - | **-** |
| | 9 | Dailekh | 144.45 | 8.22 | 118.56 | **271.23** | - | - | 239.00 | **239.00** |
| | 10 | Surkhet | 138.14 | 53.70 | 43.30 | **235.14** | 5.66 | - | 147.08 | **152.74** |
| State No. 7 | 1 | Bajura | 13.00 | - | 30.00 | **43.00** | - | - | 1.49 | **1.49** |
| | 2 | Bajhang | 60.32 | - | 48.36 | **108.68** | - | 1.19 | 2.10 | **3.29** |
| | 3 | Doti | 115.46 | 6.00 | 65.00 | **186.46** | - | - | 198.13 | **198.13** |
| | 4 | Achham | 75.00 | - | 67.00 | **142.00** | - | - | 132.16 | **132.16** |
| | 5 | Darchula | 10.00 | 50.00 | 18.42 | **78.42** | - | - | 4.11 | **4.11** |
| | 6 | Baitadi | 122.42 | - | 51.60 | **174.02** | 0.61 | - | 21.11 | **21.72** |
| | 7 | Dadeldhura | 77.08 | - | 64.00 | **141.08** | - | - | 135.00 | **135.00** |
| | 8 | Kanchanpur | 44.32 | 89.00 | 22.10 | **155.42** | 10.20 | 6.40 | 128.32 | **144.92** |
| | 9 | Kailali | 171.35 | 74.25 | 64.00 | **309.60** | - | 249.44 | 174.54 | **423.98** |

Table 4.3: State-wise summary of road Inventory

| State No. | SRN roads | | | | LRN roads | | | | Area | Population, 2014 (Projected) | GDP (Value Added, Million Rs.), 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | BT | GR | ER | Total | BT | GR | ER | Total | $Km^2$ | | |
| State No. 1 | 916.59 | 274.58 | 999.96 | 2,191.13 | 70.53 | 1,568.29 | 3,657.02 | 5,295.84 | 25,905 | 4,662,095 | 217,997.60 |
| State No. 2 | 702.07 | 366.20 | 193.00 | 1,261.27 | 10.39 | 1,172.32 | 2,223.05 | 3,405.76 | 9,661 | 5,695,236 | 202,683.90 |
| State No. 3 | 1,567.32 | 343.29 | 591.86 | 2,502.47 | 289.29 | 1,721.78 | 7,122.32 | 9,133.39 | 20,300 | 5,996,108 | 521,720.60 |
| State No. 4 | 511.16 | 70.92 | 709.27 | 1,291.35 | 65.94 | 370.07 | 6,225.41 | 6,661.42 | 21,504 | 2,455,467 | 116,002.20 |
| State No. 5 | 1,189.50 | 359.93 | 650.30 | 2,199.73 | 141.61 | 1,612.39 | 3,023.29 | 4,777.28 | 19,838 | 4,744,875 | 186,117.30 |
| State No. 6 | 328.75 | 140.42 | 625.56 | 1,094.73 | 9.36 | 23.07 | 665.81 | 698.24 | 30,435 | 1,614,065 | 48,313.80 |
| State No. 7 | 688.95 | 219.25 | 430.48 | 1,338.68 | 10.81 | 257.03 | 796.96 | 1,064.80 | 19,539 | 2,685,595 | 79,093.90 |
| **Total** | **5,904.33** | **1,774.59** | **4,200.43** | **11,879.35** | **597.93** | **6,724.94** | **23,713.85** | **31,036.72** | **147,181** | **27,853,441** | **1,371,929.30** |

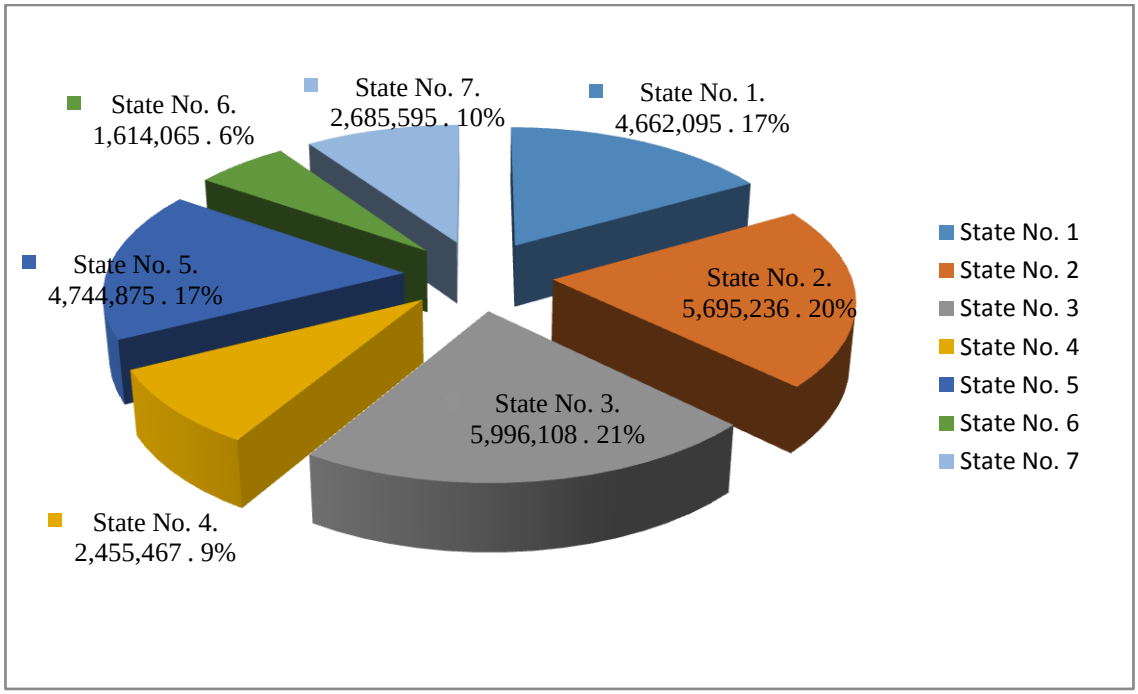


Figure 4.1: Distribution of Projected population (2014) of 7 states

The projected population of 7 states is shown in pie charts below. About 21% ofpopulations live in State No.3 and only 6% populations live in State No.6. The population in State No. 2 is 20%. 17% of populations live in State No. 1. State No. 7 and 4 covers 10% and 9% respectively.

The total area covered by each state is shown in pie charts below. State No. 4 covers almost about 21%. State No. 1 and 4 covers 18% and 15% respectively. State No. 3 covers 14% of area while State No. 5 and 7 covers about 13% of total area of 147, 181 square km.

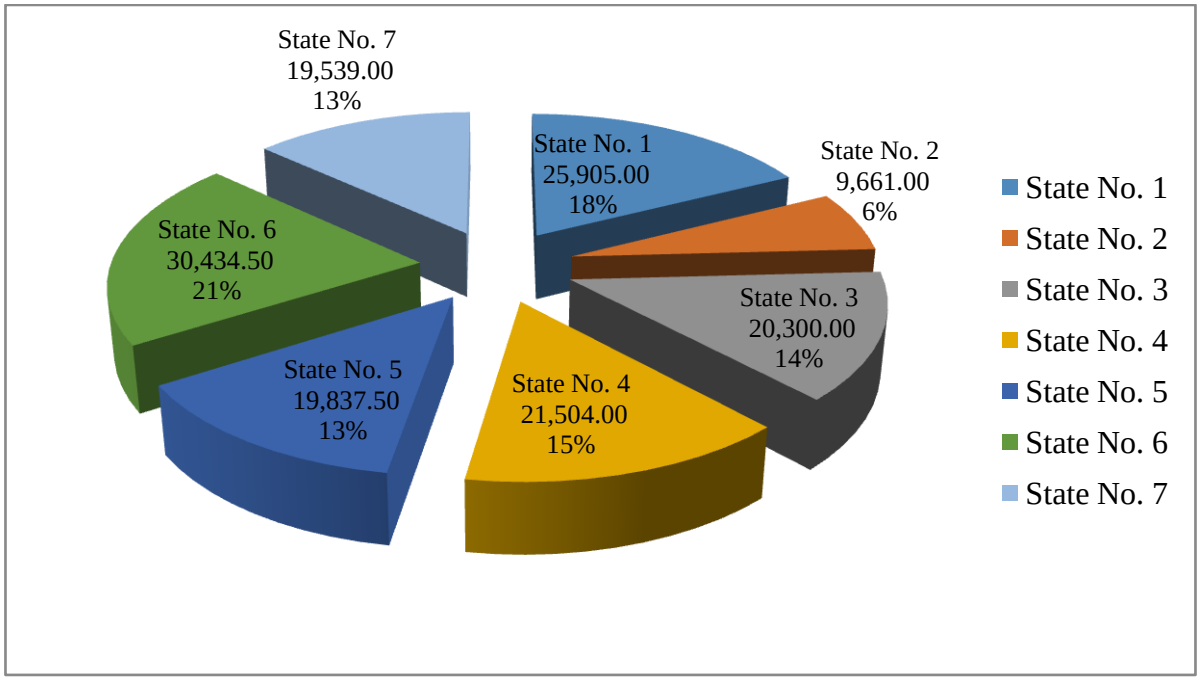


Figure4.2: Comparative pie chart of areas of 7 states

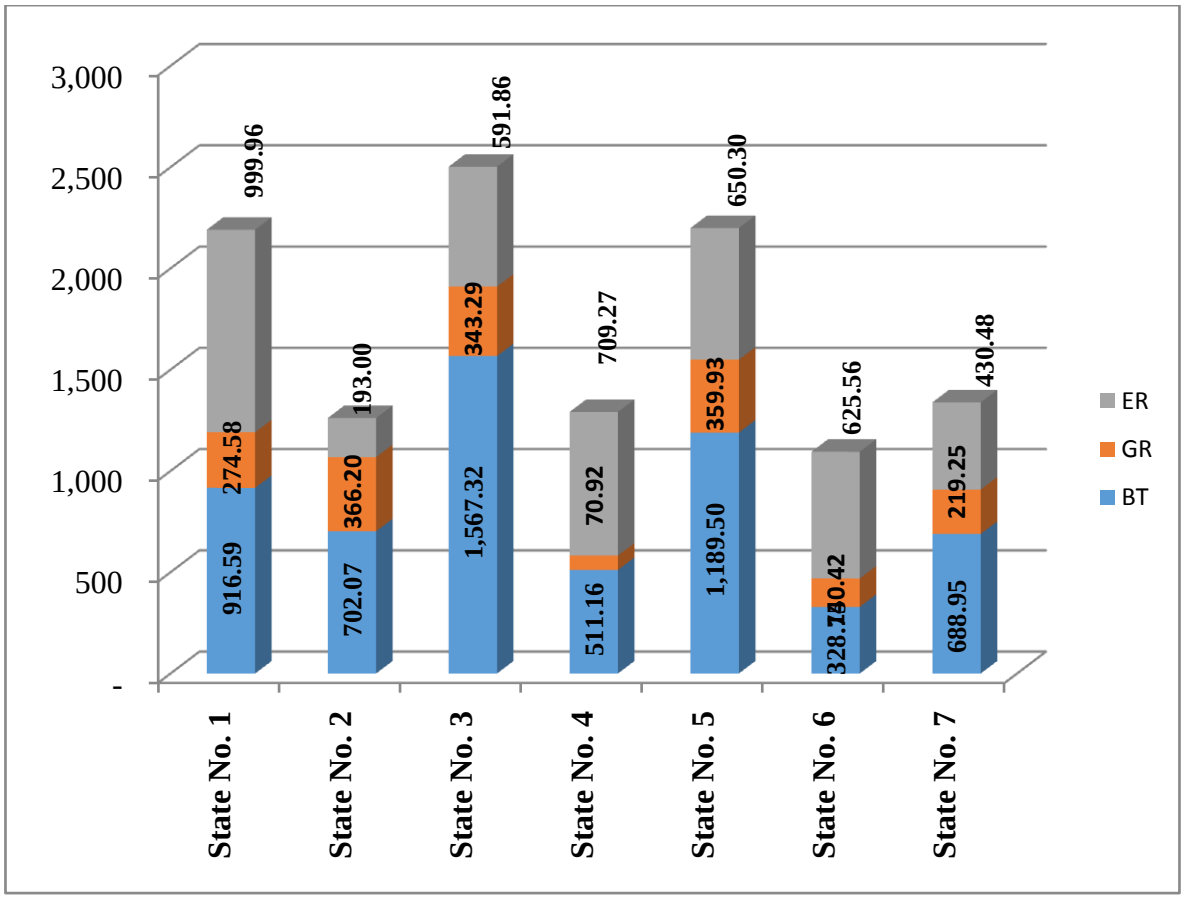


Figure 4.3: SRN distribution (km)

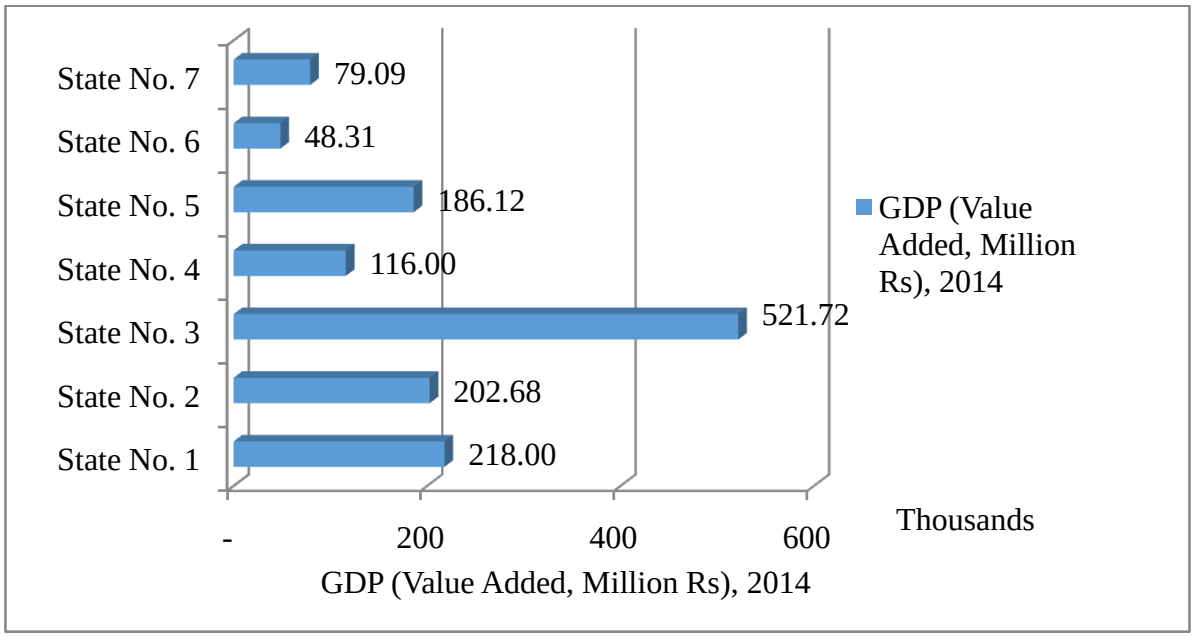


Figure 4.4: GDP distribution (Million NRs, 2014)

# CHAPTER FIVE: DATA ANALYSIS

## 5.1 Data Analysis

The data collected from secondary sources are quantitatively analyzed and a relationship between the road density with GDP & population density is established using mathematical modeling. The least square method is used to find the relation for Nepal. The data of road density, GDP and Population of various districts within Nepal are correlated using MS- Excel to establish a mathematical model.

The dataare analyzed using MS- Excel 2007 and XL-STAT software (trail version).

### 5.1.1 Projection of Socioeconomic data

The population data of various districts (2011) is obtained from the website of Central Bureu of Statisctics (www.cbs.com). The population for study period 2014 is obtained by projecting the population of 2011 with growth rate from 2001-2011.

Using growth factor (2001-2011 as per CBS)

Formula applied:

Projected population for 2014, $Pop\_14 = Pop\_11\ (1+ra\%)^3$

GDP per capita= GDP/ Pop_14

Table 5.1: Projection of socioeconomic data of Year 2011 to Year 2014

| | S.N | Name of District | Population, 2011 | Growth rate (%): 2001-2011 | Projected Population for 2014 | GDP (Value Added, Million Rs.), 2014 | GDP per capita, 2014 |
|---|---|---|---|---|---|---|---|
| State No. 1 | 1 | Taplejung | 127,461 | -5.4 | 105,347 | 6,802.80 | 54,245.66 |
| | 2 | Panchthar | 191,817 | -5.1 | 145,512 | 8,413.50 | 44,540.11 |
| | 3 | Ilam | 290,254 | 2.6 | 327,542 | 14,852.20 | 50,772.61 |
| | 4 | Sankhuwasabha | 158,742 | -0.3 | 857,580 | 7,687.80 | 48,473.14 |
| | 5 | Terhathum | 101,577 | -10.2 | 1,007,975 | 5,850.40 | 59,394.72 |
| | 6 | Dhankuta | 163,412 | -1.8 | 814,994 | 8,335.40 | 51,284.93 |
| | 7 | Bhojpur | 182,459 | -10.1 | 105,347 | 7,383.70 | 41,719.09 |
| | 8 | Khotang | 206,312 | -10.8 | 145,512 | 9,476.50 | 47,453.82 |
| | 9 | Solukhumbu | 105,886 | -1.7 | 327,542 | 7,947.90 | 75,445.03 |
| | 10 | Okhaldhunga | 147,984 | -5.6 | 857,580 | 5,748.30 | 39,504.02 |

| | S.N | Name of District | Population, 2011 | Growth rate (%): 2001-2011 | Projected Population for 2014 | GDP (Value Added, Million Rs.), 2014 | GDP per capita, 2014 |
|---|---|---|---|---|---|---|---|
| | 11 | Udayapur | 317,532 | 10.4 | 1,007,975 | 11,841.70 | 36,153.18 |
| | 12 | Jhapa | 812,650 | 18.1 | 814,994 | 40,370.20 | 47,074.54 |
| | 13 | Morang | 965,370 | 14.5 | 105,347 | 49,026.10 | 48,638.19 |
| | 14 | Sunsari | 763,487 | 22 | 145,512 | 34,261.10 | 42,038.48 |
| | | | **4,534,943** | | **4,662,095** | **217,997.60** | **46,759.58** |
| State No. 2 | 1 | Saptari | 639,284 | 12.1 | 662,772 | 20,822.90 | 31,417.90 |
| | 2 | Siraha | 637,328 | 11.3 | 659,178 | 17,784.30 | 26,979.49 |
| | 3 | Dhanusa | 754,777 | 12.4 | 783,204 | 28,727.10 | 36,678.94 |
| | 4 | Mahottari | 627,580 | 13.4 | 653,148 | 17,283.90 | 26,462.44 |
| | 5 | Sarlahi | 769,729 | 21.1 | 819,488 | 25,341.10 | 30,923.08 |
| | 6 | Rautahat | 686,722 | 26 | 741,691 | 21,193.00 | 28,573.89 |
| | 7 | Bara | 687,708 | 23 | 736,260 | 41,527.00 | 56,402.66 |
| | 8 | Parsa | 601,017 | 20.9 | 639,494 | 30,004.60 | 46,919.29 |
| | | | **5,404,145** | | **5,695,236** | **202,683.90** | **35,588.33** |
| State No.3 | 1 | Dolakha | 186,557 | -8.7 | 181,730 | 6,991.90 | 38,474.09 |
| | 2 | Ramechhap | 202,646 | -4.6 | 199,862 | 7,835.80 | 39,205.99 |
| | 3 | Sindhuli | 296,192 | 5.9 | 301,466 | 9,884.10 | 32,786.83 |
| | 4 | Kavrepalanchok | 381,937 | -1 | 380,792 | 21,777.60 | 57,190.23 |
| | 5 | Sindhupalchok | 287,798 | -5.9 | 282,734 | 12,976.40 | 45,896.15 |
| | 6 | Rasuwa | 43,300 | -3.2 | 42,886 | 2,677.40 | 62,431.14 |
| | 7 | Nuwakot | 277,471 | -3.8 | 274,320 | 12,266.70 | 44,716.78 |
| | 8 | Dhading | 336,067 | -0.8 | 335,261 | 13,391.60 | 39,943.79 |
| | 9 | Chitawan | 579,984 | 22.9 | 620,748 | 36,270.90 | 58,430.93 |
| | 10 | Makwanpur | 420,477 | 7.1 | 429,497 | 24,156.70 | 56,244.18 |
| | 11 | Bhaktapur | 304,651 | 35.1 | 337,870 | 17,142.00 | 50,735.50 |
| | 12 | Lalitpur | 468,132 | 38.6 | 524,461 | 36,179.00 | 68,983.19 |
| | 13 | Kathmandu | 1,744,240 | 61.2 | 2,084,481 | 320,170.50 | 153,597.22 |
| | | | **5,529,452** | | **5,996,108** | **521,720.60** | **87,009.87** |
| State No.4 | 1 | Gorkha | 271,061 | -5.9 | 266,291 | 11,419.70 | 42,884.21 |
| | 2 | Lamjung | 167,724 | -5.3 | 165,071 | 8,057.90 | 48,814.66 |
| | 3 | Tanahu | 323,288 | 2.6 | 325,816 | 14,006.50 | 42,988.96 |

| | S.N | Name of District | Population, 2011 | Growth rate (%): 2001-2011 | Projected Population for 2014 | GDP (Value Added, Million Rs.), 2014 | GDP per capita, 2014 |
|---|---|---|---|---|---|---|---|
| | 4 | Kaski | 492,098 | 29.3 | 536,633 | 31,244.70 | 58,223.57 |
| | 5 | Manang | 6,538 | -31.8 | 5,934 | 845 | 142,402.15 |
| | 6 | Mustang | 13,452 | -10.2 | 13,045 | 1,055.00 | 80,876.67 |
| | 7 | Parbat | 146,590 | -7.1 | 143,490 | 6,004.50 | 41,846.19 |
| | 8 | Syangja | 289,148 | -8.9 | 281,496 | 14,179.90 | 50,373.32 |
| | 9 | Myagdi | 113,641 | -0.7 | 113,403 | 4,721.80 | 41,637.52 |
| | 10 | Baglung | 268,613 | -0.1 | 268,532 | 9,397.10 | 34,994.28 |
| | 11 | Nawalparasi (East of SustaBardaghat) | 321,754 | 14.3 | 335,756 | 15,070.10 | 44,884.14 |
| | | | **2,413,907** | | **2,455,467** | **116,002.20** | **47,242.42** |
| State No. 5 | 1 | Nawalparasi (West of SustaBardaghat) | 321,754 | 14.3 | 335,756 | 15,070.10 | 44,884.14 |
| | 2 | Rupandehi | 880,196 | 24.2 | 945,657 | 40,138.80 | 42,445.40 |
| | 3 | Kapilbastu | 571,936 | 18.7 | 604,625 | 23,002.80 | 38,044.72 |
| | 4 | Palpa | 261,180 | -2.7 | 259,070 | 10,373.80 | 40,042.44 |
| | 5 | Arghakhanchi | 197,632 | -5.2 | 194,565 | 7,198.20 | 36,996.39 |
| | 6 | Gulmi | 280,160 | -5.6 | 275,480 | 8,418.20 | 30,558.34 |
| | 7 | Rukum (Eastern Part) | 104,284 | 10.7 | 107,667 | 3,297.30 | 30,625.00 |
| | 8 | Rolpa | 224,506 | 6.9 | 229,185 | 5,779.00 | 25,215.39 |
| | 9 | Pyuthan | 228,102 | 7.4 | 233,203 | 6,191.90 | 26,551.50 |
| | 10 | Dang | 552,583 | 19.5 | 585,544 | 25,240.20 | 43,105.59 |
| | 11 | Banke | 491,313 | 27.3 | 532,660 | 22,619.60 | 42,465.36 |
| | 12 | Bardiya | 426,576 | 11.5 | 441,463 | 18,787.40 | 42,557.16 |
| | | | **4,540,222** | | **4,744,875** | **186,117.30** | **39,224.91** |
| State No. 6 | 1 | Rukum (Eastern Part) | 104,284 | 10.7 | 107,667 | 3,297.30 | 30,625.00 |
| | 2 | Salyan | 242,444 | 13.6 | 252,471 | 7,703.80 | 30,513.62 |
| | 3 | Dolpa | 36,700 | 24.2 | 39,429 | 1,558.50 | 39,526.32 |
| | 4 | Jumla | 108,921 | 21.8 | 116,201 | 4,474.90 | 38,510.04 |
| | 5 | Mugu | 55,286 | 25.8 | 59,676 | 1,955.10 | 32,761.65 |
| | 6 | Humla | 50,858 | 25.3 | 54,817 | 1,649.20 | 30,085.77 |
| | 7 | Kalikot | 136,948 | 29.7 | 149,516 | 3,227.90 | 21,588.99 |

| | S.N | Name of District | Population, 2011 | Growth rate (%): 2001-2011 | Projected Population for 2014 | GDP (Value Added, Million Rs.), 2014 | GDP per capita, 2014 |
|---|---|---|---|---|---|---|---|
| | 8 | Jajarkot | 171,304 | 27 | 185,558 | 4,255.40 | 22,933.04 |
| | 9 | Dailekh | 261,770 | 16.2 | 274,699 | 7,266.70 | 26,453.30 |
| | 10 | Surkhet | 350,804 | 21.6 | 374,031 | 12,925.00 | 34,555.99 |
| | | | **1,519,319** | | **1,614,065** | **48,313.80** | **29,933.00** |
| State No. 7 | 1 | Bajura | 134,912 | 24 | 144,861 | 2,851.50 | 19,684.43 |
| | 2 | Bajhang | 195,159 | 16.8 | 205,161 | 3,816.60 | 18,602.93 |
| | 3 | Doti | 211,746 | 2.3 | 213,210 | 6,590.60 | 30,911.25 |
| | 4 | Achham | 257,477 | 11.3 | 266,304 | 5,513.80 | 20,704.87 |
| | 5 | Darchula | 133,274 | 9.2 | 136,986 | 3,397.20 | 24,799.56 |
| | 6 | Baitadi | 250,898 | 7 | 256,204 | 5,821.30 | 22,721.36 |
| | 7 | Dadeldhura | 142,094 | 12.6 | 147,533 | 4,392.40 | 29,772.30 |
| | 8 | Kanchanpur | 451,248 | 19.4 | 478,023 | 17,140.60 | 35,857.24 |
| | 9 | Kailali | 775,709 | 25.8 | 837,311 | 29,569.90 | 35,315.30 |
| | | | **2,552,517** | | **2,685,595** | **79,093.90** | **29,451.17** |
| | | | **26,494,504** | | **27,853,441** | **1,371,929.30** | **49,255.29** |

### 5.1.2 Analysis of road data

Table 5.2: Analysis of collected Road data

| | S. N | Name of District | SRN including UR, 2013/14, km | | | | LRN , 2014/15, km | | | | Total Road,km | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BT | GR | ER | Total | BT | GR | ER | Total | BT | GR | ER | Total |
| State No. 1 | 1 | Taplejung | 29.50 | - | 17.00 | **46.50** | - | - | 76.38 | **76.38** | 29.50 | - | 93.38 | **122.88** |
| | 2 | Panchthar | 91.86 | - | 124.40 | **216.26** | - | - | 427.00 | **427.00** | 91.86 | - | 551.40 | **643.26** |
| | 3 | Ilam | 115.95 | 17.40 | 127.10 | **260.45** | - | - | 920.00 | **920.00** | 115.95 | 17.40 | 1,047.10 | **1,180.45** |
| | 4 | Sankhuwasabha | 47.70 | 25.00 | 62.00 | **134.70** | - | - | 158.99 | **158.99** | 47.70 | 25.00 | 220.99 | **293.69** |
| | 5 | Terhathum | 33.07 | - | 94.60 | **127.67** | - | - | 339.24 | **339.24** | 33.07 | - | 433.84 | **466.91** |
| | 6 | Dhankuta | 80.18 | 45.50 | 9.00 | **134.68** | 1.70 | 4.00 | 347.70 | **353.40** | 81.88 | 49.50 | 356.70 | **488.08** |
| | 7 | Bhojpur | - | 7.50 | 108.50 | **116.00** | - | - | 253.42 | **253.42** | - | 7.50 | 361.92 | **369.42** |
| | 8 | Khotang | 13.00 | - | 183.76 | **196.76** | - | - | 141.55 | **141.55** | 13.00 | - | 325.31 | **338.31** |
| | 9 | Solukhumbu | - | - | 37.20 | **37.20** | - | - | 20.67 | **20.67** | - | - | 57.87 | **57.87** |
| | 10 | Okhaldhunga | 9.00 | 6.00 | 56.70 | **71.70** | - | - | 84.26 | **84.26** | 9.00 | 6.00 | 140.96 | **155.96** |
| | 11 | Udayapur | 90.86 | 42.00 | 112.50 | **245.36** | 0.81 | 16.79 | 106.52 | **124.12** | 91.67 | 58.79 | 219.02 | **369.48** |
| | 12 | Jhapa | 139.92 | 39.68 | 17.00 | **196.60** | 45.66 | 687.78 | 208.19 | **941.63** | 185.58 | 727.46 | 225.19 | **1,138.23** |
| | 13 | Morang | 150.52 | 25.50 | 40.20 | **216.22** | 22.36 | 859.72 | 230.70 | **1,112.78** | 172.88 | 885.22 | 270.90 | **1,329.00** |

| | S. N | Name of District | SRN including UR, 2013/14, km | | | | LRN , 2014/15, km | | | | Total Road,km | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14 | Sunsari | 115.03 | 66.00 | 10.00 | **191.03** | - | - | 342.40 | **342.40** | 115.03 | 66.00 | 352.40 | **533.43** |
| | | | | | | | | | | **5,295.84** | **987.12** | **1,842.87** | **4,656.98** | **7,486.97** |
| State No. 2 | 1 | Saptari | 135.00 | 65.50 | 46.00 | **246.50** | - | 42.50 | 214.26 | **256.76** | 135.00 | 108.00 | 260.26 | **503.26** |
| | 2 | Siraha | 111.93 | 19.00 | 14.00 | **144.93** | - | 92.20 | 357.50 | **449.70** | 111.93 | 111.20 | 371.50 | **594.63** |
| | 3 | Dhanusa | 104.14 | 47.50 | 43.50 | **195.14** | - | 38.06 | 610.44 | **648.50** | 104.14 | 85.56 | 653.94 | **843.64** |
| | 4 | Mahottari | 99.79 | 59.00 | 26.50 | **185.29** | 2.44 | 228.92 | 52.21 | **283.57** | 102.23 | 287.92 | 78.71 | **468.86** |
| | 5 | Sarlahi | 58.22 | 85.20 | 38.00 | **181.42** | - | 97.24 | 194.07 | **291.31** | 58.22 | 182.44 | 232.07 | **472.73** |
| | 6 | Rautahat | 71.83 | 9.00 | 7.00 | **87.83** | - | 250.87 | 314.48 | **565.35** | 71.83 | 259.87 | 321.48 | **653.18** |
| | 7 | Bara | 83.34 | 68.00 | 16.00 | **167.34** | - | 182.64 | 349.59 | **532.23** | 83.34 | 250.64 | 365.59 | **699.57** |
| | 8 | Parsa | 37.82 | 13.00 | 2.00 | **52.82** | 7.95 | 239.89 | 130.50 | **378.34** | 45.77 | 252.89 | 132.50 | **431.16** |
| | | | | | | | | | | **3,405.76** | **712.46** | **1,538.52** | **2,416.05** | **4,667.03** |
| State No.3 | 1 | Dolakha | 106.68 | 10.00 | 20.00 | **136.68** | 0.50 | 79.78 | 376.48 | **456.76** | 107.18 | 89.78 | 396.48 | **593.44** |
| | 2 | Ramechhap | 44.00 | - | 33.00 | **77.00** | - | - | 608.20 | **608.20** | 44.00 | - | 641.20 | **685.20** |
| | 3 | Sindhuli | 73.50 | 27.80 | 221.50 | **322.80** | - | - | 395.21 | **395.21** | 73.50 | 27.80 | 616.71 | **718.01** |
| | 4 | Kavrepalanchok | 130.48 | 54.34 | 4.30 | **189.12** | 23.30 | 193.7 | 1,172.70 | **1,389.70** | 153.78 | 248.04 | 1,177.00 | **1,578.82** |

| | S. N | Name of District | SRN including UR, 2013/14, km | | | | LRN , 2014/15, km | | | | Total Road,km | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 0 | | | | | | |
| | 5 | Sindhupalchok | 121.15 | 6.00 | 69.10 | **196.25** | 1.30 | 0.20 | 1,794.60 | **1,796.10** | 122.45 | 6.20 | 1,863.70 | **1,992.35** |
| | 6 | Rasuwa | 40.50 | - | 25.70 | **66.20** | - | - | 132.92 | **132.92** | 40.50 | - | 158.62 | **199.12** |
| | 7 | Nuwakot | 104.71 | 11.00 | 25.00 | **140.71** | - | 26.75 | 782.55 | **809.30** | 104.71 | 37.75 | 807.55 | **950.01** |
| | 8 | Dhading | 114.88 | 20.00 | 38.20 | **173.08** | - | - | 844.30 | **844.30** | 114.88 | 20.00 | 882.50 | **1,017.38** |
| | 9 | Chitawan | 158.45 | 56.50 | 37.00 | **251.95** | 122.05 | 1,169.52 | 180.36 | **1,471.93** | 280.50 | 1,226.02 | 217.36 | **1,723.88** |
| | 10 | Makwanpur | 193.67 | 100.77 | 40.70 | **335.14** | - | 40.50 | 268.20 | **308.70** | 193.67 | 141.27 | 308.90 | **643.84** |
| | 11 | Bhaktapur | 90.85 | 19.84 | 7.00 | **117.69** | 22.98 | 40.42 | 107.65 | **171.05** | 113.83 | 60.26 | 114.65 | **288.74** |
| | 12 | Lalitpur | 129.26 | 25.54 | 33.20 | **188.00** | 27.91 | 57.29 | 160.30 | **245.50** | 157.17 | 82.83 | 193.50 | **433.50** |
| | 13 | Kathmandu | 259.19 | 11.50 | 37.16 | **307.85** | 91.25 | 113.62 | 298.85 | **503.72** | 350.44 | 125.12 | 336.01 | **811.57** |
| | | | | | | | | | | **9,133.39** | **1,856.61** | **2,065.07** | **7,714.18** | **11,635.86** |
| State No. 4 | 1 | Gorkha | 26.84 | 40.50 | 109.90 | **177.24** | - | - | 2,366.31 | **2,366.31** | 26.84 | 40.50 | 2,476.21 | **2,543.55** |
| | 2 | Lamjung | 19.17 | 1.00 | 51.87 | **72.04** | - | - | 412.25 | **412.25** | 19.17 | 1.00 | 464.12 | **484.29** |
| | 3 | Tanahu | 128.49 | - | 33.00 | **161.49** | - | 37.21 | 972.78 | **1,009.99** | 128.49 | 37.21 | 1,005.78 | **1,171.48** |
| | 4 | Kaski | 114.46 | 5.00 | 20.50 | **139.96** | 2.70 | 25.06 | 794.25 | **822.01** | 117.16 | 30.06 | 814.75 | **961.97** |
| | 5 | Manang | | | | | | | | | - | - | | |

| | S. N | Name of District | SRN including UR, 2013/14, km | | | | LRN , 2014/15, km | | | | Total Road,km | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | - | - | 30.00 | **30.00** | - | - | 3.20 | **3.20** | | | 33.20 | **33.20** |
| | 6 | Mustang | - | - | 181.00 | **181.00** | - | - | - | **-** | - | - | 181.00 | **181.00** |
| | 7 | Parbat | 37.11 | - | 48.50 | **85.61** | 0.65 | - | 245.83 | **246.48** | 37.76 | - | 294.33 | **332.09** |
| | 8 | Syangja | 97.94 | 2.00 | 57.00 | **156.94** | - | - | 680.00 | **680.00** | 97.94 | 2.00 | 737.00 | **836.94** |
| | 9 | Myagdi | - | 10.00 | 21.00 | **31.00** | - | - | 319.01 | **319.01** | - | 10.00 | 340.01 | **350.01** |
| | 10 | Baglung | 9.71 | 2.42 | 142.00 | **154.13** | - | - | 272.02 | **272.02** | 9.71 | 2.42 | 414.02 | **426.15** |
| | 11 | Nawalparasi (East of SustaBardaghat) | 77.44 | 10.00 | 14.50 | **101.94** | 62.59 | 307.8 | 159.76 | **530.15** | 140.03 | 317.80 | 174.26 | **632.08** |
| | | | | | | | | | | **6,661.42** | **577.10** | **440.99** | **6,934.68** | **7,952.76** |
| State No. 5 | 1 | Nawalparasi (West of SustaBardaghat) | 77.44 | 10.00 | 14.50 | **101.94** | 62.59 | 307.8 | 159.76 | **530.15** | 140.03 | 317.80 | 174.26 | **632.08** |
| | 2 | Rupandehi | 137.69 | 12.50 | 13.50 | **163.69** | 71.88 | 426.09 | 19.11 | **517.08** | 209.57 | 438.59 | 32.61 | **680.77** |
| | 3 | Kapilbastu | 150.97 | 43.00 | 29.00 | **222.97** | 0.42 | 286.08 | 247.33 | **533.83** | 151.39 | 329.08 | 276.33 | **756.80** |
| | 4 | Palpa | 108.59 | - | 91.00 | **199.59** | - | - | 898.91 | **898.91** | 108.59 | - | 989.91 | **1,098.50** |
| | 5 | Arghakhanchi | 60.91 | 1.00 | 109.00 | **170.91** | - | - | 191.43 | **191.43** | 60.91 | 1.00 | 300.43 | **362.34** |
| | 6 | Gulmi | 44.54 | - | 82.50 | **127.04** | - | - | 590.47 | **590.47** | 44.54 | - | 672.97 | **717.51** |
| | 7 | Rukum (Eastern Part) | - | 10.00 | 82.70 | **92.70** | - | - | 30.50 | **30.50** | - | 10.00 | 113.20 | **123.20** |

| | S. N | Name of District | SRN including UR, 2013/14, km | | | | LRN , 2014/15, km | | | | Total Road,km | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8 | Rolpa | 38.41 | 84.00 | 34.00 | **156.41** | - | 6.14 | 208.37 | **214.51** | 38.41 | 90.14 | 242.37 | **370.92** |
| | 9 | Pyuthan | 85.43 | - | 75.00 | **160.43** | - | - | 146.10 | **146.10** | 85.43 | - | 221.10 | **306.53** |
| | 10 | Dang | 174.22 | 136.00 | 56.00 | **366.22** | - | 79.71 | 381.72 | **461.43** | 174.22 | 215.71 | 437.72 | **827.65** |
| | 11 | Banke | 178.81 | 13.50 | 34.10 | **226.41** | 6.72 | 221.75 | 90.11 | **318.58** | 185.53 | 235.25 | 124.21 | **544.99** |
| | 12 | Bardiya | 132.49 | 49.93 | 29.00 | **211.42** | - | 284.82 | 59.48 | **344.30** | 132.49 | 334.75 | 88.48 | **555.72** |
| | | | | | | | | | | **4,777.28** | **1,331.11** | **1,972.32** | **3,673.59** | **6,977.01** |
| State No. 6 | 1 | Rukum (Eastern Part) | - | 10.00 | 82.70 | **92.70** | - | - | 30.50 | **30.50** | - | 10.00 | 113.20 | **123.20** |
| | 2 | Salyan | 46.16 | 68.50 | 61.00 | **175.66** | 3.70 | 23.07 | 163.45 | **190.22** | 49.86 | 91.57 | 224.45 | **365.88** |
| | 3 | Dolpa | - | - | - | **-** | - | - | - | **-** | - | - | - | **-** |
| | 4 | Jumla | - | - | 85.00 | **85.00** | - | - | 69.20 | **69.20** | - | - | 154.20 | **154.20** |
| | 5 | Mugu | - | - | - | **-** | - | - | 16.58 | **16.58** | - | - | 16.58 | **16.58** |
| | 6 | Humla | - | - | 40.00 | **40.00** | - | - | - | **-** | - | - | 40.00 | **40.00** |
| | 7 | Kalikot | - | - | 77.00 | **77.00** | - | - | - | **-** | - | - | 77.00 | **77.00** |
| | 8 | Jajarkot | - | - | 118.00 | **118.00** | - | - | - | **-** | - | - | 118.00 | **118.00** |
| | 9 | Dailekh | 144.45 | 8.22 | 118.56 | **271.23** | - | - | 239.00 | **239.00** | 144.45 | 8.22 | 357.56 | **510.23** |
| | 10 | Surkhet | 138.14 | 53.70 | 43.30 | **235.14** | 5.66 | - | 147.08 | **152.74** | 143.80 | 53.70 | 190.38 | **387.88** |

| | S. N | Name of District | SRN including UR, 2013/14, km | | | | LRN , 2014/15, km | | | | Total Road,km | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State No. 7 | | | | | | | | | | **698.24** | **338.11** | **163.49** | **1,291.37** | **1,792.97** |
| | 1 | Bajura | 13.00 | - | 30.00 | **43.00** | - | - | 1.49 | **1.49** | 13.00 | - | 31.49 | **44.49** |
| | 2 | Bajhang | 60.32 | - | 48.36 | **108.68** | - | 1.19 | 2.10 | **3.29** | 60.32 | 1.19 | 50.46 | **111.97** |
| | 3 | Doti | 115.46 | 6.00 | 65.00 | **186.46** | - | - | 198.13 | **198.13** | 115.46 | 6.00 | 263.13 | **384.59** |
| | 4 | Achham | 75.00 | - | 67.00 | **142.00** | - | - | 132.16 | **132.16** | 75.00 | - | 199.16 | **274.16** |
| | 5 | Darchula | 10.00 | 50.00 | 18.42 | **78.42** | - | - | 4.11 | **4.11** | 10.00 | 50.00 | 22.53 | **82.53** |
| | 6 | Baitadi | 122.42 | - | 51.60 | **174.02** | 0.61 | - | 21.11 | **21.72** | 123.03 | - | 72.71 | **195.74** |
| | 7 | Dadeldhura | 77.08 | - | 64.00 | **141.08** | - | - | 135.00 | **135.00** | 77.08 | - | 199.00 | **276.08** |
| | 8 | Kanchanpur | 44.32 | 89.00 | 22.10 | **155.42** | 10.20 | 6.40 | 128.32 | **144.92** | 54.52 | 95.40 | 150.42 | **300.34** |
| | 9 | Kailali | 171.35 | 74.25 | 64.00 | **309.60** | - | 249.44 | 174.54 | **423.98** | 171.35 | 323.69 | 238.54 | **733.58** |
| | | | | | | | | | | **1,064.80** | **699.76** | **476.28** | **1,227.44** | **2,403.48** |
| | | | | | | | | | | **31,036.72** | **6,502.26** | **8,499.53** | **27,914.28** | **42,916.07** |

### 5.1.3. Calculation of road densities

The road densities are calculated in terms of km per 100 sq.km and km per 1000 population. The following formulas are used for density calculations:

Road density in km per 100 square km area= Road length ( km)/ area(km2)*100

Road density in km per 1000 popln= Road length ( km) / Population*1000

Table 5.3: Calculation of Road densities

| State No. | Total Road, km | | | | Road density (km per 100 sq km area) | | | | Road density(km per 1000 popln) | | | | GDP Per capita, 2014 Rs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BT | GR | ER | Total | BT | GR | ER | Total | BT | GR | ER | Total | |
| State No. 1 | 987.12 | 1,842.87 | 4,656.98 | 7,486.97 | 3.811 | 7.114 | 17.977 | 28.902 | 0.212 | 0.395 | 0.999 | 1.606 | 46,759.58 |
| State No. 2 | 712.46 | 1,538.52 | 2,416.05 | 4,667.03 | 7.375 | 15.925 | 25.008 | 48.308 | 0.125 | 0.270 | 0.424 | 0.819 | 35,588.33 |
| State No. 3 | 1,856.61 | 2,065.07 | 7,714.18 | 11,635.86 | 9.146 | 10.173 | 38.001 | 57.320 | 0.310 | 0.344 | 1.287 | 1.941 | 87,009.87 |
| State No. 4 | 577.10 | 440.99 | 6,934.68 | 7,952.76 | 2.684 | 2.051 | 32.248 | 36.983 | 0.235 | 0.180 | 2.824 | 3.239 | 47,242.42 |
| State No. 5 | 1,331.11 | 1,972.32 | 3,673.59 | 6,977.01 | 6.710 | 9.942 | 18.518 | 35.171 | 0.281 | 0.416 | 0.774 | 1.470 | 39,224.91 |
| State No. 6 | 338.11 | 163.49 | 1,291.37 | 1,792.97 | 1.111 | 0.537 | 4.243 | 5.891 | 0.209 | 0.101 | 0.800 | 1.111 | 29,933.00 |
| State No. 7 | 699.76 | 476.28 | 1,227.44 | 2,403.48 | 3.581 | 2.438 | 6.282 | 12.301 | 0.261 | 0.177 | 0.457 | 0.895 | 29,451.17 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total** | 6,502.26 | 8,499.53 | 27,914.28 | 42,916.07 | 4.418 | 5.775 | 18.966 | 29.159 | 0.233 | 0.305 | 1.002 | 1.541 | **49,255.29** |

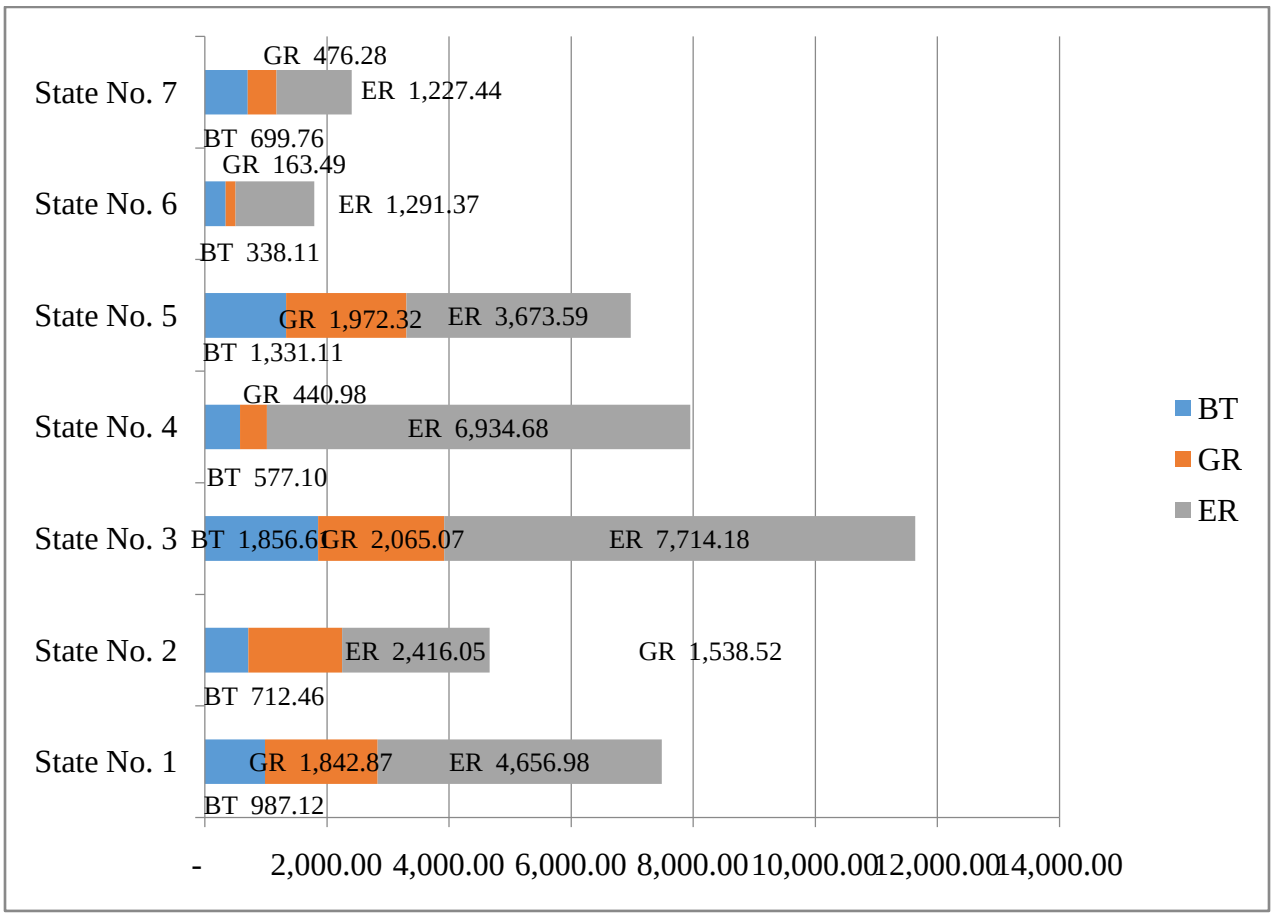


Figure 5.1: State-wise comparison of total road length (km)

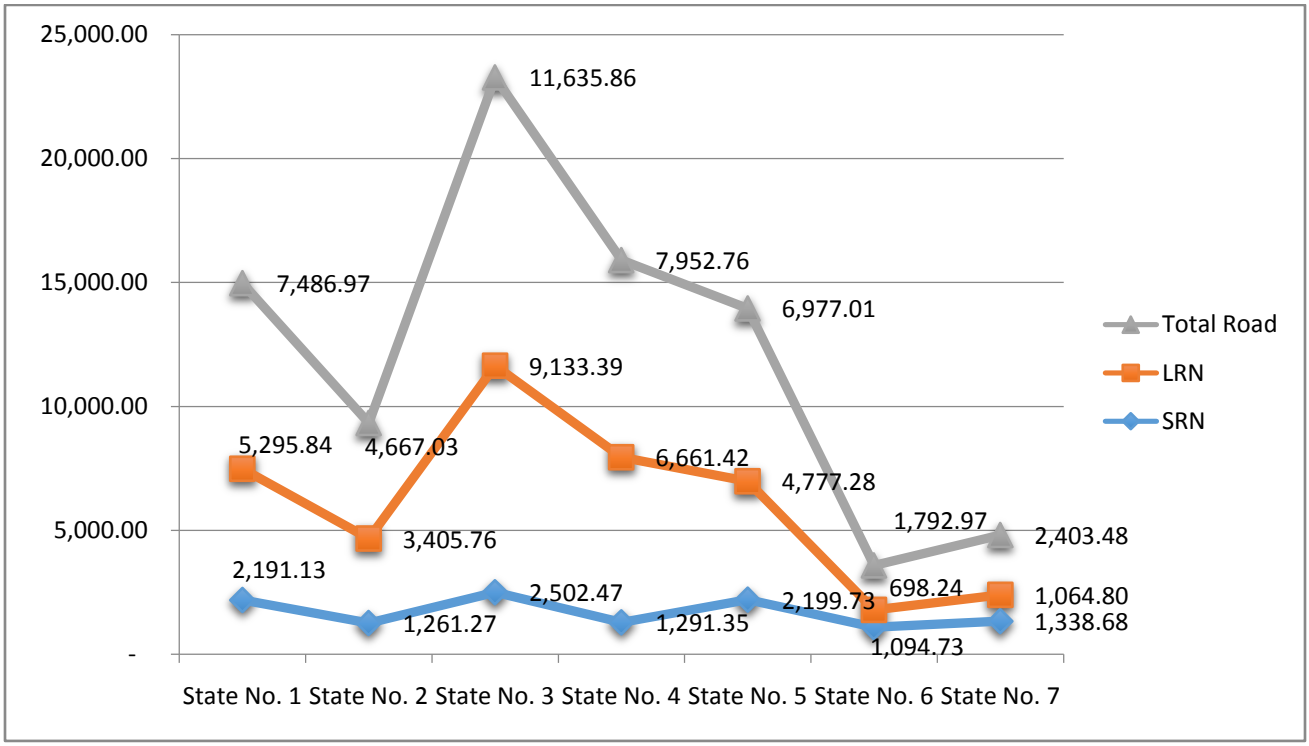


Figure 5.2: Distribution of SRN and LRN in different states (km)

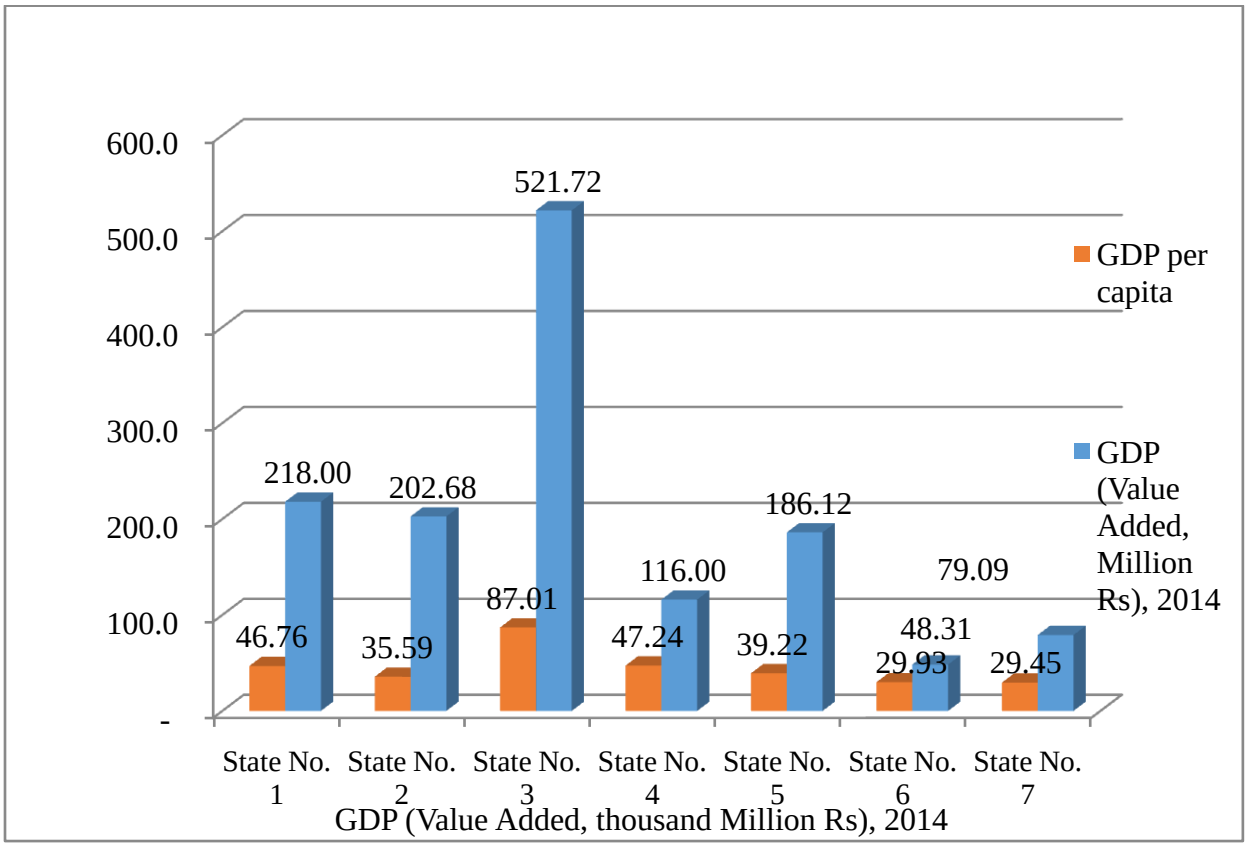


Figure 5.3: GDP and GDP per capita of 7 states

### 5.1.4 Regression analysis

Multiple regression analysis has been performed to establish relation of various parameters with GDP taking data of various districts of Nepal. Data of some districts are not used in analysis but are used for validation purpose so that they assist for the validation.

Following districts representing from different geographical locations and different federal states are used for validation purpose.

Table 5.4: List of districts taken for validation Purpose

| **Mountaneous** | **Hilly** | **Terai** | **Remarks** |
|---|---|---|---|
| | | Jhapa | |
| Dolakha | | Chitwan | |
| Gorkha | | | |
| | Rolpa | Dang | |
| | Salyan | | |
| Darchula | Doti | Kailali | |

Similarly some developing nations like Nepal, India and Brazil are also taken for validation purpose.

### 5.1.5. Mathematical Modeling of GDP as function of Road density in terms of population and area:

A regression analysis is carried out for mathematical modeling to find the relation of GDP (per capita) with road density in terms of population and area using MS-Excel. The output after analysis is as follows:

SUMMARY
OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.850952074 |
| R Square | 0.724119432 |
| Adjusted R Square | 0.70133585 |
| Standard Error | 24809.87841 |
| Observations | 58 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 2 | 9.05E+10 | 4.52E+10 | 73.49319 | 2.91E-16 |
| Residual | 56 | 3.45E+10 | 6.16E+08 | | |
| Total | 58 | 1.25E+11 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0 | | | | | | | |
| RDa | 298.7147407 | 69.47159 | 4.299811 | 6.9E-05 | 159.5464 | 437.8831 | 159.5464 | 437.8830667 |
| RDp | 9172.488166 | 1288.232 | 7.120213 | 2.19E-09 | 6591.849 | 11753.13 | 6591.849 | 11753.12754 |

GDP=298.715RDa+9172.488RDp

**Upper and Lower limit at 95% confidence interval**

Lower Limit: GDP=159.546RDa+6591.849RDp

Upper Limit: GDP=437.88RDa+11753.13 RDp

Where,

GDP= Gross Domestic Product per capita (NRs per capita)

RDa= Road density in terms of km/100sqkm

RDp= Road density in terms of km/1000 populations

The result above shows that GDP is more related with road density in terms of length per population rather than length per area. So the road density expressed in terms of km/1000 population is used as road density for further research work.

### 5.1.6. Mathematical Modeling of GDP as function of Road density of bituminous, gravel and earthen road:

A regression analysis is carried out for mathematical modeling to find the relation of GDP (per capita) with road density of bituminous, gravel and earthen road in terms of km/1000 population using MS-Excel. The output after analysis is as follows:

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.872369807 |
| R Square | 0.76102908 |

| | |
|---|---|
| Adjusted R Square | 0.73415741 |
| Standard Error | 23299.64353 |
| Observations | 58 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3 | 95086188351 | 31695396117 | 58.38450878 | 5.87934E-17 |
| Residual | 55 | 29858036369 | 542873388.5 | | |
| Total | 58 | 1.24944E+11 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0 | | | | | | | |
| RDb | 43384.0385 | 13344.35545 | 3.251115325 | 0.00196518 | 16641.3527 | 70126.7244 | 16641.3526 | 70126.7244 |
| RDg | 57907.8989 | 14015.12781 | 4.131813786 | 0.00012367 | 29820.9542 | 85994.8417 | 29820.9542 | 85994.8417 |
| Rde | 8837.45124 | 1304.393004 | 6.77514466 | 8.80583E-09 | 6223.38937 | 11451.5137 | 6223.38937 | 11451.5137 |

GDP=43384.039RDb+57907.898RDg+8837.451RDe

**Upper and Lower limit at 95% confidence interval**

Lower Limit: GDP=16641.353RDb+29820.955RDg+6223.389RDe

Upper Limit: GDP=70126.724RDb+85994.842RDg+11451.513RDe

Where,

GDP= Gross Domestic Product per capita (NRs/capita)

RDb= Road density of bituminous road in terms of km/1000 populations

RDg= Road density of gravel road in terms of km/1000 populations

RDe= Road density of earthen road in terms of km/1000 populations.

## 5.2 Result

Various mathematical expressions are generated using regression analysis through MS-Excel. The regression analysis is carried out in 95% confidence interval taking 58 districts of Nepal. Remaining districts are used for validation purpose. The results are shown as follows:

Table 5.5: Results of linear regression

| **Relation of GDP with** | **Expression for GDP** | **Lower Limit at 95% C.I.** | **Upper Limit of 95% of C.I.** | **R square value** |
|---|---|---|---|---|
| RDa, RDp | GDP=298.715RDa+9172.488RDp | GDP=159.546RDa+6591.849RDp | GDP=437.88RDa+11753.13 RDp | 0.724 |
| RDb, RDg, RDe | GDP=43384.039RDb+57907.898RDg+8837.451RDe | GDP=16641.353RDb+29820.955RDg+6223.389RDe | GDP=70126.724RDb+85994.842RDg+11451.513RDe | 0.761 |

Where,

GDP= Gross Domestic Product per capita (NRs/capita)

RDb= Road density of bituminous road in terms of km/1000 populations

RDg= Road density of gravel road in terms of km/1000 populations

RDe= Road density of earthen road in terms of km/1000 populations.

## 5.3 Validation

The results obtained from the analysis are validated by using the data of 10 districts which are not used in data analysis as follows:

### 5.3.1GDP as function of road density of bituminous, gravel and earthen road

The results after the regression is taken for validation using the data of other districts and presented in the table below:

Table 5.6: Validation of GDP as a function of road density of bituminous, gravel and earthen road

| **Districts** | **RDb** | **RDg** | **RDe** | **GDP from equation** | | **GDP, 2014 from data** | **Test** |
|---|---|---|---|---|---|---|---|
| | | | | Lower limit | Upper Limit | | |
| Jhapa | 0.2164 | 0.8483 | 0.2626 | 30,531.597 | 91,129.287 | 47,074.54 | OK |
| Dolakha | 0.5898 | 0.4940 | 2.1817 | 38,124.641 | 108,826.74 | 38,474.09 | OK |
| Chitwan | 0.4519 | 1.9751 | 0.3502 | 68,597.371 | 205,543.92 | 58,430.93 | Not OK |
| Gorkha | 0.1008 | 0.1521 | 9.2989 | 64,083.241 | 126,633.21 | 42,884.21 | Not OK |
| Rolpa | 0.1676 | 0.3933 | 1.0575 | 21,099.153 | 57,685.371 | 25,215.39 | OK |
| Dang | 0.2975 | 0.3684 | 0.7475 | 20,589.478 | 61,105.584 | 43,105.59 | OK |
| Salyan | 0.1975 | 0.3627 | 0.8890 | 19,635.068 | 55,219.674 | 30,513.62 | OK |
| Darchula | 0.0730 | 0.3650 | 0.1645 | 13,123.021 | 38,390.785 | 24,799.56 | OK |
| Doti | 0.5415 | 0.0281 | 1.2341 | 17,531.492 | 54,528.469 | 30,911.25 | OK |
| Kailali | 0.2046 | 0.3866 | 0.2849 | 16,706.772 | 50,857.467 | 35,315.30 | OK |
| Nepal | 0.2454 | 0.3208 | 1.0536 | 20,207.66 | 56,863.06 | 49,255.29 | OK |
| India[10] | 2.0223 | 1.7371 | 0 | 85,465.04 | 291,237.89 | 146,137.79 | OK |
| Brazil[11] | 1.0645 | 6.8210 | 0 | 221,122.84 | 661,219.87 | 1,302,828.38 | Not OK |

### 5.3.2List of districts whose test is positive

Out of 10 districts, 8 districts shows positive results regarding GDP whose value lies in the interval of lower and upper limit of 95% confidence interval. Following table shows the results:

[10] Data of India (2011) for validation are extracted from https://knoema.com/atlas/india in 10th March 2017, 8:23 AM, assuming paved road as bituminous and unpaved as gravel. Impact of earthen road is very small, so it is neglected.

[11] Data of Brazil (2011) for validation are extracted from https://knoema.com/atlas/brazil in 10th March 2017, 8:25 AM, assuming paved road as bituminous and unpaved as gravel. Impact of earthen road is very small, so it is neglected.

Table 5.7: List of districts with their lower and upper limit of GDP per capita whose test is positive

| S.N | District | Lower limit | Upper limit | GDP (NRs per capita) |
|---|---|---|---|---|
| 1 | Darchula | 13,123.02 | 38,390.79 | 24,799.56 |
| 2 | Dolakha | 38,124.64 | 108,826.74 | 38,474.09 |
| 3 | Kailali | 16,706.77 | 50,857.47 | 35,315.30 |
| 4 | Doti | 17,531.49 | 54,528.47 | 30,911.25 |
| 5 | Salyan | 19,635.07 | 55,219.67 | 30,513.62 |
| 6 | Dang | 20,589.48 | 61,105.58 | 43,105.59 |
| 7 | Rolpa | 21,099.15 | 57,685.37 | 25,215.39 |
| 8 | Jhapa | 30,531.60 | 91,129.29 | 47,074.54 |

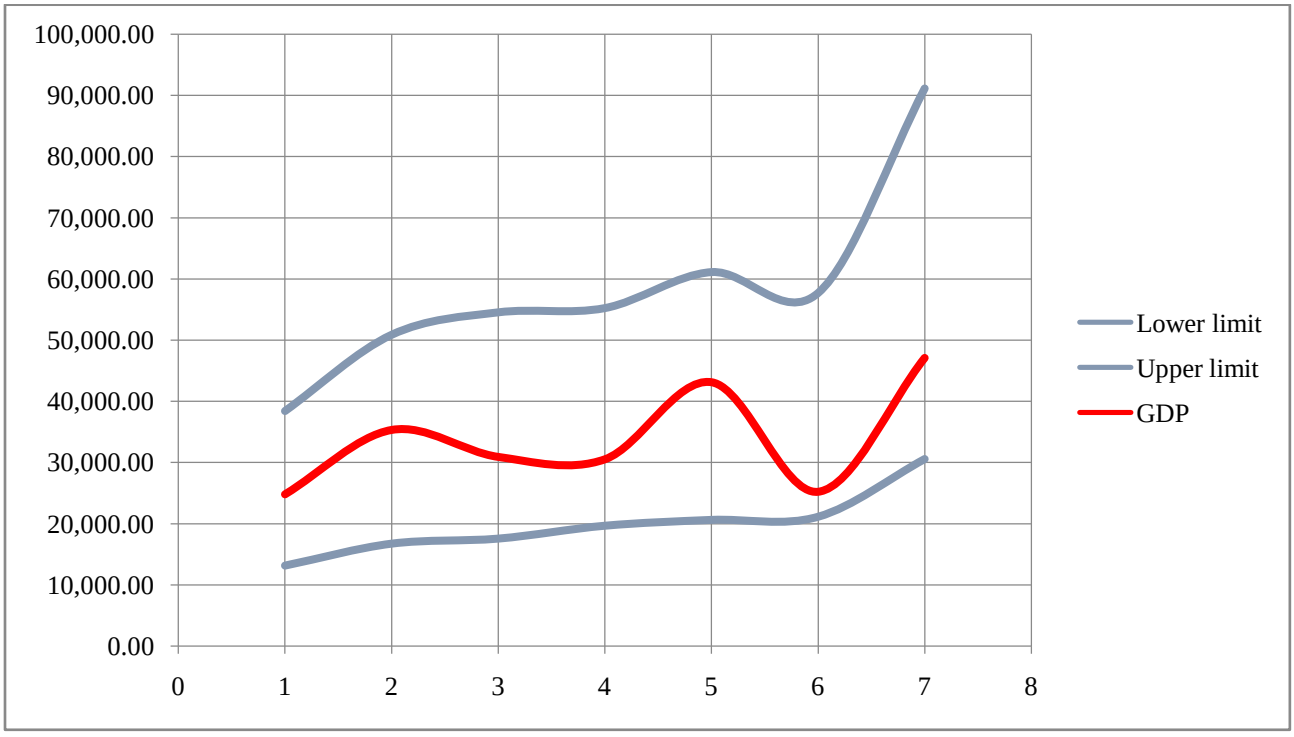


Figure 5.4: GDP of districts showing positive results in 95% confidence interval

### 5.3.3Non linearmathematical Modeling of GDP as function of Road density of bituminous, gravel and earthen road:

XLSTAT 2016.06.37287 - Nonlinear regression - Start time: 11/24/2016 at 8:31:29 AM / End time: 11/24/2016 at 8:31:31 AM
Y / Quantitative: Workbook = 1. Data Analysis r2.xlsx / Sheet = regression_bit_gra_earthen / Range = regression_bit_gra_earthen!$AB$2:$AB$40 / 38 rows and 1 column
X / Quantitative: Workbook = 1. Data Analysis r2.xlsx / Sheet = regression_bit_gra_earthen / Range = regression_bit_gra_earthen!$X$2:$Z$40 / 38 rows and 3 columns

Stop conditions: Iterations = 200 / Convergence = 0.00001
Function: Y = pr1+pr2*X1+pr3*X2+pr4*X3+pr5*X1^2+pr6*X2^2+pr7*X3^2
Run again:

Summary statistics:

| Variable | Observations | Obs. with missing data | Obs. without missing data | Minimum | Maximum | Mean | Std. deviation |
|---|---|---|---|---|---|---|---|
| GDP | 38 | 0 | 38 | 18602.934 | 68983.190 | 41928.510 | 10629.833 |
| RDb | 38 | 0 | 38 | 0.000 | 0.526 | 0.251 | 0.146 |
| RDg | 38 | 0 | 38 | 0.000 | 0.878 | 0.215 | 0.222 |
| Rde | 38 | 0 | 38 | 0.034 | 6.592 | 1.480 | 1.453 |

Correlation matrix:

| Variables | RDb | RDg | Rde | GDP |
|---|---|---|---|---|
| RDb | **1.000** | 0.012 | 0.311 | 0.266 |
| RDg | 0.012 | **1.000** | -0.425 | 0.169 |
| Rde | 0.311 | -0.425 | **1.000** | 0.312 |
| GDP | 0.266 | 0.169 | 0.312 | **1.000** |

**Nonlinear regression of variable GDP:**

Goodness of fit statistics:

| | |
|---|---|
| Observations | 38.000 |
| DF | 31.000 |
| $R^2$ | 0.270 |
| SSE | 3052231957.090 |
| MSE | 98459095.390 |
| RMSE | 9922.656 |

Model parameters:

| Parameter | Value | Standard error |
|---|---|---|
| pr1 | 24332.309 | 6708.585 |
| pr2 | 33405.732 | 41035.327 |
| pr3 | 40795.667 | 25595.879 |
| pr4 | 6947.597 | 3440.387 |
| pr5 | -53584.386 | 83500.427 |
| pr6 | -29465.180 | 31334.746 |
| pr7 | -607.073 | 567.934 |

Equation of the model:

GDP=24332.309+33405.732*RDb+40795.667*RDg+6947.597*Rde-53584.386*RDb^2-29465.180*RDg^2-607.073*Rde^2

Where,

GDP= Gross Domestic Product per capita (NRs per capita)

RDb= Road density of bituminous road in terms of km/1000 populations

RDg= Road density of gravel road in terms of km/1000 populations

RDe= Road density of earthen road in terms of km/1000 populations.

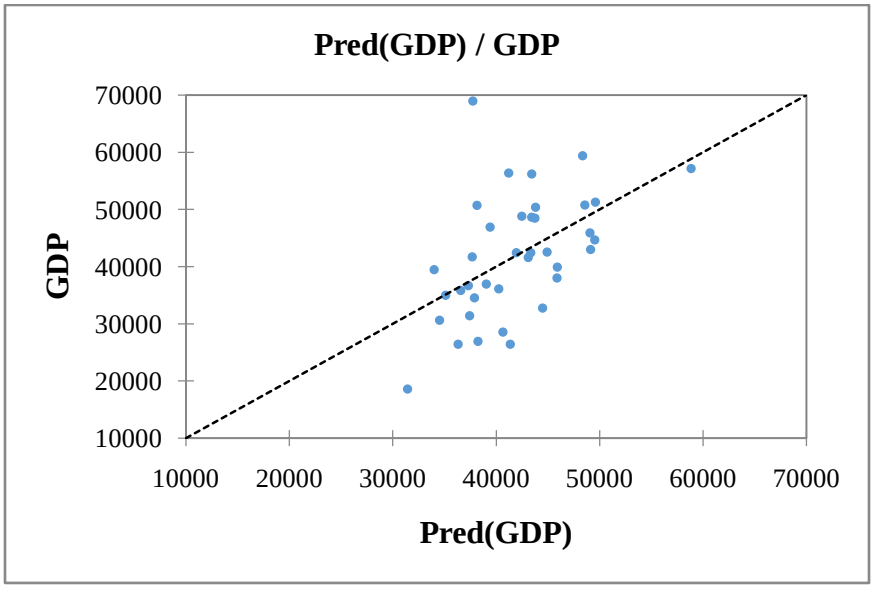


Figure 5.5: GDP Vs Predicted GDP from non linear regression

### 5.3.4Validation of Non linear regression equation

The expression from non linear regression is validated for the data of following districts as follows:

Table 5.8: Validation of data from non linear regression

| Districts | RDb | RDg | RDe | GDP from equation | GDP, 2014 from data | Error (%) | Test |
|---|---|---|---|---|---|---|---|
| Jhapa | 0.2164 | 0.8483 | 0.2626 | 44238.212 | 47,074.54 | 6.03 | OK |
| Dolakha | 0.5898 | 0.4940 | 2.1817 | 50626.494 | 38,474.09 | (31.59) | Not OK |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Chitwan | 0.4519 | 1.9751 | 0.3502 | -3521.887 | 58,430.93 | 106.03 | Not OK |
| Gorkha | 0.1008 | 0.1521 | 9.2989 | 44789.8 | 42,884.21 | (4.44) | OK |
| Rolpa | 0.1676 | 0.3933 | 1.0575 | 46581.41 | 25,215.39 | (84.73) | Not OK |
| Dang | 0.2975 | 0.3684 | 0.7475 | 45412.422 | 43,105.59 | (5.35) | OK |
| Salyan | 0.1975 | 0.3627 | 0.8890 | 45456.696 | 30,513.62 | (48.97) | Not OK |
| Darchula | 0.0730 | 0.3650 | 0.1645 | 38576.539 | 24,799.56 | (55.55) | Not OK |
| Doti | 0.5415 | 0.0281 | 1.2341 | 35482.961 | 30,911.25 | (14.79) | Not OK |
| Kailali | 0.2046 | 0.3866 | 0.2849 | 42221.969 | 35,315.30 | (19.56) | Not OK |

The mathematical expression from non linear regression analysis doesnot show satisfactory results as shown in table. Hence, the result from this analysis is not considered.

### 5.3.5Non linear (logarithmic) mathematical Modeling using of GDP as function of Road density of bituminous, gravel and earthen road:

SUMMARY
OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.485848867 |
| R Square | 0.236049121 |
| Adjusted R Square | 0.168641691 |
| Standard Error | 9692.160171 |
| Observations | 38 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3 | 986863383.3 | 328954461.1 | 3.501826422 | 0.025737438 |
| Residual | 34 | 3193890938 | 93937968.77 | | |
| Total | 37 | 4180754322 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | 49168.06065 | 4036.912285 | 12.17962076 | 5.95819E-14 | 40964.06787 | 57372.05343 | 40964.06787 | 57372.05343 |
| lnRDb | -444.3618816 | 2342.463998 | -0.189698489 | 0.850673398 | -5204.821453 | 4316.09769 | -5204.821453 | 4316.09769 |
| lnRDg | 3362.541505 | 1214.111887 | 2.769548294 | 0.009027381 | 895.1693034 | 5829.913706 | 895.1693034 | 5829.913706 |
| lnRDe | 4113.674305 | 1623.545851 | 2.533759241 | 0.016061419 | 814.2321814 | 7413.116428 | 814.2321814 | 7413.116428 |

GDP=49168.06-444.36 lnRDb+3362.54 lnRDg +4113.67lnRDe

**Upper and Lower limit at 95% confidence interval**

Lower Limit: GDP=40964.07-5204.82 lnRDb+895.17lnRDg +814.23lnRDe

Upper Limit: GDP=57372.05+4316.10ln RDb+5829.91 lnRDg+7413.12lnRDe

Where,

GDP= Gross Domestic Product per capita (NRs/capita)

RDb= Road density of bituminous road in terms of km/1000 populations

RDg= Road density of gravel road in terms of km/1000 populations

RDe= Road density of earthen road in terms of km/1000 populations.

Table 5.9: Validation of GDP as function of road density of bituminous, gravel and earthen road in log function

| **Districts** | **lnRDb** | **ln RDg** | **ln RDe** | **GDP from equation** | | **GDP, 2014 from data** | **Test** |
|---|---|---|---|---|---|---|---|
| | | | | Upper limit | Lower Limit | | |
| Jhapa | -1.531 | -0.165 | -1.337 | 47,694.704 | 39,894.325 | 47,074.54 | OK |
| Dolakha | -0.528 | -0.705 | 0.780 | 43,715.962 | 56,764.910 | 38,474.09 | Not OK |
| Chitwan | -0.794 | 0.681 | -1.049 | 44,853.164 | 50,133.533 | 58,430.93 | Not OK |
| Gorkha | -2.295 | -1.883 | 2.230 | 53,036.994 | 53,019.749 | 42,884.21 | Not OK |
| Rolpa | -1.786 | -0.933 | 0.056 | 49,470.956 | 44,636.823 | 25,215.39 | Not OK |
| Dang | -1.212 | -0.999 | -0.291 | 46,143.224 | 44,160.429 | 43,105.59 | Not OK |
| Salyan | -1.622 | -1.014 | -0.118 | 48,402.712 | 43,586.481 | 30,513.62 | Not OK |
| Darchula | -2.617 | -1.008 | -1.805 | 52,214.859 | 26,820.300 | 24,799.56 | Not OK |
| Doti | -0.613 | -3.572 | 0.210 | 41,130.504 | 35,459.427 | 30,911.25 | Not OK |
| Kailali | -1.587 | -0.950 | -1.256 | 47,349.449 | 35,675.128 | 35,315.30 | Not OK |

The mathematical expression from non linear regression analysis using logarithmic value also doesnot show satisfactory results as shown in table. Hence, the result from this analysis is also not considered.

# CHAPTER SIX: CONCLUSIONS& RECOMMENDATIONS

The main objective of this research is to analyze and understand the impact of road infrastructure on regional economy of developing nation.Collection of road related data of Nepal and its analysis has been done in this report. Establishment of a mathematical model to relate GDP per capita with road density of paved and unpaved roads (bituminous, gravel and earthen roads) is an important achievement of this thesis.

## 6.1 Conclusions

Regression analysis has been used to relate GDP with road density of bituminous, gravel and earthen roads. The road density is expressed in terms of road length per 1000 population as it has been found more appropriate than road density in terms of road length per 100 square km.

In regression analysis, 95% confidence level is used and the expressions for lower and upper limit of GDP per capita have been formulated. After carrying out regression analysis, the results are validated using data of other 10 districtswhich are not actually taken into consideration for analysis. Out of 10 districts, result has been verified by 8 districts. That means, the GDP per capita of eight districts lies in the interval of lower and upper limit of 95% confidence interval which is acceptable. Also, non linear regression analysis is done to find the expression of GDP per capita with road density of bituminous, graveled and earthen road. The validation shows that the results are not satisfactory as are not validated by the result. Only 4 out of 10 districts show that the results are within 10% error, so are not acceptable.

The linear regression analysis in which, 8 out of 10 districts show positive results is supposed to be valid and expression for 95% confidence level. The expressions for lower limit (LL) and upper limits (UL)of GDP per capita so obtainedare as follows:

GDP (NRs per capita) =43384.039RDb+57907.898RDg+8837.451RDe

$GDP_{LL}$(NRs per capita) =16641.353RDb+29820.955RDg+6223.389RDe

$GDP_{UL}$ (NRs per capita) =70126.724RDb+85994.842RDg+11451.513RDe

Where,

GDP= Gross Domestic Product per capita (NRs per capita)

RDb= Road density of bituminous road in terms of km/1000 populations

RDg= Road density of gravel road in terms of km/1000 populations

RDe= Road density of earthen road in terms of km/1000 populations

If the GDP per capita is expressed in USD per capita (Assuming 1 USD=100 NRs), results shall be,

| |
|---|
| GDP (USD per capita) =433.84RDb+579.08RDg+88.38RDe |
| GDP $_{LL}$(USD per capita) =166.41RDb+298.21RDg+62.23RDe |
| GDP$_{UL}$ (USD per capita) =701.27RDb+859.95RDg+114.52RDe |

Where,

RDb= Road density of bituminous road in terms of km/1000 populations

RDg= Road density of gravel road in terms of km/1000 populations

RDe= Road density of earthen road in terms of km/1000 populations

The above equations show that the regional economy of Nepal is driven basically by density of bituminous and gravel road. There is less influence of earthen road density in regional economy.

**6.2 Recommendations**

The mathematical equation thus generated shows that there is great influence of road transport in generating regional economy. For the regional economy of any developing nations, based on the findings of this research, following are some of the recommendations:

- It is observed from the research that bituminous and gravel road plays vital role in contributing regional economy of developing nation. So, up gradation of fair weathered (earthen) roads to all weather (at least graveled) roads is to be given higher priority by the concerned authority.
- It is found that GDP per capita is more affected by road density in terms of length/population than length/ area. So, it is recommended to give priority based

on population than geographical location to increase GDP per capita of developing nation.

### 6.3 Limitations of report and further studies

The thesis has made some considerations which are its limitations. Also, this research has made a platform for further researches in field of transport economy. The limitations of this research can be incorporated in further researches.

- Impact of other modes of transportation is not considered in this thesis, so impact of other modes can be incorporated in further researches.
- Effect of other infrastructures in generating regional economy is almost neglected in this research. So, further research can be performed by considering effect of such other infrastructures.
- This thesis has considered the impact of road infrastructure on regional economy in terms of GDP per capita of districts. Further research can be done to study the impact of road infrastructure on spatial development (land use plan etc) and its effect on economy.
- Further researches can be performed to do comparative study on benefit cost analysis (studies) for road construction in widely separated community versus resettlement of habitats to road heads.

## REFERENCES


Aljoufie, M. O. (2012). Urban Growth and Transport in Jeddah: Dynamic Modelling and Assessment. University of Twente.

Berke, P. R. (2006). *Urban Land Use Planning.* Fifth ed.Chicago : University of Illinois Press.

Burdina, M. (2004). IMPACT OF TRANSPORTATION ON BUSINESS LOCATION DECISIONS IN RURAL UPPER GREAT PLAINS. *North Dakota State University of Agriculture and Applied Science.*

Canning, D. (2011). The effect of infrastructure on Long Run Economic Growth. Harvard University.

*Department of Roads, Kathmandu*. (2014). Retrieved from Statistics of Strategic Road Network: www.dor.gov.np

Frank, L. D. (1994). *RELATIONSHIPS BETWEEN LAND USE AND TRAVELER BEHAVIOUR IN THE PUGET SOUND REGION.* Washington State: Department of Transportation.

Furst, M. W. (1999). Land Use Transport Interaction: State of the Art. *Deliverable 2a of the Project TRANSLAND (Integration of Transport and Land use Planning* .

Kjell Nilsson, T. S. ( 2014). Strategies for Sustainable Urban Development and Urban-Rural Linkages. *European Journal of Spatial Development* .

Kothari, C. R. (1990). *Research Methodology, Methods & Techniques, Second Revised edition.* India: New Age International Publishers.

Levy, J. M. (2006). *Contemporary Urban Planning, Seventh Edition.* New Jersey: Pearson Education Inc.

M.Burdina. (2004). *IMPACT OF TRANSPORTATION ON BUSINESS LOCATION DECISIONS IN RURAL UPPER GREAT PLAINS.* North Dakota State University of Agriculture and Applied Science.

Pokhrel, K. (2013). A Critical Overview of Planning Process in Nepal. *The Nepalese Journal of Public Administration, Nepal* .

Sitaula, T. (2012)*Infrastructure Development in Nepal: Oppurtunities and Challenges for Engineers.* Kathmandu.

Srinivasan, S. (2000). *Linking Land Use and Transportation: Measuring the Impact of Neighborhood-scale Spatial Patterns on Travel Behavior.* MIT: Department of Urban Studies and Planning.

Suwal, W. (2009). A Study on Land Use Planning Practices and the Relationship between Population Density and Transportation Infrastructure in Kathamdu, Nepal. Virginial Commonweatlh University.

Terefe, L. A. (2012). Impact of Road on Rural Poverty Evidence From Fifteen Rural Villages in Eghiopia. Ethiopia.

UNDP. (2014). *Nepal Human Development Report.* National Planning Commission Nepal and United Nation Development Program.

*World Development Report*(2009).

*www.ekantipur.com*.

*www.npc.gov.np*. (n.d.). Retrieved from National Planning Commission.

Zhenau, C. (2014). *Regional Imapct of Public Transportation infrastructure in the U. S. Northwest Megaregion: a spatial Econometric Computable General Equilibrium Assessment.* ason Archival Repository Service.