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Physical Infrastructure in Indian States of Punjab and Haryana with Respect to Electricity and Road Transport during 1970-71 to 2012-13

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Abstract:
Historically, the Indian Punjab was once five times the size it is now and was littered with wealth until the British Empire invaded. During partition in 1947, Punjab was divided into two parts. On November 1, 1966, the Indian part of Punjab was trifurcated, leading to the formation of Haryana and Himachal Pradesh on linguistic lines. Hence there are many similarities about the development pattern between these two states. Though Haryana grows more rapidly than Punjab on different indicators of economic development, still then, there are some areas which should be paid attention by the policy makers for achieving higher economic growth rates. Present paper attempts to analyze the development of physical infrastructure in these two major Indian states of Punjab and Haryana. The growth and comparative analysis of development of electricity sector and road transport sector, which are two important components of physical infrastructure of Punjab state and Haryana state have been examined in this paper during the period of 1970-71 to 2012-13. The paper uses semi log regression model for finding the growth of different components of physical infrastructure and independent sample t-test for making a comparative average performance of different indicators of physical infrastructure. The paper suggests that for achieving economic development both the governments of Punjab state and Haryana state should improve electricity and road transport.

Keywords: *Electricity, road transport, growth rate, physical infrastructure*

1. Introduction

On 1st November 1966, the Punjab State divided on a linguistic basis into three different Indian States, viz., Punjab, Haryana, and Himachal Pradesh. The size of Punjab became 50,362 Sq. Kms and that of Haryana as 44,212 Sq. Kms. Geographically, Punjab is land locked and bordered with disturbed neighbour, Pakistan, but Haryana's 30% area falls into the National Capital Region, Delhi, where a world class infrastructure being created. During 1971-2011, the population of Punjab increased from 1.36 crore to 2.77 crore, and that of Haryana increased from 1 crore to 2.53 crore. In 1966-67, Haryana was just a backwater and dubbed as the poor cousin of Punjab. Then, the per capita income of Haryana was Rs. 608 only as compared to Rs. 751 of Punjab. Punjab occupied 1st rank in per capita income among Indian states during 1966-93. However, with the passage of time, Punjab has turned into an economic backbencher. Haryana has outpaced the senior state on most key parameters like per capita income, average growth rate, fiscal management, Foreign Direct Investment (FDI), manufacturing and realty boom, etc. Today, it is one of the fastest growing states of India, and Number One in per capita income (among major Indian States), per capita investment, mobilizing resources, production and export of Basmati Rice, Mushroom production, etc. It won 'Krishi Karman Award' for the highest productivity of wheat and growth of agriculture during 2010-12. Punjab and Haryana are amongst the top developed states of India. The development/improvement of Infrastructure of Irrigation, Power, Roads and Road Transport is earmarking an outlay of rupees 24,962 crore which is 27.74% of the total projected outlay in Haryana against Punjab's rupees 36,362 crore which is 39.48% of the total projected outlay during the 12th Five Year Plan[1&2]. There is dire need of the Haryana State to make attention on electricity and transport system for sustaining higher economic growth rate.

2. Review of Literature

One of the major determinants of economic growth is infrastructure development especially in developing countries. Economic development of a country depends very much on the availability of its infrastructural facilities[3]. World Bank Study points out that, on an average, a percentage point increase in infrastructure stocks results in proportionate increase in GDP[4]. China's aggressive investment (around 15 percent of GDP) on Infrastructure is justified to sustain growth and minimize the impact of Global Financial Crises. Inadequate and inefficient infrastructure can prevent the economy from realizing its full growth potential regardless of the progress on other fronts. The physical infrastructure, include such services such as power, irrigation, transport telecommunication,

which in turn, initiate and accelerate economic development[5]. Physical infrastructure (utility and transportation infrastructure) lays the groundwork for economic development. There is large role of infrastructure in the economic development of Himachal Pradesh[6]. Numerous studies have emphasized the importance of individual economic social and infrastructural facilities. Some have brought out the role of industrial development, particularly power and coal, in the growth of industrial production. These very studies also reveal the role of other infrastructural facilities like transport communication, water supply etc. Physical infrastructure covering power, transportation, communication and storage besides facilitating economic growth has direct impact on quality of life. Despite the dominant role of geography, public investments in infrastructure could contribute to economic development in remote [7]. The impact of public investment and physical infrastructure on both private investment behavior and regional economic development has been found to be highly significant and positive[8]. Hence, an economy's infrastructure is more conveniently divided into two parts physical infrastructure and social infrastructure and among the two, physical infrastructure is regarded as a key driver of economic growth & its development and has the potential to fuel the economy.

3. Research Methodology

In the present paper analysis of physical infrastructure in Punjab and Haryana is based on the two important pillars of physical infrastructure namely electricity and road transport. The different components of research methodology of the present study are discussed in this section.

3.1. Statement of the Problem

Haryana state was formulated in 1966 from Punjab state. Both the Indian states of Punjab and Haryana have given their contribution in the economic, social and physical infrastructure development of India and considered as relatively developed states in India. Haryana state, which was initially at a lower level of economic development picked up subsequently in recent years but even now it lags behind Punjab on physical infrastructure indicators. This study is designed in order to compare the progress of both Punjab and Haryana state with respect to physical infrastructure development in the last four decades. The problem statement of the present study can be stated as:

"To study the comparative physical infrastructure development in Punjab and Haryana with respect to electricity sector and road transport sector"

The above mentioned research problem is studied with the help of following objectives. This research study is exploratory as well as descriptive in nature.

3.2. Objectives of the Study

The research study attempts to identify various objectives of the study stated as follows:

- Objective 1: To examine the development in road transport sector in Punjab and Haryana;
- Objective 2: To study the development in electricity sector in Punjab and Haryana;
- Objective 3: To analyze the comparison of physical infrastructure with respect to road transport and electricity sector in Punjab and Haryana.

3.3. Hypotheses to be Tested

On the basis of defined objectives, the following hypotheses are tested in the research study:

- Hypothesis 1: "There exists significant growth rate of development of physical infrastructure with respect to electricity sector of Punjab and Haryana State during the sample period"
- Hypotheses 2: "There exists significant growth rate of development of physical infrastructure with respect to road transport sector of Punjab and Haryana State during the sample period"
- Hypothesis 3: "There exists no significant difference between Punjab and Haryana state with respect to their electricity sector and road transport sector".

3.4. Research Design

This research study is an ***exploratory as well as descriptive research*** based on a large secondary data collected from different sources.

3.5. Type of Data and Data Collection

In the study the secondary data is collected from the different secondary sources.

- Economic Survey of Haryana
- Economic Survey of Punjab
- Statistical Abstract of Haryana
- Statistical Abstract of Punjab

3.6. Data Analysis and Methods

As data means raw information collected from sundry sources. This raw information needs filtrations in order to convert into relevant information having been compiled, edited and coded i.e. it has to pass through a process of analysis and has to be interpreted

accordingly before their meaning and implications are understood. Various statistical techniques are used for testing the hypothesis and drawing the inferences and conclusions about the relationship. In the research study following statistical methods is applied:

3.6.1. Descriptive Analysis

In the research study the secondary data is collected from the different secondary sources. The descriptive analysis of the various variables related to physical infrastructure development is done in the study. The measure of central tendency (mean) is estimated.

3.6.2. Independent Sample T-Test

In this study the independent sample t-test is applied to test the level of difference between Punjab and Haryana state with respect to social infrastructure development. The null hypothesis of independent sample t-test is mentioned below.

Null hypothesis: "There is no significant difference between Punjab and Haryana state with respect to their physical infrastructure development"

Bivariate Regression Analysis: Bivariate regression analysis is used to estimate the growth rate of the different aspects of social development in the Punjab and Haryana state. In the research study the following regression model (semi log model) is used to estimate the growth rate

$\text{Log } Y = \alpha + \beta_1 \text{ Time} + \varepsilon_i$

Where Y represents the variable related to social development of the state and time is independent variable represented in years.

3.7. Software Used

In the research study, MS Excel and SPSS 20 are used for the purpose of data analysis.

3.8. Statistical Framework

Before going for the data analysis, the data were segregated into four periods along with overall period of 43 years from 1970-71 to 2012-13. These periods came to be as under:

Period-I	:	1970-71 to 1979-80
Period-II	:	1980-81 to 1989-90
Period-III	:	1990-91 to 1999 to 2000
Period-IV	:	2000-01 to 2012-13

4. Results and Findings

The results and findings of the research study are presented into two parts: electricity sector development as well as road transport development.

4.1. Electricity Development in Punjab and Haryana

Electricity in the present day development scenario is one of the most important pillars of physical infrastructure. Prosperity of all the sectors is influenced by availability of power[9]. Punjab is the third largest consumer of electricity on per capita basis after Goa and Gujarat[10]. Spectacular successes have been achieved by Punjab and Haryana in the area of Electricity. Electricity plays a very important role in the development of physical infrastructure of any state. It not only improves quality of life of the people, but also helps in the growth of their business and agriculture. Electricity is widely recognized with its role in the form of significant contribution to economy in term of revenue generation, increasing employment opportunity also. Prosperity of all the sectors is influenced by availability of power in Punjab and Haryana is electricity. It can be tapped from both renewable and non-renewable resources. Development of conventional forms of energy for meeting the growing needs of people is the responsibility of the government. In the pre- independence period, the power supply was mainly in the private sector and that too restricted to the urban areas. With the formation of state electricity boards during the five-year plans, a significant step was taken in bringing about a systematic growth of power supply for industries all over the country. A number of multi-purpose projects came into being with the setting up of hydro, thermal plants etc. Both the states of Punjab and Haryana are one of the developed states of the country. With the increase in population in both the states of Punjab and Haryana, the demand for goods and services is increasing every year. To meet the ever increasing demand, there is a need to build a huge electricity infrastructure. Electricity sector is analyzed in this paper into different parts. The first part analyses the growth of generation as well as connections of electricity as follow.

4.1.1. Growth of installed capacity, generated capacity, total connections and agricultural connections of electricity Punjab and Haryana;1970-71 to 2012-13

The effort is also made in order to estimate the compounded growth rate of installed capacity of electricity, generated capacity of electricity total as well agricultural connections of electricity in both the states of Punjab and Haryana with the help of semi log model as is discussed earlier and results are presented in the Table 1 below:

	Time Period	Installed Capacity (MW)		Generated capacity (Million KWH)		Total Connections		Agricultural Connections	
		Punjab	Haryana	Punjab	Haryana	Punjab	Haryana	Punjab	Haryana
Average	1970-71 to 1979-80	1012.9	612.42	3894.94	2564.5	1404633.1	792428	155957.3	141995.4
	1980-81 to 1989-90	2262.4	1413.74	10004.72	5095.8	2974815.2	1728936	428358.1	279694.1
	1990-91 to 1999-2000	3525	1764.9	17520.55	7230.97	4474131.9	3072820.2	704139.6	371325.6
	2000-01 to 2012-13	4865.77	3023.31	24598.47	13228.66	6363789.5	4207119.9	984117.31	443022.85
	1970-71 to 2012-13	3052.51	1795.67	14743.77	7462.45	3982908.5	2572983	597164.53	318359.26
C.G.R.	1970-71 to 1979-80	9.80%	8.50%	10.50%	11.20%	8.30%	7.10%	11.40%	8.60%
	1980-81 to 1989-90	8.40%	5.60%	8.90%	3.70%	6.10%	7.10%	8.10%	4.40%
	1990-91 to 1999-2000	2.60%	0.10%	4.50%	0.20%	2.80%	3.30%	2.70%	0.00%
	2000-01 to 2012-13	2.60%	9.00%	2.40%	13.30%	3.40%	3.30%	3.40%	3.80%
	1970-71 to 2012-13	4.90%	4.80%	5.80%	4.90%	4.70%	5.20%	5.70%	3.50%
t-value and p-value	1970-71 to 1979-80	11.51**	6.52**	7.89**	7.06**	27.32**	27.03**	29.23**	18.92**
		(0.001)	*(0.001)*	*(0.001*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
	1980-81 to 1989-90	14.36**	18.43**	14.24**	5.62**	31.99**	53.00**	17.43**	27.13**
		(0.001)	*(0.001)*	*(0.001*	*(-0.001)*	*(0.001)*	*(0.001)*	*90.001)*	*(0.001)*
	1990-91 to 1999-2000	6.83**	3.74**	9.21**	0.35	29.23**	10.30**	12.65**	-0.19
		(0.001)	*(-0.006)*	*(0.001*	*(-0.737)*	*(0.001)*	*(0.001)*	*(0.001)*	*(-0.853)*
	2000-01 to 2012-13	3.10**	9.68**	6.64**	2.76*	31.69**	26.25**	31.30**	19.92**
		(-0.01)	*(0.001)*	*(0.001*	*(-0.018)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
	1970-71 to 2012-13	20.63**	18.67**	21.42**	9.44**	26.76**	27.45**	20.12**	16.08**
		(0.001)	*(0.001)*	*(0.001*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*

Table 1: Growth of Installed Capacity, Generated Capacity, Total Connections and Agricultural Connections of Electricity Punjab and Haryana;1970-71 to 2012-13
Source: Calculated from Various Issues of Statistical Abstract of Punjab and Statistical Abstract of Haryana
Note: (*) means at five percent level of Significance, (**) means at one percent level of Significance, otherwise Not Significant

The results indicate that the overall growth rate in case of installed capacity of electricity is found to be 4.9 percent per annum and 4.8 percent per annum and in case of generated capacity of electricity is found to be 5.8 percent per annum and 4.9 percent per annum in Punjab and Haryana respectively. The results indicate that the both the states have significant growth rates of installed as well as generated capacity of electricity as p-values of t-test are found to be less than 5 percent level of significance. The results also indicate that both the states have the same progress with respect to installed capacity of electricity and per annum growth rate of generated capacity of electricity is slightly better in Punjab as compare to Haryana state. In Punjab the growth rate of installed capacity of electricity was highest during the period 1970-71 to 1979-80. In Punjab Guru Nanak Thermal Plants (completed in 1974, four units of 440 MW capacity) and Ropar Thermal Plant (two units capable of generating 210 MW each) are two big thermal plants. However, in Haryana growth rate of installed capacity of electricity was highest during the period of 2000-01 to 2012-13. The results also indicate that the growth rate of generated capacity was high during the period of 1970-71 to 1979-80 in both the states of Punjab and Haryana. However, the growth rate decreases after that. Since all the p-vales of t-test are found to be less than 5 percent level of significance. Hence with 95 percent level of confidence it can be concluded that both the states of Punjab and Haryana have statistically significant growth rates of installed capacity of electricity as well as generated capacity of electricity in four sub periods as well as overall period of 43 years.

The results also indicate that the overall growth rate of total connections of electricity found to be 4.7 percent per annum and 5.2 percent per annum in Punjab and Haryana respectively. The highest growth rate of total connections of electricity was found to be during the period 1970-71 to 1979-80 in case of both the states, while slowdown is found in the subsequent years. The lowest growth is found during the period 1990-91 to 1999-00. The p-values of t-statistic for all the sub periods as well as overall period are found to be less than 5 percent level of significance. Hence with 95 percent level of confidence it can be concluded that both the states of Punjab and Haryana have statistically significant growth rates of total electrical connections. In case of agricultural connections of electricity, the overall growth rate is found to be 5.7 percent per annum and 3.5 percent per annum in Punjab and Haryana respectively. The highest growth rate of agricultural connections of electricity was found to be during the period 1970-71 to 1979-80 in case of both the states, while slowdown is found in the subsequent years. The lowest growth is found during the period 1990-91 to 1999-00. The p-values of t-statistic for all the sub periods as well as overall period are found to be less than 5 percent level of significance. Hence with 95 percent level of confidence it can be concluded that both the states of Punjab and Haryana have statistically significant growth rates of agricultural electrical connections.

4.1.2. Growth of installed capacity, generated capacity, total connections and agricultural connections of electricity Punjab and Haryana; 1970-71 to 2012-13

The progress of electricity infrastructure can be expressed with respect to total connections of electricity as well as agricultural connections of electricity in both the states of Punjab and Haryana. In the research study the growth rate in the number of total and agricultural connections of electricity are estimated for both the states of Punjab and Haryana with the help of semi log model. The growth rates in electrical connections of Punjab and Haryana are estimated for four decades. In addition to these the overall exponential growth rate for the last forty-two years from 1970-71 to 2012-13 is also estimated. The calculated value of growth rates is shown in Table 2.

									(KWH)
	Time Period	**Annual per capita consumption of electricity**				**Consumption of electricity**			
		Total		**Agricultural**		**Total**		**Agricultural**	
		Punjab	**Haryana**	**Punjab**	**Haryana**	**Punjab**	**Haryana**	**Punjab**	**Haryana**
Average	1970-71 to 1979-80	215.49	143.95	64.54	54.41	22045.37	16005.35	9578.42	6091.27
	1980-81 to 1989-90	424.69	255.54	166.08	109.46	70438.63	37177.34	30356.32	15985.11
	1990-91 to 1999-2000	738.96	448.21	291.74	212.58	159196.1	81024.48	63011.2	38366.07
	2000-01 to 2012-13	1006.27	731.96	306.05	289.77	266160.76	175728.34	81554.39	66998.39
	1970-71 to 2012-13	624.95	418.43	214.01	175.15	138997.46	84338.14	48596.9	34311.78
C.G.R.	1970-71 to 1979-80	7.70%	8.50%	13.00%	9.40%	13.30%	10.60%	14.80%	11.60%
	1980-81 to 1989-90	8.40%	4.80%	10.40%	7.20%	11.10%	7.40%	12.20%	9.90%
	1990-91 to 1999-2000	4.30%	1.60%	2.20%	1.10%	5.80%	3.80%	3.20%	3.40%
	2000-01 to 2012-13	3.60%	5.70%	5.10%	4.60%	5.60%	8.60%	6.60%	5.70%
	1970-71 to 2012-13	5.00%	5.20%	5.30%	5.40%	8.00%	7.60%	6.90%	7.70%
t - value and p-value	1970-71 to 1979-80	5.89**	9.46**	10.96**	8.47**	11.29**	11.89**	12.82**	10.54**
		(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
	1980-81 to 1989-90	12.06**	5.4**	9.37**	6.73**	24.62**	8.82**	12.71**	9.69**
		(0.001)	*(-0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
	1990-91 to 1999-2000	11.01**	2.48*	2.05	1.05	24.36**	5.82**	4.16**	3.13*
		(0.001)	*(-0.038)*	*(0.075)*	*(-0.324)*	*(0.001)*	*(0.001)*	*(0.001)*	*(-0.014)*
	2000-01 to 2012-13	10.19**	13.15**	9.10**	15.5**	23.92**	36.73**	11.65**	11.52**
		(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
	1970-71 to 2012-13	26.62**	38.53**	13.39**	24.36**	27.25**	54.63**	17.88**	31.77**
		(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*

Table 2 :Growth of Annual Per Capita Total and Agricultural Consumption of Electricity in Punjab and Haryana; 1970-71 to 2012-13
Source: Calculated from Various Issues of Statistical Abstract of Punjab and Statistical Abstract of Haryana
Note: (*) means at five percent level of Significance, (**) means at one percent level of Significance, otherwise Not Significant

The results indicate that the overall growth rate in case of per capita annual total consumption of electricity is found to be 5.0 percent per annum and 5.2 percent per annum, and in case of per capita annual agricultural consumption of electricity, it is found to be 5.3 percent per annum and 5.4 percent per annum in Punjab and Haryana respectively. The highest growth rate of per capita annual total consumption of electricity was found to be during the period 1970-71 to 1979-80 in case of Haryana against period 1980-81 to 1989-90 in case of Punjab, whereas, in case of per capita annual agricultural consumption of electricity, it is found to be during the period 1970-71 to 1979-80 in case of both the states of Punjab and Haryana, this is because of the green revolution. The results indicate that the overall growth rate of total consumption of electricity is found to be 13.3 percent per annum and 10.6 percent per annum in Punjab and Haryana respectively. Similarly, the results indicate that the overall growth rate of agricultural consumption of electricity is found to be 14.8 percent per annum and 11.6 percent per annum in Punjab and Haryana respectively. The highest growth rate of total as well as agricultural consumption of electricity was found to be during the period 1970-71 to 1979-80 in case of both the states of Punjab and Haryana. The p-values of t-statistic for all the sub periods as well as overall period are found to be less than 5 percent level of significance. Hence with 95 percent level of confidence it can be concluded that both the states of Punjab and Haryana have statistically significant growth rates of per capita annual total as well as agricultural consumption of electricity for all the sub periods as well as overall period of the study. There are various factors responsible for increasing the consumption of electricity in both the states of Punjab and Haryana. The important cause of increasing demand of electricity in Punjab is ever increasing demand of electricity by agriculture sector.

4.1.3. Comparative analysis of installed capacity, generated capacity and connections of electricity in Punjab and Haryana;1970-71 to 2012-13

In the study independent sample t test is applied in order to test the null hypothesis that there is not significant difference in the development of installed capacity of electricity, generated capacity of electricity and connections of electricity between Punjab and Haryana. The results of independent sample t-test are shown in Table 3.

	Time Period	Average		Standard Deviation		t- value and p-value	
		Punjab	Haryana	Punjab	Haryana		
Installed Capacity (MW)	1970-71 to 1979-80	1012.9	612.42	324.85	195.45	3.34**	*(-0.004)*
	1980-81 to 1989-90	2262.4	1413.74	573	243.69	4.31**	*(0.001)*
	1990-91 to 1999-2000	3525	1764.9	294.85	10.31	18.86**	*(0.001)*
	2000-01 to 2012-13	4865.77	3023.31	880.53	1296.82	4.24**	*(0.001)*
	1970-71 to 2012-13	3052.51	1795.67	1594.7	1155.95	4.18**	*(0.001)*
Generated Capacity (Million KWH)	1970-71 to 1979-80	3894.94	2564.5	1372.65	888.23	2.57*	*(-0.019)*
	1980-81 to 1989-90	10004.72	5095.8	2700.49	652.79	5.59**	*(0.001)*
	1990-91 to 1999-2000	17520.55	7230.97	2569.82	441.22	12.48**	*(0.001)*
	2000-01 to 2012-13	24598.47	13228.66	2637.12	6154.33	6.12**	*(0.001)*
	1970-71 to 2012-13	14743.77	7462.45	8404.42	5336.04	4.80**	*(0.001)*
Total Connections	1970-71 to 1979-80	1404633.1	792428	355330.7	169318.45	4.92**	*(0.001)*
	1980-81 to 1989-90	2974815.2	1728936	541357.25	368937.18	6.01**	*(0.001)*
	1990-91 to 1999-2000	4474131.9	3072820.2	378034.57	313849.16	9.02**	*(0.001)*
	2000-01 to 2012-13	6363789.5	4207119.9	861662.37	557974.35	7.57**	*(0.001)*
	1970-71 to 2012-13	3982908.5	2572983	1992318.5	1388529.1	3.80**	*(0.001)*
Agricultural Connections	1970-71 to 1979-80	155957.3	141995.4	54568.44	36382.28	0.67	*(-0.509)*
	1980-81 to 1989-90	428358.1	279694.1	102500.9	37665.31	4.30**	*(0.001)*
	1990-91 to 1999-2000	704139.6	371325.6	56545.89	11861.15	18.22**	*(0.001)*
	2000-01 to 2012-13	984117.31	443022.85	132985.69	68100.95	13.06**	*(0.001)*
	1970-71 to 2012-13	597164.53	318359.26	332913.17	123218.71	5.15**	*(0.001)*

Table 3: Comparative Analysis of Installed Capacity, Generated Capacity and connections of Electricity in Punjab and Haryana; 1970-71 to 2012-13

Source: Calculated from Various Issues of Statistical Abstract of Punjab and Statistical Abstract of Haryana

Note: (*) means at five percent level of Significance, (**) means at one percent level of Significance, Otherwise Not Significant

The results indicate that the p-value of t-statistic in all the sub periods as well as overall period in case of installed capacity of electricity as well as generated capacity of electricity is found to be less than 5 percent level of significance. Hence the null hypothesis of no difference in the development of installed capacity of electricity and generated capacity of electricity between Punjab and Haryana cannot be accepted. The results indicate that there exist significant differences between Punjab and Haryana. The average installed capacity of electricity is found to be better in Punjab as compare to Haryana state. Hence it can be concluded that the size of installed capacity of electricity is significantly high in case of Punjab than Haryana. Similarly, the average generated capacity of electricity is found to be high in Punjab as compare to Haryana during all the sub periods and overall period of the study of 43 years. Hence it can be concluded that Punjab is always better than Haryana in term of generation of electricity. Punjab's average performance regarding installed capacity and generated capacity of electricity is significantly higher than Haryana's. It is because Haryana state has limited availability of natural sources of energy. Hydro generation potential is very less in Haryana. The coal mines are also located far away from the state. Wind velocity is also low. Haryana State has been depending on the limited thermal generation capacity installed within the State and hydropower from the jointly owned projects.

The results also indicate that the average number of total connections as well as average number of agricultural connections of electricity are significantly higher in Punjab as compare to Haryana during all the sub periods and overall period of 43 years of the research study except the decade of 1970-71 to 1979-80 in case of agricultural connections of electricity of Haryana. As p-values of t-statistic for all sub periods as well as overall period are found to be less than 5 percent level of significance, except the period of first decade in case of agricultural connections. Hence the null hypothesis of no significant difference between Punjab and Haryana state with respect to total and as well as agricultural connections of electricity cannot be accepted, except the period of first decade in case of agricultural connections. This is because of the effect of green revolution, recorded in 1966, whose effects persistent in subsequent years. There is ever increasing demand of electricity can be seen by agriculture sector of Punjab, because electricity is free to agriculture sector of Punjab.

4.1.4. Comparative analysis of consumption of electricity in Punjab and Haryana; 1970-71 to 2012-13

In the study independent sample t test is applied in order to test the null hypothesis that there is not significant difference in the development of consumption of electricity between Punjab and Haryana. The results of independent sample t-test are shown in Table 4 The results indicate that the average of per capita annual total consumption of electricity is significantly higher in Punjab as compare

to Haryana during all the sub periods and overall period of 43 years of the research study as p-values of t-statistic for all sub periods as well as overall period are found to be less than 5 percent level of significance. Hence the null hypothesis of no significant difference between Punjab and Haryana state with respect to per capita annual total consumption of electricity cannot be accepted. It is interesting to note that in case of per capita annual agricultural consumption of electricity, both the states of Punjab and Haryana shows almost same performance. There is not found any significant difference between Punjab and Haryana with respect to average of per capita annual agricultural consumption of electricity. This is because both the states are agricultural based economies. The average of per capita annual agricultural consumption of electricity is almost same during first, recent and overall period of the study.

							(LKW)
Consumption of Electricity	**Time Period**	**Average**		**Standard Deviation**		**t- value and p-value**	
		Punjab	**Haryana**	**Punjab**	**Haryana**		
Total Annual Per Capita	1970-71 to 1979-80	215.49	143.95	57.8	37.7	3.28**	*(-0.004)*
	1980-81 to 1989-90	424.69	255.54	114.29	43.01	4.38**	*(0.001)*
	1990-91 to 1999-2000	738.96	448.21	98.64	30.94	8.90**	*(0.001)*
	2000-01 to 2012-13	1006.27	731.96	145.76	165.24	4.49**	*(0.001)*
	1970-71 to 2012-13	624.95	418.43	330.51	252.2	3.26**	*(-0.002)*
Agricultural Annual Per Capita	1970-71 to 1979-80	64.54	54.41	28.67	15.4	0.98	*(-0.338)*
	1980-81 to 1989-90	166.08	109.46	57.72	26.9	2.81	*(-0.012)*
	1990-91 to 1999-2000	291.74	212.58	34.55	19.8	6.23**	*(0.001)*
	2000-01 to 2012-13	306.05	289.77	61.77	53.05	0.72	*(-0.478)*
	1970-71 to 2012-13	214.01	175.15	110.29	99.96	1.71	*(-0.091)*
Total	1970-71 to 1979-80	22045.37	16005.35	9888.25	5194.01	1.71	*(-0.104)*
	1980-81 to 1989-90	70438.63	37177.34	24005.24	9049.4	4.10**	*(-0.001)*
	1990-91 to 1999-2000	159196.1	81024.48	28497.36	9827.55	8.20**	*(0.001)*
	2000-01 to 2012-13	266160.76	175728.34	57198.71	58334.43	4.00**	*(-0.001)*
	1970-71 to 2012-13	138997.46	84338.14	103591.8	72425.17	2.84**	*(-0.006)*
Agricultural	1970-71 to 1979-80	9578.42	6091.27	4773.9	2102.36	2.11*	*(-0.049)*
	1980-81 to 1989-90	30356.32	15985.11	11861.94	5178.87	3.51**	*(-0.002)*
	1990-91 to 1999-2000	63011.2	38366.07	9290.44	4857.7	7.43**	*(0.001)*
	2000-01 to 2012-13	81554.39	66998.39	20852.33	15326.37	2.03	*(-0.054)*
	1970-71 to 2012-13	48596.9	34311.78	31703.98	26135.59	2.28*	*(-0.025)*

Table 4: Comparative Analysis of Consumption of Electricity in Punjab and Haryana; 1970-71 to 2012-13
Source: Calculated from Various Issues of Statistical Abstract of Punjab and Statistical Abstract of Haryana
Note: (*) means at five percent level of Significance, (**) means at one percent level of Significance, Otherwise Not Significant

The results as shown in Table 4 also indicate that the average total consumption of electricity is significantly higher in Punjab as compare to Haryana during all the sub periods (except during 1970-71 to 1979-80) and overall period of 43 years of the research study as p-values of t-statistic for all sub periods (except during 1970-71 to 1979-80) as well as overall period are found to be less than 5 percent level of significance. Hence the null hypothesis of no significant difference between Punjab and Haryana state with respect to average of total consumption of electricity cannot be accepted (except during 1970-71 to 1979-80). The results also indicate that the average agricultural consumption of electricity is significantly higher in Punjab as compare to Haryana during all the sub periods (except during 2000-01 to 2012-13) and overall period of 43 years of the research study as p-values of t-statistic for all sub periods (except during 2000-01 to 2012-13) as well as overall period are found to be less than 5 percent level of significance. Hence the null hypothesis of no significant difference between Punjab and Haryana state with respect to average of agricultural consumption of electricity cannot be accepted (except during 2000-01 to 2012-13).

4.2. Road Transport Development in Punjab and Haryana

Roads are the basic means of communication for the development of any economy. In Punjab and Haryana in order to further strengthen the road network and making it more efficient as per traffic requirements, the main emphasis has been laid on the improvement/up gradation of existing road network, construction of bye passes, bridges/Railway Over Bridges (ROBs) and completion of road construction works. Total number of vehicles registered in Punjab and Haryana are increasing manifold during overall period of the study i.e. from 1970-71 to 2012-13. A well-planned and efficient network of transport is an essential component for a developing economy. The transportation infrastructure includes roads, vehicles, railways, tracks, trains, ports, airports, ships and vessels. Road transportation is the most important because the railway tracks cannot be laid everywhere. The roads are the means by which the movement of people and goods from one place to another is ensured. Millions of people move out of their houses every day to reach their places of work, trade or business daily. They not only generate income from working but also fulfill the needs of others. They use roads and vehicles available to them. The national highways are mainly used to move from one city to another and for supply of essential goods, food grains and other articles of use from one city to another. Road transport in this paper has been

examined in lieu of vehicles registered on road and road length. As there is found higher tendency of accidents on roads in both the Indian states of Punjab and Haryana, so an attempt is also made in order to examine the growth of accidents on roads and vehicles involved in these accidents.

4.2.1. Growth of road transport and accidents in Punjab and Haryana; 1970-71 to 2012-13

The increase in the number of vehicles registered on road and road length is due to the increase in the requirement of increased population. Government of both the Punjab and Haryana states make continuously effort in the development of road transport. As a result of this there is found increasing accidents on roads on Punjab and Haryana. In the research study the growth rate in the vehicles registered on road and road length along with accidents on roads and vehicles involved in the accidents are estimated for both the states of Punjab and Haryana with the help of semi log model as discussed earlier. The growth rate in the vehicles registered on road and road length along with accidents on roads and vehicles involved in the accidents are estimated for four decades. In addition to these the overall exponential growth rate for the last forty-three years from 1970-71 to 2012-13 is also estimated. The calculated value of growth rates is shown in Table 5

	Time Period	Vehicles Registered		Road Length (kms)		Accidents on Road		Vehicles Involved	
		Punjab	Haryana	Punjab	Haryana	Punjab	Haryana	Punjab	Haryana
Average	1970-71 to 1979-80	196891.5	13280.4	23816.6	16073.9	887.4	1017.8	960.1	1117.5
	1980-81 to 1989-90	740128.4	43150.8	34292.7	21893.5	1219.9	2382.9	1225.3	2900.6
	1990-91 to 1999-2000	1923133.3	131201.4	40053.6	23363.4	2591.9	6393.6	2521.6	6753.3
	2000-01 to 2012-13	4490788.5	389797.85	56618.08	24301.08	5034.08	9748.69	5034.08	11118.85
	1970-71 to 2012-13	2022832.2	161481.35	39945.67	21609.81	2614.77	5225.02	2616.58	5866.49
C.G.R.	1970-71 to 1979-80	10.50%	11.10%	9.40%	5.10%	6.10%	8.00%	4.60%	7.80%
	1980-81 to 1989-90	13.30%	11.70%	1.40%	1.10%	4.80%	6.00%	4.50%	12.30%
	1990-91 to 1999-2000	7.90%	12.40%	1.30%	0.40%	9.80%	6.00%	11.90%	6.60%
	2000-01 to 2012-13	6.90%	10.10%	3.10%	1.00%	3.80%	2.80%	3.80%	3.60%
	1970-71 to 2012-13	9.80%	11.30%	2.80%	1.20%	5.70%	7.20%	5.50%	7.30%
t-value and p-value	1970-71 to 1979-80	8.19**	7.36**	9.18**	10.06**	6.02**	3.96**	3.37*	3.82**
		(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(-0.01)*	*(-0.005)*
	1980-81 to 1989-90	37.89**	18.46**	11.80**	7.15**	5.24**	1.79	4.71**	28.48**
		(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(-0.001)*	*(-0.112)*	*(-0.002)*	*(0.001)*
	1990-91 to 1999-2000	59.28**	9.83**	5.73**	5.65**	12.59**	19.26**	7.41**	8.39**
		(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
	2000-01 to 2012-13	54.54**	25.73**	14.73**	5.98**	10.57**	4.45**	10.57**	5.22**
		(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(-0.001)*	*(0.001)*	*(0.001)*
	1970-71 to 2012-13	42.99**	76.88**	18.97**	10.14**	34.57**	23.20**	24.91**	28.89**
		(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*

Table 5:Growth of Road Transport and Accidents on Roads and Vehicles Involved in the Accidents in Punjab and Haryana; 1970-71 to 2012-13

Source: Calculated from Various Issues of Statistical Abstract of Punjab and Statistical Abstract of Haryana

Note: (*) means at five percent level of Significance, (**) means at one percent level of Significance, Otherwise Not Significant

As shown in the results, it is found that the overall growth rate of the vehicles registered on roads is 9.8 percent per annum in case of Punjab state against 11.3 percent per annum of Haryana state. The results indicate that the growth rate of vehicles registered on roads is higher in Haryana as compare to Punjab during overall period of the study. The results also indicate that there is significant growth of vehicles on roads in both the states of Punjab and Haryana during the 43 years of the study. In Punjab the growth rate of vehicles registered on roads was highest during the period 1980-81 to 1989-90. However, in Haryana growth rate of vehicles registered on roads was highest during the period of 1990-91 to 1999-00. Similarly, in case of road length, the growth rate is found to be 2.8 percent per annum in Punjab as compare to 1.2 percent per annum in Haryana. The results indicate that the growth rate of road length is higher in Punjab as compare to Haryana during overall period of the study. The results also indicate that there is significant growth of road length in both the states of Punjab and Haryana during the 43 years of the study. The growth rate of the road length was highest during the period 1970-71 to 1979-80 in both the states of Punjab and Haryana. Since all the p-vales of t-test are found to be less than 5 percent level of significance. Hence with 95 percent level of confidence it can be concluded that both the states of Punjab and Haryana have statistically significant growth rates of the vehicles registered on roads and road length in four sub periods as well as overall period of 43 years. It is also found that Punjab state has higher growth rate in case of road length than Haryana state and lower growth rate in case of vehicles registered on road as compare to Haryana state during overall period of 43 years of the study. The Punjab state has developed a good network of roads. The economy took a new turn with the construction of rural roads in the Punjab state. During 1970- 71 to 2000-01, road network in Punjab increased 3.3 times. Almost all (99.24%) villages are connected by roads. It is further found in the study that the overall growth rate of the incidents of accidents on roads and vehicles involved is 5.7 percent per annum and 5.5 percent per annum in case of Punjab state against 7.2 percent per annum and 7.3 percent per annum of

Haryana state respectively. The results indicate that the growth rate of incidents of accidents on roads and vehicles involved is higher in Haryana as compare to Punjab during overall period of the study. It can be concluded that there is significant growth of incidents of accidents on roads and vehicles involved in both the states of Punjab and Haryana during the 43 years of the study. In Punjab the growth rate of incidents of accidents on roads and vehicles involved was highest during the period 1990-91 to 1999-00. However, in Haryana growth rate of incidents of accidents on roads and vehicles involved was highest during the period of 1970-71 to 1979-80 and 1980-81 to 1989-90 respectively. Since all the p-vales of t-test are found to be less than 5 percent level of significance. Hence with 95 percent level of confidence it can be concluded that both the states of Punjab and Haryana have statistically significant growth rates of the incidents of accidents on roads and vehicles involved in these incidents during four sub periods as well as overall period of 43 years.

4.2.2. Comparative analysis of road transport and accidents in Punjab and Haryana; 1970-71 to 2012-13

Both the states have significant growth of vehicles on roads, road length, incidents of accidents on roads and vehicles involved road transport sector in last many years. In the study independent sample t test is applied in order to test the null hypothesis that there is not significant difference in vehicles on roads, road length, incidents of accidents on roads and vehicles involved road between Punjab and Haryana. The results of independent sample t-test are shown below in Table 6

	Time Period	Average		Standard Deviation		t- value and p-value	
		Punjab	Haryana	Punjab	Haryana		
Vehicles	1970-71 to 1979-80	196891.5	13280.4	69829.5	5181.7	8.29**	*(0.001)*
	1980-81 to 1989-90	740128.4	43150.8	284667.7	15528.6	7.73**	*(0.001)*
	1990-91 to 1999-2000	1923133.3	131201.4	470071	53504.2	11.98**	*(0.001)*
	2000-01 to 2012-13	4490788.5	389797.85	1227971.3	150023.4	11.95**	*(0.001)*
	1970-71 to 2012-13	2022832.2	161481.35	1889385.5	178935.7	6.43**	*(0.001)*
Road Length (in kms.)	1970-71 to 1979-80	23816.6	16073.9	6357.6	2442.9	3.60**	*(-0.002)*
	1980-81 to 1989-90	34292.7	21893.5	1489.7	748.6	23.52**	*(0.001)*
	1990-91 to 1999-2000	40053.6	23363.4	1881.9	290.2	27.72**	*(0.001)*
	2000-01 to 2012-13	56618.08	24301.08	7127	1037.6	16.18**	*(0.001)*
	1970-71 to 2012-13	39945.67	21609.81	13416.3	3466.2	8.68**	*(0.001)*
Accidents on Road	1970-71 to 1979-80	887.4	1017.8	188.38	310.26	-1.14	*(-0.271)*
	1980-81 to 1989-90	1219.9	2382.9	211.18	839.6	-4.25**	*(0.001)*
	1990-91 to 1999-2000	2591.9	6393.6	765.27	1176.32	-8.57**	*(0.001)*
	2000-01 to 2012-13	5034.08	9748.69	799.82	1295.58	-11.16**	*(0.001)*
	1970-71 to 2012-13	2614.77	5225.02	1819.59	3707.37	-4.14**	*(0.001)*
Vehicles Involved in Accidents	1970-71 to 1979-80	960.1	1117.5	178.54	321.9	-1.35	*(-0.193)*
	1980-81 to 1989-90	1225.3	2900.6	205.84	1088.29	-4.78**	*(0.001)*
	1990-91 to 1999-2000	2521.6	6753.3	867.03	1413.36	-8.07**	*(0.001)*
	2000-01 to 2012-13	5034.08	11118.85	799.82	1866.86	-10.8**	*(0.001)*
	1970-71 to 2012-13	2616.58	5866.49	1812.47	4229.67	-4.63**	*(0.001)*

Table 6: Comparative Analysis of Road Transport and Accidents in Punjab and Haryana; 1970-71 to 2012-13
Source: Calculated from Various Issues of Statistical Abstract of Punjab and Statistical Abstract of Haryana
Note: (*) means at five percent level of Significance, (**) means at one percent level of Significance, Otherwise Not Significant

The results indicate that the average number of vehicles registered on roads and average of road length is significantly higher in Punjab as compare to Haryana during all the sub periods and overall period of 43 years of the research study as p-values of t-statistic for all sub periods as well as overall period are found to be less than 5 percent level of significance. Hence the null hypothesis of no significant difference between Punjab and Haryana state with respect to average number of vehicles registered on roads and average of road length cannot be accepted. Hence, it is found that Punjab has performed better than Haryana in case of average number of vehicles registered on roads and average of road length during all the sub periods and overall period of 43 years of the research study. The results shown in table 4.6 also indicate that the average number of the incidents of accidents on roads and vehicles involved is significantly higher in Haryana as compare to Punjab during all the sub periods and overall period of 43 years of the research study (except first decade of the study) as p-values of t-statistic for all sub periods (except first decade of the study) as well as overall period are found to be less than 5 percent level of significance. Hence the null hypothesis of no significant difference between Punjab and Haryana state with respect to average number of incidents of accidents on roads and vehicles involved cannot be accepted. Hence, it is found that Punjab has performed better than Haryana in case of average number of incidents of accidents on roads and vehicles involved during all the sub periods (except first period) and overall period of 43 years of the research study.

5. Conclusion

It is found in the study that the governments of both the states of Punjab and Haryana are encouraging more private participation through public private partnership (PPP) concept since last few years in all the aspect of infrastructure development. It is found that

both the states of Punjab and Haryana have made tremendous growth in case of electricity and road transport. The performance of Punjab state is found always better than Haryana in term of electricity with special reference to electricity generation, per capita consumption of electricity etc. Since its formation, the Punjab state has been making every effort to augment its energy resources. By 1975-76, it achieved 100 per cent electrification of all its villages. All the villages are connected to a grid. Thermal power continues to be the major supplier of energy in the Punjab state. Haryana state has limited availability of natural sources of energy. In spite of the importance of energy, the expenditure on it in the Haryana state has been continuously declining during successive five-year and annual plans. By the year 1999-2000, among the states, Punjab kept its record of highest per capita consumption followed by Goa and Gujarat [11]. To make physical infrastructure more effectively operative, there is always a greater need of road transport which heavily depends upon vehicles registered on roads and road length in any economy. Government of both the Punjab and Haryana states make continuously effort in the development of road transport. It is found in the study that the number of vehicles registered on road and road length maintained by Public Department Works (Buildings and Road) in Punjab and Haryana are increasing manifold during overall period of the study. Growth rate of road length is found to be higher in Punjab as compare to Haryana during overall period of the study. Whereas the growth rate in case of vehicles registered on road is found lower in Punjab as compare to Haryana state during overall period of 43 years of the study. It is found that Punjab has performed better than Haryana in case of average number of vehicles registered on roads and average of road length during all the sub periods and overall period of 43 years of the research study. It is also found in the study that the incidents of accidents on road and vehicles in these accidents in Punjab and Haryana are increasing manifold during overall period of the study with upper hand of Haryana. But it is a matter of serious concern that the increasing demand of electricity in both the states immediately required the intensive surveys that should be undertaken to commercialize non-conventional renewable resources of energy such as solar energy, wind power, bio-mass and geo-thermal energy etc. as it is pollution free and specialized organizational and management skills are not called for[12]. As road length and number of vehicles are increasing very rapidly, all the villages are linked with *Pucca* village roads in both the states of Punjab and Haryana, Though the government Haryana is very keen to implement strict road safety measures, yet there are increasing number of accidents and vehicles involved on road being significantly higher in Haryana.

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