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**Research Paper**

# Revolution of Emerging Information Technology in Transportation and Logistics Management System Context of Indian Smart City: Economical Aspects

Nilanjan Das[1*], Ritam Chatterjee[2] and Ratnankur Majumdar[1]

[1]Department of Computer Application, Siliguri Institute of Technology, Siliguri, West Bengal, India
[2]Department of CIS, Raiganj University, West Bengal, India

*Corresponding author: nilanjan.das81@gmail.com (**ORCID ID:** 0009-0002-5064-6929)

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**ABSTRACT**

Good quality transportation system enhances the growth of economy and extends social development in the country. Transportation fills the gap of communication between the places. It helps to improve trading, businesses in different states of the country. Logistic management is another side of transportation of goods from the factory source to the delivery point. Logistics management is the vital to increase the growth of business as well as economic growth of the country. Technology plays the role to improve transportation and logistics management system. Technologies are renovated in regular basis and new technologies are appeared in this era. Emerging information technologies are included to mold the transportation system as smart and intelligent. The modern city is advancing in all the directions nowadays, modern cities are comprising as smart and advance city. Smart transportation is the essential aspect of smart city. Therefore, advancement of transportation in smart city is very significant. Logistic management is emergent aspect of business. Progress of business extend the economical potency of country. Therefore, modernization of logistic management system is very essential. Role of information technology in transportation and logistics management system is portrayed in this paper. Impact of economic factors in growth of transportation and logistics management system in context of Indian smart cities are emphasis in this paper.

**HIGHLIGHTS**

- Smart Transportation is the intelligent transportation system in terms of smart technology.
- Smart Transportation is the advance transportation in context of smart city.
- Smart transportation develops the economy of city and country.
- Economy extends smart projects in transportation.
- Technology emergence associated in development advance projects in transportation.
- Economy enhances technology-based project in transportation.

**Keywords:** Smart City, IT, Transportation System, Logistics management System, AI, Cloud Computing, IoT

The transportation system has undergone radical changes parallel to the progress of the era. Evolutionary changes observed in transportation modes in the 21st century from earlier edge (Mrityunjaya *et al.* 2017). Nowadays, transportation decreases the gap of communication and movement from one location to another. Transportation plays a main role in the development of society and extends strength of the country's economy (Paul & Aithal

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2018). As per extensive evolution in technology, emerging and innovative technology associate with transportation to renovate the transportation system (Singh *et al.* 2022). Involvement of advance technology in transportation make transportation smarter (Chatterjee 2022; Chen*et al.* 2022; Pau*et al.* 2019) Areas of transportation are traffic controls, vehicles and modes of transportation. Transportation is more advanced and progressive in urban areas (Agarwal *et al.* 2015; Ang *et al.* 2022). Therefore, comparatively urban transportation is better than rural transportation. Nowadays cities moving forward in every direction according to the variation and modernization of technology (Balasubramaniam *et al.* 2017; Bamwesigye & Hlavackova 2019; Bamwesigye & Hlavackova 2019).

Cutting edge technology depicted in every dimension to extends the life standard of people resides in the country (Paul *et al.* 2020). Prosperity of urban areas rises slowly in India (John *et al.* 2019). Cities are switch to the smartest cities with state of art technologies (Silva *et al.* 2018). Transportation in smart cities become smart in nature (Fantin Irudaya *et al.* 2022; Telang *et al.* 2021; Vakula & Raviteja, 2017). Transportation and logistics system rapidly changing and improving in urban areas because transportation is the significant areas to develop socio economic aspects (Chopra *et al.* 2021; Das *et al.* 2023; Paul & Aithal, 2018). Logistics management system is very crucial to improve business and increase profit for industries. Various smart based cities in India investing in development of transportation and logistics management system (Nikitas *et al.* 2020; Vadgama *et al.* 2015). Roles of ICT in transportation is very significant to make transportation smarter and to extent the cities as intelligent (Bohloul 2020; Chatterjee, 2022; Turner *et al.* 2016). This study prioritizes the comparative analysis on the investment in transportation for smartest cities in India according to technological implementation (Das *et al.* 2023; Perboli *et al.* 2014).

## Objectives of the work

The paper entitled "Revolution of Emerging Information Technology in Transportation and Logistics Management System Context of Indian Smart City: Economical Aspects" is analytical in nature and based on the experiments. Various aims of this study are as follows:

- To analyze investment of transportation in smart cities
- To study and analyze about ICT technology implementation in transportation
- To analysis economy of technology association for development of transportation as per investment in transportation projects of smart city
- To compare the investment in Non-ICT and ICT in Transportation and logistics management system in progressive smart cities in India

## Methodology Adopted

This work is the analysis of the fund allocated for build technology infrastructure in smart transportation and logistics management in smart cities of India. Funds allocated for each project in aspects of technology and non-technological infrastructure of transportation are analyzed in this work. The main purpose of this research work is to find the technology association to build transportation as advanced and intelligent. Research methodologies are applied to make analysis of data. First data collected and processed to further analysis of data. Then sample is designed for the analysis. Analysis is divided into two steps one summarizes or exploration of data and then experiments the results or outcomes to find valuable insights. Following methodologies are adopted in this work.

### *Data Collection*

Data is gathered from the smart city projects investments in different direction of transportation and logistics management. Data collected from smart city government website smartcities.gov.in as primary data (Smart Cities (n.d.)). Data collected according to the investment in transportation for each project assign to various smart cities in India. Data related to the investment on the ICT and non-ICT transportation and logistics management projects in the smart cities in India. In this study, different categories ICT and non-ICT related projects of transportation considered for survey and analysis regarding amount of investment. Intelligent traffic, Intelligent signaling, Intelligent parking management system, Intelligent Transit Management System, Smart Vehicle monitoring using CCTV camera, PTZ camera, GPS tracking, Smart Digital Signage, Smart

Passenger Information System, Smart Ticketing, Non Motorist Transportation System (NMT), Smart multilevel Parking management system, Smart Bus Stop, Smart Bus Shelter, Fleet Management System, Infrastructure related to road construction and upgradation, Vehicle sharing, e-buses, e-rickshaw, pedestrian construction and upgradation, Development of green corridor, Re development of bus stand, Modernization of Junction, Development of BRT corridor, Development of bus stand, Depot and bus shelter development, Bicycle Lane, Footpath, Traffic Calming Street, following are the projects parameter surveyed and analyze in this study (Barone *et al.* 2014; Javaid *et al*. 2018; Pop *et al.* 2018; Vlahogianni *et al.* 2016). After gathering all the transportations projects parameters data, data grouped into two samples as investment in the advanced ICT technology in transportation projects and non-ICT infrastructure project investments for smart cities.

### *Data Sample*

Approximately 100 smart cities are available in India at present. In this study 30 cities out of 100 cities are consider as sample size in this study for survey and analysis of transportation projects investment data. Data gathered from these 30 cities in different states in India for analysis.

### *Data Analysis using Statistical Tools*

Analysis of investment data in transportation have been done using descriptive statistics, and data explored by graph and charts. Relation between variables measured using inferential statistical tools and conclusion made according the result of analysis. Descriptive statistics help to analyze and summarize the investment in transportation. Analysis has been made using the statistical software such as SPSS, JAMOVI, and EXCELL. Results are compared accurately with both statistical software tools SPSS and JAMOVI.

### Data Analysis

Data is grouped together by analyzing various factors regarding advanced ICT based technological involvement in the projects then data processed and categorized into four variables ICT infrastructure investment, non-ICT infrastructure investment, number of transportation projects in each city, total investment including ICT and Non-ICT investment. All the data gathered to analyze the factors that how much data invested for the technological aspects as compared with non-technological data. Other analysis including difference between both the variables including ICT infrastructure investment and non-ICT infrastructure investment in smart cities. Therefore, mean and standard deviation explored here using bar graph. Experiments done in the following ways:

- Exploratory data analysis done with tables and graphs. Number of projects and total investment are analyzed to know what is amount invested for transportation projects in 30 smart cities. It is explored with graphically. Number of projects also analyzed here to find is there any relationship between total number of projects and total investment regarding each smart city.
- ICT infrastructure and non-ICT infrastructure investment data compared to find the differences between both the parameters. The main objective of this analysis to compare two parameters to find, technological infrastructure investment is higher than non-technological infrastructure investment or not according to the different sample of cities.
- To make inference of the analysis, various statistical methods are applied to proof the hypothesis drawn for analysis. ICT infrastructure investment and non-ICT infrastructure investment are analyzed with non-parametric inferential statistical methods. Relation between two parameter such as number projects and total investment analyze with correlation coefficient method to find is there any direct relation available between number projects and total investment. Total number of projects influences the investment or not is analyzed.

Fig. 1 summarize number of transportation projects in some smart cities of India. In this study 30 smart cities transportation projects have been taken as sample data including ICT and non-ICT infrastructure. Some of the smart cities has highest number of transportation projects. The main observation is Chandigarh and Jaipur city have highest number of transportation projects

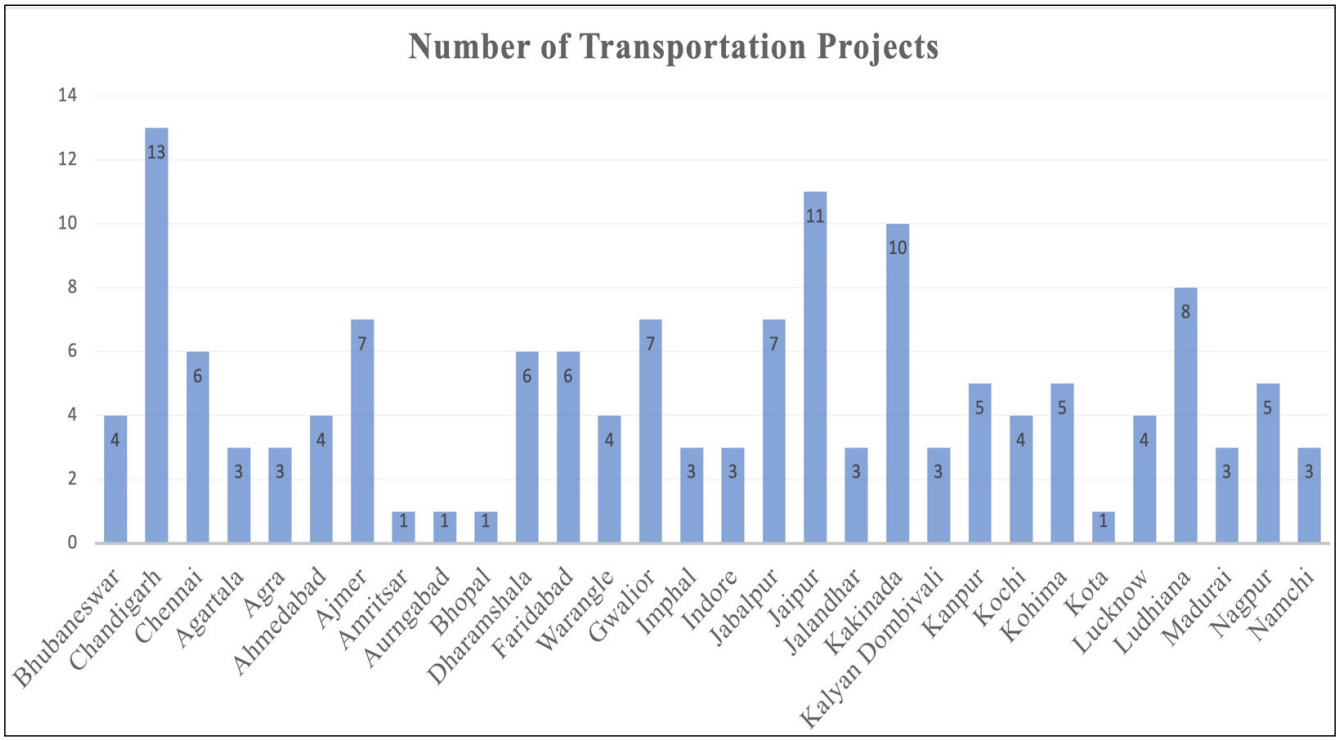


**Fig. 1:** Number of Transportation Projects in Smart Cities

out of 30 smart cities. Kota, Amritsar, Aurangabad, and Bhopal have lowest number of transportation projects. Therefore, limited number of city emphasis on the improvement of transportation and logistics management to make cities more progressive and smarter.

**Table 1:** Non-ICT Infrastructure and Infrastructure Investment

| States | Smart City | Non-ICT Infrastructure Investment (unit percentage) | ICT Infrastructure Investment (unit percentage) |
|---|---|---|---|
| Odisha | Bhubaneswar | 73% | 27% |
| Punjab | Chandigarh | 91% | 9% |
| Tamil Nadu | Chennai | 26% | 74% |
| Tripura | Agartala | 20% | 80% |
| Uttar Pradesh | Agra | 0 | 100% |
| Gujrat | Ahmedabad | 0 | 100% |
| Rajasthan | Ajmer | 70% | 30% |
| Punjab | Amritsar | 0 | 100% |
| Maharashtra | Aurangabad | 0 | 100% |
| Madhya Pradesh | Bhopal | 0 | 100% |
| Uttarakhand | Dharamshala | 0 | 100% |
| Haryana | Faridabad | 31% | 69% |
| Telangana | Warangal | 0 | 100% |
| Madhya Pradesh | Gwalior | 86% | 14% |
| Manipur | Imphal | 48% | 52% |
| Madhya Pradesh | Indore | 67% | 33% |
| Madhya Pradesh | Jabalpur | 63% | 37% |
| Rajasthan | Jaipur | 25% | 75% |
| Punjab | Jalandhar | 66% | 34% |
| Andhra Pradesh | Kakinada | 1% | 99% |
| Maharashtra | Kalyan Dombivli | 0 | 100% |
| Uttar Pradesh | Kanpur | 25% | 75% |
| Kerala | Kochi | 76% | 24% |
| Nagaland | Kohima | 35% | 65% |
| Rajasthan | Kota | 0 | 100% |
| Uttar Pradesh | Lucknow | 0 | 100% |
| Punjab | Ludhiana | 34% | 66% |
| Tamil Nadu | Madurai | 66% | 34% |
| Maharashtra | Nagpur | 94% | 6% |
| Sikkim | Namchi | 61% | 39% |

Fig. 2 represents total amount of investment for transportation projects in smart cities. According to the number of samples in this study, 30 smart cities total investment in transportation projects including all categories of projects summarized using above

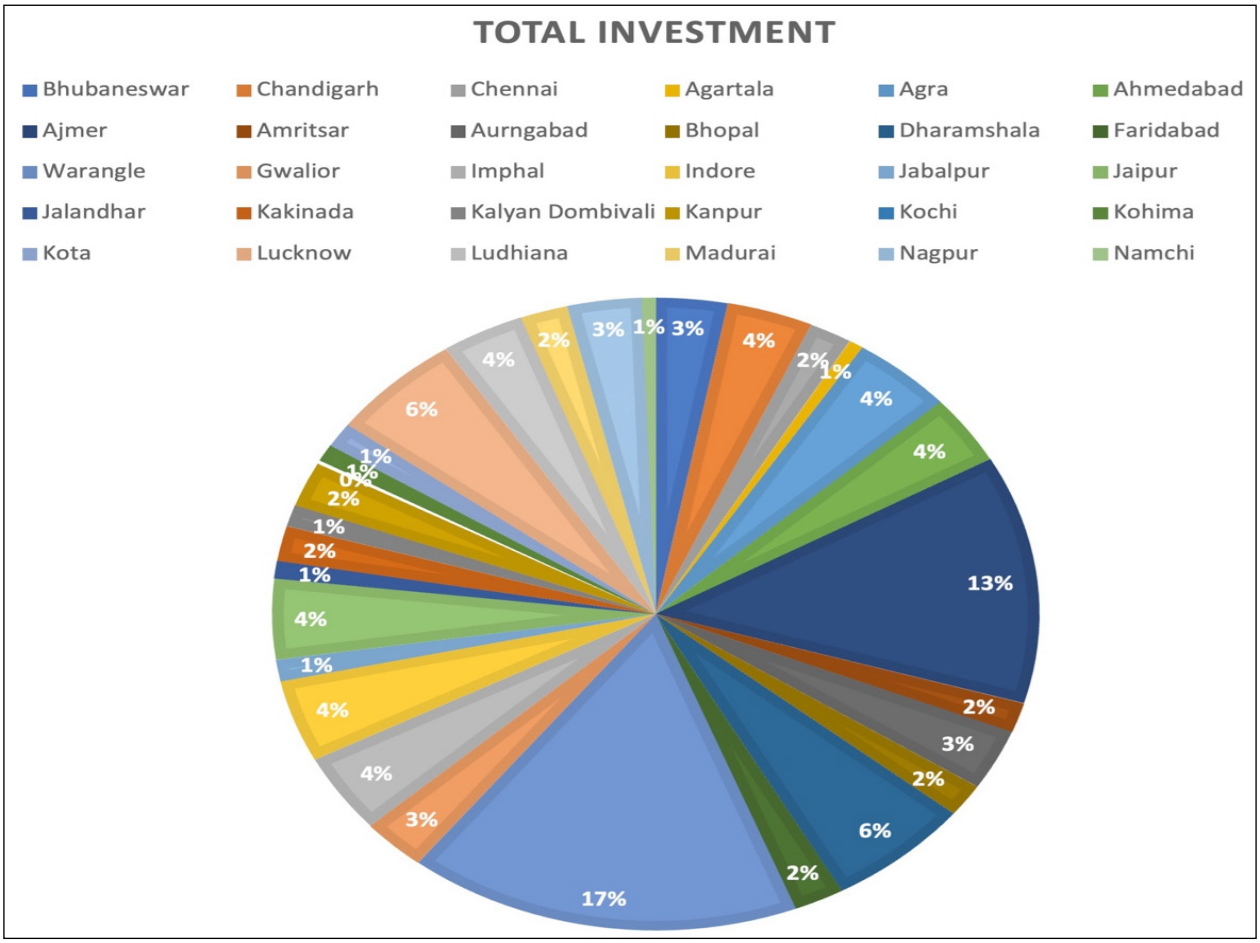


**Fig. 2:** Total Investment for Transportation Projects in Smart Cities

chart. Wrangle city has maximum investment in transportation as compared with other smart cities investment out of 30 smart cities. Ajmer placed in second highest position has maximum investment as compared with other cities out of 30 smart cities. Namchi and Agartala belongs to states Sikkim and Tripura have minimum investment in transportation projects.

Transportation projects invested amount explore here using the bar charts. In this analysis, it is found that some of the cities might not be invested in the non-ICT infrastructure projects. Like Agra, Amritsar, Bhopal, Aurangabad, Ahmedabad, Kalyan Dombivli, Lucknow, Warangal, Kota, and Dharamsala has zero investment in non-ICT infrastructure. Observation of analysis is minimum amount invested for non-ICT based projects by each city whereas large amount invested for development of ICT based projects. Only Ajmer city emphasize on investment in development of non-ICT projects. Warangal in highest position for ICT projects investment. Therefore, maximum amount assigned in ICT related projects. Figure-3 summarize ICT and Non-ICT related transportation projects investment in smart city.

**Table 2:** Statistical Data of Transportation Projects

| Types of Transportation Projects | Mean | Standard Deviation |
|---|---|---|
| ICT based Projects | 203.4606667 | 279.8878912 |
| Non-ICT | 95.56166667 | 160.9794195 |

Table 2 presents the statistical data analysis of ICT and Non-ICT projects investment. Standard deviations of both project investment are higher than means. Average investment in ICT based project is higher than average investment in non-ICT based project. ICT project investment is greater than non-ICT project investment as per standard deviation. Large standard deviation is observed in both samples. Therefore, data spread in scattered way around the mean and maximum variance available around the mean.

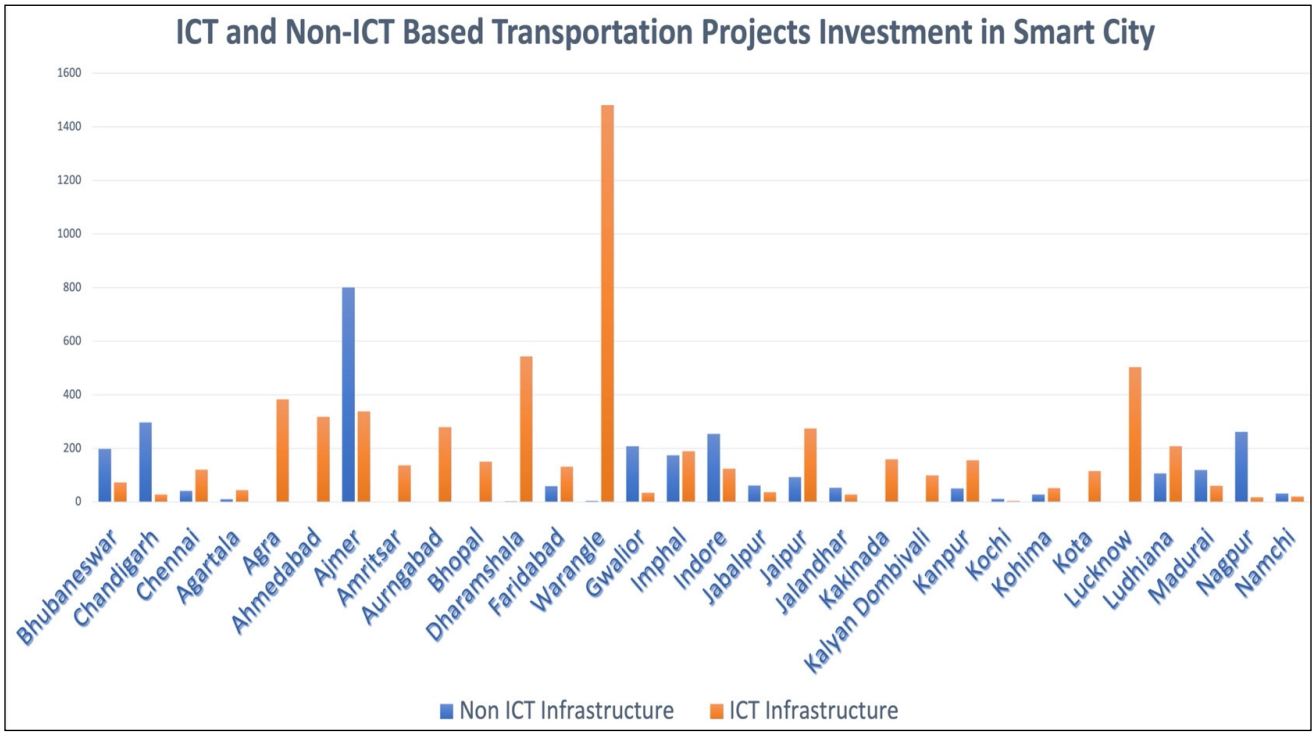


**Fig. 3:** ICT and Non-ICT Based Transportation Projects Investment in Smart City

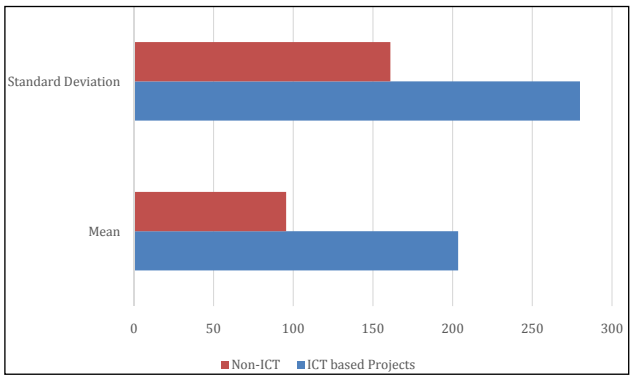


**Fig. 4:** Statistical analysis between ICT and Non-ICT project Investment

## RESULT AND FINDINGS

In this study two variables such as Non-ICT Infrastructure investment and ICT infrastructure investment data first analyzed to experiments that what is impact of advanced technology to develop transportation as smart and intelligent. Inferential statistical methods applied to proof the outcome of this analysis.

First normality of two variables tested before analysis. Shapiro-Wilk test used here to check normality of each variables data. Table 3 summarize the data of two variables using descriptive statistics and with normality test.

**Table 3:** Descriptive Statistics and Normality Test

| Descriptive | | |
|---|---|---|
| | **Non-ICT Infrastructure** | **ICT Infrastructure** |
| N | 30 | 30 |
| Missing | 0 | 0 |
| Mean | 95.6 | 203 |
| Median | 36.4 | 128 |
| Standard deviation | 161 | 280 |
| Minimum | 0.00 | 3.60 |
| Maximum | 801 | 1481 |
| Skewness | 3.17 | 3.54 |
| Std. error skewness | 0.427 | 0.427 |
| Kurtosis | 12.5 | 15.3 |
| Std. error kurtosis | 0.833 | 0.833 |
| Shapiro-Wilk W | 0.620 | 0.610 |
| Shapiro-Wilk p | < .001 | < .001 |

This table shows that mean value is greater than median and skewness in the table represents positive skewness of the data. Shapiro-Wilk p value is .001 for both the variable. Here p value is lesser than 5% level of significance that mean it lesser than 0.05. This result proof that null hypothesis is not accepted here. The null hypothesis is data normally distributed. Therefore, both the variables are not normally distributed which are proved

using observation of mean value, skewness, and Shapiro-wilk tests.

According to result of normality test, parametric test is not applicable for this experiment as the data not normally distributed. Therefore, non-parametric statistical method is used to analyze both independent variables. These two independent samples are analyzed using Mann-Whitney U test which is the appropriate test for this experiment and it related with the parametric t test methodology. Mann-Whitney U non parametric test is used two analyze two independent samples which are not normally distributed or data might be ordinal and categorical in nature. Using Mann-Whitney U test following experiments done to know fact about both the sample values are equal or not. If both sample values are not equal then which sample values are differed from other is shown in this outcome analysis using Mann-Whitney U test. Following are the experiments results using Mann-Whitney U non parametric statistical test. Table 4 shows the hypothesis of this analysis.

**Table 4:** Hypothesis of Analysis

| Null Hypothesis | Alternative Hypothesis |
|---|---|
| $H_0$: Both the sample are equals | Ha: Both the samples are not equal. |
| $H_0$: First sample is lesser than second sample | Ha: First sample is greater than second sample |
| $H_0$: First sample is greater than second sample | Ha: Second sample is greater than first sample |

**Table 5:** Outcome of Hypothesis-1 Analysis Using Mann-Whitney Test

| | | Statistics | P |
|---|---|---|---|
| Investment | Mann -Whitney U | 252 | 0.003 |

Table 5 portray the result of hypothesis testing. p value is lesser than 0.05 which statistically significant that means null hypothesis is not considered in this analysis. Alternative hypothesis is true here and granted as result of analysis. Therefore, there is differences between non-ICT infrastructure investment and ICT infrastructure investment in transportation projects.

Table 6 represents the result of hypothesis testing. Here p value greater than 0.05 and is not significant and null hypothesis is true. Alternative hypothesis is not granted here. As per the second null hypothesis, first sample is lesser than second sample. Therefore, Non-ICT investment samples lesser than ICT investment samples.

**Table 6:** Outcome of Hypothesis-2 Analysis Using Mann-Whitney Test

| | | Statistics | P |
|---|---|---|---|
| Investment | Mann -Whitney U | 252 | 0.998 |

Table 7 highlights the result of hypothesis analysis. In this result, p value is lesser than 0.05 as 5% significant level. Therefore, the result is statistically significant and null hypothesis is not granted for this analysis and alternative hypothesis is true. Alternative hypothesis of the third hypothesis testing shows that second sample values are greater than first sample values. Therefore, the inferential fact is the ICT investment is higher than non-ICT investment in development of transportation infrastructure.

**Table 7:** Outcome of Hypothesis-3 Analysis Using Mann-Whitney Test

| | | Statistics | P |
|---|---|---|---|
| Investment | Mann -Whitney U | 252 | 0.002 |

These experiments validate is there any relationship between two sample number of projects and total investment in transportations. The objective of this analysis is to investigate if number of projects is increased then investment is also increased accordingly. Pearson's correlations coefficient statistical method applied to experiment the relation between two samples. As per the result of analysis using pearson's correlation, positive relationship exists between two samples. The value of r in the table shows 0.141 which is lies between 0 and 1 and p value is greater than 0.05 that means null hypothesis is granted. If the null hypothesis is granted then there is no relationship between number of projects and total investment for projects of transportation.

Table 8 shows statistics of Pearson's correlation and coefficient analysis between two samples such as number of projects and total investment. The results of these experiments are mentioned in the table. Hypothesis of this analysis are correlated or not, correlated positively, and correlated negatively. In all these cases p-value is higher than 0.05 and

the result is null hypothesis true. According to the analysis result, there is relationship between number of projects and total investment. Therefore, both samples are correlated with each other's, positively correlated according to the Pearson's r value 0.141, and no negative correlation. Here r value of pearsons correlation effect the results which is lies between 0 and 1.

**Table 8:** Pearson's Correlation Coefficient Analysis

| Hypothesis | Pearson's r | Df | p-value |
|---|---|---|---|
| Correlated | 0.141 | 28 | 0.457 |
| Correlated Positively | 0.141 | 28 | 0.229 |
| Correlated Negatively | 0.141 | 28 | 0.771 |

## CONCLUSION

As per the analysis results, cutting edge technology used to advancement of transportation system as intelligent transportation in this modern era. The main goal is to create smarter solutions for transportation and logistics management using the aid of emerging technology. It has been observed from the experiment outcome, large amount of fund approved for several ICT associated projects of mobility and transportation. As per the comparison between investment in technology and non-technology projects of mobility and transportation, investment in technology-oriented projects is larger than investment in non-technology projects. Therefore, smart cities are focused in transforming, upgradation, and advancement of transportation with the help of recent updated technology. All the statistical analysis done in this work to study the economic support for development of intelligent technology-based transportation and logistics system. Finally, the observation of experiment is maximum economic support is given for technological infrastructure development in transportation and mobility. Transportation sectors are improving in limited cities. Due to the evolution of state of art information technology, today information technology is inevitable.

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