CHAPTER 3

RESEARCH METHODOLOGY OF THE STUDY

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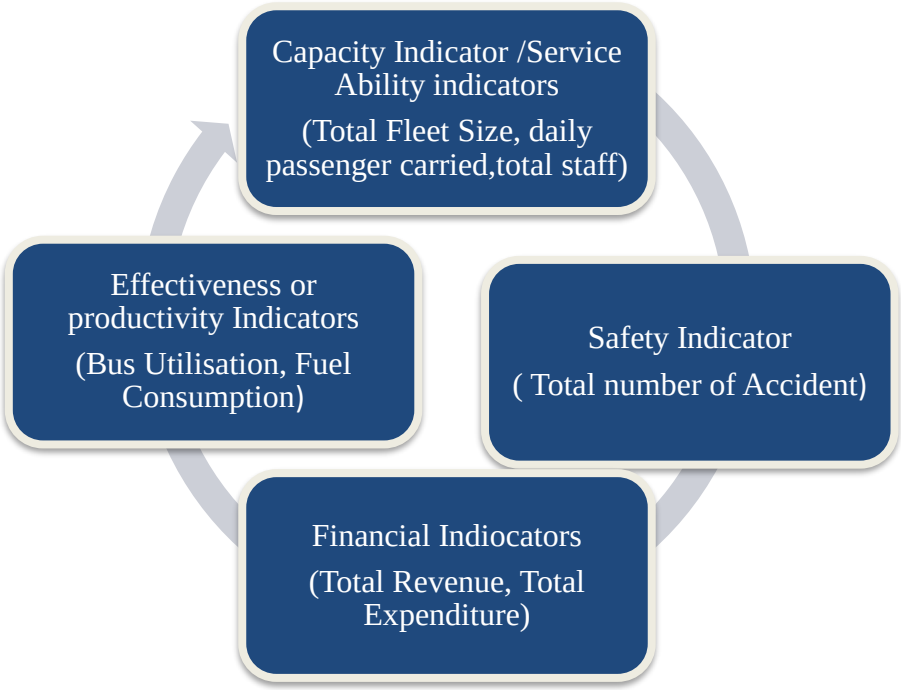
Appropriate research methodology has been adopted based on the problems and objectives of the study. This study has been entirely based on secondary data. The data has been collected from various secondary sources including the official documents, reports, press reports of the state of Haryana. In Haryana, Haryana Roadways is the public mode of road transport. Presently, in Haryana there are 24 depots and 13 sub depots that are operated by Haryana Roadways. For the present study 20 depots have been taken, except FBD (CBS), Palwal, Charkhi Dadri and Nuh. The selected depots are- Ambala,Chandigarh, Karnal, Jind, Kaithal, Sonepat, Yamunagar, Delhi, Kurukshetra, Panipat, Gurugram, Rohtak, Hisar, Rewari, Bhiwani, Sirsa, Faridabad, Fatehabad, Jhajjar and Narnaul. Fardabad bus depot (city bus service), Palwal, Charkhi Dadri and Nuh has not been considered for the study because the time period for the study was 2001-02 to 2016-17. These depots were established after 2001- 02 and data of these depots is not available, however these depots included in their parental depots. Gurgram was the parental depot of Nuh, Bhiwani parental depot of Charkhi Dadri and Faridabad was the parental depots for CBS and Palwal. On 15 August 1979, Gurugram district divided in to a new Faridabad district at that time Palwal was the part of it, but in 15 August 2008 Palwal became the twenty first district of Haryana, correspondingly before first December 2016 Charkhi Dadri was included in Bhiwani district but in December 2016 Charkhi Dadri became the twenty two district of Haryana. Nuh depots seprated from gurugram depot in 1st January 2013 similarly Faridabad bus service was seprated from Faridabad depot in 1st June 2012.

3.1 Trends and Performance of Haryana Roadways

On the basis of previous national and international literature works, there are various type of indicators which can be used for the measuring the performance of public transport such as average fleet size, number of bus route in a day, average daily passenger km trips, road density, no of station per km, taxes, cost, depreciation, number of accidents, number of breakdowns etc. But as per availability of limited data, in this present study suitable indicators have been used for the analysis the performance of Haryana Roadways. Broadly, performance indicators are divided into four categories. They are as follows-



3.1.1Capacity Indicator-

Capacity indicators simply defines such type of indicators which measured that how much Haryana Roadways capable to fulfill the demand of transport. The total output production of Haryana Roadways depends upon various capacity indicators or service ability indicators. In this

study for measuring the production capacity of Haryana Roadways Fleet Size, Total Number of staff, and daily passenger carried had been choosen.

1. Fleet Size- Fleet size describes the total number of buses of Haryana Roadways on road in a depot. Fleet size shows the capital of Harayna Transport department. As per previous studies (Agarwal 2010) explains that the fleet size of public transport can be used as capital. The service provided by Haryana Roadways depends upon its number of buses on road.

   Fleet size= $Total\ number\ of\ buses\ operated\ on\ road$

2. Daily passenger carried- The service utility of Haryana Roadways can be measures with the help of total number of daily passenger carried by each bus in a day. Daily passenger carried regarded as the sum of movement by every single passenger.

   DPC=$\sum_{i=0}^{n} passenger\ load\ between\ discrete\ stop$

3. Total number of staff- Both indicators which are explained above are very important for measurement of service ability of Haryana Roadways but they are useless without adequate or efficient staff.

   Total staff= $administrative\ worker + transport\ worker + workshop\ worker$

3.1.2 Productivity indicators-

Productivity simply implies the ratio of output to input. Productivity indicators are those indicators which are tells about the productivity of Haryana Roadways.

1. Bus utilization- Bus utilization denotes the total effective bus kilometer done by a Haryana Roadways on road in a day. It can calculated as

$$\text{Bus utilization} = \frac{total\ effective\ kilometers\ done\ on\ a\ day}{total\ number\ of\ buses}$$

2. Fuel consumption- Fuel consumption means total fuel consumed by a bus in a day.

$$\text{Fuel Consumption} = \frac{total\ effective\ kilometer\ done}{total\ fuel\ consumed}$$

3.1.3 Financial Indicators-

Financial indicators are used to check the viability of unit. With the help of financial indicators it is easy to calculate the possible practicable condition of decision making units. Here two major financial indicators has been used for measured the trends and performance analysis of Haryana roadways.

1. Total Receipts- Total Receipts refers to the total cash received by each depot in a year.

   Total Receipts- $total\ transport\ income + other\ income + resturant\ income$

2. Total Expenditures- It includes total expenditure which related to investment, price and cost.

3.1.4 Safety Indicator-

For safety parameter, accident by each depot in a year has been taken. Negative growth or positive growth rate of total number of accidents means that rate of total number of accident in 16 years has been decline or increase , as a safety indicator this is very important in reduction of total number of accidents by Haryana roadways for their best utilization.

3.1.5 CAGR of Performance Indicators

To measure the growth rate of all performance indicators which have been used for performance analysis, percentage method and compound annual growth rate method have been used.

Compound Annual Growth Rate (%)= [logest (Y_{a1}+Y_{a2}+Y_{a3}+……..Y_{an})-1]*100

Here, Y= variables which used for analysis

A= Time (1, 2, 3,…….n) for each period

3.2 Efficiency of Haryana Roadways

Multiple input and output variables have been selected to measure the efficiency and effectiveness of decision making units. In previous studies energy consumption, fuel consumption, fleet size, total number of staff etc. considered as input variables. For output variables passenger per kilometer, tone per kilometer, bus utilization, effective kilometer per day etc. was used. But in this study the efficiency of Haryana Roadways has been calculated so, some major inputs and outputs has taken which was perfectly suitable for measurement of the efficiency of Haryana Roadways, explained below-

3.2.1 Inputs

I. Capital input- Fleet size (Total number of buses) will be taken as capital input.
II. Labor input- Total Staff (Total number of employers worked in a Depot) will taken as labor input.
III. Material input- Fuel Consumption

Fuel Consumption-Total earned kilometer / Fuel Average

3.2.2 Output

I. Bus Utilization (Total effective kilometer done by per bus on road per day).

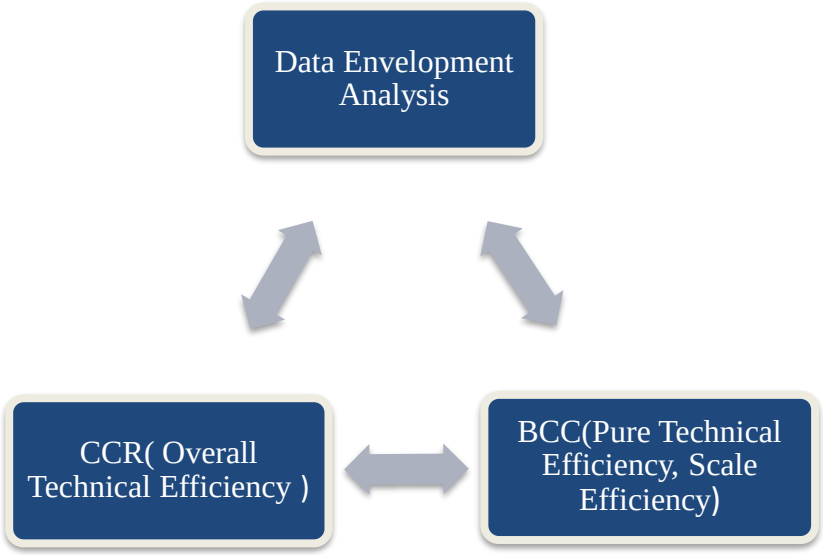
In previous studies bus utilization were used to measured the efficiency of STUs and passenger per kilometer used for measured the effectiveness of STUs (Agarwal 2016). In present study, the efficiency was measured therefore only bus utilization has been taken. The adequate data of above inputs and out was available. Fleet size was used as capital input in public transport, fleet size major used as capital input in previous transport literature. The total staff working and fuel consumption were very helpful in obtained total efficiency of Haryana Roadways as per previous studies.

3.2.3 Tools and Techniques for efficiency computation of Haryana roadways

To analysis the data for this study, various tools and technique has been used, that given empirical results. To evaluating efficiency of Haryana Roadways, Data Envelopment Analysis is used. Data Envelopment Analysis technique is based on linear programming. It is a multifactor productivity analysis model. DEA used for relatively efficiency of homogenous set of DMUs. It handles multiple inputs and outputs. This study measures the pure technical efficiency, overall technical efficiency (OTE), and scale efficiency (SE) of the Haryana roadways for each depot. The technical efficiency refers to the extent to which Depot can produce the maximum output from its chosen combination of factor inputs and scale efficiency refers to sub optimal activity levels.

DEA is a non parametric technique that is free from distributional assumptions. With the help of DEA cross-sectional comparison could be easily measured. Stochastic Frontier Analysis is also an Econometric based technique which is also used to measure efficiency of DMUs but Stochastic Frontier Analysis decomposes error into two components- Firstly it is technical and

not efficient as much as DEA, secondly usually Stochastic Frontier Analysis includes error term of a econometric model that is why the results of SFA is not relatively appropriate than DEA technique.DEA handles multiple inputs and multiple outputs. It does not require a prior weight (as in index number) and emphasizes individual observations rather than statistical estimates (as in regression analysis).



In DEA models, calculates *n* number of DMUs. For each DMUs *p* different inputs has been taken for the producing of *q* outputs. The efficiency score of each DMU cannot be greater than 1. And one more important thing is that the weights for all inputs and outputs must be greater than 0 i.e $\lambda_a+\lambda_b+\lambda_c+\ldots\ldots\ldots\lambda_n \geq 0$. For model specification homogeneous *n* DMU units has been taken (DMU_j,j=1,2,3…….n).

For evaluate the efficiency -

$$\text{Max } E_k = \frac{\sum_{r=1}^{s} u_{rn} y_{rn}}{\sum_{i=1}^{m} v_{in} x_{in}}$$

Overall technical efficiency, pure technical efficiency and scale efficiency calculated here through CCR model and BCC models. In 1978 Charnes, Cooper and Rhodes proposed CCR model. CCR input oriented model used for calculates the overall technical efficiency of Haryana roadways. CCR model is based on constant return to scale. Through input oriented models efficiency easily calculated by using -

$$\lambda_a y_{1a}+\lambda_b y_{1b}+\lambda_c y_{1c}+\ldots\ldots\ldots\ldots\ldots\ldots\lambda_n y_{1n} \geq y_{1a}$$

BCC input oriented model has been applied to decompose the pure technical efficiency and scale efficiency. This model was introduced by Banker, Charnes and Cooper in 1984. BCC model is more practical then CCR model. BCC model is based on variable return to scale.

BCC input oriented model-

$$\lambda_a+\lambda_b+\lambda_c+\ldots\ldots\ldots\lambda_n=1$$

$$\lambda_a, \lambda_b+\lambda_c+\lambda_d\ldots\ldots\ldots\ldots\ldots\lambda_n \geq 0$$

If the score of DMUs is efficient in BCC model but inefficient in CCR model it indicates that the unit is inefficient unit.

Efficiency Score under BCC always greater than the score of CCR.

Use of λ values-

To determine peer DMUs- For an efficient unit its own λ values is unity

$\lambda_a=1$ (DMU a is efficient score will be one)

$\lambda_b+\lambda_c+\lambda_d\ldots\ldots\ldots\ldots\lambda_n=0$ (Relatively inefficient DMUs)

The Return to Scale can be determine with the help of these λ scores

$\sum_{I=A}^{E} \lambda = 1$, DMU operates Constant Return to Scale.

$\sum_{I=A}^{E} \lambda \geq 1$, Decreasing Return to Scale

$\sum_{I=A}^{E} \lambda \leq 1$, Increasing Return to scale

Scale Efficiency of nth DMUs= $\frac{Overall\ Technical\ Efficiency\ of\ nth\ DMUs}{Pure\ technical\ efficiency\ of\ nth\ DMUs}$

3.3 Data Source

This study is based on secondary data. The data has been collected from Statistical Records of Transport Department of Haryana, Statistical Abstract of Haryana, Annual reports etc. for over sixteen years 2001-2002 to 2016-2017.