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INDICATORS TO MEASURE PERFORMANCE EFFICIENCY OF BUS SYSTEMS

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INDICATORS TO MEASURE PERFORMANCE EFFICIENCY OF BUS SYSTEMS

FINAL REPORT

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List of Abbreviations

AMTS	Ahmedabad Municipal Transport Service
APSRTC	Andhra Pradesh State Road Transport Corporation
ASRTU	Association of State Road Transport Undertakings
BEST	Brihan Mumbai Electric Supply and Transport Undertaking
BMTC	Bangalore Metropolitan Transport Corporation
BSRTC	Bihar State Road Transport Corporation
CHNTU	Chandigarh Transport Undertaking
CIRT	Central Institute of Road Transport
CNG	Compressed Natural Gas
CSTC	Calcutta State Transport Corporation
CTDOT	Connecticut Department of Transportation
DDOT	District Department of Transportation
DOT(s)	Department(s) of Transportation
DTC	Delhi Transport Corporation
FDOT	Florida Department of Transportation
FY	Financial Year
GSRTC	Gujarat State Road Transport Corporation
HSD	High Speed Diesel
IT	Information Technology
KDOT	Kansas Department of Transportation
KDTC	Kadamba Transport Corporation Ltd
KMTU	Kolhapur Municipal Transport Undertaking
KnSRTC	Karnataka State Road Transport Corporation
KPI	Key Performance Indicator
KSRTC	Kerala State Road Transport Corporation
LACMTA	Los Angeles County Metropolitan Transportation Authority
LTA	Land Transport Authority
MEGTC	Meghalaya Transport Corporation
MHA	Ministry of Home Affairs
MoRTH	Ministry of Road Transport and Highways
MoUD	Ministry of Urban Development
MSRTC	Maharashtra State Road Transport Corporation
MTA – NYC	Metropolitan Transportation Authority New York City
MTC (CNI)	Metropolitan Transport Corporation Ltd (Chennai)
MTR (HK)	Mass Transit Railway (Hong Kong)
MZST	Mizoram State Transport
NBSTC	North Bengal State Transport Corporation
NCHRP	National Cooperative Highway Research Program
NEKnRTC	North Eastern Karnataka Road Transport Corporation
NHAI	National Highway Authority of India
NJDOT	New Jersey Department of Transportation
NMT	Non-Motorized Transport
NWKnRTC	North Western Karnataka Road Transport Corporation
OSRTC	Odisha State Road Transport Corporation
PCRA	Petrol Conservation Research Association
PMPML	Pune Mahanagar Parivahan Mahamandal Ltd
PT	Public Transport
QOS	Quality of Service

RRD	Research Results Digest
RSRTC	Rajasthan State Road Transport Corporation
SBSTC	South Bengal State Transport Corporation
SETC (TN)	State Express Transport Corporation Ltd (Tamil Nadu)
SKNT	Sikkim Nationalized Transport
SMRT	Singapore Mass Rapid Transit
SRTC	State Road Transport Corporation
STHAR	State Transport Haryana
STU	State Transport Undertaking
TCRP	Transit Cooperative Research Program
TfL	Transport for London
TMTU	Thane Municipal Transport Undertaking
TNSTC (CBE)	Tamil Nadu State Transport Corporation Ltd (Coimbatore)
TNSTC (KUM)	Tamil Nadu State Transport Corporation Ltd (Kumbakonam)
TNSTC (MDU)	Tamil Nadu State Transport Corporation Ltd (Madurai)
TNSTC (SLM)	Tamil Nadu State Transport Corporation (Salem)
TNSTC (VPM)	Tamil Nadu State Transport Corporation Ltd (Villupuram)
TRB	Transportation Research Board
TRPTC	Tripura Transport Corporation
TRW	Transport Research Wing
UITP	International Association of Public Transport
UPSRTC	Uttar Pradesh State Road Transport Corporation
UTC	Uttarakhand Transport Corporation
VADOT	Virginia Department of Transportation

1. Introduction

This report presents analysis of ongoing practices in performance measurement of the State Road Transport Undertakings (SRTUs) in India and suggests improvements. Operational performance of SRTUs have been discussed by policy makers and researchers (MoRTH, 2015). Generally poor financial performance of SRTUs has drawn attention of many and resulted in discontinuing SRTU operations. Association of State Road Transport Undertakings (ASRTU) is responsible for undertaking advocacy for public transport issues in general and SRTUs in particular. It provides forum for exchange of ideas on best practices in providing efficient, economic, safe and reliable public transport facility in urban, hilly and rural areas across the country.

Currently, there are 53 SRTUs owned and regulated by respective state governments. There can be multiple SRTUs in one state. SRTUs are accountable for funds they receive from central and state governments. Hence, they maintain their performance data in terms of capital investment, revenue, bus services and maintenance, which are collected and published by Central Institute of Road Transport (CIRT), India on an annual basis. The Transport Research Wing (TRW) of Ministry of Road Transport and Highways (MoRTH) conducts research and analysis in the road transportation sector. They also compile, review and publish data covering physical and financial performance of SRTUs annually. This study reviews the aforementioned publications in order to understand the current data maintenance practices of SRTUs, and compares them with international best practices to suggest improvements in performance measurement system.

Out of 53 existing SRTUs in India, 24 are corporations, 7 are municipal undertakings, 9 are run by respective State Governments' Transport Departments, and 13 are government companies. Interestingly, Tamil Nadu alone has 8 SRTUs, including 6 from district corporations. According to MoRTH's latest annual publication —Review of The Performance of State Road Transport Undertakings (Passenger Services) for April 2013 – March 2014 — 44 reporting SRTUs in India owned more than 1.4 lakhs buses as on March 2014. With overall fleet utilization of 89.5%, roughly 1.25 lakhs buses were on road daily covering 15.5 billion revenue earning kms carrying more than 6.8 crore passengers per day.

The average buses held by SRTUs and average buses on road have increased by 1.55% and 0.08% respectively during 2013-14 as compared to 2012-13. However, fleet utilization has declined marginally from 90.8% in 2012-13 to 89.5% in 2013-14. The total number of passengers carried by the reporting SRTUs during 2013-14 has decreased by 1.6% as compared to the previous year. The passenger km offered and passenger km performed also declined by 0.9% and 4.2% respectively during 2013-14. The average occupancy ratio dipped from 70.2% in 2012-13 to 67.9% in 2013-14.

The total revenue generated was roughly ₹452 billion against the total cost of ₹549 billion, leaving a loss of about ₹97 billion during the year 2013-14. The net loss is increased by 27% over the previous year. The highest share of total cost, 39%, was

used on personnel cost during 2013-14. For the reporting SRTUs, personnel cost and fuel and lubricants cost account for more than 71% of the total cost which is alarming.

While only 2 SRTUs, Karnataka State Road Transport Corporation (SRTC) and Orissa SRTC, have made profit of about ₹1.7 crores and ₹7.2 crores respectively in the year 2012-13 according to CIRT (2014), there was only one profit making SRTU in the year 2013-14 according to MoRTH (2015), viz. Punjab State Bus Stand Management Company Ltd with a profit of ₹22 crore. With such financial performance, SRTUs don't seem to go long way unless they come up with innovative means and methods to control rising cost of operation, distribute funds effectively, attract people to use public buses and hence increase their productivity and efficiency.

1.1 Need for Study

It is known that transportation has significant impacts on environment and economy globally, owing to its huge energy consumption and necessity to move people and goods around; the current transportation system is not sustainable as we continue to see increasing motorization as well as increase in adverse environmental impacts. It is well recognized that transportation needs careful forecast and planning at both local and national level to reduce carbon foot print and ensure economic growth, so that, decision-makers can take informed decisions. Various approaches to increase public transport (PT) share at local levels are evident worldwide (UITP, 2011). Optimal share of PT and non-motorized travel (NMT) modes will help realize better quality of life in urban areas by reducing greenhouse gas emissions and reducing adverse health impacts of transports (Woodcock et al. 2010).

Indian cities have mixed land-use patterns. Large number of trips are short trips (<10kms). Share of PT and para-transit ranges from 15-40%. However, majority of PT users are captive users because they cannot afford to commute to their work in their own vehicle. Because the quality of PT is perceived to be not good by non-captive users in two main aspects: crowdedness and punctuality, they prefer to use private transport. (Suman, H. et al. 2005)

There are about 5,000 cities and towns in India including cities having a population of less than 1 million to those that have more than 9 million. There are 147 cities which have a population of less than 1 lakh, and 177 cities that have a population between 1 to 5 lakhs (Census of India 2012). About 28 cities have a population of 5 to 10 lakhs, 6 cities with populations of 10 to 20 lakhs, 3 cities with populations of 50 to 100 lakhs and 3 cities with a population of more than 100 lakhs.

There is a large variation in the travel demand met by public transport systems, intermediate public transport systems and personal vehicles in these cities. A large variation exists in the share of bus trips even amongst cities of similar size. Clearly there are factors other than population size that are responsible for this large variation. Spatial and temporal availability, reliability, comfort and affordability are some of the important parameters that influence the usage pattern of bus services. If an extensive

bus network, having high frequency, is available to commuters at affordable prices (often less than the marginal cost of using a two wheeler), it is likely to attract a large number of commuters. However, this may result in over supply leading to large gaps between the cost of providing the system and revenue generation. Therefore planning strategies that can meet the varying demands efficiently are required.

In some small cities, bus service is only a single route across the city. Often intercity buses run by the SRTU are used for city operations. Scheduling of these services is not based on demand analysis. The second level of bus services includes more than one route; however, scheduling is based on the observation that the morning and evening peak requirements are more than the rest of the day. Many metropolitan cities have public owned transport companies for example Bangalore, Delhi, Mumbai, and Pune. The services provided by these companies are based on demand analysis. However improvements in reliability, speeds, availability and cost reduction can be brought about by improved scheduling, feeder systems, changes in road design, bus stop location, and signal systems. The Bus system is capable of carrying 100 persons in each bus to about 40,000 persons per hour depending on the strategies that used for designing the system.

1.2 Problem Definition

PT policies and strategies must balance conflicting goals (e.g. mobility for all and safety for all) and hence improve the efficiency of a PT system. To achieve this, data needs to generate results, whether it be for operations management, transport planning, policy-making or strategic decision-making. Moreover, today's complexity and abundance of data makes it even more difficult for transport professionals to sort out the most useful information. Although the SRTUs in the country have a pool of data annually based on financial, physical and material performances, they are facing declining ridership and increasing losses. There is a gap in extracting useful information from this data, to assist SRTUs to improve their performance. The gap could be the use of substandard Key Performance Indicators (KPIs) or even absence of important KPIs which could, if found, help in measuring and evaluating deficiencies in the system. To do this, the system must be observed through multiple perspectives, i.e. user, operator, societal (community as a whole) and regulatory bodies (authority). On the other hand, such applications of data would also add to better resource utilization since data comes at a cost of manpower, time and money.

2. Aim and Objective

The objective of this study is to review the current data maintenance practices of SRTUs, understand their performance management system and suggest improvements based on international best practices.

This is based on the overall aim of increasing PT ridership by choice, and not just restricted to captive users.

3. Scope and Methodology

This study is based on SRTUs' performance data available from CIRT and MoRTH for the years 2009-2013 and 2013-2014 respectively and proposes new indicators based on literature review on international best practices.

Following points attribute to the scope of this study:

a) Existing performance data for 2009-14 of the reporting SRTUs in India from the primary source which is CIRT and MoRTH annual publication. It is assumed that data not reported is data not recorded. These publications include:
   - Financial performance – capital investment, total cost, total revenue, profit/loss, etc.
   - Physical performance – fleet utilization, vehicle productivity, volume of operation, passengers carried, manpower productivity, etc.
   - Material performance – fuel performance, spare parts performance, etc.

b) Best practices in performance measurement from various PT authorities/operators around the world. These are available from annual reports and articles from research organizations.

c) Prime focus on tasks related to performance measurement which come within SRTUs' extent.

d) Infrastructure related issues are not considered in this study which are related to performance under serviceability but are interdependent on bodies other than SRTUs. For example, road connectivity/coverage of service area, accessibility for people with disabilities outside the vehicles, etc. comes under departments like Public Works Department, National Highway Authority of India (NHAI) and MoRTH.

The study includes review of local and international practices in performance measurement system of PT, followed by comparison of the indicators used by various PT authorities and operators. The patterns in performance data have helped in understanding the generic framework of performance measurement system. By comparing local practices with that of best, it was viable to identify indicators which can be derived from existing data and know what purpose they can serve.

4. Literature Review

Activities conducted to explore best practices in performance measurement of PT across the world are described in this section. It includes reviewing existing literature that describes various framework of performance measurement system and commonly used indicators in evaluating performance of PT. Important conclusions from these sources have helped in consolidation of proposed indicators.

4.1 Indian Literature

The CIRT library is the primary source of data, information and statistics on the SRTUs in the country. All SRTUs must report their data to CIRT quarterly in a pre-defined

format. CIRT's annual report 'State Transport Undertakings Profile and Performance' consists of nationwide exhaustive statistics on both physical and financial performance of SRTUs. The compiled records provide data on various financial performance indicators like personnel and material costs, taxes, interest, depreciation, revenue, surplus before tax, profit / loss and percentage return on the capital invested. Facts on the physical performance parameters such as fleet vintage and utilisation, capacity utilisation, manpower productivity, spares, fuel and tyre performance are outlined in detail in this data.

These annual publications also observes the trend in major cost components like fuel and personnel costs of last 10 years. Innovative measures pertaining to rising costs taken by several SRTUs (APSRTC, GSRTC, UPSRTC, Tamil Nadu SRTUs, RSRTC, NWKnRTC, KnSRTC and NEKnRTC) include managerial and technical measures like counselling of drivers and incentives on fuel conservation, checking of bus as per Petrol Conservation Research Association (PCRA) norms, etc. (CIRT 2014).

Trends in physical performance like fleet strength and volume of operation shows the rising demand while trends in fleet utilization, vehicle productivity and ridership does not seem to cope with demand. Other characteristics of performance observed in a trend were mileage, breakdown and accident rates. These annual publication encompasses financial, physical and material performance as well as length of national highways, road accident statistics, production and sale (including export) of motor vehicles, total registered motor vehicles and state-wise month-wise fuel price distribution.

MoRTH also reviews performance of reporting SRTUs and publishes it annually. The information in these publications showcases broader picture of performance of public buses in the whole country compared to that in CIRT which is more detailed indicator-wise at each SRTU level. It includes an overall performance of SRTUs in terms of physical and financial performance indicators, record of highest and lowest performing SRTUs in terms of profit/loss, manpower productivity, average fleet age, etc. and highlights comparison of performance with previous years. However, it was useful to compare publications from both the publishers in order to understand pattern in SRTUs reporting their data to one or both publisher(s).

Poor performance of Indian SRTUs and the factors behind it have been discussed since long. Bhattacharya, A. et al. (1995) in their study of ownership structure and cost efficiency of public bus found that performance of corporations and government departmental units had worsened over time. The inefficiencies were likely to be magnified several times in the near future unless conscious efforts were made for raising the efficiency of input variables, especially fuel. According to Deb, K. et al (2002), public sector road transport companies (or SRTUs) owned 28.7% of the total buses in India and road transport comprised of 80% of passenger movement throughout the country. Transportation demand has been rising with population and urbanization. The total strength of buses held by SRTUs grew from roughly 10,000 in

1991 to 13,500 in 1999. However, overall vehicle population grew at almost 10% per year in the same decade.

The demand of moving people is high and escalating. 90% of passenger movement is met by road transport sector of India and remaining by railways. Most cities have no rail transport and rely heavily on combination of buses, minivans, auto-rickshaws, etc. (Pucher, J. et al. 2004). There were 67 SRTUs in operation according to 1999 data (Deb, K. et al. 2002) but at present there are 53 SRTUs in the country (CIRT 2014). Poor financial performance have led to shut down operations. Government regulations and control have worsen the poor operational and financial performance of public buses which are main modes of transport in rural areas. The conflict between government and SRTUs is that SRTUs have financial pressure against rising cost of operation but government is under pressure to keep fares at existing levels as well as maintain money losing operations.

The scientific literature on PT systems attest to the fact that measuring performance of PT services is not limited to the scope of existing system and should also be planned for the future (Eboli and Mazzulla, 2012; Gandhi 2013). In the same context, it is necessary to track performance of PT systems in various dimensions like economic viability, sustainability and society. These dimensions, in most cases, form the overall aim of any PT policy by the government. Hence, performance indicators must reflect to the overall goal(s) stated in policy document. Black, J. et al (2002) describes analytical approaches to identify performance indicators which can be linked to the overall targets of the PT system. This can also be seen in work carried out by TRB (2003) and Eboli and Mazzulla (2012).

4.2 International Literature

4.2.1 Transportation Research Board, 2003

Transit Cooperative Research Program (TCRP) Report 88 ‘A Guidebook for Developing a Transit Performance-Measurement System’ is a manual to help PT agencies in improving their decision-making processes. It maps a progressive and a step-by-step process for authorities and operators to establish a performance measurement system.

It explains importance of measuring performance and difference in perception of performance among various stakeholders like agency (PT authorities and operators), customer (passengers), community (society as a whole) and driver (crew). According to the Guidebook, the key characteristics of an effective performance measurement system are as follows:

a) Stakeholder acceptance
b) Linkage to agency and community goals
c) Clarity
d) Reliability and credibility

e) Variety of indicators
f) Number of indicators
g) Level of detail
h) Flexibility
i) Realism of goals and targets
j) Timeliness
k) Integration into agency decision-making

The manual also includes 12 case studies of successful performance measurement programs, 6 examples were based on overall performance measurement system and other 6 focused on specific aspects of performance measurement system. Successful PT performance measurement programs were chosen on the basis of meeting agency goals and objectives defined in the PT provider's long-range transportation plan (FDOT 2014).

The report showcases extensive collection of over 400 individual performance indicators which are divided into 10 categories as follows:

a) Availability
b) Service delivery
c) Community
d) Travel time
e) Safety and security
f) Maintenance and construction
g) Economic (operator perspective reflecting their traditional point of view)
h) Capacity
i) Para-transit
j) Comfort

These categories can be used to form authority's goals and objectives based on which it is easy to identify performance indicators using user-friendly menu guides that quickly identify indicators appropriate to an agency's goals, objectives, and resources.

As cited in FDOT (2014), the Guidebook states that it is important to consider the establishment of a performance measurement system involves a number of trade-offs:

- How many indicators should be reported? – Too many indicators can overwhelm the users with too much data, while too few indicators may not address an agency's goals and/or objectives.
- How much detail should be included? – More detailed indicators will use a greater number of factors, while general indicators will be easier to track, calculate and present.
- Will performance indicators be evaluated internally or compared with other agencies? – Choosing indicators designed to be shared or compared with other agencies may limit the amount of performance indicators an agency can use and may not address an agency's objectives.

- Who is the intended audience? – Some audiences may or may not be familiar with PT service concepts, so selecting performance indicators to be correctly displayed and interpreted is vital to the success of the performance measurement system.

4.2.2 Transportation Research Board, 2011

The purpose of National Cooperative Highway Research Program (NCHRP) Research Results Digest 361 is "to provide more information on performance measures and performance management approaches that can be used in relation to public transportation programs." The report affirms that decision-making can be improved if performance indicators are used more effectively. The authors, in order to explore effectiveness of performance indicators reviewed existing literature on performance of state Departments of Transportation (DOTs), conducted a web survey of DOTs and interviewed selected DOTs within the United States. This survey helped identifying steps that agencies took to improve efficiency and productivity of their transportation systems. It was clear several DOTs using numerous performance indicators in order to track the activities going around their transportation system and provide transparency. And the interviews indicated that funds deficit have resulted in many DOTs developing performance measurement systems or revising existing ones as a means of allocating funds more effectively.

As cited in FDOT (2014), the research report has identified several commonly used performance measurement categories and indicators in those categories as follows:

a) Ridership indicators focus on the level of riders using a service or services within a particular PT system. Examples:
    - Total ridership, or ridership by mode or service type
    - Passenger trips
    - Passenger miles
    - Ratio of ridership growth to population growth
    - Passengers per capita
    - Number of riders at park-and-ride lot
b) Availability indicators focus on the availability of PT services provided by a transportation agency. Examples:
    - Total service hours provided versus total hours needed to meet PT demand
    - Average days per week that PT service is available
c) Internal cost and efficiency indicators focus primarily on internal utilization of resources, cost, and other indicators of efficiency. Examples:
    - Passengers per vehicle mile
    - Passengers per vehicle hour
    - Total operating cost per passenger
    - Operating expense per vehicle revenue mile
    - Fuel economy

d) Quality indicators address factors that affect the quality of service (QOS) experienced by PT riders, which encompasses speed, safety, reliability, and comfort. Examples:
    - On-time performance by mode
    - Rate of injuries and/or fatalities involving PT vehicles
    - Ratings of public transportation system
e) Asset management indicators address the maintenance of the physical components of the public transportation agency. Examples:
    - Age of fleet by vehicle type
    - Percent of vehicle useful life remaining
    - Number of mechanical failures
    - Distance between vehicle failures
f) Community indicators focus on impacts, both economic and environmental, to communities served by PT. The surveys conducted for NCHRP RRD 361 suggest that state DOTs do not use community indicators as often as they use other categories of indicators; however, commute indicators can be relevant to a DOT's overall goals. Examples:
    - Percent of non–single-occupant vehicle commuters
    - Number of auto vehicle trips reduced
    - Energy savings
    - Percentage of fleet vehicles transitioned to clean or alternative fuels

The research report provides a list of characteristics of good performance indicators which can help in selecting appropriate indicators. These characteristics were concluded from the interview conducted for selected DOTs and are as follows:

- Traceable over Time – can be consistently used over many years.
- Storytelling Potential – should be meaningful and convincing, particularly over the long term. They should "help weave a storyline around public transportation performance in the state."
- Meaningful for Types of Service Measured – The set of performance indicators should include non-traditional indicators (e.g., community indicators) so as to represent social values and quality of life concerns.
- Relation to State-wide Public Transportation Goals – should allow agencies to track progress towards achieving goals.
- Available Data – should be calculable from data that are readily available.

The report also identifies the following challenges in the use of PT performance indicators:

- Lack of data to support PT performance measurement / monitoring
- Lack of technical resources to support PT performance measurement / monitoring

- Connection between PT performance and decision-making for funding allocations
- Lack of operator influence over authority decision-making
- Accounting for variations in PT agency types and purposes

The report identifies the following best practices in performance measurement system:

- Choose indicators that can be consistently evaluated over time.
- Select indicators that are meaningful to the type of PT service being provided and the purpose of the PT service.
- Choose indicators that show progress toward goals.
- Seek input from other operators, authorities and other partners when identifying indicators. Develop data partnerships with these entities.
- Make use of national research and studies.
- Cooperate and coordinate with authorities and operators.
- PT performance measurements can be used formally or informally. They can be used to support qualitative evaluations.
- Consider hiring a staff person to focus on performance measurement.
- Tie PT performance measurement to funding decisions.

4.2.3 Land Transport Authority (LTA), Singapore, 2014

LTA Academy's biannual professional journal, JOURNEYS, showcases and shares urban transport knowledge with transport professionals. In its Issue 6 to Issue 11 ranging from May 2011 to May 2014, it shares and compares Singapore's as well as world's selected PT agencies performance statistics.

Most common indicators used in reporting were:

a) Average Fleet Size
b) No. of routes
c) Average daily vehicle-kms
d) Average daily passenger trips
e) Average journey distance (km/passenger-km)
f) Public bus fleet per million passenger
g) Average daily PT trips per person
h) Road density (km/km^2)
i) No. of stations per km^2

LTA (2013, p.97) acknowledges London's use of Information Technology (IT) systems in its PT —Transport for London— to rely heavily upon for performance measurement, vehicle tracking and reporting, on-board information, mileage tracking and service control.

LTA (2011b, p.71) agrees that timely comparison can easily help in identifying solutions to generic problems. Therefore, it is always better to know what and how your peer groups are doing to excel. "Comparing the performances of public transport

operators helps surface some understanding of the best practices employed in the industry".

Table 1: Consolidation of Important Conclusions from Literature Review

S. No.	Article Name	Publication Year	Author/ Publisher	Important Conclusions
1.	TCRP Report 88 A Guidebook for Developing a Transit Performance-Measurement System	2003	TRB	A large variety of Performance Indicators categorized in terms of organizational goals and perceptions of different stakeholders (user, operator, staff environmental and authority); factors influencing choice of performance indicators; characteristics and uses of performance measurement system and case studies of successful systems.
2.	Public Health Benefits of Strategies to Reduce Greenhouse-gas Emissions: Urban Land Transport	2009	Woodcock J. et al.	Advantages of PT and NMT and promoting them to decrease adverse health impacts of Greenhouse-gas emissions of which transportation sector is a significant contributor.
3.	NCHRP Research Results Digest - State DOT Public Transportation Performance Measures: State of the Practice and Future Needs	2011	TRB	Indicators used by various State DOTs; current and best practices in performance measurement and advantages of using performance measurement system.
4.	Census of India 2011	2012	MHA	Detailed description of India's demographics; population size of small, medium and big cities.

S. No.	Article Name	Publication Year	Author/ Publisher	Important Conclusions
5.	Performance Indicators for An Objective Measure of Public Transport Service Quality	2012	Eboli L. and Mazzulla G.	The importance of holistic approach (subjective and objective) to identify and consistently maintain performance indicators for ensuring continuous increase in service quality of PT.
6.	Service Level Benchmarks for Urban Transport	2013	MoUD	Tool for Benchmarking of Urban Transport in specific categories and calculating overall level of service.
7.	Development of Bus Performance Measures (Master's Thesis)	2013	Gandhi S. (Student) and Tiwari G. (Supervisor)	Choice of performance indicators is important while considering all the stakeholders of a PT system. This can affect the evaluation and further decision-making.
8.	State Transport Undertakings Profile and Performance	2014	CIRT	Financial, Physical and Material performance of the SRTUs from 2009-13; Patterns in using, collecting and reporting performance data.
9.	Best Practices in Evaluating Transit Performance (Final Report)	2014	FDOT	Standard Performance Indicators used by FDOT; use of performance data for planning and strategic decision-making.
10.	Journeys	2014	LTA	Consistently used performance indicators; comparison of modal share among 28 cities in the world including Ahmedabad, Bengaluru, Delhi and Mumbai and comparison of performance under specific indicators of PT operators from Singapore, Hong Kong, Shanghai, Taipei, Tokyo, Sydney, London, Dublin, Barcelona, Stockholm, New York, Washington, Vancouver, and Chicago.

S. No.	Article Name	Publication Year	Author/ Publisher	Important Conclusions
11.	Review of the Performance of State Road Transport Undertakings (Passenger Services) for April 2013 – March 2014	2015	MoRTH	Policy makers are concerned with adverse impacts of rapidly increasing private modes of transport and want to change user perception towards PT to increase PT ridership and also do better business.
12.	Analysis of Factors Influencing the Use of Public Buses in Delhi	2016	Suman H., Bolia N. and Tiwari G.	Need of policy interventions to retain public bus ridership; use of public buses limited to captive users and reason(s) for non-attractiveness of people to public buses in Delhi.

4.3 Summary of Literature Review

In case of Indian SRTUs, their poor performances have augmented owing to government regulations and control (Singh, S. 2005). However, strict regulations were not the only reason. Since 90% of the passenger movement is covered by road transport sector and only 28.7% of the total buses are publicly owned; it was always difficult, but an only option for government, to maintain the transport services despite of money-losing operations to provide services economically backward section of society; only 3 SRTUs made profit in the FY 2012-13 (CIRT 2014 and Deb, K. et al. 2002). SRTUs like BSRTC have 100% of their fleet over aged and average age being 11.8 years (MoRTH, 2015). It is clear that resources were not utilized optimally.

Performance measurement system is developed and practiced in order to identify how well service is being provided to customers, the areas of improvement and effects of actions previously taken. It helps in driving the organization towards set targets by supported decision-making. It is also needed to communicate results to organization's stakeholders in the context of accountability (TRB 2003 and 2011).

In a large and complex system like PT, it is difficult to monitor its performance (Gandhi, S. 2013). Often, wrong choice of indicators misguide the experts and its further evaluation. It is necessary to link indicators to goals while taking into account different perspectives of stakeholders (community issues, customer-oriented, etc.) (TRB 2003).

After reviewing existing literature, it is understood that a successful performance measurement system is based on achieving the goals and objectives set by the PT agency. The goals and objectives defined by a PT agency should be used to help

categorize performance indicators. TRB (2003) had the most comprehensive guide to finding and defining PT performance indicators. It lays out a progressive process for PT agencies to establish a performance measurement system. The report outlines both traditional and non-traditional performance indicators that are recommended based on PT agency goals. Table 1 summarizes important conclusions from the literature on performance measurement of PT system.

After a transportation agency has identified its goals and has chosen its performance indicators, it can compare the performance with peers and benchmark the performance. LTA (2011) recognizes the importance of comparing the performances in identifying best practices around the world. Based on comparison of data maintenance practices among Indian and International agencies, table 2 shows the most widely used KPIs in performance measurement of a PT system.

Table 2: Commonly used Performance Indicators among the Indian SRTUs and International Agencies

S. No.	Indicators	Example User Agency
Category I – Capacity		
1.	Fleet Size	KDOT, SMRT
2.	Vehicle Seat Capacity	DDOT, TfL
Category II – Serviceability		
3.	Revenue kms	FDOT, DDOT, SMRT
4.	Passenger kms	US DOTs, MTR (HK)
5.	Load Factor	LACMTA
6.	Passengers Carried	SMRT, US DOTs
7.	No. of Routes	SMRT, LTA
Category III – Safety		
8.	No. of Accidents	LTA, US DOTs, TfL, MTR (HK)
9.	No. of Fatalities	
10.	No. of Injuries	
Category IV – Productivity		
11.	Operating Cost	SMRT, US DOTs
12.	Cost per km	US DOTs
13.	Maintenance Cost	SMRT
14.	Traffic Revenue	SMRT, US DOTs
15.	Non-Traffic Revenue	LTA, TfL
16.	Operating Ratio	US DOTs
17.	Cost Recovery	MTR (HK), LTA, US DOTs
Category V – Effectiveness		
18.	Passenger Lead	LTA
19.	Bus Utilization	US DOTs
Category VI – Reliability		
20.	Trips Scheduled	SMRT
21.	Regularity	SMRT
22.	Actual Trips Operated	SMRT
23.	Punctuality (Departure, Arrival)	SMRT
24.	No. of Breakdowns	MTA-NYCT

S. No.	Indicators	Example User Agency
25.	Rate of Breakdowns	Houston-Metro
Category VII – Comfort		
26.	Average Age of Fleet	CTDOT, NJDOT, VADOT

5. Review of Existing Practices of SRTUs

The published data provides detailed figures on both the financial and physical performance of the SRTUs. The financial performance indicators are grouped in terms of capital, liabilities, assets, cost, taxes, interest and revenue. Since financial performance (profitability) of the system depends on physical performance to a wide extent, this study focuses largely on physical performance indicators, which are mainly categorized in terms of fleet utilization, capacity utilization, quality of service, manpower productivity, and material performance (includes fuel, oil, tyre, battery, spring, etc.).

Diversity of data maintained by SRTUs is wide, expanding from make of buses (Leyland, Tata, Volvo, etc.) to attributes related to spare parts of the bus (springs, batteries, tyres and tubes, their cost and replacement details, etc.). Naturally, this comes at a cost (salaries, manpower and time). If these data are utilized to its potential, spending of money, manpower and time is justified.

A closer look on the publications from CIRT and MoRTH shows that for a particular year, number of SRTUs reporting to CIRT and MoRTH are different. For the year 2012-13, CIRT (2014) claims that 25 SRTUs have reported data to them. On the other hand, for the same period, MoRTH (2014) says 38 SRTUs have reported their data. The publications reviewed in this study reveals that not all the SRTUs report data to CIRT consistently. In the latest annual publication (2014) it is observed that 25 SRTUs out of 53 have reported data where as in the year before i.e. 2013, 28 SRTUs had reported. Similarly, MoRTH (2015) shows that 44 SRTUs have reported their data for the year 2013-14 but MoRTH (2014) acknowledges 38 SRTUs for reporting their data. Within the reporting SRTUs, there are few dissimilarities in the type of data reported. For example, under financial performance, personnel cost incurred by SRTUs is divided in to sub-categories viz. drivers, conductors, traffic supervisory, workshop and maintenance staff, admin and others. However, few SRTUs (TNSTC-SLM, APSRTC, STHAR, etc.) only report personnel cost as a total of aforementioned sub-categories of the staff while, some SRTUs (GSRTC, MSRTC, etc.) also mention the cost sub-category wise. Similar observation in the case of material cost, interests on loan and other physical performance parameters which include cancelled kms and no. of breakdowns and their sub-categories (CIRT 2013).

Some indicators are consistently reported by all the reporting SRTUs. These are measures of fleet utilization, serviceability, operational productivity and manpower productivity. The list of indicators reported by all the reporting SRTUs is as follows:

a) Buses held
b) Buses off road
c) Fleet utilization
d) Effective, dead and gross kms
e) Bus Utilization per day
f) Carrying capacity kms
g) Passenger kms
h) Load factor
i) Passenger lead
j) Passengers carried
k) Passengers per bus on road per day
l) Staff per bus ratio

Additionally, an analysis (table 3) done out of 36 SRTUs and 71 indicators from financial, physical and material performances taken into consideration over a period of 2009 – 2013 shows that none SRTUs report 100% indicators. Fleet size of these 36 SRTUs have been also taken into account to better understand the size of the SRTUs. BMTC has reported highest number of indicators among all the SRTUs (including rural, urban and hill region SRTUs). Among all the rural SRTUs, KnSRTC and NEKnRTC has reported maximum number of indicators followed by NWKnRTC; all three belongs to state of Karnataka which have been able to maintain average trip regularity above 95% consistently for 4 years (CIRT 2011 – 2014). Therefore it seems that they have one of the best data maintenance practices in the country which is helping them run better services.

The SRTUs reporting more than 90% of the indicators are big in size according to fleet strength; more than 3600 buses in urban SRTUs and at least 7900 buses in the rural ones. SRTUs from north-east part of the country are among the least reporting SRTUs. They are SKNT, TRPTC, MZST and MEGTC. This may be attributed to their size, which is very small compared to other SRTUs in the country. Hence, the organization structure and management may not be equipped enough to practice performance measurement. This comparison is based on fleet strength of highest and lowest reporting SRTUs.

The indicators related to financial performance like components of cost and revenue, tax, etc. are among the consistently reported indicators by all the SRTUs. Other categories that are reported by 100% SRTUs are fleet and capacity utilization, manpower productivity and material performance. There are some indicators which few SRTUs doesn't report at all. Punctuality in departure and arrival of bus from and to the depot is among the least reported indicators by SRTUs. It was found that 20 SRTUs do not maintain records of punctuality. Third most under reported indicator is number of public complaints reported by 50% of the SRTUs in consideration. It is observed that, indicators consistently reported are from operator's perspective. They are measures of cost, revenue, tax, fleet utilization, manpower productivity, etc.

However, punctuality and number of public complaints are among least reported. These indicators are from user's perspective.

Measures of safety like accidents, fatalities and injuries are not reported at all by KSRTC, SKNT, TRPTC, MZST and MEGTC. Some SRTUs report them partially and inconsistently; they are STHAR, NBSTC, BSRTC and CSTC.

The table 3 below is a compiled chart of 71 indicators and 36 SRTUs. It shows the pattern in reporting data for the period 2010-14. The figure '1' signifies data has been reported consistently for the period under consideration. '0' signifies not reported at all and a blank space ( ) means either not applicable or inconsistent reporting.

It is observed in the below table 3, SRTUS from Karnataka i.e. (BMTC, KnSRTC, NWKnRTC and NEKnRTC) followed by urban SRTU of Chennai (i.e. MTC-CNI) report most of the data. These SRTUs are old and with the expansion in services, they have grown bigger in fleet size and manpower. Thus, they have also gained experience with time. Therefore, it can be inferred that these SRTUs understand the advantages of performance data and thus continue to follow consistent data maintenance practices. Despite of losses, these SRTUs have maintained their service which means that the state government has supported them with financial assistance.

Table 3: Reporting Pattern of SRTUs (2010-14)

	BMTC	KnSRTC	NEKnRTC	NWKnRTC	MTC-CNI	PMPML	APSRTC	GSRTC	TNSTC(KUM)	OSRTC	TNSTC(SLM)	SETC (TN)	RSRTC	TMTU	TNSTC(VPM)	TNSTC(CBE)	KDTC	MSRTC	BEST	KMTU	UTC	TNSTC(MDU)	DTC	AMTS	UPSRTC	CSTC	STHAR	KSRTC	SBSTC	CHNTU	SKNT	NBSTC	MZST	BSRTC	MEGTC	TRPTC	
Fleet Size including HB as on March 2013 unless specified	6443	7902	4356	4718	3637	1523	22574	8069	3784	428	2236	1079	4555	338	3558	3268	425	17902	4336	138@@	1189	2503	5438	1081	9329	1013$	3844	5803*	492$	417@	96	763#	33	414	62*	81*	% SRTUs reporting
Personnel Cost	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Material Cost	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Traffic Revenue	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Tot. earnings per bus (on road) per day	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Tot. cost per bus (on road) per day	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Surplus before tax	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Profit/loss	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
% operating ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Buses held	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Buses off road	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Buses on road	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Fleet Utilization	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Effective kms.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Dead kms.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Gross kms.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Bus utilization per day (kms.)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Carrying capacity kms.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Passenger kms.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Load factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Passenger lead	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Passengers carried	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Passengers per bus (on road) per day	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Staff ratio per bus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100

	BMTC	KnSRTC	NEKnRTC	NWKnRTC	MTC-CNI	PMPML	APSRTC	GSRTC	TNSTC(KUM)	OSRTC	TNSTC(SLM)	SETC (TN)	RSRTC	TMTU	TNSTC(VPM)	TNSTC(CBE)	KDTC	MSRTC	BEST	KMTU	UTC	TNSTC(MDU)	DTC	AMTS	UPSRTC	CSTC	STHAR	KSRTC	SBSTC	CHNTU	SKNT	NBSTC	MZST	BSRTC	MEGTC	TRPTC	
Fleet Size including HB as on March 2013 unless specified	6443	7902	4356	4718	3637	1523	22574	8069	3784	428	2236	1079	4555	338	3558	3268	425	17902	4336	138@@	1189	2503	5438	1081	9329	1013$	3844	5803*	492$	417@	96	763#	33	414	62*	81*	% SRTUs reporting
HSD or CNG consumed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
KMPL or Km per kg (for CNG)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100
Taxes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	97
Misc. & Others	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	97
Non-traffic Revenue	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	97
Traffic Staff	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	97
Workshop&Maintenance Staff	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	97
Administration and other staff	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	97
Avg. salary/employee/day	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	94
Seating capacity	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	92
Manpower Productivity/day	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	92
Accidents per lakh eff. kms.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	1	1	0	89
Eff.kms./crew member/day	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	89
Interests	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	1	83
Seat kms.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	0	1	1	83
Occupancy Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	1	0	1	1	83
Fatal accidents	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1	0	1	0	0	83
Major & serious accidents	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1	0	1	0	0	83
Minor accidents	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1	0	1	0	0	83
No. of depots	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	0	0	83
Depreciation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	0	1	0	1	0	0	1	0	78
Total no. of routes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1	0	0	0	78
No. of standees	1		1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1		1	1	1	0		1	1	1			1		1			69
Actual trips operated	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	69

	BMTC	KnSRTC	NEKnRTC	NWKnRTC	MTC-CNI	PMPML	APSRTC	GSRTC	TNSTC(KUM)	OSRTC	TNSTC(SLM)	SETC (TN)	RSRTC	TMTU	TNSTC(VPM)	TNSTC(CBE)	KDTC	MSRTC	BEST	KMTU	UTC	TNSTC(MDU)	DTC	AMTS	UPSRTC	CSTC	STHAR	KSRTC	SBSTC	CHNTU	SKNT	NBSTC	MZST	BSRTC	MEGTC	TRPTC	
Fleet Size including HB as on March 2013 unless specified	6443	7902	4356	4718	3637	1523	22574	8069	3784	428	2236	1079	4555	338	3558	3268	425	17902	4336	138@@	1189	2503	5438	1081	9329	1013$	3844	5803*	492$	417@	96	763#	33	414	62*	81*	% SRTUs reporting
Average route length	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1	0	0	0	69
Scheduled kms.	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	67
% of cancelled kms. to scheduled kms	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	67
No. of breakdowns	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	67
Breakdown per 10,000 eff. kms.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	67
No. of fatalities	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	67
% of total kms	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	0	1	1	1	1		1	1	1	1	0	1	0	0	0	0	0	0	0	0	67
Trips to be operated	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	64
Regularity	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	64
No. of Bus Stations	1	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	1	1	1	1	1	0	0	1	1	1	1	0	0	0	1	0	1	0	0	0	64
Tot. no. of schedules	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	61
No. of person injured	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	58
Scheduled services	1	1	0	1	1	0	1	1	1	1	1	1	1	0	1	1	1		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	53
Subsidy Reimbursement	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1				1	1														50
No. of public complaints	1	1	1	0	1	1	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	50
Schedules earning more than total cost	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	47
Schedules earning between total & variable cost	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	47
Schedules earning less than variable cost	1	1	1		1	1	0	1	1	1	1	1	1	0	1	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	47
Punctuality	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44
No. of Bus Shelters	1	1	1	1	1	1	1	1	0	1	0	0	0	1	0	0	0	1	1	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	44

	BMTC	KnSRTC	NEKnRTC	NWKnRTC	MTC-CNI	PMPML	APSRTC	GSRTC	TNSTC(KUM)	OSRTC	TNSTC(SLM)	SETC (TN)	RSRTC	TMTU	TNSTC(VPM)	TNSTC(CBE)	KDTC	MSRTC	BEST	KMTU	UTC	TNSTC(MDU)	DTC	AMTS	UPSRTC	CSTC	STHAR	KSRTC	SBSTC	CHNTU	SKNT	NBSTC	MZST	BSRTC	MEGTC	TRPTC	
Fleet Size including HB as on March 2013 unless specified	6443	7902	4356	4718	3637	1523	22574	8069	3784	428	2236	1079	4555	338	3558	3268	425	17902	4336	138@@	1189	2503	5438	1081	9329	1013$	3844	5803*	492$	417@	96	763#	33	414	62*	81*	% SRTUs reporting
Payment to HB	1					1	1	1					1	1			1	1			1			1	1												31
% return on capital employed	1	1	1	1	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28
% return on capital invested	1	1	1	1	0	1	1	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28
Reimbursement of Fare Concessions															1		1			1	1																11
% of reported KPIs	97	96	96	94	94	94	92	92	92	92	90	90	90	90	89	89	89	87	87	85	83	82	79	77	72	70	63	61	61	61	59	58	58	56	56	54	

*as on March 2012, # as on March 2008, $ as on March 2010, @ as on March 2009, @@ as on March 2011, HB=Hired Buses

The SRTUs in the table 3 which report least data are mostly from northeast part of the country (i.e. TRPTC, MEGTC, MZST and SKNT). These SRTUs are relatively young and smaller in size in both terms: fleet and manpower. Therefore, least reporting of data may be attributed to lack of manpower which focuses more on operating the services than data. Other potential factors could also be lack of financial assistance from the state government, political agendas different from public bus systems, etc. Interestingly, BSRTC is an old SRTU compared to northeast SRTUs, therefore it could also have gained experience and understood the importance of data with time. However, it is one of the least reporting SRTU. It has also highest percentage of overage buses which points towards poor services. Other factors which may have influenced BSRTC's performance could be operational losses, lack of financial assistance from the state government, infrastructure development issues, etc.

Since transport is a state subject in India, it may not be mandatory for SRTUs to report performance data to ASRTU or CIRT if they are not a member of ASRTU. Therefore, it is possible that a SRTU collects and maintain data but do not publish or report it.

In general, if a SRTU outsource the operations or maintenance or both, it is as of now unclear that all the indicators discussed above are being collected, maintained and reported thoroughly by which party, SRTU or contracted partner. Therefore, it is possible that data to SRTU is partially available and thus partially reported.

Below, table 4, is a list of performance indicators in practice by Indian SRTUs broadly divided in 3 groups viz. Financial Performance, Physical Performance and Material Performance.

Financial Performance – The indicators in this group mainly reflect components of cost and revenue and profit/loss. Indicators here are from operator's perspectives.

Physical Performance – The indicators in this group are further categorized in terms of characteristics of PT system. The performance indicators in categories I and II give quick view about utilization of fleet and total capacity of the system respectively. In category I, fleet utilization is calculated in terms of total kms covered by the SRTU and count of buses on road and buses held. Whereas category II measures capacity utilization in terms of average no. of seats and standees per bus, total passengers carried and load factor. To make a note, occupancy ratio shows two views each from operator and user perspectives. Users can see occupancy ratio as a measure of comfort because it is a ratio of passenger kms to seat kms describing passengers per seat. While operator can see it as ridership measure. However, combining both indicators from category I and II can explain more about overall system utilization. This is given in detail in the following section. Category III is a group of indicators on QOS of the PT. It includes a measure of regularity in terms of percentage of trips operated with respect to scheduled trips and a measure of reliability in terms of punctuality and no. of breakdowns. It also includes level of safety in terms of accidents, injuries and fatalities. Categories IV and V are only operator specific focusing on manpower

productivity and operational information. However, overall system utilization, efficiency and service attributes are undermined due to lack of user perspective indicators specific to these functional areas.

Material Performance – The indicators in this group shows detailed information about consumption of fuel and other materials during lifetime operation of the fleet. These materials include fuel, lubricants, engine oil, tyres, batteries, frequently replaced spare parts, etc.

Table 4: Performance Indicators in Current Practices of Indian SRTUs

Indicators	Unit	Indicators	Unit
Financial Performance			
Category I – Total Cost			
a. Personal Cost i. Drivers ii. Conductors iii. Traffic Supervisory iv. Total Traffic Staff v. W/shop[1] & Maintenance vi. Admin & Others vii. P.F.[2] Welfare, etc. viii. Total (i. to vii.)	₹ (in Lakhs) or Ps./eff. km*	b. Material Cost i. Fuel ii. Lubricants iii. Springs iv. Auto Spare Parts v. Tyres & Tubes vi. Batteries vii. General Items viii. Reconditioned Items ix. Total (i. to viii.)	₹ (in Lakhs) or Ps./eff. km
c. Taxes i. M.V.[3] Tax ii. Passenger Tax iii. Special Road Tax iv. Misc. & Other Tax v. Total (i. to iv.)	₹ (in Lakhs) or Ps./eff. km	d. Interest i. To Central Govt. ii. To State Govt. iii. On Borrowings iv. Total (i. to iii.)	₹ (in Lakhs) or Ps./eff. km
e. Misc.[4] & Others	₹ (in Lakhs) or Ps./eff. km	f. Payment to Hired Buses	₹ (in Lakhs) or Ps./eff. km
g. Depreciation i. On Buses ii. On Other Assets	₹ (in Lakhs) or Ps./eff. km	Total Cost (a. to g.)	₹ (in Lakhs) or Ps./eff. km
Category II – Total Revenue		Category III – Profit/Loss	
Traffic Revenue	₹ (in Lakhs) or Ps./eff. km	Surplus before Tax	₹ (in Lakhs) or Ps./eff. km

[1] Workshop
[2] Provident Fund
[3] Motor Vehicle
[4] Miscellaneous

Indicators	Unit	Indicators	Unit
Reimbursement of Fare Concessions	₹ (in Lakhs) or Ps./eff. km)	Profit/Loss	₹ (in Lakhs) or Ps./eff. km
Subsidy	₹ (in Lakhs) or Ps./eff. km		
Non-traffic Revenue	₹ (in Lakhs) or Ps./eff. km		
Category IV – Financial Ratios			
Total earning per bus (on road) per day	₹	Total cost per bus (on road) per day	₹
% Return on Capital Employed	%	% Return on Capital Invested	%
% Operating ratio	%		
Physical Performance			
Category I – Utilization of Fleet		Category II – Capacity Utilization	
Buses held	Count	Seating capacity	Count
Buses off road	Count	No. of standees	Count
No. of spare buses	Count	Seat kms.	Lakhs km
Buses on road	Count	Carrying capacity kms.	Lakhs km
Fleet Utilization	%	Passenger kms.	Lakhs km
Scheduled services	Count	Occupancy Ratio	%
Scheduled kms.	Lakhs km	Load factor	%
Effective kms.	Lakhs km	Passenger lead	Km/passenger
Dead kms.	Lakhs km	Passengers carried	Count
Gross kms.	Lakhs km	Passengers per bus on road per day	Count
Cancelled kms.	Lakhs km		
Bus utilization per day On buses on road On buses held	Km		
Category III – QOS		Category IV – Manpower Productivity	
Trips to be operated	Count	Traffic Staff	Count
Actual trips operated	Count	Workshop and Maintenance Staff	Count
Regularity	%	Administration and other staff	Count

Indicators	Unit	Indicators	Unit
No. of breakdowns	Count	Staff ratio per bus i. Drivers ii. Conductors iii. Checkers & Traffic Supervisory Staff iv. Workshop & Maintenance v. Administration vi. Others	Staff/bus
Breakdown per 10,000 eff. kms.	Count	Manpower Productivity per day	Km
Punctuality Departure Arrival	%	Avg. salary/employee/day	₹
Fatal accidents	Count	Eff.kms./crew member/day	Km
Major & serious accidents	Count		
Minor accidents	Count		
Total accidents	Count		
Accidents per lakh eff. kms.	Count		
No. of person injured	Count		
No. of fatalities	Count		
No. of public complaints	Count		
Category V – Operational Information			
Total No. of Schedules	Count	Total No. of Routes	Count
Classification of Schedules A. Earning more than total cost B. Earning between variable cost and total cost C. Earning less than variable cost	Count	Average Route Length	Km
No. of Depots	Count	% of Total Kms	%
No. of Bus Stations	Count	No. of Bus Shelters/Stops	Count
Material Performance			
HSD (High-speed Diesel)	Kiloliters	CNG (Compressed Natural Gas)	Km/kg

Indicators	Unit	Indicators	Unit
KMPL (Kilometer per Liter) i. Tata ii. Leyland iii. Volvo iv. Others	Km/liter	Engine oil used /oil change i. Tata ii. Leyland iii. Volvo iv. Others	Kiloliters / Lakhs km (for oil change)
Engine oil top-up i. Tata ii. Leyland iii. Volvo iv. Others	Kiloliters or Lakhs km (for oil change)	New tyres consumed	Units/lakh km
Engine oil KMPL	Km/liter	Spring	Kg/lakh km
Battery life	Months/ lakh km	Retreaded tyres consumed	Units/lakh km
Gearbox oil i. Top-up ii. Oil change	Kiloliters	Differential oil i. Top-up ii. Oil change	Liters
Engine Life i. New a. Tata b. Leyland c. Volvo d. Others ii. Reconditioned (R/C) a. Tata b. Leyland c. Volvo d. Others iii. Overall	Lakhs km	Crown wheel & pinion life i. Tata ii. Leyland iii. Volvo iv. Others v. Overall	Lakhs km
Fuel injection pump life i. New a. Tata b. Leyland c. Volvo d. Others ii. R/C a. Tata b. Leyland c. Volvo d. Others iii. Overall	Lakhs km	Gearbox life i. New a. Tata b. Leyland c. Volvo d. Others ii. R/C a. Tata b. Leyland c. Volvo d. Others iii. Overall	Lakhs km

Indicators	Unit
Piston assembly life i. Tata ii. Leyland iii. Volvo iv. Others v. Overall	Lakhs km

Indicators	Unit
Clutch plate life i. Tata ii. Leyland iii. Volvo iv. Others v. Overall	Lakhs km

The indicators shown above in table 4 are currently practiced by Indian SRTUs. Although the quantity of indicators in financial and material performance is not less when compared to international best practices, Indian SRTUs do lack user perception indicators in physical performance. For example in an urban operation, information on user demand, average waiting time at bus stops, average speed of the public bus systems, etc. become more vital as they throw more light on user perception. Similarly in rural operations, measures of connectivity between two points, number of transfers, etc. are some characteristics of bus operations which should be measured in order to understand user perception. Apart from user perception, environmental and community perception indicators could have been included. For example, carbon foot print, etc.

6. Inference on Comparison between Indian and International Practices

Based on the comparison of Indian practices with International best practices, inferences are as follows:

a) National Transit Database (NTD) is main source for all kinds of data and statistics on the PT systems around the USA. Each PT agency has unique four-digit NTD identification number which is used to submit data in forms according to their category (urban or rural) via Internet Reporting system after NTD training is provided by Federal Transit Administration. (FDOT 2014)
   On the contrary, not all the SRTUs in India report their data to CIRT. For instance, 25 SRTUs reported their data to CIRT during the year 2012-13 (CIRT 2014). Moreover, 2 or more SRTUs cannot be compared on the same indicator because one or more SRTUs do not report it.
   Thus, it is inferred that Indian SRTUs lack enforcement in reporting data while CIRT has prescribed standard format for reporting data. Additionally, use of IT systems which can ease data reporting and management is not observed in Indian SRTUs.
b) SRTUs have raw data in abundance but they lack variety of indicators which has the potential of story-telling from various points of view. This is based on the comparison of indicators found in international literature from Singapore (LTA 2011) and USA (TRB 2011).
c) The compiled records of SRTUs by CIRT shows predominantly operator perspective indicators categorized in financial, physical and material

performance. While there are some safety indicators which are applicable to user perception, but they lack indicators on serviceability, portion of population using PT, etc. For instance, bus fleet per million passengers, density of roads (km/km^2), etc.

d) While comparing Indian SRTUs performance measurement system with that of the USA, it is found that community or environmental impacts are hardly measured. Though there has been initiatives like use of CNG buses and enforcing stricter pollution norms by the Centre and the State Governments for eco-friendly transport system in India, no relevant data is seen in SRTUs. For instance, carbon foot print.
e) All the SRTUs at individual level do not publish their data. If done, could be used for peer comparison, seeking inputs from consultants and academicians. For instance, BMTC publishes some indicators on their website while DTC, OSRTC, MSRTC, etc. do not.
f) Use of data collection technology is substandard in Indian SRTUs which otherwise could simplify data collection, improve data quality and consistency and reduce human errors. “London relies on its IT systems for vehicle tracking and reporting, service control, on-board information, mileage tracking and performance measurement of its bus network that services over 6.4 million passenger journeys every day”, (LTA 2013).
g) According to Indian literature, there is already abundant raw data, which could be utilized to its maximum potential. The following section explains about what useful indicators can be derived using existing data in Indian literature.
h) In the existing practices, data related to accidents such as number of injuries, number of fatalities, seems difficult to be interpreted because of following reasons –
    - The figures do not state victims inside the bus and victims outside the bus
    - Travel mode of victims outside the bus is unknown
i) Based on comparison of KPIs among local and international PT agencies, following table 5 shows the indicators (but not limited to) which are not used in current practices of Indian SRTUs.

Table 5: Performance Indicators Uncommon to Indian SRTUs

S. No.	Indicators	S. No.	Indicators
1.	Cost per Passenger	2.	Avg. Passenger km per Vehicle km
3.	Annual ridership per bus station	4.	Annual ridership per bus
5.	Operating cost per trip	6.	Passenger trips per effective vehicle km
7.	Operating cost per passenger km	8.	Operating cost per boarding
9.	Revenue per passenger	10.	Riders per effective km
11.	Operating cost per passenger	12.	Compensation per accident
13.	Accidents per day	14.	Injuries per lakh passenger
15.	Avg. fare per passenger km	16.	Avg. fare per boarding
17.	Passengers per capita	18.	Ratio of ridership growth to population growth
19.	Air pollutants (tons per day)		

6.1 Proposed Performance Indicators

Based on comparison with international best practices, a set of derived performance indicators has been compiled in this study as shown in Table 6. Since these indicators are purely based on data maintained in local practices, there is no requirement for further data collection. Additionally, for easy interpretation of new indicators, example calculations by substituting data from 2 Urban and 2 Rural SRTUs for the year 2012-13 have been shown in Table 6. The results of new indicators are compared between both the SRTUs among each category i.e. Urban and Rural. The indicators cannot be compared between Urban and Rural categories because of difference in type of operation in Urban and Rural services. Therefore, results have been highlighted as green and red for desirable and undesirable value respectively in each category.

Table 6: Proposed Performance Indicators

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Category I – System Utilization							
Avg. passenger-km per vehicle-km $= \frac{Total\ Passenger\ Kms.}{Total\ Effective\ Kms.}$	LTA (2011b)	Toei – Tokyo, Tokyo Metro, Taipei Metro, SMRT – Singapore, MTR – Hong Kong, MTA – New York, London Underground, CTA – Chicago	This indicator measures the average system loading, in other words, how well the operating capacity has been utilized. A higher value suggests better utilization.	Avg. passenger-km per vehicle-km $= \frac{210556\ lakhs}{4638.38\ lakhs}$ = 45.39	Avg. passenger-km per vehicle-km $= \frac{179485.76\ lakhs}{3329.67\ lakhs}$ = 53.90	Avg. passenger-km per vehicle-km $= \frac{368678.00\ lakhs}{9415.64\ lakhs}$ = 107.94	Avg. passenger-km per vehicle-km $= \frac{10394.78\ lakhs}{320.53\ lakhs}$ = 32.43
Annual ridership per bus station $= \frac{Total\ Passengers\ Carried}{No.of\ bus\ stations\ served}$	LTA (2011b)	Toei – Tokyo, Tokyo Metro, TMB – Barcelona, Taipei Metro, SMRT – Singapore, Shanghai Shentong, Nexus Tyne & Wear, MTR – Hong Kong, MTA – New York, London Underground, CTA – Chicago	This indicator normalizes the ridership by the number of bus stations. A higher value suggests a better utilization of the system.	Annual ridership per bus station $= \frac{17686.75\ lakhs}{50}$ = 353.74 lakhs passenger / bus station	Annual ridership per bus station $= \frac{10045.23\ lakhs}{46}$ = 218.37 lakhs passenger / bus station	Annual ridership per bus station $= \frac{9391.00\ lakhs}{145}$ = 64.77 lakhs passenger / bus station	Annual ridership per bus station $= \frac{57.21\ lakhs}{43}$ = 1.33 lakhs passenger / bus station

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Annual ridership per bus $= \frac{Total\ Passengers\ Carried}{Total\ no.of\ buses}$	LTA (2011b)	Translink – Vancouver, Toei – Tokyo, TMB – Barcelona, SL Stockholm, SBST – Singapore, MTA – New York, KMB – Hong Kong, Dublin, CTA – Chicago, SMRT – Singapore, London Bus, MTA – Washington, Sydney Bus	This indicator normalizes bus ridership by bus fleet size, and reflects the asset utilization. A higher value means that on average, a bus carries more passengers and suggests better asset utilization.	Annual ridership per bus $= \frac{17686.75\ lakhs}{6330}$ = 2.79 lakhs passenger / bus	Annual ridership per bus $= \frac{10045.23\ lakhs}{5363}$ = 1.87 lakhs passenger / bus	Annual ridership per bus $= \frac{9391.00\ lakhs}{7831}$ = 1.2 lakhs passenger / bus	Annual ridership per bus $= \frac{57.21\ lakhs}{376}$ = 0.15 lakhs passenger / bus
Category II – Operating Efficiency							
Operating cost[5] per trip $= \frac{Operating\ Cost}{Total\ Actual\ Trips\ Operated}$	TRB (2011)	Florida DOT, Mississippi DOT, Virginia DOT	This indicator measure average cost to run a scheduled trip from origin to destination. Lower value suggests better cost efficiency.	Operating cost per trip[6] $= \frac{168826.2\ lakhs}{278.37\ lakhs}$ = 606.48 ₹ / trip	Operating cost per trip $= \frac{208527.29\ lakhs}{134.39\ lakhs}$ = 1551.66 ₹ / trip	Operating cost per trip $= \frac{243729.25\ lakhs}{174.27\ lakhs}$ = 1398.57 ₹ / trip	Operating cost per trip $= \frac{6352.36\ lakhs}{0.54\ lakhs}$ = 11763.63 ₹ / trip

[5] Operating cost = Total cost – (total interest + total tax)
[6] Only for SRTU owned buses; does not include hired buses.

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Passenger trips per effective vehicle km $= \frac{Total\ Passengers\ Carried}{Total\ Eff.\ Kms.}$	TRB (2011)	Washington (state) DOT, New Jersey DOT	This indicator measures average no. of passenger trips per bus per km. Higher the value, higher is the system efficiency and vice versa. However in SRTUs' case, passenger trips are unlinked therefore total passengers carried is equal to total passenger trips.	Passenger trips per effective vehicle km $= \frac{17686.75\ lakhs}{4638.38\ lakhs}$ = 3.81 trips / eff. vehicle km	Passenger trips per effective vehicle km $= \frac{10045.23\ lakhs}{3329.67\ lakhs}$ = 3.01 trips / eff. vehicle km	Passenger trips per effective vehicle km $= \frac{9391.00\ lakhs}{9415.64\ lakhs}$ = 0.99 trips / eff. vehicle km	Passenger trips per effective vehicle km $= \frac{57.21\ lakhs}{320.53\ lakhs}$ = 0.18 trips / eff. vehicle km

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Operating cost per passenger-km $= \frac{Operating\ Cost}{Total\ Passenger\ Kms.}$	SMRT (2011)	SMRT – Singapore	This indicator measures the cost required to deliver every kilometer a passenger travels. As operating cost is largely fixed (e.g. manpower cost, fuel cost) once the route and schedule are determined, a higher ridership and longer trip distance would lead to higher operational efficiency.	Operating cost per passenger-km $= \frac{169071.91\ lakhs}{210556.00\ lakhs}$ = 0.80 ₹ / passenger-km	Operating cost per passenger-km $= \frac{208527.29\ lakhs}{179485.76\ lakhs}$ = 1.16 ₹ / passenger-km	Operating cost per passenger-km $= \frac{243729.25\ lakhs}{368678.00\ lakhs}$ = 0.66 ₹ / passenger-km	Operating cost per passenger-km $= \frac{6352.36\ lakhs}{10394.78\ lakhs}$ = 0.61 ₹ / passenger-km

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Operating cost per boarding $= \frac{Operating\ Cost}{Total\ Passengers\ Carried}$	LTA (2011b)	Toei – Tokyo, Tokyo Metro, TMB – Barcelona, Taipei Metro, SMRT – Singapore, Shanghai Shentong, Nexus Tyne & Wear, MTR – Hong Kong, MTA – New York, London Underground, CTA – Chicago	This indicator measures the operating cost for every passenger boarding. A higher value refers to lower efficiency. In SRTUs' case, passenger trips are unlinked therefore, total passengers carried is equal to total no. of boardings.	Operating cost per boarding $= \frac{169071.91\ lakhs}{17686.75\ lakhs}$ = 9.56 ₹ / boarding	Operating cost per boarding $= \frac{208527.29\ lakhs}{10045.23\ lakhs}$ = 20.76 ₹ / boarding	Operating cost per boarding $= \frac{243729.25\ lakhs}{9391.00\ lakhs}$ = 25.95 ₹ / boarding	Operating cost per boarding $= \frac{6352.36\ lakhs}{57.21\ lakhs}$ = 111.04 ₹ / boarding
Farebox Ratio $= \frac{Total\ Traffic\ Revenue}{Total\ Cost}$	LTA (2011b) and TRB (2011)	Toei – Tokyo, Tokyo Metro, TMB – Barcelona, Taipei Metro, SMRT – Singapore, Shanghai Shentong, Nexus Tyne & Wear, MTR – Hong Kong, MTA – New York, London Underground, CTA – Chicago	This indicator measures the financial viability of an operator without subsidy. A ratio above 1 suggests that the operator is able to recover its total cost from fare (traffic) revenue.	Farebox Ratio $= \frac{151600.16\ lakhs}{180800.43\ lakhs}$ = 0.84	Farebox Ratio $= \frac{108184.67\ lakhs}{401852.87\ lakhs}$ = 0.27	Farebox Ratio $= \frac{231706.69\ lakhs}{258799.40\ lakhs}$ = 0.89	Farebox Ratio $= \frac{6440.18\ lakhs}{6923.09\ lakhs}$ = 0.93

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Revenue per passenger $= \frac{Total\ Traffic\ Revenue}{Total\ Passengers\ Carried}$	TRB (2011)	New Mexico DOT	This indicator measures average money paid by each passenger for using the service. It will help consider whether or not to revise fare structure. Higher value suggests better amount drawn from passenger.	Revenue per passenger $= \frac{151600.16\ lakhs}{17686.75\ lakhs}$ = 8.57 ₹ / passenger	Revenue per passenger $= \frac{108184.67\ lakhs}{10045.23\ lakhs}$ = 10.77 ₹ / passenger	Revenue per passenger $= \frac{231706.69\ lakhs}{9391.00\ lakhs}$ = 24.67 ₹ / passenger	Revenue per passenger $= \frac{6440.18\ lakhs}{57.21\ lakhs}$ = 112.57 ₹ / passenger
Passengers per eff. vehicle km $= \frac{Total\ Passengers\ Carried}{Total\ Effective\ Kms.}$	TRB (2011)	Colorado DOT, District of Columbia DOT, Texas DOT, Mississippi DOT	This indicator measures passengers moved per effective km. Higher value suggests better revenue generation. This is similar to passenger trips per eff. vehicle km because passenger trips in SRTUs' case are unlinked.	Passengers per eff. vehicle km $= \frac{17686.75\ lakhs}{4638.38\ lakhs}$ = 3.81 passengers / eff. vehicle km	Passengers per eff. vehicle km $= \frac{10045.23\ lakhs}{3329.67\ lakhs}$ = 3.01 passengers / eff. vehicle km	Passengers per eff. vehicle km $= \frac{9391.00\ lakhs}{9415.64\ lakhs}$ = 0.99 passengers / eff. vehicle km	Passengers per revenue km $= \frac{57.21\ lakhs}{320.53\ lakhs}$ = 0.18 passengers / eff. vehicle km

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Compensation per accident $= \frac{Total\ Road\ Accident\ Compensation}{Total\ no.of\ Accidents}$			This indicator measures average compensation paid for an accident occurred. As an aspect of safety, it can be reduced thereby reducing net losses.	Compensation per accident[7] $= \frac{273.41\ lakhs}{414}$ = 0.66 lakhs ₹ / accident	Compensation per accident $= \frac{214.17\ lakhs}{232}$ = 0.92 lakhs ₹ / accident	Compensation per accident $= \frac{2549.35\ lakhs}{1167}$ = 2.18 lakhs ₹ / accident	Compensation per accident $= \frac{103.03\ lakhs}{26}$ = 3.96 lakhs ₹ / accident
Category III – Safety							
Accidents per day $= \frac{Total\ Accidents}{365}$	TRB (2003)		This indicator measures average no. of accidents in a day.	Accidents per day[8] $= \frac{414}{365}$ = 1.13 accidents / day	Accidents per day $= \frac{232}{365}$ = 0.64 accidents / day	Accidents per day $= \frac{1167}{365}$ = 3.2 accidents / day	Accidents per day $= \frac{26}{365}$ = 0.07 accidents / day
Fatal Accidents per day $= \frac{Total\ Fatal\ Accidents}{365}$	TRB (2003)		This indicator measures average no. of fatal accidents which involve SRTU vehicle.	Fatal accidents per day[9] $= \frac{87}{365}$ = 0.24 fatal accidents / day	Fatal Accidents per day (data unavailable)	Fatal Accidents per day $= \frac{269}{365}$ = 0.74 fatal accidents / day	Fatal Accidents per day $= \frac{7}{365}$ = 0.02 fatal accidents / day

[7] , [8] , [9] Only for SRTU owned buses; does not include hired buses.

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Fatal Accidents per lakh vehicle km per year $=\frac{Total\ Fatal\ Accidents}{Gross\ Kms}$	TRB (2003)		This indicator measures no. of fatal accidents per lakh vehicle km driven including dead km.	Fatal Accidents per lakh vehicle km per year $=\frac{87}{4814.62\ lakhs}$ = 0.02 fatal accidents / lakh vehicle km	Fatal Accidents per lakh vehicle km per year (data unavailable)	Fatal Accidents per lakh vehicle km per year $=\frac{269}{9856.32\ lakhs}$ = 0.03 fatal accidents / lakh vehicle km	Fatal Accidents per lakh vehicle km per year $=\frac{7}{324.42\ lakhs}$ = 0.02 fatal accidents / lakh vehicle km
Fatalities per lakh passenger per year $=\frac{Total\ no.of\ Fatalities}{Passengers\ carried}$	TRB (2003)		This indicator measures average no. of fatalities per lakh passengers carried in a year.	Fatalities per lakh passenger per year $=\frac{90}{17686.75\ lakhs}$ = 0.005 fatalities / lakh passengers	Fatalities per lakh passenger per year $=\frac{77}{10045.23\ lakhs}$ = 0.008 fatalities / lakh passengers	Fatalities per lakh passenger per year $=\frac{349}{9391.00\ lakhs}$ = 0.04 fatalities / lakh passengers	Fatalities per lakh passenger per year $=\frac{7}{57.21\ lakhs}$ = 0.12 fatalities / lakh passenger
Injuries per lakh passengers $=\frac{Total\ no.of\ persons\ injured}{Total\ passengers\ carried}$	TRB (2003)	MTA – New York City Transit	This indicator measures average no. of injured passengers per lakh passengers carried in a year.	Injuries per lakh passenger $=\frac{424}{17686.75\ lakhs}$ = 0.024 injuries / lakh passenger	Injuries per lakh passenger $=\frac{70}{10045.23\ lakh}$ = 0.007 injuries / lakh passengers	Injuries per lakh passenger $=\frac{1552}{9391.00\ lakhs}$ = 0.17 injuries / lakh passengers	Injuries per lakh passenger $=\frac{14}{57.21\ lakhs}$ = 0.24 injuries / lakh passengers
Category IV – Fare Level							

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Average fare per passenger-km $= \frac{Total\ Traffic\ Revenue}{Total\ Passenger\ Kms.}$	LTA (2011b)	Toei – Tokyo, Tokyo Metro, Taipei Metro, SMRT – Singapore, MTR – Hong Kong, MTA – New York, London Underground, CTA – Chicago	This indicator measures how much a commuter pays for one km he/she travels in the PT system.	Average fare per passenger-km $= \frac{151600.16\ lakhs}{210556.00\ lakhs}$ = 0.72 ₹ / passenger km	Average fare per passenger-km $= \frac{108184.67\ lakhs}{179485.76\ lakhs}$ = 0.60 ₹ / passenger km	Average fare per passenger-km $= \frac{231706.69\ lakhs}{368678.00\ lakhs}$ = 0.63 ₹ / passenger km	Average fare per passenger-km $= \frac{6440.18\ lakhs}{10394.78\ lakhs}$ = 0.62 ₹ / passenger km
Avg. fare per boarding $= \frac{Total\ Traffic\ Revenue}{Total\ Passengers\ Carried}$	LTA (2011b)	Toei – Tokyo, Tokyo Metro, TMB – Barcelona, Taipei Metro, SMRT – Singapore, Shanghai Shentong, Nexus Tyne & Wear, MTR – Hong Kong, MTA – New York, London Underground, CTA – Chicago	This indicator measures average fare per trip directly. The comparison of this indicator is still meaningful as commuters usually would not compute how long they have travelled; instead, they care more for how much they have been charged for a trip. This indicator can also be interpreted as average fare per passenger trip because of its unlinked nature in SRTUs.	Avg. fare per boarding $= \frac{151600.16\ lakhs}{17686.75\ lakhs}$ = 8.57 ₹ / boarding	Avg. fare per boarding $= \frac{108184.67\ lakhs}{10045.23\ lakhs}$ = 10.77 ₹ / boarding	Avg. fare per boarding $= \frac{231706.69\ lakhs}{9391.00\ lakhs}$ = 24.67 ₹ / boarding	Avg. fare per boarding $= \frac{6440.18\ lakhs}{57.21\ lakhs}$ = 112.57 ₹ / boarding

Proposed Performance Indicators	Source	User Agencies	Description	Intra-city or Urban SRTUs		Inter-city or Rural SRTUs	
				BMTC (2012-13)	DTC Urban (2012-13)	KnSRTC (2012-13)	OSRTC (2012-13)
Category V – Comfort							
Occupancy Ratio $= \frac{Total\ Passenger\ kms}{Total\ Seat\ kms}$	CIRT (2014)	SRTUs (KMTU, MTC, BMTC, etc.)	This indicator measures passengers per seat. As a measure of comfort, it is more suitable for inter-city services because the journey is fairly longer than that in intra-city services.	Occupancy Ratio $= \frac{210556.00\ lakhs}{204552.56\ lakhs}$ = 1.03	Occupancy Ratio $= \frac{179485.76\ lakhs}{126457.97\ lakhs}$ = 1.42	Occupancy Ratio $= \frac{368678.00\ lakhs}{489613.28\ lakhs}$ = 0.75	Occupancy Ratio $= \frac{10394.78\ lakhs}{15064.91\ lakhs}$ = 0.69

In the list of proposed (derived) performance indicators, category I, namely System Utilization, describes relating two existing categories in local practices viz. Fleet Utilization and Capacity Utilization. Since it captures a broader picture of a PT system in an area, it is recommended to follow population trend simultaneously in the area to closely understand utilization of system over a period of time. Refer to case study below for illustration.

Category II groups indicators which are derived from relating financial and physical performance indicators together in ratios. The prime focus is to track how well monetary resources are working in operational sides of the system. Thus, this category is named as operating efficiency.

Category III and IV in derived performance indicators are based on user perception of any PT system. Safety (in category III) is an important aspect which a user thinks before choosing any mode of transport. At the same time, fare level (in category IV) is an important factor for different socio-economic groups of people to decide on PT. To make a note, the user perspective is not limited to indicators mentioned in these categories. It always depends on local situations, urban planners, operators and governing bodies.

In category V, occupancy ratio, which is already being used in local practices as a measure of capacity utilization, is shown with a user perspective idea of comfort. Note – Occupancy Ratio and Load Factor, both should not be confused as one. It is observed that same formula has been used to calculate the duo, which is as follows:

$$\text{Occupancy Ratio (\%)} = \frac{Total\ Passenger\ Kms.}{Total\ Carrying\ Capacity\ Kms.}\ X\ 100 = \text{Load Factor (\%)}$$

Instead, occupancy ratio is based on seats available in the bus and load factor is based on total carrying capacity (seats + standing spaces) in the bus. However, it is also observed that, figures for occupancy ratio and load factor are same for some SRTUs (APSRTC, MSRTC, UPSRTC, etc.), whereas different for some SRTUs (BMTC, KDTC, BEST, etc.). It can therefore be concluded that, some SRTUs may have miscalculated the figures by applying same formula to both indicators. (CIRT 2012-13)

Following case study of aforementioned Urban and Rural SRTUs' performance with respect to proposed (derived) performance indicators will illustrate the use of these indicators in more detail.

Case Study – Interpreting Proposed Performance Indicators

For urban case, DTC and BMTC and for rural case, Karnataka SRTC and Odisha SRTC are compared in terms of 'proposed performance indicators' grouped in 5 categories in above table 6.

In category I, system utilization (see figure 1), DTC has higher utilization (passenger-km) of service supply (vehicle-km) than BMTC. This can be interpreted as average number of passengers per bus at any given time. In a typical metropolitan bus operations, the value ranges from 45 to 54; and in rural operations the range can be wider on both ends (see figure 2). The differences in average passenger-km per vehicle-km can be attributed to following factors –

i. Passenger lead (trip length)
ii. Passengers per bus
iii. Buses on road

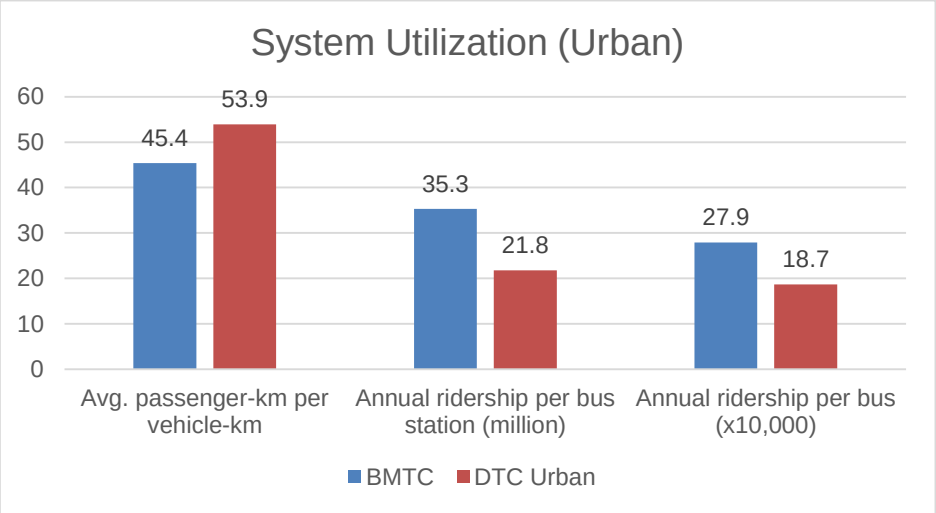

Figure 1- System Utilization (Urban)

Utilization of station is higher on BMTC's side when compared to DTC (see figure 1) and similarly higher for Karnataka SRTC than Odisha SRTC (see figure 2). Thus, this indicator may be helpful in allocating sufficient planning and budget towards infrastructure depending on type of operation (urban or rural) and passenger traffic per station.

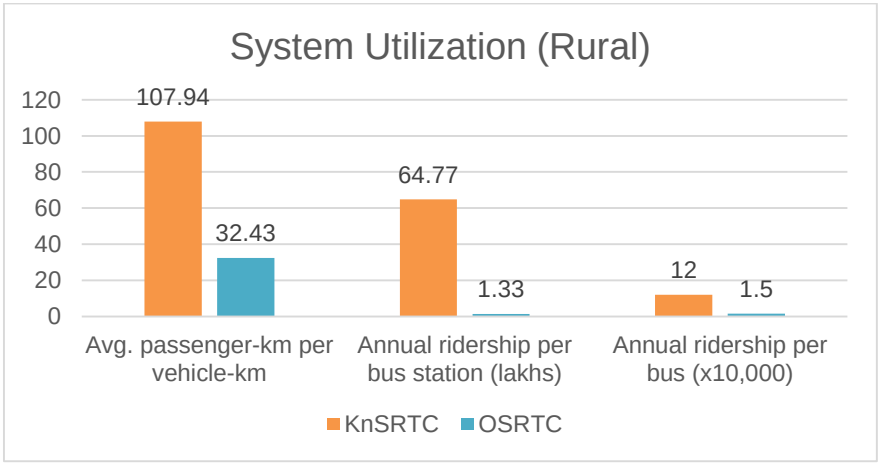

Figure 2- System Utilization (Rural)

In third indicator of category I, annual ridership per bus, ridership is normalised in terms of total buses held by SRTUs. This helps in understanding utilization of fleet (including buses off road) and not just buses on road. Here, utilization of fleet is significantly higher in BMTC and Karnataka SRTC when compared to DTC and Odisha SRTC respectively (see figure 1 and 2).

The figure 3 below shows operating cost per trip and farebox ratio from category III i.e. operating efficiency for both urban and rural cases. DTC's operating cost per trip is more than double that of BMTC's; keeping in mind little difference between average route lengths of DTC and BMTC which is 3.1km (i.e. 26.6km for DTC and 23.5km for BMTC). Also, DTC's farebox ratio is significantly lower than that of BMTC.

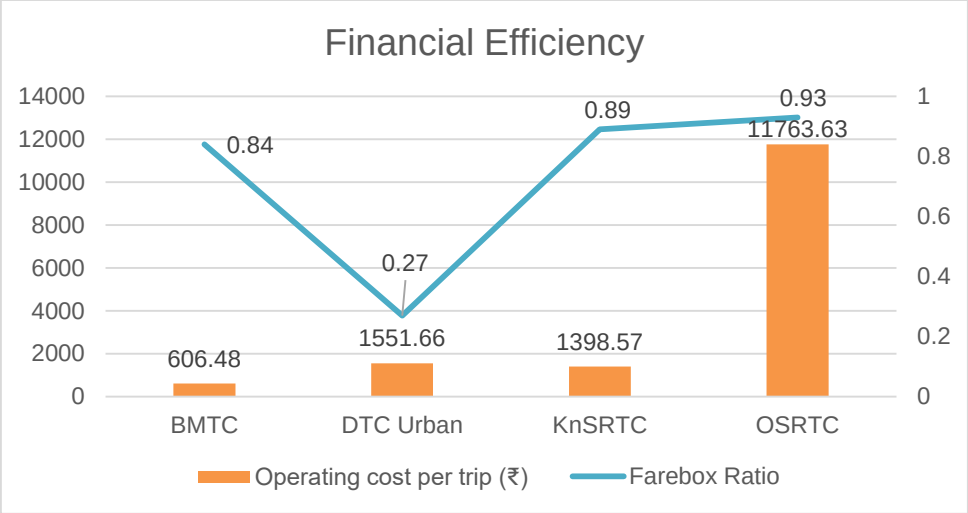

Figure 3- Financial Efficiency

In case of rural operations, OSRTC has exceptionally higher operating cost per trip (more than 8 times KnSRTC's operating cost per trip). On the other hand, OSRTC also maintains higher farebox ratio (see figure 3). Here, the difference in average route length is 218.4km (i.e. 313km for OSRTC and 94.6km for KnSRTC), which is notably high in rural operations.

In general, cost depends on following important factors –

i. Manpower (personnel)
ii. Material (fuel, lubricants, stationary, etc.)
iii. Passenger facilities (infrastructure)

whereas, traffic revenue depends only on fare level.

In the following figure 4, cost per boarding is higher than fare per boarding in 3 out of 4 SRTUs. However, average fare per passenger-km range is quite narrow i.e. between ₹0.60 to ₹0.72. This can be attributed to the cap on fare level which is provided by respective state government policies.

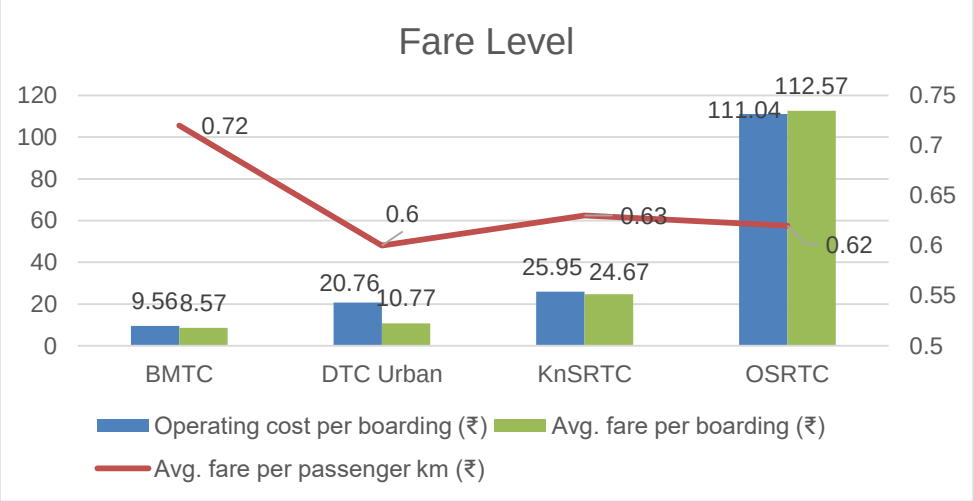

Figure 4- Fare Level

Interestingly, OSRTC has been able to maintain higher average fare per boarding than operating cost per boarding while also keeping average fare per passenger-km well within the range.

The figure 5 shows safety indicators for all 4 SRTUs. Average number of fatalities is lower in urban operations when compared with rural. This can be attributed to average transit speed which is fairly lower in urban operations. However, safety also depends on –

i. Infrastructure
ii. Vehicle design
iii. Driver training

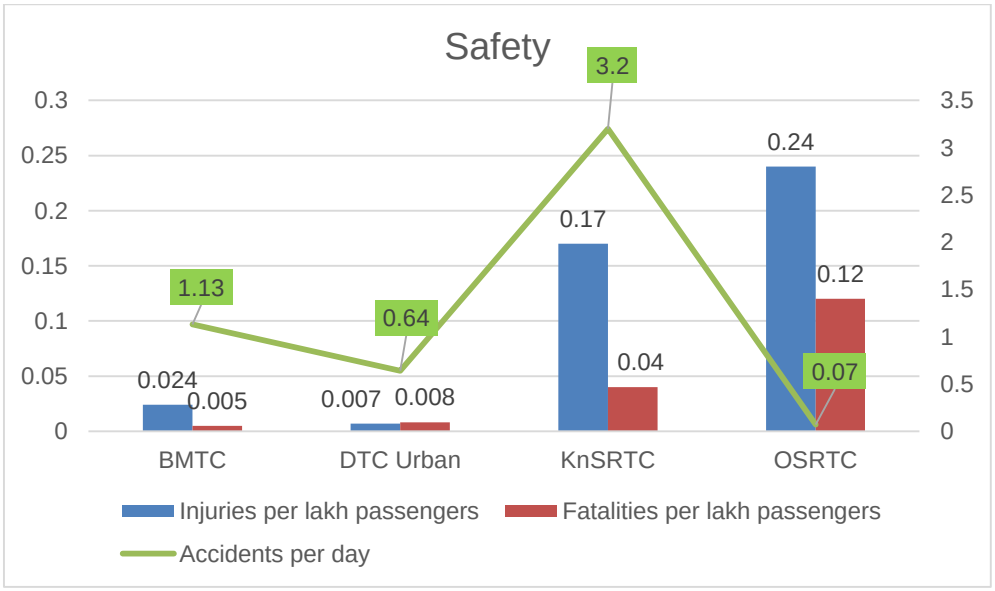

Figure 5- Safety

6.2 Recommendations

Based on gaps inferred on comparing Indian and International literature in data maintenance and performance measurement in PT following recommendations are concluded in different categories:

6.2.1 New Indicators

i. SRTUs could use derived indicators which are explained in various categories in table 6.

ii. Since SRTUs lack user perspective indicators which they should include in their data management practices. Unlike indicators proposed in table 6, these indicators cannot be derived from existing database therefore, they need to be collected. User perspective indicators can include both quantitative and qualitative parameters as given below:

   a. Quantitative Parameters –
      i. Average passenger waiting time (min.)
      ii. Average transit speed (km/h)
   b. Qualitative Parameters –
      i. Crew behavior
      ii. Ride Quality (cleanliness, sudden acceleration/deceleration, etc.)

Table 7 below shows a comprehensive list of KPIs including existing KPIs (grey colored background), KPIs which can be derived (pink colored background) and KPIs that need new types of data to be collected (green colored background). The table also shows if it is relevant for a particular KPI to be used in urban and/or rural context(s). While most of the existing KPIs are applicable to both kinds of operation, some new proposed (i.e. derived) ones have application to only urban operations.

Table 7: Final List of KPIs

KPIs	Relevance	
	Urban	Rural
Operator Perspective		
Category I – Total Cost (a. to g.)		
a. Personal Cost (i. to vii.)	✓	✓
i. Drivers	✓	✓
ii. Conductors	✓	✓
iii. Traffic Supervisory	✓	✓
iv. Total Traffic Staff	✓	✓
v. W/shop & Maintenance	✓	✓
vi. Admin & Others	✓	✓
vii. P.F. Welfare, etc.	✓	✓
b. Material Cost (i. to viii.)	✓	✓
i. Fuel	✓	✓
ii. Lubricants	✓	✓

KPIs	Relevance	
	Urban	Rural
iii. Springs	✓	✓
iv. Auto Spare Parts	✓	✓
v. Tyres & tubes	✓	✓
vi. Batteries	✓	✓
vii. General Items	✓	✓
viii. Reconditioned Items	✓	✓
c. Taxes (i. to iv.)	✓	✓
i. M.V. Tax	✓	✓
ii. Passenger Tax	✓	✓
iii. Special Road Tax	✓	✓
iv. Misc. & Other tax	✓	✓
d. Interest (i. to iii.)	✓	✓
i. To Central Government	✓	✓
ii. To State Government	✓	✓
iii. On Borrowings	✓	✓
e. Misc. & Others	✓	✓
f. Payment to Hired Buses	✓	✓
g. Depreciation (i. & ii.)	✓	✓
i. On Buses	✓	✓
ii. On Other Assets	✓	✓
Category II – Total Revenue (a. to d.)		
a. Traffic Revenue	✓	✓
b. Reimbursement of Fare Concessions	✓	✓
c. Subsidy	✓	✓
d. Non-traffic Revenue	✓	✓
Category III – Profit/Loss		
Surplus before Tax	✓	✓
Profit/Loss	✓	✓
Category IV – Financial Ratios		
Total earning per bus (on road) per day	✓	✓
% Return on Capital Employed	✓	✓
% Operating ratio	✓	✓
Total cost per bus (on road) per day	✓	✓
% Return on Capital Invested	✓	✓
Operating cost per passenger-km	✓	✓
Farebox Ratio	✓	✓
Operating cost per boarding	✓	✓
Revenue per passenger	✓	✓
Operating cost per passenger	✓	✓
Compensation per accident	✓	✓
Category V – Utilization of Fleet		
Buses held	✓	✓
Buses off road	✓	✓
No. of spare buses	✓	✓
Buses on road	✓	✓
Fleet Utilization	✓	✓

KPIs	Relevance	
	Urban	Rural
Scheduled services	✓	✓
Scheduled kms.	✓	✓
Effective kms.	✓	✓
Dead kms.	✓	✓
Gross kms.	✓	✓
Cancelled kms.	✓	✓
Bus utilization per day (i. & ii.)	✓	✓
i. On buses on road	✓	✓
ii. On buses held	✓	✓
Category VI – Quality of Service		
No. of breakdowns	✓	✓
Breakdown per 10,000 eff. kms.	✓	✓
Category VII – Capacity Utilization		
Seating capacity	✓	✓
No. of standees	✓	✓
Seat kms.	✓	✓
Carrying capacity kms.	✓	✓
Passenger kms.	✓	✓
Occupancy Ratio	✓	✓
Load factor	✓	✓
Passenger lead	✓	✓
Passengers carried	✓	✓
Passengers per bus on road per day	✓	✓
Passenger trips per effective vehicle km	✓	✓
Avg. passenger-km per vehicle-km	✓	✓
Annual ridership per bus station	✓	✓
Annual ridership per bus	✓	✓
Passengers per eff. vehicle km	✓	✓
Category VIII – Manpower Productivity		
Traffic Staff	✓	✓
Workshop and Maintenance Staff	✓	✓
Administration and other staff	✓	✓
Staff ratio per bus (i. to vi.)	✓	✓
i. Drivers	✓	✓
ii. Conductors	✓	✓
iii. Checkers & Traffic Supervisory Staff	✓	✓
iv. Workshop & Maintenance	✓	✓
v. Administration	✓	✓
vi. Others	✓	✓
Manpower Productivity per day	✓	✓
Avg. salary/employee/day	✓	✓
Eff.kms./crew member/day	✓	✓
Category IX – Operational Information		
Total No. of Schedules	✓	✓
Classification of Schedules (A. to C.)	✓	✓
A. Earning more than total cost	✓	✓

KPIs	Relevance	
	Urban	Rural
B. Earning between variable cost and total cost	✓	✓
C. Earning less than variable cost	✓	✓
No. of Depots	✓	✓
No. of Bus Stations	✓	✓
Total No. of Routes	✓	✓
Average Route Length	✓	✓
% of Total Km	✓	✓
No. of Bus Shelters/Stops	✓	✓
Category X – Material Performance		
HSD (High-speed Diesel)	✓	✓
KMPL (Kilometer per Liter)	✓	✓
Engine oil top-up	✓	✓
Engine oil KMPL	✓	✓
Battery life	✓	✓
Gearbox oil (i. & ii.)	✓	✓
i. Top-up	✓	✓
ii. Oil Change	✓	✓
Engine Life (i. & ii.)	✓	✓
i. New	✓	✓
ii. Reconditioned (R/C)	✓	✓
Fuel injection pump life (i. & ii.)	✓	✓
i. New	✓	✓
ii. R/C	✓	✓
Piston assembly life	✓	✓
CNG (Compressed Natural Gas)	✓	✓
Engine oil used /oil change	✓	✓
New tyres consumed	✓	✓
Spring	✓	✓
Retreaded tyres consumed	✓	✓
Differential oil	✓	✓
i. Top-up	✓	✓
ii. Oil Change	✓	✓
Crown wheel & pinion life	✓	✓
Gearbox life (i. & ii.)	✓	✓
i. New	✓	✓
ii. R/C	✓	✓
Clutch plate life	✓	✓
User Perspective		
Category I – Quality of Service		
Trips to be operated	✓	✓
Actual trips operated	✓	✓
Regularity	✓	✓
Punctuality (i. & ii.)	✓	✓
i. Departure	✓	✓
ii. Arrival	✓	✓
Fatal accidents	✓	✓

KPIs	Relevance	
	Urban	Rural
Major & serious accidents	✓	✓
Minor accidents	✓	✓
Total accidents	✓	✓
Accidents per lakh eff. kms.	✓	✓
No. of person injured	✓	✓
No. of fatalities	✓	✓
No. of public complaints	✓	✓
Accidents per day	✓	✓
Fatal Accidents per day	✓	✓
Fatal Accidents per lakh vehicle km per year	✓	✓
Fatalities per lakh passenger per year	✓	✓
Injuries per lakh passengers	✓	✓
Average fare per passenger-km	✓	✓
Avg. fare per boarding	✓	✓
Access/Egress Time	✓	
Access/Egress Distance	✓	
Avg. Passenger Waiting Time	✓	
Avg. Passenger Transit Time	✓	
No. of transfers	✓	
Informative Bus Stops	✓	
Headway	✓	
Buses per lakh population	✓	
Density of bus route (km/km^2)	✓	
% villages serviced		✓
% towns serviced		✓
% cities serviced		✓
Environment Perspective		
Noise	✓	✓
Emissions (i. to vii.)	✓	✓
i. CO	✓	✓
ii. CO_2	✓	✓
iii. NO_x	✓	✓
iv. HC	✓	✓
v. PM	✓	✓
vi. SO_x	✓	✓
vii. VOCs	✓	✓

From environment perspective, noise and emission impacts are widely considered. Noise is a byproduct of transport service and may affect passengers, residents of the surrounding community and places and activities that acquire PT setting. It can be calculated by using weighted decibels. Major factors that contributes to noise levels are tire-pavement interaction, vehicle engines and exhaust, traffic volume and speed, proportion of heavy traffic like trucks and proportion of halt-and-go traffic. However, at busy intersections or other locations, it may be difficult to isolate

the effects of PT on aggregate noise levels. In some areas, noise emanating from PT may be only a small portion of total noise levels.

PT, for the most part, play a role in reduction of traffic-induced pollution and other types of environmental impacts. Pollution affects the health of a community's residents and threatens their quality of life. Therefore, assessing the environmental impact of PT is important, especially in urban areas, where the quality of air is already inadequate, and in non-attainment areas. Because PT often alleviates pollution, comparing the impact with and without PT would be helpful in determining the overall impact of PT.

Therefore, each vehicle must be checked and maintained under emission norms set by policy. In addition, it would be also benefiting to compare pollution and its impact with and without PT. This requires collaboration of multiple agencies in order to include other components of traffic (i.e. private cars, trucks, etc.)

6.2.2 Data Collection

i. Use of smart ticketing technology can help in counting number of passengers during peak/non-peak hours, travel demand on fixed routes, etc. For example: Near Field Communication (NFC) enabled devices (smartphones, travel cards like Delhi Metro).
ii. Use of GPS technology can help in determining punctuality, regularity and travel time of buses.
iii. Use of On-Board Vehicle Diagnostic System in buses can help in tracking and recording vehicle health data which is useful for repair and maintenance of the fleet.

6.2.3 Data Reporting

i. Revising the list of indicators to be reported by SRTUs followed by establishment of Online Data Reporting System which allows SRTUs, using their unique ID, to report their performance data periodically to the central database in CIRT or ASRTU.
ii. Enforcement by MoRTH on SRTUs to collect and report their data.

6.2.4 Performance Measurement System

i. Establishing targets and timeframe are the first step of developing Performance Measurement System. For example, to achieve higher safety (target) a PT operator decides to reduce number of accidents by 10% in one year (timeframe) compared to that in previous year.
ii. Choose indicators which can be consistently evaluated over time and show progress towards goal. For example, from the list of Proposed Indicators in table 6, where indicators are derived from existing data following indicators can be evaluated for past as well as future and also shows the direction of SRTUs performance:
    a. Average passenger km per vehicle km

b. Annual ridership per bus
c. Operating cost per boarding or passenger
d. Passengers per effective km, etc.

iii. Employ dedicated team skilled in data analytics to understand Performance Measurement System from level of indicators to goals and targets stated in the policy. This may bring some significant changes in institutional structure.
iv. Include indicators reflecting environmental impacts of PT. For example: Air Pollutants (CO_2 Equivalent or tons).
v. Tie performance measurement to funding decisions in order to optimize financial resources and not face huge losses.
vi. Staff at various levels i.e. crew, administration, maintenance, etc. can be incentivized based on performance measurement in order to improve manpower productivity.

6.2.5 Others

With regards to difficulty in understanding accident related data due to lack of standard definitions of indicators and lack of accuracy in data provided, it is recommended that – in an accident, the victims inside and outside the bus should be recorded; and travel mode of victim outside the bus should also be recorded.

7. Conclusion and Way Forward

This study is based on performance reports of Indian SRTUs and their comparison with that of international public transport agencies in terms of KPIs used for performance measurement in various agencies. It is concluded that,

- Indian SRTUs have sufficient indicators for financial and material performance but they lack different perceptions of measuring physical performance like user, environmental and community perceptions.
- SRTUs from Karnataka report maximum data among 53 SRTUs in the country and SRTUs from northeastern states report the minimum.
- Some indicators are reported by all the SRTUs such as operational costs and manpower productivity while some indicators were not reported by many SRTUs such as number of public complaints and arrival/departure punctuality to/from the depot.

Some possible conclusions were also drawn on factors which may influence a public transport agency's approach towards data management practices. For example, lack of manpower, operational losses, lack of financial aid from state government, lack of enforcement, stakeholder coordination issues, etc. These conclusions are speculations, hence further study is needed to understand SRTUs' approach towards data management practices by going through their organizational structure, standard operating procedures related to data coming from different functionalities of a SRTU and various issues faced by the SRTU at institutional level.

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