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A STUDY ON MODE SWITCHING TO DECREASE BUS ACCIDENTS AT TIRUCHIRAPPALLI

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ABSTRACT
When compared to other forms of transportation, such as private vehicles, public transportation buses could be thought of as a safer choice. However, given the pertinent implications it raises, safety is a critical problem for both operators and passengers when it comes to transit vehicles. Therefore, evaluating the accident risk on bus routes is an opportunity to improve the safety record of transit operators. Because they have the potential to do catastrophic damage, accidents are always a reason for worry, whether they occur locally, nationally, or internationally. Any study project should have a primary emphasis on creating and evaluating preventive or remedial techniques. This essay explores the subject of safety management via an examination of events that took place in Tiruchirappalli, sometimes referred to as Trichy, in India. We have decided to concentrate on the years 2000 through 2004 in order to meet the requirements of the study. The Tamil Nadu State Transport Corporation, a government-owned company in Tamil Nadu, provided the reliable, recorded data used in this study. In this thesis, we provide a breakdown of the data by vehicle type, involved parties, accident outcomes, accident attributes, and accident type that was gathered between 2000 and 2004. The outcomes are broken out each year. SPSS, or the Statistical Package for the Social Sciences, is used to examine these data.

1. INTRODUCTION
Road accidents are an inherent element of working in transportation. However, every care must be taken to minimize or considerably decrease accidents. Transportation's main purpose is to carry people safely. Transportation choice has a key impact in preventive activities. This study analyzes how altering transportation modes could enhance security.

1.1 Types of Bus Services
Major mode of passenger transport in cities can be categorized as
Normal (Stopping)
Limited (Stopping)
Express (Non-stop)

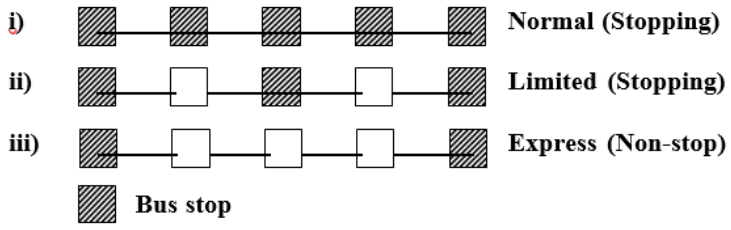

Figure 1 Types of bus services

Normal (stopping) services stop every 0.4 to 0.8 kilometers, whereas express (non-stop) services don't stop at all between the starting and terminating locations. (TNSTC 2000). This article looks at the overall number of accidents recorded in the city between January 2000 and December 2006 using data from the Kumbakonam Division - II Tiruchirappalli office of the Tamil Nadu State Transport Corporation. The precise location of bus stops in Tiruchirappalli is shown in Figure.

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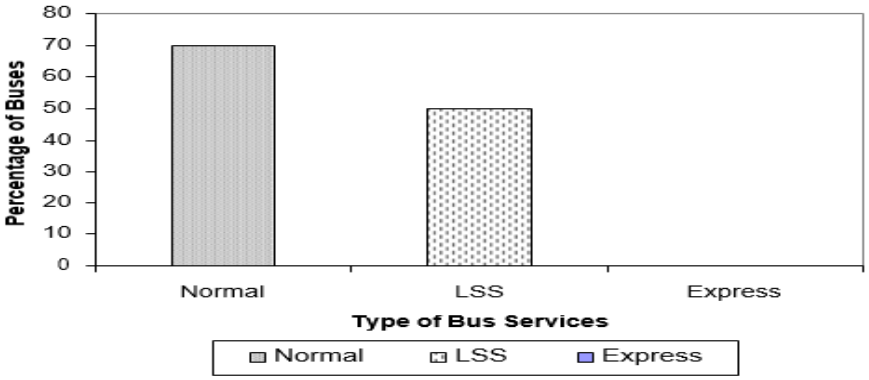

Figure 2 Distribution of bus service in Tiruchirappalli city

It should be mentioned that express bus services are not yet available in the city, but they soon will be. There are several viewpoints discussed on the need of introducing these expedited services. Overall, there are a lot of accidents (8.00 am–10.00 am and 4.00 pm–6.00 pm; that is, 8–10 hours and 16–18 hours). The bulk of the city's workforce commutes to work every day by bus. Within the municipal boundaries of Tiruchirappalli, the number of bus services that are offered during peak hours is compared among ten distinct industrial sectors. Figure 2 displays the percentage of Local and LSS bus service alternatives. Although there are other bus transit choices available around the state, the city solely offers local (regular) and LSS (limited stop) bus services.

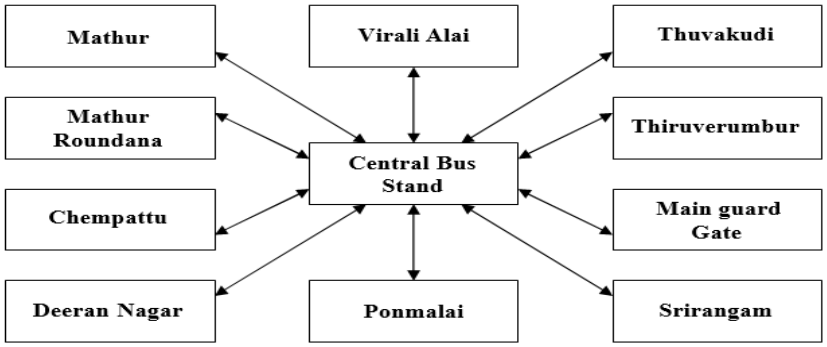

Figure 3 Block diagram of sites identified and studied.

2. METHODOLOGY

2.1 Development of Conceptual Transportation Method

The examination of accident data shows that the peak times for fatal accidents are between eight and ten in the morning and four and six in the evening. Therefore, research is being undertaken currently since it is peak hours. Table provides a breakdown of the average number of available buses and the total number of people scheduled to travel.

Table 1 Distribution of bus services (area-wise)

Sl. No	Area	Average No. of Buses available	Total No. of Passengers (Relative)
1	Thuvakudi	5	300
2	Thiruverumbur	5	300
3	Mathur	5	300
4	Mathur - Rounding	5	300
5	Champeta	5	300
6	Virali Alai	5	300

7	Dheeran Nagar	5	300
8	Panmoli	5	300
9	Srirangan	6	300
10	Main guard Gate	6	300

The number of buses in service and the volume of passengers around peak hours are details found in the records of TNSTC, Kumbakonam Division-II. Table shows that during rush hour, there are only six buses available for the Srirangan and Main guard Gate sectors, and only five for the other locations. During rush hour, almost 300 people choose to make use of the local and LSS bus services. About 60% of these peak-hour passengers board buses at Central bus station and go to their final destinations in the surrounding regions (industrial zones). These customers do not need any intermediate stops. Since passenger demand and bus accidents are both highest during peak hours, there is a large market for express bus services. The primary rationale for the introduction of rapid bus services is grounded on a simulation of the typical travel behavior of passengers. This facility is optimal for passenger transport when passenger flows are sufficiently concentrated in space and time to justify the provision of rapid services.

2.2 Changing Regular Bus Routes to Express Routes

If there is enough demand during rush hours, half of the local buses may be rerouted to operate as express buses. It's not the best possible distribution, but it might work. The process for setting up fast bus services to get people to their jobs in industrial zones is described. The findings point to a significant improvement in the effectiveness of urban bus services. During rush hour, over 60% of all passengers report a desire to go to commercial or industrial zones.

The introduction of fast bus service offers several benefits, including reduced congestion, fewer bus accidents, shorter wait times, lower emissions, and longer vehicle lifespans.

2.3 Reducing the Need for Hast

The management issues plaguing State Transport Undertakings have been assessed by Venkaji Rao (1973), with particular attention to Mysore State. He has uncovered certain organizational obstacles to improving State Transport Undertakings' efficiency. They were juggling peak-loads, the most efficient utilization of vehicles and staff based on the moving has given loads of passengers, and future traffic planning in order to strike a balance between the community's transport needs and the other facilities served. The standard carrying capacity of the vehicle is fifty people. To accommodate the roughly 60% of passengers who want to make the journey from origin to destination, at least 60% of the available buses must be converted to express (non-stop) bus services. The goal of this research is to transform a subset of the available buses into express services during peak hours, with the exact number dependent on passenger demand.

2.4 The Process of Creating Mathematical Models

The purchase price of the bus is denoted by $C.

Rn = Annual Operating Costs n Interest Rate The definition of the discounting factor, often known as the present worth factor, V = 1/(1+i) n, is as follows.

Considering that the expenditure may be thought of as occurring at the start of each year, the present value of all the years' expenditures associated with replacing the bus after n years, Pn, is provided by.

$$Pn=C+VoR1+V1R2+.. +Vn-1Rn$$

The present value of a cost incurred by replacing the bus in year (n+1) as opposed to year (n) would be P(n+1) as opposed to Pn as Pn grows with n. One is paying an additional P(n+1) - Pn in exchange for an additional year of service.

When a service gets too expensive, a substitute is sought for right away. The period at which skipping a service will result in a net financial loss is determined using the present value. We use the following formula to convert Pn into a series of fixed annual payments of X at the start of each year for n years:
Pn = Vo X + Vn-1 X + V1 X + V2 x + …)
Pn = X (1-Vn) / (1-V) X = Pn (1-V) / (1-Vn)
We may now modify the present value, Pn, of all the expenses related to purchasing a new bus in n years, given the breakdown of the vehicle's value in pieces.
For n = 1, 2,, n, Pn = C - Sn Vn + V R2 + V2 R3+… + Vn-1Rn. = C - Sn Vn + Summation (Vn-1 Rn).
Now, the aforementioned value of Pn may be substituted to write the fixed yearly payout "X" (Sasieni et al., 1957).
Pn = (summation (Vn-1Rn) + C-SnVn)] (1-V)/(1-Vn) for n = 1 through n

3. RESULTS & DISCUSSIONS

During rush hour, five busses departing for Thuvakudi every hour from the Central bus station. More than 300 passengers prefer to use these buses during peak hour. During rush hour, around 160 out of 300 people try to get to the terminal via the central bus station. (Report from TNSTC). To accommodate the increased demand from passengers, three of the current buses will be converted into express bus services. The load decrease percentage is likewise determined to be 53.33 percent. Table displays the results of research conducted in all the regions using the same methodology.

Table 2 Determination of percentage reduction of load

Sl.No	Area	Average No. of Buses availabl e	Express Bus Services (To be converted)	Load Expected (Express Service)	Total No. of Passengers (Relative)	% Reduc tion of load
1	Thuvakudi	5	3	160	300	53.33
2	Thiruveru mbur	5	3	170	300	56.66
3	Mathur	5	3	150	300	50.00
4	Mathur - Roundana	5	3	160	300	53.33
5	Chempattu	5	2	130	300	43.33
6	Virali Alai	5	3	160	300	53.33
7	Deeran Nagar	5	2	110	300	36.66
8	Ponmalai	5	3	160	300	53.33
9	Srirangam	6	4	210	300	70.00
10	Main guard Gate	6	4	220	300	73.33

Average % = 54.33
Appr. (55 %)

As a result, roughly 55% of rush will be reduced right from the get-go, and the remaining 45% of passengers who prefer to alight between stops will use the local and LSS bus services.

3.1 Reducing the Incidence of Bus Crashes

The overcrowding of bus stops is a leading cause of serious incidents involving public transportation. Converting local bus services to express buses during rush hour has been shown to reduce congestion by 55%. Therefore, this change will significantly reduce the amount of time spent in a hurry. Accidents, by extension, will be reduced if there is less hurrying about. From 2000 to 2004, there were a total of

39, 33, 57, 52, and 48 passenger response accidents that occurred during peak hours (From 2000 to 2004, there were a total of 123 accidents, 104 in 2001, 195 in 2002, 179 in 2003, and 163 in 2004 during rush hour.

In this we learn that an overabundance of people milling about the bus station and the plant where the incidents occurred is a contributing factor. If the new form of transportation can reduce congestion at the terminal by 55 percent, the number of accidents caused by passengers reacting to the change would drop significantly. The formula for determining the fraction of all peak-hour accidents that were avoided.

$$\% \, r_a = \frac{t_{p(pr)} \times 100}{t_p}$$

where tp (pr) is the sum of all accidents caused by passengers responding to an alert and tp is the sum of all accidents that occurred during peak hours.

Table 3 Calculation of reduction in peak hour accidents

Year	**Passenger response accidents (peak hour)**	**Total peak hour accidents**	% Reduction in accidents
2000	39	123	31.7
2001	33	104	31.7
2002	57	195	29.2
2003	52	179	29.1
2004	48	163	29.4

appr ≃ **30%**

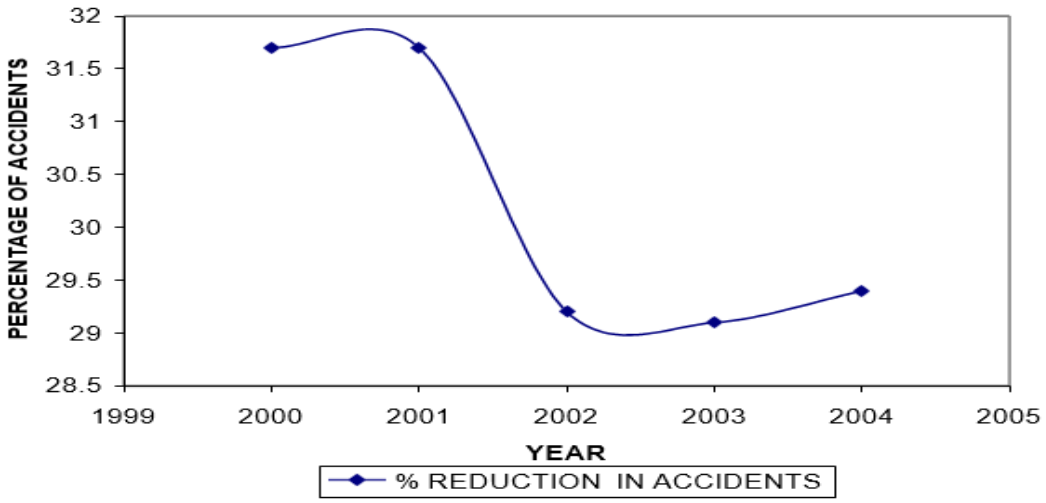

Figure 4 Calculation of reduction in peak hour accidents

Table shows that the new transportation system will reduce the number of peak-hour accidents by over 30%. This proportion dips to its lowest point around the year 2002, which is an intriguing finding.

3.2 Reducing Travel and Waiting Times

The introduction of this new technology will significantly cut down on travel and waiting time, compiles the sum running time of local bus services tR(L) from the origin (central bus station) to the

studied locations. Stopping time () is reduced to a minimum in express bus services by just making one stop each way, at the origin and destination. The method may also be used to determine the amount of time saved owing to express bus services (in percent)

$$\% \tau_e = \frac{N_S \times \tau_e \times 100}{t_{R(L)}}$$

where Ns is the total number of stops, tR(L) is the total running time, and 1 is the delay time per stop, assumed to be 0.5 minutes. (Local).

Table 4 Determination of reduction in delay time due to express busservices

Sl.No	Area	N_s	N Km	$t_{R(L)}$ (mts)	τ (mts)	$t_{R(e)}$ (mts)	$\%\tau_e$ (mts)
1	Thuvakudi	36	28	50	18	32	36
2	Thiruverumbur	26	20	35	13	22	37
3	Mathur	20	16	35	10	25	28.5
4	Mathur – Roundana	16	13	30	8	22	26.67
5	Chempattu	11	10	25	5.5	19.5	22
6	Virali Alai	32	28	60	16	44	26.67
7	Deeran Nagar	7	5	10	3.5	6.5	35
8	Ponmalai	13	8	20	6.5	13.5	32.5
9	Srirangam	15	11	45	7.5	37.5	16.6
10	Main guard Gate	10	6	25	5.0	20.0	20

$\simeq$ 28%

Nearly 18 km separate Thuvakudi from the nearest bus station. From the main bus terminal to Thuvakudi, there are 36 stations in between. From the main bus terminal to Thuvakudi, the travel time on the local bus route tR(L) is 50 minutes. It takes 18 minutes longer than expected because of the intermediate stops, and there are 36 of them. Converting the buses to express bus services would reduce the 18 minutes of delay time caused by the stops from the overall operating time of local bus services. The current estimated total operating time for express bus services is 32 minutes. Using the same method, we find that we can reduce the overall running time by 36%. Table displays the aggregate running time savings calculated across all the study's other focused regions.

The following graph shows the overall travel time because of regular bus service and converted express bus service.

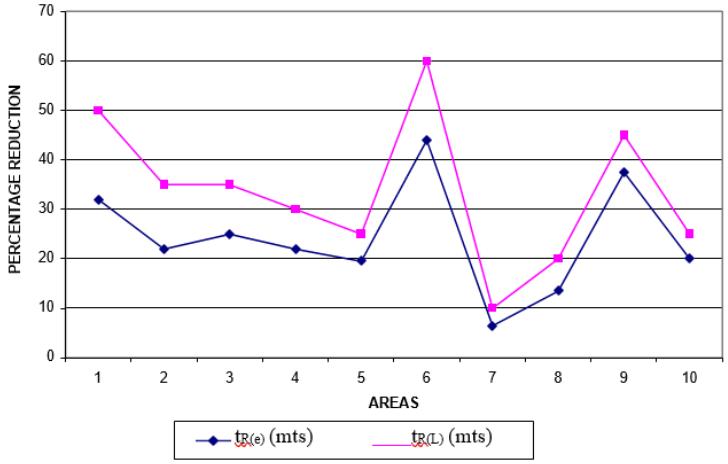

Figure 5 Graphical representation of total running time

3.3 Reduce Pollution Levels in The Environment

3.3.1 Transportation and Air Pollution

The chemical and related industries emit a lot of smoke and harmful substances into the environment, which makes them a major source of air pollution. By using a broad range of tools to maximize the technology we now have and control its use to avoid irreversible harm to environmental standards, Kenneth M. William and Harry Gerling's (1994) work demonstrates how technology may be utilized for environmental protection. The exhaust from cars and diesel heavy vehicles releases a lot of harmful compounds into the atmosphere, which makes ground-level air pollution a more urgent problem. Since most people's everyday activities take place here, vehicle pollution has been constantly rising. Hydrocarbons, nitrogen oxides (NOx), and carbon monoxide are the main contributors to air pollution. Diesel engine exhaust contains large levels of hydrocarbons and nitrogen oxides.

The most prevalent contaminants together with their concentrations per 1000 gallons of fuel combustion. For every gallon of gasoline utilized, diesel engine exhaust has around 10 times the amount of nitrogen oxide as gasoline engine exhaust. However, the gas that gas-powered cars create that is the most harmful is carbon monoxide. (Pandey, 2005).

Table 5 Pollutants per 1000 gallons of fuel consumed.

Pollutant	Gasoline Engine, 1b	Diesel Engine,1b
Carbon monoxide	2300	60
Hydrocarbons	200	136
Oxides of Nitrogen	113	222
Particulars	12	110
Oxides of Sulphur	9	40
Acetic Acid	4	31
Aldehydes	4	10

3.3.2 Pollutant Gas Suppression

India's air pollution problem is mostly caused by two factors, even though the country has less cars on the road than wealthier nations. First,

Indian vehicles are in poor condition, and the majority of them are located in large, industrialized cities where air pollution from autos and other sources interacts. This emphasizes how important automated exhaust control is.

Reducing hydrocarbons, CO, and NOx emissions is the main objective of any emission control approach. (Rajendra Jayana, 1988).

There are several approaches to increase fuel economy, including:

i) Modifications to Engine Schematic
ii) Switching the Engine
iv) Managing Exhaust Gas
iv) Reusing exhaust gasses from vehicles and
v) The appropriate transportation routes

It is quite practical to reduce undesirable exhaust emissions by using fuels lighter than gasoline since no products of inadequate combustion are created. Although they might be used as fuel, light hydrocarbon blends like methane and steam-reformed hexane are now limited by inadequate technology. The use of inexpensive additives like barium salts in gasoline has shown a lot of promise. (Pandey, 2005).

3.4 Determining the Ideal Duration of Economic Activity

The cost of living has been determined using the following techniques: (Taha, 1989)

Every year, a variety of categories of data are gathered and analyzed, such as age;

i) distribution;

ii) cost of purchase;
iii) cost of operation and maintenance
iii) Giving input data to the model in order to use it to create a solution.

3.5 Purchasing Cost of Buses

The annualized rate of inflation for bus fares was calculated using the following formula:
Cn = C (1 + j) where Cn is the bus's n-year purchase price and n-1
where C is the bus's base year (1991–1992) beginning price.
j = Average Annual Percentage of New Bus Inflation Rate The number n, or years.
The year of purchase and debut (the "base year") is used to determine the bus's age. We may calculate the rate of inflation by entering the bus's purchase price from the base year into formula

Table 6 Annual purchase price of the bus

Sl.no	Year	Purchase price of the bus(in Rupees)
1	1991- 1992	8,00,676
2	1992- 1993	8,40,709
3	1993- 1994	8,82,744
4	1994- 1995	9,26,881
5	1995- 1996	9,73,225
6	1996- 1997	10,21,786
7	1997- 1998	10,72,775
8	1998- 1999	11,26,318
9	1999- 2000	11,82,833
10	2000- 2001	12,40,974
11	2001- 2002	12,97,875

Records kept by the Tamil Nadu State Transport Corporation showed the bus purchase price for 1991 through 2002. The cost of purchasing the bus increased annually by around Rs. 20,000 over the previous year. We determine that the inflation rate (j) is 5% by using the computation.

3.6 The Buses' Scrap Value

The formula below has been used to calculate used bus pricing. (Sharma, 2000).

$$Sn = Ce^{-0.05n}$$

where C is the bus purchase price in 1991 (the base year), the year the buses were first installed.
n is the bus's age in years, determined by working backwards from the base year, or the year it was originally placed into service.
An older bus has an accounting annual depreciation rate of 0.05 = constant factor. Depreciation of buses, which is the difference between the purchase price and the salvage value, has been predicted to occur at a rate of 20% per year.
The value of the exponential constant, e, is 2.718.
The bus salvage values that were determined using the methodology.

3.7 Factor of Discounting

Multiplying the total cost of all future trips by a discounting factor, V, yields the present value of the unit cost that will be incurred in a year. For this reason, the following formula has been established:
in which the nth-year discount rate, Vn, is.

I stand for cost of capital, which is the interest rate—let's say 20%—at which a bank loans money to companies in return for capital.
The bus is now worth Sn Vn, but in n years it will be worth its scrap metal.
One way to calculate capital expenditure is as follows: purchase price less the salvage items' current worth.
Acquisition cost of the bus minus its salvage value after n years of discount.

(capital) = C – Sn Vn

The following is covered by the bus's operational costs:
i) Oils and diesel
(ii) fuel Taxes and insurance
iii) The pay of drivers.
iv) Regular maintenance and upkeep.
The age of the local bus service is the sole variable in this model that influences maintenance and repair costs. Taking into account the aforementioned, we list the bus's maintenance and repair costs
The current value and cumulative running cost, depending on the known operating cost and discounting factor, are shown respectively. To generate a total cost estimate, one must sum the capital costs and the cumulative operational expenses.

4. CONCLUSION

This technique is used to schedule rapid bus services during rush hour to transport workers between several industrial zones in Trichy Town. The results indicate a noteworthy improvement in the efficiency of bus services. Thirty of the fifty-two vehicles may be operated during peak hours after the express bus system are set up, enabling them to service around fifty-five percent of the patrons. During peak hours, the remaining 22 buses serve passengers who like to spend their time exploring the city between stops by operating on regular (stopping) routes. All express buses resume normal service after peak hour. Compared to passengers on the earlier, stopping routes, the average journey time for express bus riders has decreased by 28%. In light of this new method of transportation, the economic lifespan of buses has been examined using the replacement model. The analysis of data procured from Tamil Nadu State Transport Corporation yields the operational expenses of both local and LSS services. LSS bus service has an economic life that is two years longer than local service. There are fewer intermediate stops on LSS as opposed to Local services. There is conjecture on the decrease in mechanics. modifications made to the engine when it is being started and stopped. Undoubtedly, converting local services to express ones would extend the buses' economic life. As a result, the new mode of transportation will also boost bus revenue.

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