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Bus Route Optimization and Scheduling In Hyderabad City Using Arc-Gis in Association with Lumiplan Pvt. Ltd.

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***Abstract*— Transportation is the movement of people or goods from one place to other place. It is the backbone of each economy. Different modes includes air, water, rail and road. The two important things considered before journey are, the route and the mode to reach the destination. The fleet management, logistics, and networking has got huge importance in this century. So without the above mentioned, the transportation system won't be efficient. Public transportation is one of the most important mode of transportation which is being used by the common people. So proper optimized schedule results in increased dependence on public transportation system, that ultimately reduce the traffic congestion, pollution etc. This project will be focussing on the city bus route system in Hyderabad, includes two pilot routes named route 40 (Secunderabad to Koti) and route 86J (Secunderabad Rathfile to Kesari hanuman Temple). The project is given to the French company in ITS field named LUMIPLAN ITS by the TSRTC (Telangana State Road Transport Corporartion)**

***Index Terms*— Arc-GIS,Heures, Public Transportation, Route Optimization, Scheduling, .**

I. INTRODUCTION

Transport is important because it enables trade between people, which is essential for the development of civilizations. It's very important to note the importance of the transportation. Modes of transport include air, land (rail and road), water, cable, pipeline and space the field can be divided into infrastructure, vehicles and operations. It is equivalent in the weightage about the mode as well as the route that selected for the travel. Use of public transport has a wide range of effects in environmental pollution. In order to get the people attracted towards the public transport the efficient schedules and passenger comfort should be offered from the authorities.

II. STUDY AREA & OBJECTIVES

TSRTC (Telangana State Road Transport Corporation) for the first time implementing the optimized schedule in their service pattern. So considered the two major routes from where the most of the revenue comes, that is Secunderabad to Koti (Route 40) and Secunderabad Rathfile to Kesari Hanuman temple (Route 86J). From the runtime analysis of the old pattern it's not actually syncing with the ground reality. They are following the old run time pattern as they made roughly before 10 years. So now also the total run time still remains the same even if the traffic and demand got increased. So the trips will be more with respect to the run time, which cannot be implemented successfully now a days just because of the hike in demand and the speed. So the drivers will be pressurized to complete their task in order to avoid the blackmark in their career. So skipping of the stops and inefficient run time, and the overtime duty (OT) will happen that will ultimately affect the passengers and the revenue to TSRTC. Digitized So the major objectives are given below.

- To find out the candid routes(CR) in the city (route which is beneficial to both passengers and service providers)
- Identify the redundant stops, removing them and allocating new stops efficiently if necessory
- Creating optimized schedule using Lumiplan software (Heures)
- Comparison of the existing and revised schedules in terms of revenue

Digitized study area is given below in Figure 1

Fig.1 Study area

III. CONCEPTS AND METHODS FOR OPTIMIZED SCHEDULING

Optimization doesn't always means to find out the shortest routes with low cost. Every time it will not be the same with a profitable service pattern which is useful for the bus owners and passengers. For optimized scheduling the concepts used are run time analysis and ticketing analysis .By using the run time it's very easy to adjust the frequency of the bus service, and the demand analysis shows the major stops/fare stages

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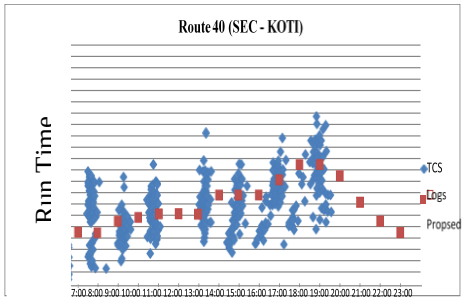
with high demand. By this its easy to know the passenger boarding and alighting direction at peak and off peak hours.

I. Run time analysis can be done by two ways. By manual field surveys and the GPS logs from the devices attached to bus. With the runtime it's easy to set the frequency of the buses which will fit with ground reality. GPS logs . The GPS LOG graphs for route 40 is given below in Figure 2



Day Hours

Fig.2 GPS log graph for route

II. Demand analysis can be done with the help of the ticketing data from the electronic ticketing machine.

IV. SOFTWARE USED

Heures is the Lumiplan developed software for the optimized scheduling . Tools used for the optimized scheduling are cartograaghy tool, vehicle scheduling tool, crew scheduling tool.

4.1 Cartography tool

With the cartography tools in relation with google maps and the Heures software its very easy to find out the exact path between the origin and destinations. Its fully updated with google Even in the case of bus stops also (redundancy) its very helpful. Figure 3 shows the tool.

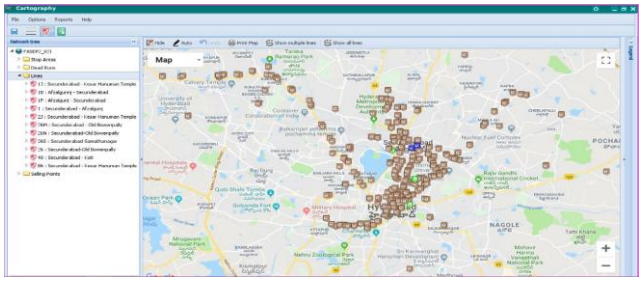


Fig. 3 Cartography tool

4.2 Vehicle scheduling tool

Optimization of routes means travelling between the points with less time and cost, not only that it should be profitable in the passenger's point of view (passengers must not wait more time in bus stops) and in governments point of view (profitable service pattern). Here comes the importance of vehicle scheduling software. Here in this tool the different options are available to check the timings between the two depots including the dead run analysis also considering the fuel efficiency while traveling. So by using this tool we can schedule the peak and off peak bus services properly. Figure 4 shows the vehicle scheduling tool.

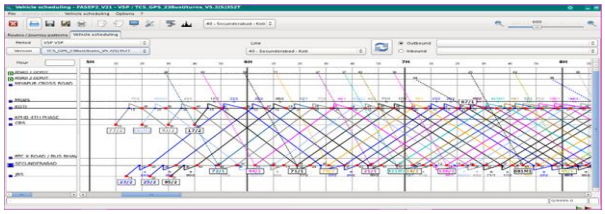


Fig. 4 Vehicle scheduling tool

4.3 Crew scheduling tool

Crew scheduling has not much importance in this project. In Indian aspect there are two

conditions available. One vehicle one crew system and one vehicle two crew system. But the one vehicle one crew system is not common due to the peak demand. So in this tool we are selecting the ne vehicle two crew system. By the optimized schedule of crew and vehicle optimization works. Figure 4 shows the tool

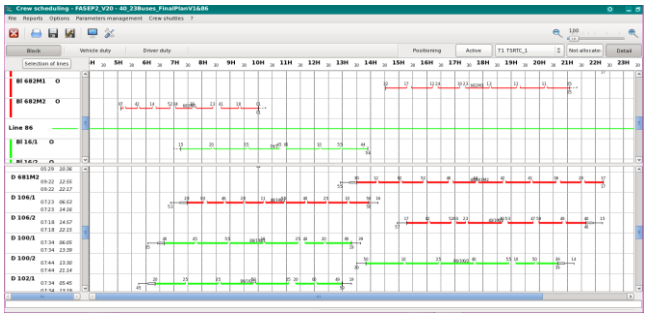


Fig.4 Crew scheduling tool

V. DATA ANALYSIS

Runtime analysis and ticketing analysis are the major two analysis carried out for the optimized scheduling.

5.1 Runtime Analysis

5.1.1 Route 40 runtime analysis

The field performance of the existing schedule on route 40 (Secunderabad to Koti) is given below in figure 5. It includes the waiting time at the major stations Secunderabad and Koti in the route. From the graph it's clear that the waiting time at the peak time is more. That means the schedule should be revised to a optimized one.

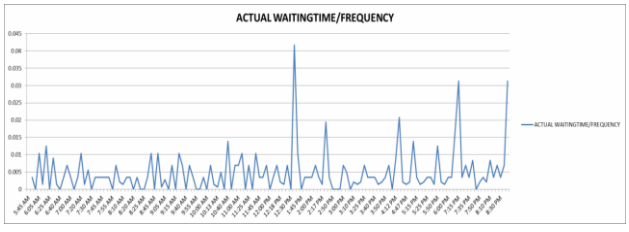


Fig.5 Actual waiting time / frequency

Digitalized the schedules in the planning and scheduling application and analysed the theoretical travel time pattern. In the current planning done manually by TSRTC, travel time patterns were not fitting with the ground reality and also were not coherent. For checking the existing travel time pattern

irregularities, using Heures. The digitized schedule is given below in Figure 6

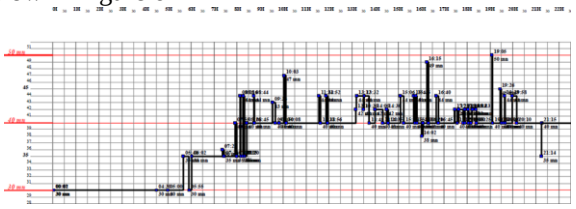


Fig.6 Digitized schedule of TSRTC

5.1.2 Route 86J analysis

Route 86J connects between the Kesari hanuman temple to Secunderabad rathfile. As compared to the route 40 the trip cancellation, irregular run times were less. It is a route where there are multiple journey patterns to be performed by a crew. They are,

- Secunderabad Rethifile – Kesar Hanuman temple
- Secunderabad Rethifile – Afzalgunj
- Secunderabad Rethifile – Koti

GPS log graph of route 86J is given below in figure 7

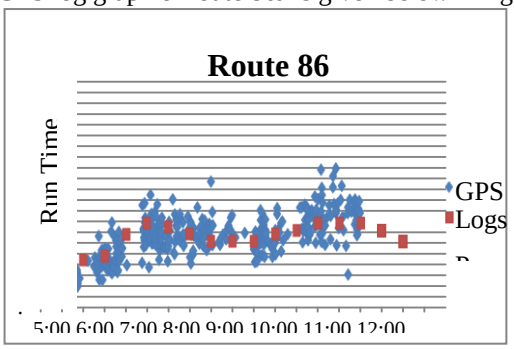


Fig.7 GPS log graph for Route 86J

5.2 Ticketing Analysis

Ticketing analysis is also the another important part in optimization. TSRTC is equipped with ETMs (Electronic ticketing machines) for issuing tickets for the passengers. These ticketing data is stored in the central database which can be accessed only by TSRTC. The Ticketing dump from MSRD1, MSRD2 & KCG was received for the month of

April 2018 for the analysis. So the analysis includes the following things. From the MSRD1 and MSRD2 depots .It is easy to get the whole ticketing data of the route 40U and 40D, similarly from the KCG depot the ticketing data of 86J is collected. The data used for the analysis purpose is demand from the stops. Here in TSRTC the demand or the ticketing is set with respect to the fare stages. There are two or three stops maximum in between the fare stages in both the routes (40 and 86J) .So the concept taken into consideration in the demand analysis is, from each fare stage the boarding and alighting data of the preceding stops are summed up in order to make sure that no passenger entered the vehicle is skipped from count. Given below figure 8 shows example for the collected data.

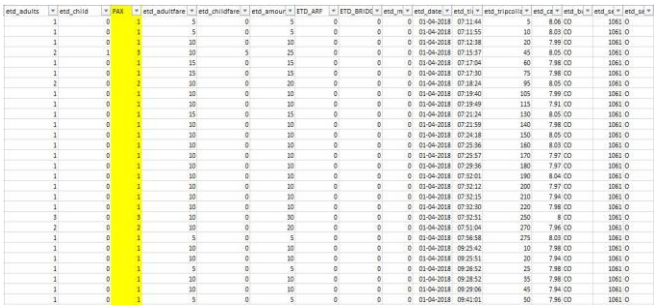


Fig. 8 Collected data sample

From the ticketing analysis the exact peak time can be calculated. With respect to that the scheduling is being done. The ticketing analysis will give the following details.

- Peak time (both morning and evening peak in different directions)
- The stops with more demand.
- Boarding and alighting data in each directions.

5.2.1 Route 40 – Ticket analysis

By the ticketing analysis its easy to get the demand from each stops/fare stages, and the passenger boarding and alighting direction ,the trend of travelling at various time, maximum passenger/hour, average passenger per hour, peak and non peak times etc. Knowing the peak time is important ,to cross check with the frequency of the bus services. The ticketing analysis (maximum pax per hour) and the mapping using Arc-GIS for the route 40 and 86 is given below in figure 9,10,11 and 12

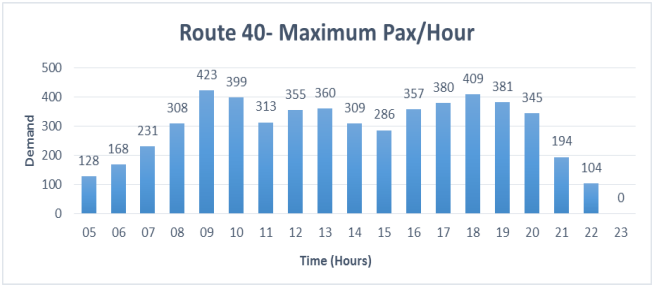


Fig. 9 Ticketing analysis(maximum pax per hour) of route 40

Fig. 10 Demand mapping of route 40 using Arc-GIS

From the analysis for route 40 the morning peak time is from 8.30-11.30 am and the evening peak is from 4.30-7.30.pm.

5.2.2 Route 86J ticketing analysis

The ticketing analysis (maximum pax.per hour) of route 86J and the demand mapping is given below in figure 11 and 12

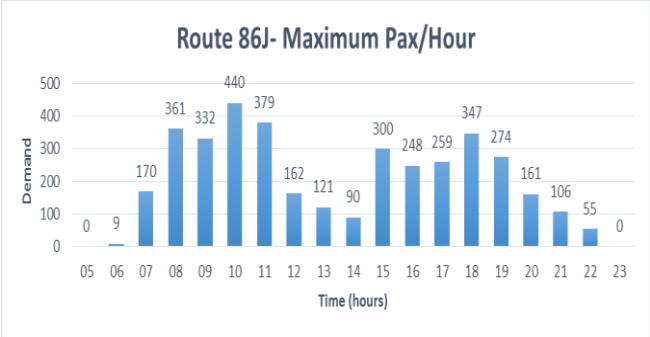


Fig.11 Ticketing analysis(maximum pax.per hour) of route 86J

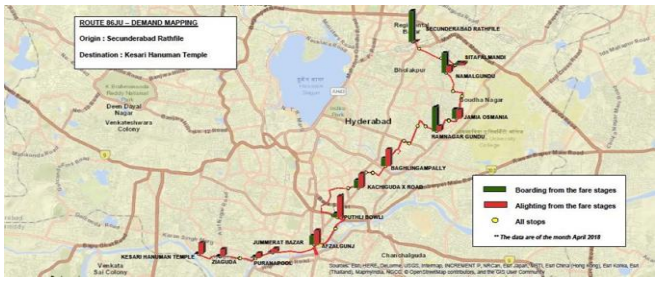


Fig.12 Demand mapping of route 86J using Arc-GIS

From the analysis it's clear that the morning peak time is from 8.00-11.00 am and the evening peak is from 5.00-7.00 pm. So cross checking the peak time and demand at various stages and the frequency of bus services using Heures scenarios will give the optimized schedules.

VI. RESULTS

6.1 Route 40- Scheduling

Three scenarios were considere for the scheduling of frequency of bus service.

6.1.1 Scenario 1: Improving the frequency for Existing plan (23 vehicles)

The scheduled output from Heures software is given below in fig. 13 and fig. 14 shows the same for koti and secunderabad (Vehicle scheduling)

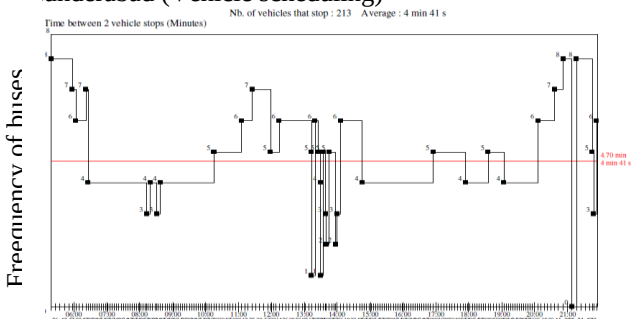


Fig.13

Theoretical frequencies for passengers after rationalizing at Koti for 23 Buses

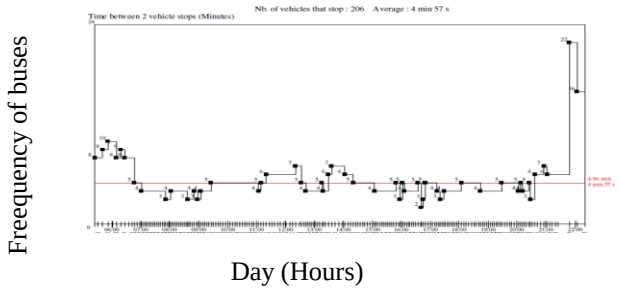


Fig.14 Theoretical frequencies for passengers after rationalizing at Secunderabad for 23

Bases on the above scenario the schedule is created. The given below fig.15 shows the reschedule on route 40 based on the first scenario.

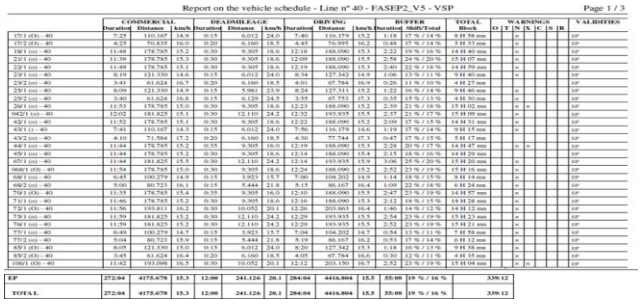
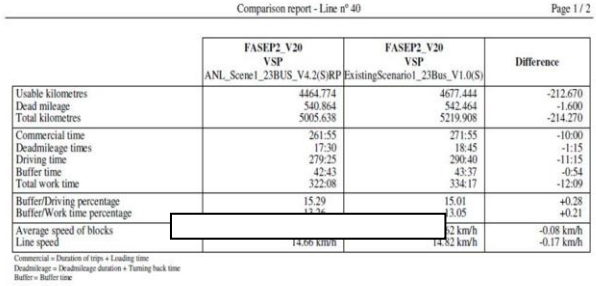


Fig.15 Vehicle Schedule Report after rationalizing for 23 Buses (Route 40)

The comparison report before and after implementation is given below in fig 16



	FASEP2_V20 VSP ANL_Scene1_23BUS_V4.2(S)RP	FASEP2_V20 VSP ExistingScenario1_23Bus_V1.0(S)	Difference
Usable kilometres	4464.774	4677.444	-212.670
Dead mileage	540.864	542.464	-1.600
Total kilometres	5005.638	5219.908	-214.270
Commercial time	261:55	271:55	-10:00
Deadmileage times	17:30	18:45	-1:15
Driving time	279:25	290:40	-11:15
Buffer time	42:43	43:37	-0:54
Total work time	322:08	334:17	-12:09
Buffer/Driving percentage	15.29	15.01	+0.28
Buffer/Work time percentage	13.26	13.05	+0.21
Average speed of blocks	[redacted]	2 km/h	-0.08 km/h
Line speed	14.66 km/h	14.52 km/h	-0.17 km/h

Commercial = Duration of trips + Loading time
Deadmileage = Deadmileage duration + Turning back time
Buffer = Buffer time

Fig.16 Comparison report of route 40

6.1.2 Scenario 2: Proposed plan of 22 buses with rationalized Frequency

Tried to generate a simulation for 22 buses to see if the average frequency can be still maintained the same as with 23 buses. Given below figure 17 and 18 shows the second scenario from Secunderabad and Koti.

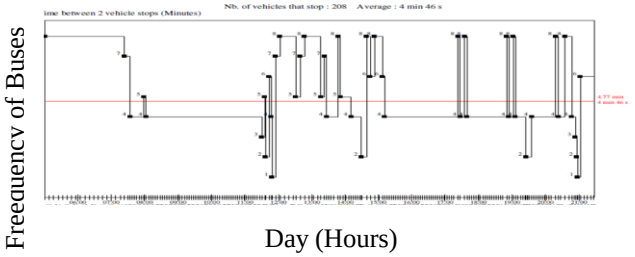


Fig.17 Theoretical frequencies for passengers after

rationalizing at Koti for 22 BUSES (Route 40)

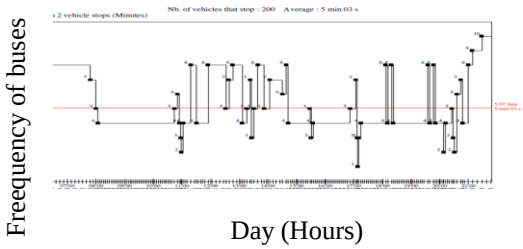


Fig.18 Theoretical frequencies for passengers after rationalizing at Secunderabad for 22 BUSES (Route 40)

The realtime revised bus schedule for the route 40 is given below in fig.19

Fig.19 Vehicle Schedule Report after rationalizing for 22 Buses (Route 40)

The comparison report of the new schedule and the existing one is given below in Fig.20

	FASEP2_V5 VSP Scenario2_22Bus_V1.0(J)	FASEP2_V5 VSP Existing_23Bus_V1.0	Difference
Usable kilometres	4071.551	4175.678	-104.127
Dead mileage	234.750	241.126	-6.376
Total kilometres	4306.301	4416.804	-110.503
Commercial time	266:36	271:58	-5:22
Deadmileage times	11:20	12:00	-0:40
Driving time	277:56	283:58	-6:02
Buffer time	44:51	53:58	-9:07
Total work time	322:47	337:56	-15:09
Buffer/Driving percentage	16.14	19.00	-2.87
Buffer/Work time percentage	13.89	15.97	-2.07
Average speed of blocks	13.34 km/h	13.07 km/h	+0.27 km/h
Line speed	13.07 km/h	12.81 km/h	+0.26 km/h

Commercial = Duration of trips + Loading time
Deadmileage = Deadmileage duration + Turning back time
Buffer = Buffer time

Fig.20 Comparison report – Line 40 (22 BUSES) Verses Line 40(23 Buses)

6.1.3 Scenario 3: Tried to generate a simulation for 21 buses to see if the average frequency can be still maintained the same as with 23 buses (from two depots). Fig.21 and 22 shows the theoretical frequencies for passengers.

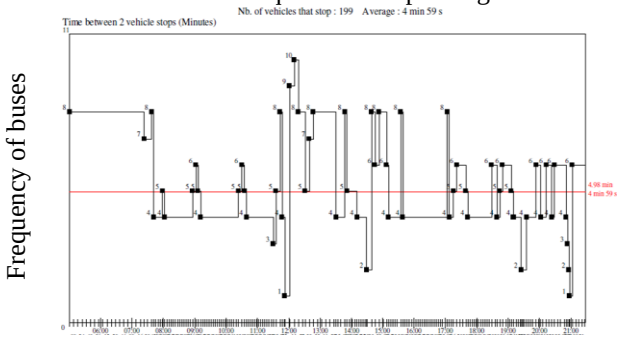


Fig.21 Theoretical frequencies for passengers after rationalizing at Koti for 21 BUSES

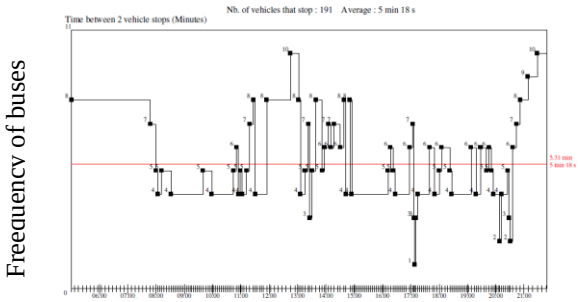
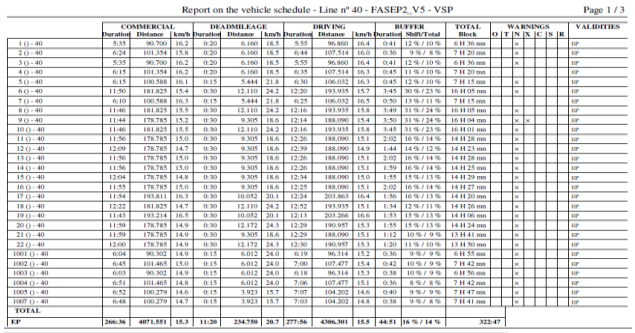


Fig.22 Theoretical frequencies for passengers after rationalizing at Koti for 21 BUSES

The comparison report of line 40 (21 buses versus 23 buses) is given below in figure 23


Report on the vehicle schedule - Line nº 40 - FASEP2_V5 - VSP Page 1 / 3

	COMMERCIAL			DEADMILEAGE			DRIVING			BUFFER		TOTAL	WARNINGS					VALIDITIES
	Duration	Distance	km/h	Duration	Distance	km/h	Duration	Distance	km/h	Duration	Shift/Total	Block	O	T	N	X	C	S	R	
1 () - 40	5:35	90.700	16.2	0:20	6.160	18.5	5:55	96.860	16.4	0:41	12 % / 10 %	6 H 36 mn		x						HP
2 () - 40	6:24	101.354	15.8	0:20	6.160	18.5	6:44	107.514	16.0	0:36	9 % / 8 %	7 H 20 mn		x						HP
3 () - 40	5:35	90.700	16.2	0:20	6.160	18.5	5:55	96.860	16.4	0:41	12 % / 10 %	6 H 36 mn		x						HP
4 () - 40	6:15	101.354	16.2	0:20	6.160	18.5	6:35	107.514	16.3	0:45	11 % / 10 %	7 H 20 mn		x						HP
5 () - 40	6:15	100.588	16.1	0:15	5.444	21.8	6:30	106.032	16.3	0:45	12 % / 10 %	7 H 15 mn		x						HP
6 () - 40	11:50	181.825	15.4	0:30	12.110	24.2	12:20	193.935	15.7	3:45	30 % / 23 %	16 H 05 mn		x						HP
7 () - 40	6:10	100.588	16.3	0:15	5.444	21.8	6:25	106.032	16.5	0:50	13 % / 11 %	7 H 15 mn		x						HP
8 () - 40	11:46	181.825	15.5	0:30	12.110	24.2	12:16	193.935	15.8	3:49	31 % / 24 %	16 H 05 mn		x						HP
9 () - 40	11:44	178.785	15.2	0:30	9.305	18.6	12:14	188.090	15.4	3:50	31 % / 24 %	16 H 04 mn		x	x					HP
10 () - 40	11:46	181.825	15.5	0:30	12.110	24.2	12:16	193.935	15.8	3:45	31 % / 23 %	16 H 01 mn		x						HP
11 () - 40	11:56	178.785	15.0	0:30	9.305	18.6	12:26	188.090	15.1	2:02	16 % / 14 %	14 H 28 mn		x						HP
12 () - 40	12:09	178.785	14.7	0:30	9.305	18.6	12:39	188.090	14.9	1:44	14 % / 12 %	14 H 23 mn		x						HP
13 () - 40	11:56	178.785	15.0	0:30	9.305	18.6	12:26	188.090	15.1	2:02	16 % / 14 %	14 H 28 mn		x						HP
14 () - 40	11:56	178.785	15.0	0:30	9.305	18.6	12:26	188.090	15.1	1:59	16 % / 14 %	14 H 25 mn		x						HP
15 () - 40	12:04	178.785	14.8	0:30	9.305	18.6	12:34	188.090	15.0	1:55	15 % / 13 %	14 H 29 mn		x						HP
16 () - 40	11:55	178.785	15.0	0:30	9.305	18.6	12:25	188.090	15.1	2:02	16 % / 14 %	14 H 27 mn		x						HP
17 () - 40	11:54	193.811	16.3	0:30	10.052	20.1	12:24	203.863	16.4	1:56	16 % / 13 %	14 H 20 mn		x						HP
18 () - 40	12:22	181.825	14.7	0:30	12.110	24.2	12:52	193.935	15.1	1:34	12 % / 11 %	14 H 26 mn		x						HP
19 () - 40	11:43	193.214	16.5	0:30	10.052	20.1	12:13	203.266	16.6	1:53	15 % / 13 %	14 H 06 mn		x						HP
20 () - 40	11:59	178.785	14.9	0:30	12.172	24.3	12:29	190.957	15.3	1:55	15 % / 13 %	14 H 24 mn		x						HP
21 () - 40	11:59	178.785	14.9	0:30	9.305	18.6	12:29	188.090	15.1	1:12	10 % / 9 %	13 H 41 mn		x						HP
22 () - 40	12:00	178.785	14.9	0:30	12.172	24.3	12:30	190.957	15.3	1:20	11 % / 10 %	13 H 50 mn		x						HP
1001 () - 40	6:04	90.302	14.9	0:15	6.012	24.0	6:19	96.314	15.2	0:36	9 % / 9 %	6 H 55 mn		x						HP
1002 () - 40	6:45	101.465	15.0	0:15	6.012	24.0	7:00	107.477	15.4	0:42	10 % / 9 %	7 H 42 mn		x						HP
1003 () - 40	6:03	90.302	14.9	0:15	6.012	24.0	6:18	96.314	15.3	0:38	10 % / 9 %	6 H 56 mn		x						HP
1004 () - 40	6:51	101.465	14.8	0:15	6.012	24.0	7:06	107.477	15.1	0:36	8 % / 8 %	7 H 42 mn		x						HP
1005 () - 40	6:52	100.279	14.6	0:15	3.923	15.7	7:07	104.202	14.6	0:40	9 % / 9 %	7 H 47 mn		x						HP
1007 () - 40	6:48	100.279	14.7	0:15	3.923	15.7	7:03	104.202	14.8	0:38	9 % / 8 %	7 H 41 mn		x						HP
TOTAL																				
EP	266:36	4071.551	15.3	11:20	234.750	20.7	277:56	4306.301	15.5	44:51	16 % / 14 %	322:47								
TOTAL	266:36	4071.551	15.3	11:20	234.750	20.7	277:56	4306.301	15.5	44:51	16 % / 14 %	322:47								

	FASEP2_V5 VSP Scenario3_21Bus_V1.0(J)	FASEP2_V5 VSP Existing_23Bus_V1.0	Difference
Usable kilometres	3892.766	4175.678	-282.912
Dead mileage	225.445	241.126	-15.681
Total kilometres	4118.211	4416.804	-298.593
Commercial time	254:44	271:58	-17:14
Deadmileage times	10:50	12:00	-1:10
Driving time	265:34	283:58	-18:24
Buffer time	42:52	53:58	-11:06
Total work time	308:26	337:56	-29:30
Buffer/Driving percentage	16.14	19.00	-2.86
Buffer/Work time percentage	13.90	15.97	-2.07
Average speed of blocks	13.35 km/h	13.07 km/h	+0.28 km/h
Line speed	13.08 km/h	12.81 km/h	+0.27 km/h

Commercial = Duration of trips + Loading time
Deadmileage = Deadmileage duration + Turning back time
Buffer = Buffer time

Line 40

	FASEP2_V5 VSP Scenario3_21Bus_V1.0(J)		FASEP2_V5 VSP Existing_23Bus_V1.0		Difference	
	nb	km	nb	km	nb	km
Scc-CBS - SECUNDERABAD - CBS	815	1439	1	10.842	+0	+0.000
KOTI-MGBS - KOTI - MGBS	348	6008	4	4.112	+0	+0.000
SEC-JBS - SECUNDERABAD - JBS	815	4298	2	4.280	-1	-2.140
KOTI-CBS - KOTI - CBS	348	1439	3	2.862	+0	+0.000
MDOFF-KPHB - RTC X ROAD / BUS BHAVAN	353	1901	1	20.877	+0	+0.000
MDOFF-MYP - RTC X ROAD / BUS BHAVAN	353	864	1	21.777	+0	+0.000
40D - KOTI - SECUNDERABAD	348	815	191	1905.607	205	2045.285	-14	-139.678
MGBS-KOTI - MGBS - KOTI	6008	348	4	8.048	5	10.060	-1	-2.012
JBS-SEC - JBS - SECUNDERABAD	4298	815	2	4.058	3	6.087	-1	-2.029
CBS-KOT - CBS - KOTI	1243	348	4	5.052	3	3.789	+1	+1.263
KPHB-KOTI - KPHB 4TH PHASE - KOTI	1095	348	1	27.289	1	27.289	+0	+0.000
MYP-KOTI - MIYAPUR CROSS ROAD - KOTI	865	348	1	25.789	1	25.789	+0	+0.000
40U - SECUNDERABAD - KOTI	815	348	186	1839.168	200	1977.600	-14	-138.432
SEC-MDOFF - SECUNDERABAD - RTC X Rd	815	368	2	13.008	1	6.504	+1	+6.504
SEC-RTC - SECUNDERABAD - RTC X ROAD	815	368			1	6.388	-1	-6.388
TOTAL			403	3892.766	433	417.5.678	-30	-282.912

Fig.23 Comparison report – Line 40(23 BUSES) Verses Line 40(21 Buses)

6.2 Route 86J – Scheduling

2 scenarios were produced using the runtimes

6.2.1 Scenario 1: Number of buses as 14 and total number of trips as 187. Based on that the vehicle frequency the arrangement of buses at diferent times are given below in fig. 24

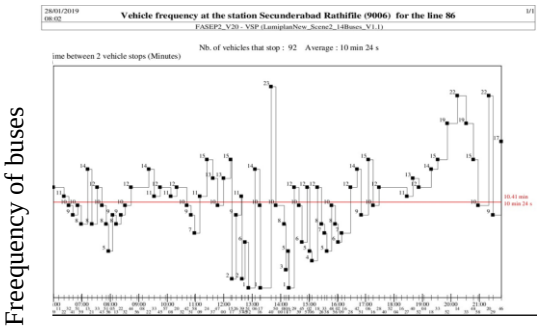
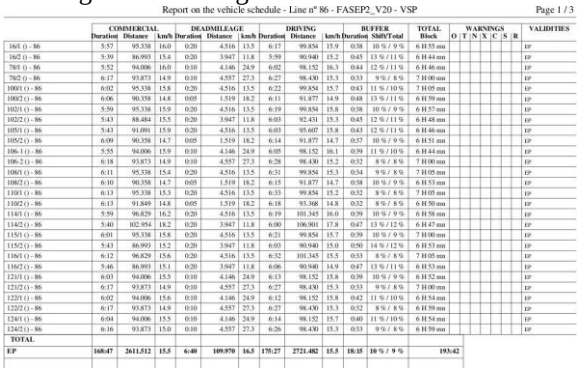


Fig.24 Theoretical frequencies for passengers after

rationalizing at Secunderabad for 14 BUSES (Route 86)

Based on the frequency arrangement the vehicle scheduling is revised. Fig.25 shows the revised schedule



Report on the vehicle schedule - Line n° 86 - FASEP2_V20 - VSP — Page 1 / 3

	COMMERCIAL			DEADMILEAGE			DRIVING			BUFFER		TOTAL	WARNINGS						VALIDITIES
	Duration	Distance	km/h	Duration	Distance	km/h	Duration	Distance	km/h	Duration	Shift/Total	Block	O	T	N	X	C	S	R	
16/1 () - 86	5:57	95.338	16.0	0:20	4.516	13.5	6:17	99.854	15.9	0:38	10 % / 9 %	6 H 55 mn								EP
16/2 () - 86	5:39	86.993	15.4	0:20	3.947	11.8	5:59	90.940	15.2	0:45	13 % / 11 %	6 H 44 mn								EP
78/1 () - 86	5:52	94.006	16.0	0:10	4.146	24.9	6:02	98.152	16.3	0:44	12 % / 11 %	6 H 46 mn								EP
78/2 () - 86	6:17	93.873	14.9	0:10	4.557	27.3	6:27	98.430	15.3	0:33	9 % / 8 %	7 H 00 mn								EP
100/1 () - 86	6:02	95.338	15.8	0:20	4.516	13.5	6:22	99.854	15.7	0:43	11 % / 10 %	7 H 05 mn								EP
100/2 () - 86	6:06	90.358	14.8	0:05	1.519	18.2	6:11	91.877	14.9	0:48	13 % / 11 %	6 H 59 mn								EP
102/1 () - 86	5:59	95.338	15.9	0:20	4.516	13.5	6:19	99.854	15.8	0:38	10 % / 9 %	6 H 57 mn								EP
102/2 () - 86	5:43	88.484	15.5	0:20	3.947	11.8	6:03	92.431	15.3	0:45	12 % / 11 %	6 H 48 mn								EP
105/1 () - 86	5:43	91.091	15.9	0:20	4.516	13.5	6:03	95.607	15.8	0:43	12 % / 11 %	6 H 46 mn								EP
105/2 () - 86	6:09	90.358	14.7	0:05	1.519	18.2	6:14	91.877	14.7	0:37	10 % / 9 %	6 H 51 mn								EP
106-1 () - 86	5:55	94.006	15.9	0:10	4.146	24.9	6:05	98.152	16.1	0:39	11 % / 10 %	6 H 44 mn								EP
106-2 () - 86	6:18	93.873	14.9	0:10	4.557	27.3	6:28	98.430	15.2	0:32	8 % / 8 %	7 H 00 mn								EP
108/1 () - 86	6:11	95.338	15.4	0:20	4.516	13.5	6:31	99.854	15.3	0:34	9 % / 8 %	7 H 05 mn								EP
108/2 () - 86	6:10	90.358	14.7	0:05	1.519	18.2	6:15	91.877	14.7	0:38	10 % / 9 %	6 H 53 mn								EP
110/1 () - 86	6:13	95.338	15.3	0:20	4.516	13.5	6:33	99.854	15.2	0:32	8 % / 8 %	7 H 05 mn								EP
110/2 () - 86	6:13	91.849	14.8	0:05	1.519	18.2	6:18	93.368	14.8	0:32	8 % / 8 %	6 H 50 mn								EP
114/1 () - 86	5:59	96.829	16.2	0:20	4.516	13.5	6:19	101.345	16.0	0:39	10 % / 9 %	6 H 58 mn								EP
114/2 () - 86	5:40	102.954	18.2	0:20	3.947	11.8	6:00	106.901	17.8	0:47	13 % / 12 %	6 H 47 mn								EP
115/1 () - 86	6:01	95.338	15.8	0:20	4.516	13.5	6:21	99.854	15.7	0:39	10 % / 9 %	7 H 00 mn								EP
115/2 () - 86	5:43	86.993	15.2	0:20	3.947	11.8	6:03	90.940	15.0	0:50	14 % / 12 %	6 H 53 mn								EP
116/1 () - 86	6:12	96.829	15.6	0:20	4.516	13.5	6:32	101.345	15.5	0:33	8 % / 8 %	7 H 05 mn								EP
116/2 () - 86	5:46	86.993	15.1	0:20	3.947	11.8	6:06	90.940	14.9	0:47	13 % / 11 %	6 H 53 mn								EP
121/1 () - 86	6:03	94.006	15.5	0:10	4.146	24.9	6:13	98.152	15.8	0:39	10 % / 9 %	6 H 52 mn								EP
121/2 () - 86	6:17	93.873	14.9	0:10	4.557	27.3	6:27	98.430	15.3	0:33	9 % / 8 %	7 H 00 mn								EP
122/1 () - 86	6:02	94.006	15.6	0:10	4.146	24.9	6:12	98.152	15.8	0:42	11 % / 10 %	6 H 54 mn								EP
122/2 () - 86	6:17	93.873	14.9	0:10	4.557	27.3	6:27	98.430	15.3	0:32	8 % / 8 %	6 H 59 mn								EP
124/1 () - 86	6:04	94.006	15.5	0:10	4.146	24.9	6:14	98.152	15.7	0:40	11 % / 10 %	6 H 54 mn								EP
124/2 () - 86	6:16	93.873	15.0	0:10	4.557	27.3	6:26	98.430	15.3	0:33	9 % / 8 %	6 H 59 mn								EP
TOTAL																				
EP	**168:47**	**2611.512**	**15.5**	**6:40**	**109.970**	**16.5**	**175:27**	**2721.482**	**15.5**	**18:15**	**10 % / 9 %**	**193:42**								

Fig.25 Vehicle Schedule Report after rationalizing for 14 Buses (Route 86)

6.2.1 Scenario 2: (No. of buses: 15, No. of trips: 201) The figure 26 given below shows the revised schedule with the new number of bus (15 bus).

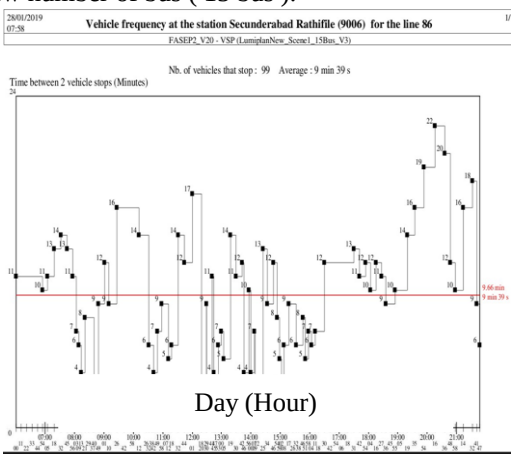
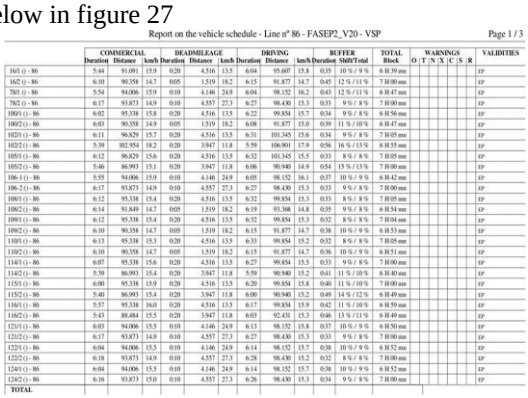


Fig.26 Theoretical frequencies for passengers after rationalizing at SECUNDRABAD for 15 BUSES (Route 86)

The revised schedule based on the above graph is given below in figure 27



Report on the vehicle schedule - Line n° 86 - FASEP2_V20 - VSP — Page 1 / 3

	COMMERCIAL			DEADMILEAGE			DRIVING			BUFFER		TOTAL	WARNINGS						VALIDITIES
	Duration	Distance	km/h	Duration	Distance	km/h	Duration	Distance	km/h	Duration	Shift/Total	Block	O	T	N	X	C	S	R	
16/1 () - 86	5:44	91.091	15.9	0:20	4.516	13.5	6:04	95.607	15.8	0:35	10 % / 9 %	6 H 39 mn								EP
16/2 () - 86	6:10	90.358	14.7	0:05	1.519	18.2	6:15	91.877	14.7	0:45	12 % / 11 %	7 H 00 mn								EP
78/1 () - 86	5:54	94.006	15.9	0:10	4.146	24.9	6:04	98.152	16.2	0:43	12 % / 11 %	6 H 47 mn								EP
78/2 () - 86	6:17	93.873	14.9	0:10	4.557	27.3	6:27	98.430	15.3	0:33	9 % / 8 %	7 H 00 mn								EP
100/1 () - 86	6:02	95.338	15.8	0:20	4.516	13.5	6:22	99.854	15.7	0:34	9 % / 8 %	6 H 56 mn								EP
100/2 () - 86	6:03	90.358	14.9	0:05	1.519	18.2	6:08	91.877	15.0	0:39	11 % / 10 %	6 H 47 mn								EP
102/1 () - 86	6:11	96.829	15.7	0:20	4.516	13.5	6:31	101.345	15.6	0:34	9 % / 8 %	7 H 05 mn								EP
102/2 () - 86	5:39	102.954	18.2	0:20	3.947	11.8	5:59	106.901	17.9	0:56	16 % / 13 %	6 H 55 mn								EP
105/1 () - 86	6:12	96.829	15.6	0:20	4.516	13.5	6:32	101.345	15.5	0:33	8 % / 8 %	7 H 05 mn								EP
105/2 () - 86	5:46	86.993	15.1	0:20	3.947	11.8	6:06	90.940	14.9	0:54	15 % / 13 %	7 H 00 mn								EP
106-1 () - 86	5:55	94.006	15.9	0:10	4.146	24.9	6:05	98.152	16.1	0:37	10 % / 9 %	6 H 42 mn								EP
106-2 () - 86	6:17	93.873	14.9	0:10	4.557	27.3	6:27	98.430	15.3	0:33	9 % / 8 %	7 H 00 mn								EP
108/1 () - 86	6:12	95.338	15.4	0:20	4.516	13.5	6:32	99.854	15.3	0:33	8 % / 8 %	7 H 05 mn								EP
108/2 () - 86	6:14	91.849	14.7	0:05	1.519	18.2	6:19	93.368	14.8	0:35	9 % / 8 %	6 H 54 mn								EP
110/1 () - 86	6:12	95.338	15.4	0:20	4.516	13.5	6:32	99.854	15.3	0:32	8 % / 8 %	7 H 04 mn								EP
110/2 () - 86	6:10	90.358	14.7	0:05	1.519	18.2	6:15	91.877	14.7	0:38	10 % / 9 %	6 H 53 mn								EP
110/1 () - 86	6:13	95.338	15.3	0:20	4.516	13.5	6:33	99.854	15.2	0:32	8 % / 8 %	7 H 05 mn								EP
110/2 () - 86	6:10	90.358	14.7	0:05	1.519	18.2	6:15	91.877	14.7	0:36	10 % / 9 %	6 H 51 mn								EP
114/1 () - 86	6:07	95.338	15.6	0:20	4.516	13.5	6:27	99.854	15.5	0:33	9 % / 8 %	7 H 00 mn								EP
114/2 () - 86	5:39	86.993	15.4	0:20	3.947	11.8	5:59	90.940	15.2	0:41	11 % / 10 %	6 H 40 mn								EP
115/1 () - 86	6:00	95.338	15.9	0:20	4.516	13.5	6:20	99.854	15.8	0:40	11 % / 10 %	7 H 00 mn								EP
115/2 () - 86	5:40	86.993	15.4	0:20	3.947	11.8	6:00	90.940	15.2	0:49	14 % / 12 %	6 H 49 mn								EP
116/1 () - 86	5:57	95.338	16.0	0:20	4.516	13.5	6:17	99.854	15.9	0:42	11 % / 10 %	6 H 59 mn								EP
116/2 () - 86	5:43	88.484	15.5	0:20	3.947	11.8	6:03	92.431	15.3	0:46	13 % / 11 %	6 H 49 mn								EP
121/1 () - 86	6:03	94.006	15.5	0:10	4.146	24.9	6:13	98.152	15.8	0:37	10 % / 9 %	6 H 50 mn								EP
121/2 () - 86	6:17	93.873	14.9	0:10	4.557	27.3	6:27	98.430	15.3	0:33	9 % / 8 %	7 H 00 mn								EP
122/1 () - 86	6:04	94.006	15.5	0:10	4.146	24.9	6:14	98.152	15.7	0:38	10 % / 9 %	6 H 52 mn								EP
122/2 () - 86	6:18	93.873	14.9	0:10	4.557	27.3	6:28	98.430	15.2	0:32	8 % / 8 %	7 H 00 mn								EP
124/1 () - 86	6:04	94.006	15.5	0:10	4.146	24.9	6:14	98.152	15.7	0:38	10 % / 9 %	6 H 52 mn								EP
124/2 () - 86	6:16	93.873	15.0	0:10	4.557	27.3	6:26	98.430	15.3	0:34	9 % / 8 %	7 H 00 mn								EP
TOTAL																				

Fig.27 Vehicle Schedule Report after rationalizing for 15 Buses (Route 86J)

The monitoring of the existing schedule and the proposed are are going on.

VII. Conclusions

- Route 40 is implemented (scenario 1 is approved by the TSRTC) and the financial benefits are monitoring.

- Lumiplan proposed 2 possible pans in the route 86J, but due to some road construction and renovation works are going on in that particular route all the buses are not following the real time schedule and routes. So waiting for the construction works to be finished for the implementation for the scenario 2.
- Rearrangement of trips in the morning shift

- Curtailment of trips to Toli Mazjid - As trip to Toli Mazjid has negligible or no load, the trips were curtailed to 4 trips from 6 trips which are provided in the peak hours.

- Re- Engineering of trips in the afternoon - According to the study, evening peak has more traffic congestion than the morning peak resulting in cancellation of trips due to insufficient run times. Hence most of the trips are shortened to Afzalgunj and Ramnagar gundu considering both passenger load and cancellations.

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