

RATIO DELAY STUDY OF PUBLIC TRANSPORT BUSES

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ABSTRACT : The top management of any organization, either private or government always want to know the utilization of their resources i.e. manpower or machines or financial resources so that they can initiate necessary actions for maximum utilization and hence higher productivity for their organization. Work sampling or Ratio delay study is one of the techniques to identify the real situation of whether the workers or manpower are working or not working at a given point of time.

The proposed work is carried out at Telangana State Road Transport Corporation (TSRTC), which is into Public bus Transportation in Telangana and other states. The objective of this paper is to assess the percentage of working of buses for a given period and the loss incurred due to non operation. The data is collected, from one of the Depots of the Corporation. This analysis will help in understanding the failure rate of buses and the management may think of refining the maintenance schedules to improve the service level to customers.

Key Words: Activity sampling or Ratio delay study, work measurement, productivity, probability, random sampling

I. INTRODUCTION

Activity sampling was developed by L.H.C. Tippet in Britain in 1934 for the British Cotton Industry Research Board. R.L.Morrow used this technique in America during 1945 and named it as Ratio Delay Study. In 1952, C.L.Brisley renamed this technique as Work sampling. Presently, it is the most commonly used technique of Work Measurement.

Activity sampling as defined by B.S.3138: 1969, is a technique in which large number of observations are made over a period of time of one or group of machines, processes or workers. Each observation records what is happening at that point of time or instant and the percent of observations recorded for a particular activity or delay is a measure of the percentage of time during which that the activity or delay occurs.

It is a technique for analyzing activity by taking a large number of observations at random times and to investigate the proportions of total time devoted to the various activities that constitute a job or work situation. The results of work sampling are effective for determining machine and personnel utilization, allowances applicable to the job and production standards. It provides the same information faster and considerably at less cost than time study.

The ratio of observations of a given activity to the total observations approximates the percentage of time that the process is in that state of activity. The accuracy of the data determined by work sampling depends on the number of observations and the period over which the random observations are taken.

Advantages of Work Sampling

- (i) It does not require continuous observation by an analyst over a long period of time,
- (ii) Clerical time is diminished,
- (iii) The total work-hours expended by the analyst are usually much fewer,
- (iv) The operator is not subjected to long period stopwatch observations.
- (v) Crew operations can be readily studied by a single analyst.

Uses of Work Sampling:

- (i) Activity and delay sampling (to measure the activities and delays of workers or machines. Ex: Determine machine utilization)
- (ii) Performance sampling (to measure working time and nonworking time of a person on a manual task and to establish a performance index or performance level for the person during his or her working time).
- (iii) Work measurement (under certain circumstances, to measure a manual task, that is, to establish a time standard for an operation.

II. THEORY OF WORK SAMPLING (RATIO DELAY STUDY)

The theory of work sampling is based on the fundamental law of probability. At a given instant, an event can be either present or absent. Random sampling requires that there be no bias in the sampling process. It is important that the concept of randomness be understood and carefully followed in work sampling studies.

The normal distribution curve is typical of the kind of frequency distribution which is of importance in work sampling because it represents graphically the probability of the occurrence of certain chance phenomena. At the outset it is necessary to decide what level of confidence is desired in the final work sampling results.

The most common interval is 95%.The area under the curve at 2 sigma or two standard deviations is 95.45 %. This means that the probability is that 95% of the time the random observations will represent the facts and 5 percent of the time they will not.

The formula for determining the sample size for a given confidence level is: $Sp = [K * \sqrt{p(1-p)/N}]$ where, S=desired relative accuracy, p=percentage expressed as a decimal, k=1,2 or 3 confidence level, N=number of random observations (sample size).

For Eg: if $p=25%=0.25$, $S=\pm 5% = \pm 0.05$, $k=2$, $N=?$

$$Sp = [K * \sqrt{p(1-p)/N}]$$

$$= 0.05p = [2 * \sqrt{p(1-p)/N}]$$

$$= 0.0025p^2 = 4[p(1-p)/N]$$

$$N = 4p(1-p) / 0.0025p^2 = 4800 \text{ observations.}$$

The work sampling procedure in its simplest form consists of making observations at random intervals of one or more operators or machines and noting whether they are working or idle.

For example; Operator working=72times, Idle=8times ,Total=80 observations, Percentage of idle time=(8/80)*100=10%, Percentage of working time=(72/80)*100=90%.

If one operator performed task for an 8 hour day. Operator was idle for 48 minutes of the day (480*10/100=48) and was working 432 minutes of the day (480*90/100=432).

The same principle is used in this work to find the percentage of working and non working of RTC buses during the given period which is useful to management in making certain decisions for higher productivity.

III. BACKGROUND

Top management is always interested to know whether their equipment/machines or manpower is running up to the set standards. At the same time the top managers who have less time to involve deeply, would only pay attention on the areas working at lower efficiency.

To give them some insight of Bus utilization, a study has been conducted for a period of 300 days randomly (1st April 2015 to 30 April 2017) on a sample group of 40 buses of Dilsukhnagar depot of Telangana State Road Transport Corporation (TSRTC).Hyderabad, Telangana State, India.

The present expository study acquaints with simple and informative method of estimating the utilization levels of buses operated in the same environment and working conditions.

IV. ORGANIZATION PROFILE

The origin of TSRTC dates back to June 1932, when it was first established as NSR-RTD (Nizam state rail & road transport department) a wing of Nizam state railway in the erstwhile Hyderabad state with 27 buses and 166 employees. As department of Hyderabad state Government on 01-11-1951. And As A.P.S.R.T.C on 11-01-1958.TSRTC under the present name was established in 2014.

It is observed that, presently the Corporation follows preventive maintenance system in two levels.

1. At Depot level (Minor Items)
2. At Zonal workshop level (for major parts service)

The regular maintenance schedules (4 Types) are followed at Depot level, whereas the Workshops cater to the repair/ replacement of Major parts/aggregates and act as the production units of the Corporation and help in improving the availability of buses for Depot operations.

In spite of these schedules, there is no guarantee that the buses run without any breakdowns. Hence it is proposed to conduct a study to know what is the proportion of working time and idle time of buses. So that the management may take remedial actions for maximizing the utilization hours of the buses.

V. DATA COLLECTION

The data of 40 buses of Disukhnagar depot, which are put into service at that point of time (day) is collected randomly from 01.4.2015 to 30.04.2017 for 300 days on different dates. The status of working or not working and the kilometers lost is tabulated hereunder:

Sl.No	Date	No. of buses not working	No. of buses working	No of KM Lost
1	01-04-2015	2	38	99
2	03-04-2015	1	39	138
3	05-04-2015	2	38	64
4	07-04-2015	1	39	194
5	10-04-2015	0	40	0
6	12-04-2015	1	39	84
7	13-04-2015	0	40	0
8	16-04-2015	2	38	118

9	18-04-2015	1	39	105
10	19-04-2015	0	40	0
11	21-04-2015	0	40	0
12	25-04-2015	1	39	28
13	26-04-2015	0	40	0
14	30-04-2015	2	38	330
15	01-05-2015	2	38	138
16	03-05-2015	2	38	106
17	05-05-2015	0	40	0
18	08-04-2015	0	40	0
19	12-04-2015	0	40	0
20	16-05-2015	2	38	214
21	19-05-2015	2	38	100
22	22-05-2015	1	39	219
23	27-05-2015	0	40	0
24	28-05-2015	0	40	0
25	31-05-2015	0	40	0
26	01-06-2015	2	38	219
27	3-06-2015	2	38	50
28	5-06-2015	2	38	107
29	9-06-2015	2	38	130
30	12-06-2015	2	38	322
31	13-06-2015	0	40	0
32	17-06-2015	0	40	0
33	20-06-2015	2	38	161
34	22-06-2015	2	38	322
35	26-06-2015	0	40	0
36	28-06-2015	0	40	0
37	30-06-2015	0	40	0
38	01-07-2015	1	39	244
39	3-07-2015	2	38	117
40	6-07-2015	0	40	0
41	9-07-2015	1	39	102
42	11-07-2015	0	40	0
43	14-07-2015	2	38	155
44	16-07-2015	0	40	0
45	19-07-2015	0	40	0
46	20-07-2015	0	40	0
47	23-07-2015	0	40	0
48	26-07-2015	1	39	42
49	29-07-2015	1	39	68
50	31-07-2015	0	40	0
51	01-08-2015	2	38	304
52	2-08-2015	0	40	0
53	8-08-2015	0	40	0
54	11-08-2015	0	40	0

55	15-08-2015	0	40	0
56	16-08-2015	2	38	111
57	18-08-2015	2	38	78
58	20-08-2015	2	38	400
59	22-08-2015	2	38	166
60	23-08-2015	0	40	0
61	26-08-2015	0	40	0
62	28-08-2015	0	40	0
63	31-08-2015	0	40	0
64	01-09-2015	0	40	0
65	3-09-2015	2	38	250
66	6-09-2015	1	39	20
67	8-09-2015	2	38	112
68	12-09-2015	0	40	0
69	13-09-2015	0	40	0
70	17-09-2015	0	40	0
71	18-09-2015	1	39	54
72	20-09-2015	0	40	0
73	23-09-2015	1	39	70
74	26-09-2015	0	40	0
75	27-09-2015	0	40	0
76	30-09-2015	2	38	185
77	01-10-2015	0	40	0
78	3-10-2015	1	39	158
79	5-10-2015	2	38	84
80	10-10-2015	0	40	0
81	11-10-2015	1	39	62
82	13-10-2015	3	37	410
83	16-10-2015	1	39	70
84	18-10-2015	1	39	20
85	20-10-2015	0	40	0
86	23-10-2015	0	40	0
87	26-10-2015	0	40	0
88	28-10-2015	3	37	218
89	31-10-2015	2	38	277
90	01-11-2015	1	39	122
91	4-11-2015	2	38	165
92	8-11-2015	0	40	0
93	10-11-2015	0	40	0
94	13-11-2015	2	38	58
95	15-11-2015	0	40	0
96	18-11-2015	0	40	0
97	21-11-2015	0	40	0
98	23-11-2015	2	38	176
99	26-11-2015	1	39	75
100	28-11-2015	1	39	42
101	29-11-2015	1	39	60

102	30-11-2015	2	38	159
103	01-12-2015	3	37	230
104	3-12-2015	2	38	76
105	5-12-2015	0	40	0
106	6-12-2015	0	40	0
107	9-12-2015	2	38	313
108	12-12-2015	0	40	0
109	14-12-2015	0	40	0
110	16-12-2015	0	40	0
111	21-12-2015	2	38	182
112	22-12-2015	0	40	0
113	24-12-2015	0	40	0
114	27-12-2015	0	40	0
115	28-12-2015	0	40	0
116	01-01-2016	1	39	48
117	3-01-2016	2	38	131
118	4-01-2016	0	40	0
119	9-01-2016	0	40	0
120	10-01-2016	0	40	0
121	13-01-2016	0	40	0
122	15-01-2016	0	40	0
123	17-01-2016	1	39	24
124	19-01-2016	2	38	82
125	21-01-2016	2	38	183
126	24-01-2016	0	40	0
127	26-01-2016	1	39	54
128	30-01-2016	0	40	0
129	31-01-2016	2	38	70
130	01-02-2016	2	38	52
131	4-02-2016	3	37	333
132	8-02-2016	2	38	43
133	9-02-2016	0	40	0
134	11-02-2016	0	40	0
135	13-02-2016	0	40	0
136	16-02-2016	2	38	42
137	18-02-2016	0	40	0
138	22-02-2016	3	37	229
139	23-02-2016	2	38	97
140	25-02-2016	1	39	116
141	27-02-2016	0	40	0
142	29-02-2016	0	40	0
143	01-03-2016	0	40	0
144	3-03-2016	2	38	45
145	5-03-2016	2	38	154
146	7-03-2016	0	40	0
147	10-03-2016	3	37	274
148	13-03-2016	0	40	0

149	16-03-2016	0	40	0
150	19-03-2016	0	40	0
151	20-03-2016	0	40	0
152	22-03-2016	3	37	210
153	24-03-2016	2	38	132
154	25-03-2016	0	40	0
155	27-03-2016	0	40	0
156	28-03-2016	2	38	145
157	30-03-2016	1	39	56
158	31-03-2016	0	40	0
159	01-04-2016	1	39	55
160	3-04-2016	0	40	0
161	7-04-2016	0	40	0
162	9-04-2016	0	40	0
163	11-04-2016	0	40	0
164	15-04-2016	0	40	0
165	17-04-2016	1	39	20
166	19-04-2016	2	38	179
167	21-04-2016	1	39	44
168	25-04-2016	0	40	0
169	27-04-2016	0	40	0
170	28-04-2016	2	38	209
171	30-04-2016	1	39	40
172	01-05-2016	0	40	0
173	3-05-2016	1	39	112
174	6-05-2016	2	38	119
175	8-05-2016	0	40	0
176	10-05-2016	2	38	164
177	11-05-2016	0	40	0
178	14-05-2016	0	40	0
179	18-05-2016	2	38	40
180	20-05-2016	0	40	0
181	21-05-2016	0	40	0
182	25-05-2016	2	38	340
183	28-05-2016	0	40	0
184	30-05-2016	1	39	30
185	31-05-2016	0	40	0
186	01-06-2016	1	39	52
187	2-06-2016	0	40	0
188	6-06-2016	1	39	31
189	9-06-2016	2	38	92
190	12-06-2016	0	40	0
191	15-06-2016	2	38	160
192	17-06-2016	1	39	54
193	19-06-2016	1	39	16
194	21-06-2016	1	39	12
195	22-06-2016	2	38	122

196	26-06-2016	0	40	0
197	27-06-2016	2	38	46
198	29-06-2016	1	39	82
199	30-06-2016	0	40	0
200	01-07-2016	3	37	114
201	3-07-2016	1	39	22
202	6-07-2016	1	39	18
203	8-07-2016	1	39	34
204	11-07-2016	0	40	0
205	12-07-2016	3	37	120
206	15-07-2016	1	39	80
207	17-07-2016	0	40	0
208	20-07-2016	2	38	294
209	22-07-2016	0	40	0
210	24-07-2016	1	39	56
211	27-07-2016	1	39	20
212	29-07-2016	1	39	32
213	31-07-2016	0	40	0
214	01-08-2016	1	39	16
215	3-08-2016	1	39	184
216	7-08-2016	0	40	0
217	10-08-2016	2	38	116
218	13-08-2016	0	40	0
219	15-08-2016	2	38	65
220	19-08-2016	1	39	24
221	22-08-2016	0	40	0
222	29-08-2016	1	39	20
223	31-08-2016	0	40	0
224	01-09-2016	0	40	0
225	2-09-2016	0	40	0
226	6-09-2016	1	39	20
227	9-09-2016	1	39	48
228	14-09-2016	2	38	56
229	15-09-2016	0	40	0
230	21-09-2016	1	39	130
231	24-09-2016	1	39	18
232	28-09-2016	0	40	0
233	30-09-2016	0	40	0
234	01-10-2016	2	38	68
235	3-10-2016	1	39	30
236	8-10-2016	0	40	0
237	11-10-2016	0	40	0
238	15-10-2016	2	38	76
239	16-10-2016	0	40	0
240	21-10-2016	1	39	112
241	23-10-2016	0	40	0
242	25-10-2016	1	39	126

243	29-10-2016	0	40	0
244	30-10-2016	0	40	0
245	31-10-2016	1	39	80
246	01-11-2016	2	38	189
247	3-11-2016	2	38	161
248	6-11-2016	0	40	0
249	8-11-2016	1	39	44
250	12-11-2016	0	40	0
251	19-11-2016	1	39	30
252	24-11-2016	1	39	16
253	28-11-2016	2	38	62
254	30-11-2016	1	39	162
255	01-12-2016	1	39	70
256	4-12-2016	2	38	56
257	10-12-2016	0	40	0
258	11-12-2016	0	40	0
259	13-12-2016	1	39	58
260	18-12-2016	0	40	0
261	21-12-2016	1	39	28
262	25-12-2016	0	40	0
263	28-12-2016	2	38	90
264	31-12-2016	0	40	0
265	01-01-2017	0	40	0
266	4-01-2017	2	38	112
267	8-01-2017	0	40	0
268	13-01-2017	0	40	0
269	15-01-2017	0	40	0
270	17-01-2017	0	40	0
271	22-01-2017	1	39	76
272	25-01-2017	0	40	0
273	29-01-2017	0	40	0
274	31-01-2017	0	40	0
275	02-02-2017	1	39	109
276	5-02-2017	0	40	0
277	7-02-2017	2	38	158
278	11-02-2017	0	40	0
279	17-02-2017	1	39	319
280	19-02-2017	2	38	66
281	20-02-2017	0	40	0
282	24-02-2017	0	40	0
283	28-02-2017	1	39	8
284	01-03-2017	2	38	160
285	4-03-2017	0	40	0
286	12-03-2017	0	40	0
287	13-03-2017	2	38	62
288	18-03-2017	2	38	70
289	21-03-2017	2	38	150

290	25-03-2017	1	39	74
291	31-03-2017	2	38	64
292	01-04-2017	2	38	215
293	2-04-2017	0	40	0
294	9-04-2017	0	40	0
295	11-04-2017	0	40	0
296	17-04-2017	0	40	0
297	19-04-2017	2	38	102
298	21-04-2017	1	39	51
299	24-04-2017	0	40	0
300	28-04-2017	1	39	68
		252	11748	18031

VI. OBSERVATIONS

Following are the observations from the above table:

1. That, out of 300 days, it is observed that during 147 days all buses were plying and during 153 days the bus failures were observed.

2. The Total no. of buses Failed = 252, and total no. of buses working=11748,

3. Total No. of actual observations (N) =300daysx40buses=12000

VII. DISCUSSIONS AND CALCULATIONS

For 95% confidence level and an accuracy limit of $\pm 2\%$,
The total number of observations required are given by;

$$N=4p(100-p)/L^2 = [4*97.9(100-97.9)]/2^2 = 205 \text{ days}$$

where, probability (P) = No.of Failures/ No.of observations
and L=limit of accuracy.

So, the observations for 300 days is sufficient for establishing 95% confidence level.

In terms of total bus days, the total no. of actual observations (N) =300days*40buses=12000

143 days (5720 times) all buses were working and

157 days (6280 times) failed i.e. the Percentage working during observation period is 47.67% and not working is 52.37%.

But, during the same period, the cumulative no. of buses Failed = 252 and cumulative no. of buses working =11748,

Therefore, the % not working =252/12000=0.020833=2.10% and % working 11748/12000= 97.9%

Income lost during the study period due to non operation ure is = 18031*30 (approx) = Rs 5,40, 930.00.

VIII. RESULTS AND CONCLUSIONS

1. As per ratio delay study, it can be concluded that, during the observation period (i.e from 01.04.2015 to 28.04.2017 randomly for 300 days), only 47.67% buses were working and 52.37% were not working.
2. Hence, it is advised to reschedule monthly and quarterly maintenance schedules to much closer periods i.e. to fortnightly and bi-monthly respectively and observed for some period to know if there is any decrease in failures.
3. The amount lost due to temporary failure (because, these buses were put into use on same day after repair) is Rs.5.5 Lacks (approx), if it were to be for longer periods, the loss must have been higher.
4. This study was limited to 40 buses only but if it were for whole fleet of the depot, then the percentage of not working would have been definitely higher.
5. It is suggested that the, the management should carry out similar studies internally to know the ground realities in other depots too.

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