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Research Article

Work Sampling to improve Labour Utilization of Fabrication Shop

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Abstract

Work Sampling study performed to determine the labour utilization of fabrication shop within objective to improve the productivity. Work sampling has been used to indirectly measure crew productivity. Although favored for being less costly, easy to adopt, and able to provide quick information. In this study, the work sampling performed in the regular shift from 8:30AM to 5:00PM

Keywords: *Work Sampling, Labour utilization, Team size, work sampling*

1. Introduction

"Work sampling is a method of finding the percentage occurrence of a certain activity by statistical sampling and random observations"

In order to obtain a complete and accurate picture of the productive time and idle time of the machines in a specific production area, it would be necessary to observe continuously all the machines in that area and to record when and why any of the machines were stopped. It would of course be quite impossible to do this unless a large number of workers spent the whole of their time on this task alone an unrealistic proposition.

If it were possible to note at a glance the state of every machine in a factory at a given moment, however, it might be found that, say, 80 per cent of the machines were working and 20 per cent were stopped. If this action was repeated 20 or more times at different times of the day and if each time the proportion of machines working was always 80 per cent, it would be possible to say with some confidence that at any one time there were always 80 per cent of the machines working.

Work sampling is very useful for the study of: non repetitive activities or when the work method is nonspecific and the cycle times are long. It allows "by means of statistical sampling with random observations to determine the percentage of appearance of a certain activity". Work sampling arose in the Thirties, by L.H. Tippett, in the English textile industry. In 1952 C.L. Brisley and H.L. Waddell presented them in the United States; they were very opportune as in that time more attention was placed on indirect manual labor where it became very useful. At present, the time required to carry out the work sampling depends on the necessities of the study and can vary between hours or days to determine the percentage of time and intensity in which each activity is performed during the work day (J. de la Riva, A. I. Garcia, *et. al.* 2015)

Limitations of Work Sampling

- WS is not an economical solution to monitor the job related activities of one worker or for studying a group of workers spread out over a wide area, because the observer is either idle or walking the majority of the time rather than observing.
- WS is not a direct measure of an individual's strengths and weaknesses; it only allows one to draw conclusions about the average behavior of the group.
- WS does not provide the researcher with any measure of the quality of the work performed.
- If more than one observer is used, inter-observer difference in attention to fundamental details of the WS method may invalidate the study's results. Specifically, one must be careful to insure 1) that each observer makes instantaneous observations at the prearranged times, 2) that the work categories are sufficiently well described to insure that incorrect classifications are not made, 3) that the control charts for each of the observers are relatively consistent, and 4) that enough samples are made to reach the desired accuracy in the final estimates.
- Although it is not likely due to the large number of observations made, workers may be able to change their work patterns upon sight of the observer.

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This so-called "Hawthorne effect" [Named after experiments conducted at the Hawthorne Works of the Western Electric Company from 1927-1932 in which workers' productivity increased in response to both positive and negative changes in working conditions. The investigators concluded that the increased attention brought on by the experimental set-up motivated the workers to improve their performance regardless of working conditions.] is well documented.

- The statistical basis of the study may be difficult for workers and/or management to comprehend. 7. A WS study requires trained observers to make inferences concerning cognitive processes. Observers are expensive to train (Abraham Assefa Tsehayae, 2012).

Advantages of Work-Sampling

- WS is generally far less expensive to perform than time-motion analyses and provides a quantitative estimate of the amount of time spent in each category rather than a subjective estimate.
- One observer can perform WS studies of different workers and/or different tasks as opposed to a one-on one (observer/worker) ratio in time/motion analyses.
- Observations can be made over an extended time period which decreases the effects of cyclic (i.e., day-to-day, week-to-week, or even seasonal) variations.
- The chance of obtaining skewed results due to the Hawthorne effect is reduced in a WS study since no single worker is under direct, continuous observation for extended time periods and the total number of observations taken makes it extremely difficult for an entire group of workers to manipulate the outcome.
- The study can be interrupted at any time with a minimal effect on the results.
- A WS study is not as tedious to perform on the part of the observer as a conventional time-motion analysis because the observer is constantly moving around and looking at different workers. In addition, since the observations are spread out, it is quite possible that the observer can do at least a portion of his/her job (Dean F. Sittig).

2. Methodology

Before conducting the study following steps needs to be followed.

1) Select job for the study
2) Take the sample observation to determine the approximate value of p and q.
3) For confidence interval range determining n
4) Determine the frequency of observation using random number.
5) Design study sheet to meet objective of study.

Work Sampling observation are carried out on random basis from shift start time i.e. 8:30 to 4:30, To record observed readings we categorized the activities of worker in following way:

Working reading are paper work means paperwork is the preparing gate pass, invoices, file updating etc, Drawing reading means the time spends in reading the drawing, understanding it, meeting means time spend in the morning meeting, Performing work means time invested by operator in actual performing work like assembly, machining, fitting, welding, tightening bolt.

Reasons of Idleness

1. Not at Work Place: If worker is not seen at his work place then reading is recorded under this field.
2. Waiting: Waiting Covers Force idleness due to unavailability of tool or machine or drawing or proper information.
3. Forced Idleness: Idle category covers that if a worker is just sitting because of maintenance or he is idle due to nature of Process, like in case of welding.
4. Observing: Observing covers that if an operator is watching another operator that how he perform the work.
5. Talk: Chatting is covered that an operator is talking to another operator or talking on phone or two operator discussing non work related topics.
6. Material Movement: This category is only for unnecessary material movement.
7. Roaming Around: If operator is just walking at shop floor without any reason.
8. Searching: If someone is searching tools, drawings, work piece then reading is recorded here.

3. Determination of Sample size

Statistical method

The formula used in this method is:

$(6P)^2 = pq/n$

Where

6p=Standard error of proportion
*p=P*ercentage of idle time
*q=P*ercentage of working time
n = number of observations or sample size we wish to determine.

Before we can use this formula, however, we need to have at least an idea of the values *of p* and *q.* The first step is therefore to carry out a number of random observations in the working area. Let us assume that some 30 observations were carried out as a preliminary study and at random, and that these showed the machine to be idle in 33 per cent of the cases *(p* = 33) and to be working 67 per cent of the time *(q* = 67). We thus have approximate values for p

and *q;* in order now to determine the value of *n,* we must find out the value of *6p.*
Let us choose a confidence level of 95 per cent with a 10 per cent margin of error (that is, we are confident that in 95 per cent of the cases our estimates will be ± 10 per cent of the real value)

At the 95 per cent confidence level:

1.96 6p = 10
6p= 5 (approx.).

We can now go back to our original equation to derive *n:*
$6p)^2 = pq/n$
$(5)^2 = (33*67/n)$
n= (33*67)/25
n = 88 observations

4. Work sampling sheet format to perform a study:

Work sampling sheet format used to study in the fabrication shop shown in the Table.1

Table 1: Work Sampling Sheet

WORK SAMPLING SHEET									
Date: 06-12-2015			Shop: Fabrication shop			Total working count: 47			
Work Order No. 14-0112			Equipment No- HPH70B#1						
Component/Sub Assembly: Main shell assembly			Crew Size: 2 welder, 1 Helper			Total Not working count: 28			
Operation: Saddle welding									
Sr No.	Visit Time	Activity Description	Working			Not Working			Remark
			Welder-1	Welder-2	Helper	Welder-1	Welder-2	Helper	
1	8.40.00 AM	Saddle Welding	1	1				1	Helper force idleness
2	8.50.00 AM	Saddle Welding	1	1	1				
3	9.05.00 AM	Saddle Welding	1		1	1			Observe
4	9.15.00 AM	Saddle Welding	1	1	1				
5	9.40.00 AM	Slag remove		1	1		1		Welder force idleness
6	9.50.00 AM	Electrode Issue			1	1	1		Waiting for Helper
7	10.15.00 AM	Sitting idle				1	1	1	Power failure
8	10.32.00 AM	Saddle Welding	1	1				1	Helper force idleness
9	10.45.00 AM	Saddle Welding	1	1				1	Helper force idleness
10	11.05.00 AM	Electrode Issue			1	1	1		Waiting for Helper
11	11.35.00 AM	Saddle Welding	1	1	1				
12	11.45.00 AM	Saddle Welding	1	1				1	Helper force idleness
13	12.45.00 PM	Slag remove	1		1		1		Welder force idleness
14	1.05.00 PM	Slag remove		1	1	1			Welder force idleness
15	1.20.00 PM	Saddle Welding		1	1	1			Go to drink water
16	1.30.00 PM	Saddle Welding	1	1	1				
17	1.45.00 PM	Saddle Welding	1	1				1	Helper force idleness
18	2.30.00 PM	Slag remove	1		1		1		Welder force idleness
19	2.40.00 PM	Sitting idle				1	1	1	Power failure
20	3.08.00 PM	Slag remove	1				1	1	Talk
21	3.25.00 PM	Saddle Welding	1	1	1				
22	3.55.00 PM	Saddle Welding	1	1	1				
23	4.05.00 PM	Saddle Welding	1	1				1	Helper force idleness
24	4.35.00 PM	Saddle Welding		1	1	1			Observe
25	4.50.00 PM	Sitting idle				1	1	1	Talk

Here we didnot use the standard format of work sampling, which is given in the "Introduction of work study" by International Labour Organization, forth revised edition because of in the fabrication shop you have to study the different assembly at the same time. There are different crew size skill wise on the different assembly so we use this format which is shown in the Table.1 for work sampling. This format is easy to use and study for fabrication shop.

5. Analysis of Work sampling:

Analysis of work sampling for the seven days for fabrication shop is shown in Table:2. Analysis of seven days categorized in the two categories, which are company worker and supply worker. Analysis is summerized in day wise, time wise, number of survey wise.

Table 2: Analysis of Work Sampling

FABRICATION SHOP				Company Worker						Supply Worker						TOTAL			
Date	**Day**	**Time**	**No of Survey**	**Total Working**	**Average Working**	**Total Not Working**	**Average Not Working**	**% Total working**	**% Total Not working**	**Total Working**	**Average Working**	**Total Not Working**	**Average Not Working**	**% Total Working**	**% Total Not working**	**Average Total Working**	**Average Total not Working**	**% Total Working**	**% Total Not Working**
06-12-15	1	8.30 to 10.00	5	15	3.0	9.0	1.80	63%	38%	12	2.40	11.00	2.20	52%	48%	5.40	4.00	57%	43%
06-12-15	1	10.10 to 12.00	6	27	4.5	4.0	0.67	87%	13%	50	8.33	12.00	2.00	81%	19%	12.83	2.67	83%	17%
06-12-15	1	12.30 to 3.00	8	40	5.0	30.0	3.75	57%	43%	45	5.63	26.00	3.25	63%	37%	10.63	7.00	60%	40%
06-12-15	1	3.10 to 5.10	6	38	6.3	12.0	2.00	76%	24%	19	3.17	29.00	4.83	40%	60%	9.50	6.83	58%	42%
		DAILY		**120**	**18.8**	**55.0**	**8.22**	70%	30%	**126**	**19.53**	**78.00**	**12.28**	61%	39%	**38.36**	**20.50**	65%	**35%**
07-12-15	2	8.30 to 10.00	5	17	3.4	19.0	3.80	47%	53%	33	6.60	25.00	5.00	57%	43%	10.00	8.80	53%	47%
07-12-15	2	10.10 to 12.00	6	39	6.5	20.0	3.33	66%	34%	44	7.33	45.00	7.50	49%	51%	13.83	10.83	56%	44%
07-12-15	2	12.30 to 3.00	8	38	4.8	30.0	3.75	56%	44%	20	2.50	49.00	6.13	29%	71%	7.25	9.88	42%	58%
07-12-15	2	3.10 to 5.10	6	19	3.2	23.0	3.83	45%	55%	33	5.50	32.00	5.33	51%	49%	8.67	9.17	49%	51%
		DAILY		**113**	**17.8**	**92.0**	**14.72**	55%	45%	**130**	**21.93**	**151.00**	**23.96**	48%	52%	**39.75**	**38.68**	51%	**49%**

10-12-15	10-12-15		09-12-15	09-12-15	09-12-15	09-12-15		08-12-15	08-12-15	08-12-15	08-12-15
5	5		4	4	4	4		3	3	3	3
10.10 to 12.00	8.30 to 10.00	**DAILY**	3.10 to 5.10	12.30 to 3.00	10.10 to 12.00	8.30 to 10.00	**DAILY**	3.10 to 5.10	12.30 to 3.00	10.10 to 12.00	8.30 to 10.00
6	5		6	8	6	5		6	8	6	5
30	35	**80**	22	25	15	18	**91**	18	26	22	25
5.0	7.0	**12.9**	3.7	3.1	2.5	3.6	**14.9**	3.0	3.3	3.7	5.0
18.0	20.0	**64.0**	15.0	22.0	14.0	13.0	**88.0**	20.0	25.0	22.0	21.0
3.00	4.00	**10.18**	2.50	2.75	2.33	2.60	**14.33**	3.33	3.13	3.67	4.20
63%	64%	56%	59%	53%	52%	58%	51%	47%	51%	50%	54%
38%	36%	44%	41%	47%	48%	42%	49%	53%	49%	50%	46%
54.000	37.000	**110**	32	35	25	18	**145**	35	38	40	32
9.00	7.40	**17.48**	5.33	4.38	4.17	3.60	**23.65**	5.83	4.75	6.67	6.40
15.00	10.00	**53.00**	10.00	12.00	15.00	16.00	**79.00**	21.00	18.00	15.00	25.00
2.50	2.00	**8.87**	1.67	1.50	2.50	3.20	**13.25**	3.50	2.25	2.50	5.00
78%	79%	66%	76%	74%	63%	53%	64%	63%	68%	73%	56%
22%	21%	34%	24%	26%	38%	47%	36%	38%	32%	27%	44%
14.00	14.40	**30.37**	9.00	7.50	6.67	7.20	**38.57**	8.83	8.00	10.33	11.40
5.50	6.00	**19.05**	4.17	4.25	4.83	5.80	**27.58**	6.83	5.38	6.17	9.20
72%	71%	61%	68%	64%	58%	55%	58%	56%	60%	63%	55%
28%	29%	**39%**	32%	36%	42%	45%	**42%**	44%	40%	37%	45%

12-12-15	12-12-15	12-12-15	12-12-15		11-12-15	11-12-15	11-12-15	11-12-15		10-12-15	10-12-15
7	7	7	7		6	6	6	6		5	5
3.10 to 5.10	12.30 to 3.00	10.10 to 12.00	8.30 to 10.00	**DAILY**	3.10 to 5.10	12.30 to 3.00	10.10 to 12.00	8.30 to 10.00	**DAILY**	3.10 to 5.10	12.30 to 3.00
6	8	6	5		6	8	6	5		6	8
12	36	24	15	**92**	21	24	22	25	**133**	32	36
2.0	4.5	4.0	3.0	**15.2**	3.5	3.0	3.7	5.0	**21.8**	5.3	4.5
35.0	30.0	24.0	28.0	**79.0**	20.0	25.0	15.0	19.0	**79.0**	22.0	19.0
5.83	3.75	4.00	5.60	**12.76**	3.33	3.13	2.50	3.80	**13.04**	3.67	2.38
26%	55%	50%	35%	54%	51%	49%	59%	57%	63%	59%	65%
74%	45%	50%	65%	46%	49%	51%	41%	43%	37%	41%	35%
55	60	58	40	**182**	42.000	58.000	49.000	33.000	**227**	59.000	77.000
9.17	7.50	9.67	8.00	**29.02**	7.00	7.25	8.17	6.60	**35.86**	9.83	9.63
25.00	22.00	15.00	20.00	**85.00**	19.00	28.00	20.00	18.00	**55.00**	12.00	18.00
4.17	2.75	2.50	4.00	**13.60**	3.17	3.50	3.33	3.60	**8.75**	2.00	2.25
69%	73%	79%	67%	68%	69%	67%	71%	65%	80%	83%	81%
31%	27%	21%	33%	32%	31%	33%	29%	35%	20%	17%	19%
11.17	12.00	13.67	11.00	**44.18**	10.50	10.25	11.83	11.60	**57.69**	15.17	14.13
10.00	6.50	6.50	9.60	**26.36**	6.50	6.63	5.83	7.40	**21.79**	5.67	4.63
53%	65%	68%	53%	63%	62%	61%	67%	61%	73%	73%	75%
47%	35%	32%	47%	**37%**	38%	39%	33%	39%	**27%**	27%	25%

		DAILY	**87**	**13.5**	**117.0**	**19.18**	41%	59%	**213**	**34.33**	**82.00**	**13.42**	72%	28%	**47.83**	**32.60**	59%	**41%**
		TOTAL	**716.00**	**115.0**	**574.0**	**92.43**	**55%**	**45%**	**1133.000**	**181.79**	**583.00**	**94.13**	**66%**	**34%**	**296.75**	**186.55**	61%	**39%**

Table: 3 Work sampling analysis of company workers

	Company worker_ Time wise_Trend Analysis							
	Morning 8.30 to 10.00		Post Tea I 10.10 to 12.00		Post Lunch 12.30 to 3.00		Post Tea II 3.10 to 5.10	
	% Working	% Not Working	% Working	% Not Working	% Working	% Not Working	% Working	% Not Working
6-Dec-15	63	37	87	13	57	43	76	24
7-Dec-15	47	53	66	34	56	44	45	55
8-Dec-15	54	46	50	50	51	49	47	53
9-Dec-15	58	42	52	48	53	47	59	41
10-Dec-15	64	36	63	37	65	35	59	41
11-Dec-15	57	43	59	41	49	51	51	49
12-Dec-15	35	65	50	50	55	45	26	74

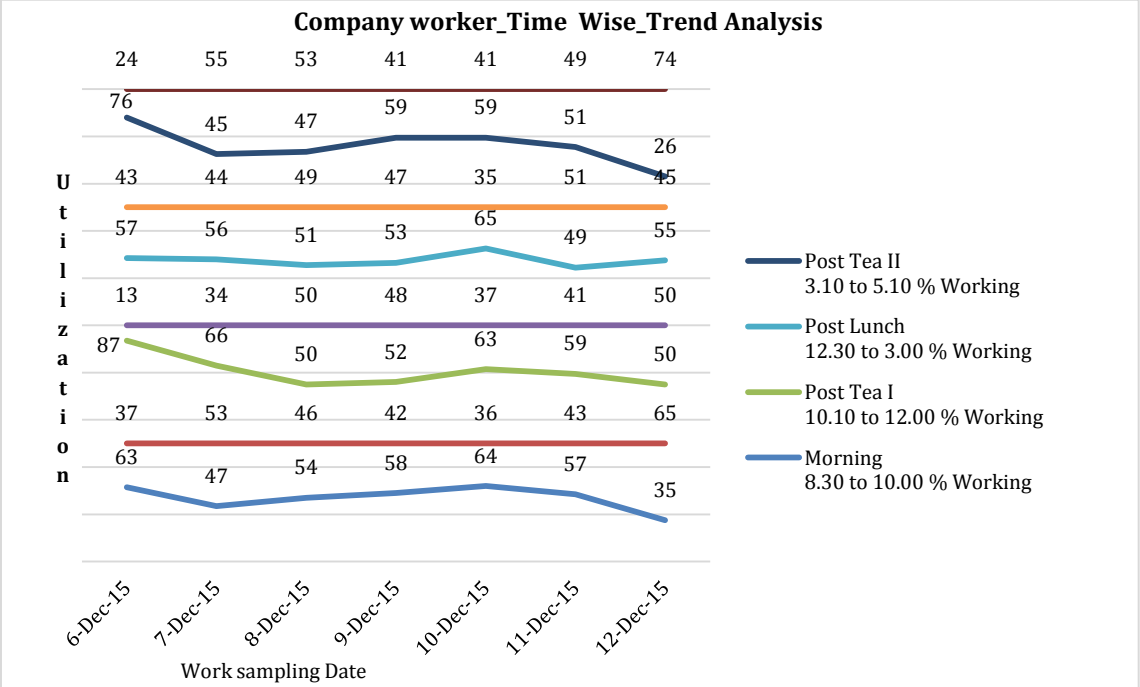

Figure: 1 Time wise Trend analysis of company workers

Work sampling analysis of company workers

Work sampling analysis of the company worker % Working and % Not Working shown in the Table:3 and Time wise trend analysis of company workers shown in the Figure: 1

Work sampling analysis of Supply workers

Work sampling analysis of the Supply worker % Working and % Not Working shown in the Table:4 and Time wise trend analysis of Supply workers shown in the Figure: 2

Table: 4 Work sampling analysis of Supply workers

	Supply worker_Time wise_Trend Analysis							
	Morning 8.30 to 10.00		Post Tea I 10.10 to 12.00		Post Lunch 12.30 to 3.00		Post Tea II 3.10 to 5.10	
	% Working	% Not Working	% Working	% Not Working	% Working	% Not Working	% Working	% Not Working
6-Dec-15	52	48	81	19	63	37	40	60
7-Dec-15	57	43	49	51	29	71	51	49
8-Dec-15	56	44	73	27	68	32	63	37
9-Dec-15	53	47	63	37	74	26	76	24
10-Dec-15	79	21	78	22	81	19	83	17
11-Dec-15	65	35	71	29	67	33	69	31
12-Dec-15	67	33	79	21	73	27	69	31

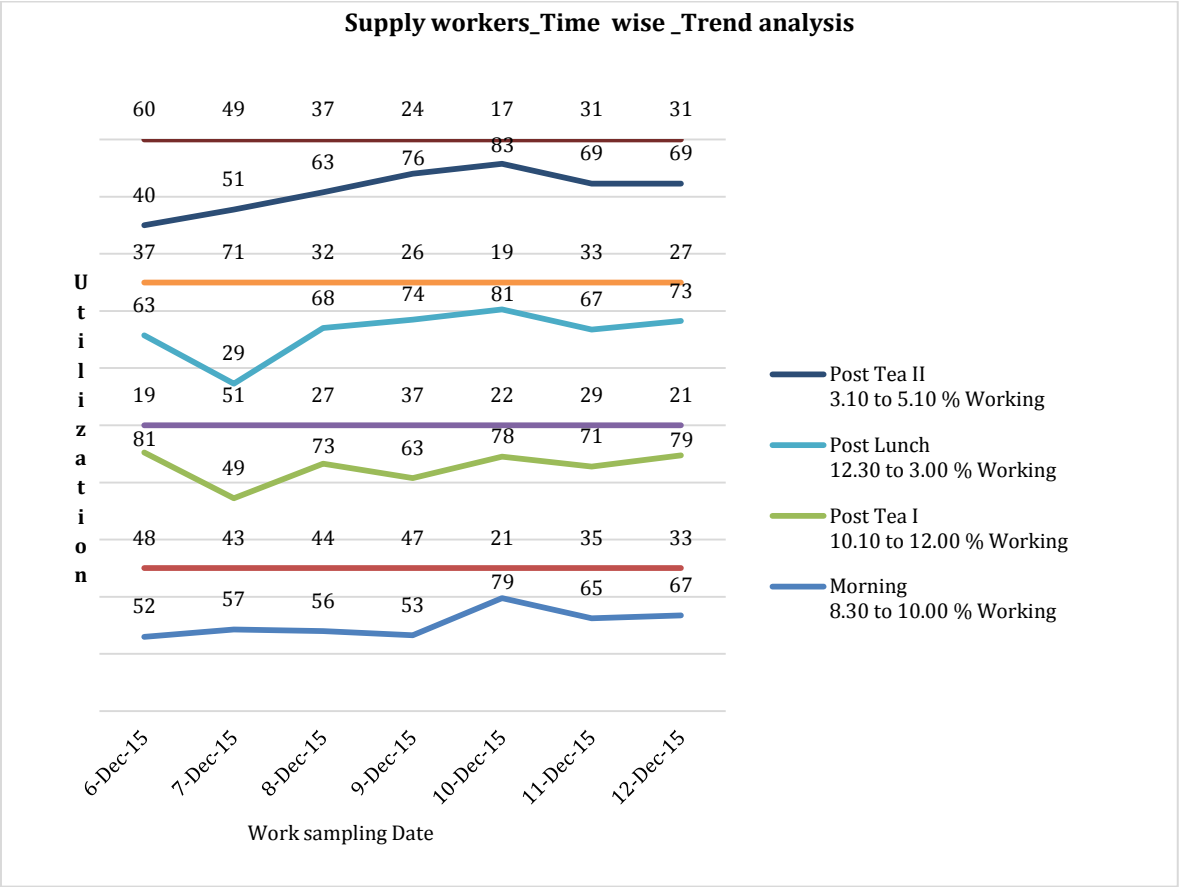

Figure: 2 Time wise Trend analysis of Supply workers

Table: 5 Work sampling analysis of all workers

	Work sampling_Fabrication Shop Time wise_Trend Analysis							
	Morning 8.30 to 10.00		Post Tea I 10.10 to 12.00		Post Lunch 12.30 to 3.00		Post Tea II 3.10 to 5.10	
	% Working	% Not Working	% Working	% Not Working	% Working	% Not Working	% Working	% Not Working
6-Dec-15	57	43	83	17	60	40	58	42
7-Dec-15	53	47	56	44	42	58	49	51
8-Dec-15	55	45	63	37	60	40	56	44
09-Dec-15	55	45	58	42	64	36	68	32
10-Dec-15	71	29	72	28	75	25	73	27
11-Dec-15	61	39	67	33	61	39	62	38
12-Dec-15	53	47	68	32	65	35	53	47
Total	58	42	67	33	61	39	60	40

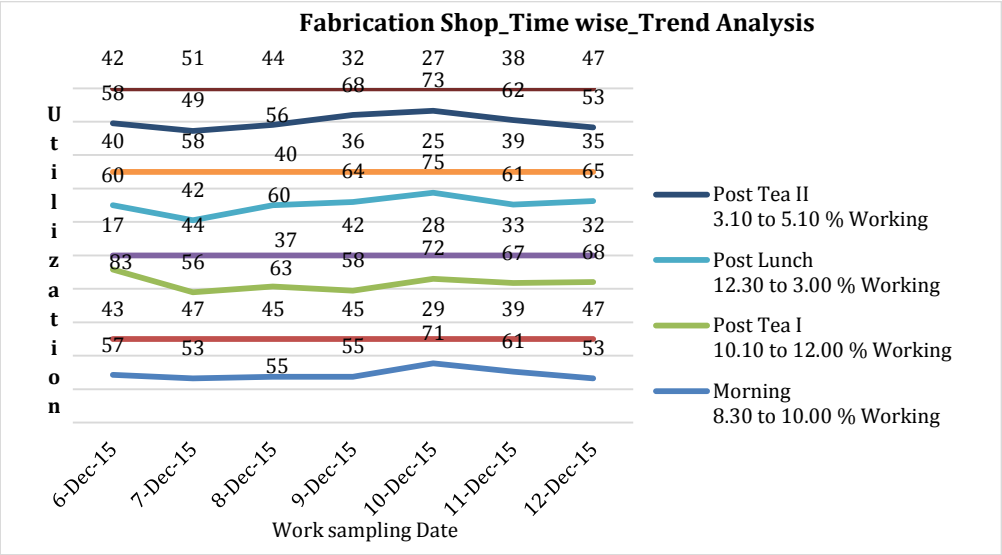

Figure: 3 Time wise Trend analysis of all workers

Work sampling analysis of all workers

Work sampling analysis of all worker % Working and % Not Working shown in the Table:4 and Time wise trend analysis of all workers shown in the Figure: 3.

Area of Concern

1. Before and after Tea break and lunch break they took more time to resume the actual work.
2. % Utilization is 61 due to frequent Power failure.
3. Less Productive results due to Supervisors mostly busy to avail the resources to the workers like Burners, upcoming components from M/c Shop so that the he cannot spent more time on the assembly job.
4. In some area Preparatory work needs to be done like Preheating of the Component starts in the end of 3rd shift.
5. Changing the priority so that, around 25 to 30 minutes waste by welder and his helper to move the welding machine and get ready time to start the work.
6. Unproductive work done by workers like Talk, Mobile.
7. After Completion of work workers did not communicated with Supervisor.
8. Preheating temperature is not monitored that's why the temperature crossed the required Range (200 to 250 C) in low alloy steel, hence had to wait for Cooling to start the work.

Plan of Action

1. Discuss the Important topics at the start of shift for Maintaining Productivity and share Targets to maintain Company time.
2. Critical Activities like Preheating of the Component/Joint and required accessories must be done at start of the shift so that the idleness of workers will reduce.
3. Workers should be loaded fully 8 hour load so that they will do the work priority wise as given by the supervisor.
4. For remove the unproductive activities, smaller the crew size so that the workers will not spent time in Talk and mobile.
5. Avail the Resources like Burners, Hydra, and some Components so that the supervisors spend more time on Job.

Conclusion

Using the Work sampling we knew the worker utilization during the general shift and we address different reasons behind it and take the action against it to reduce the less labour utilization during the different shift.

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