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A Study of Labour Productivity and Work-Hour Loss -Case Study for Brick Masonry

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Abstract: - Recourse inputs at the project site include men, material, machinery and money. These inputs produce outputs in the form of work. The success of any project depends upon the performance availability of these resources. This paper elaborates the methodology used for controlling labour productivity which can be improved by cutting down un productivity time of the labour. The control process involves accounting of actual productivity of labors, comparing and analyzing the causes for finding the remedial measures to improve productivity. A case study approach is used to compare the B.B Masonry work, constructed at two similar, medium sized commercial construction projects located in at Walwadi area of Dhule city. The objectives of this case study are to qualify the potential benefits. For a concern site, Material related problems are identified and linked to the material management practices. A Study for Brick Masonry is taken. The numbers of work - hours lost, time loss and work-Hour overturn as well percentages of ineffective days were calculated.

Keywords: - *Work - hours loss ,Labour productivity , Time loss ,Ineffective days*

Abbreviations

B. B. Masonry	*Burn Brick Masonry*	D wh	*Daily working hour*
Cum. D prod.	*Cumulative Daily productivity*	LP	*Labor Productivity*
Cum.D wh	*Cumulative Day Work Hour*	Nom	*Number of masons*
Dprod.	*Daily productivity*	TQ	*Total quality work*
DQty.	*Daily quantity of work done*	Wd. No.	*Work Day Number*

I. INTRODUCTION

Productivity commonly is the ratio of out put to in put, but it convey different meaning to different people as productivity and production capability. Productivity linked to mean workers out put capability; they express productivity as work quality production per man-hours of input. In the narrow sense of controlling project resources, the productivity concept is used to measure the performance of the resource.
The actual quantity of units produced by a team of people compared to the standard amount of time needed to produce those units is generally accepted as the measurement of a factory's productivity. While productivity improvement itself is not typically a stated goal of the Lean manufacturer, the methodologies .Lean manufacturings inherently cause process improvement to improve. Formal strategies, like kaizen, focus on the incremental reductions of wait time, queue time, and other non value-adding activities. By eliminating wasteful time elements embedded in manufacturing processes, manufacturing operators are able to spend more of the working day producing products. Productivity improvement is an excellent advantage of Lean manufacturing.

II. DATA COLLECTION

The data collection method consist of observation and documentary analysis .The data collected for this case study were collected as part of an ongoing study of construction labour productivity. The goal of the research is to test a productivity measurement technique that provides daily assessment of the problems affecting production without the need for continuous on site work measurement methods.

The technique depends upon both quantitative and qualitative data. The site supervisor visits each case study projects daily and classifies the day according to a set of site factors that include material management, work content and constructability issues, construction methods, environmental conditions, and other management aspects.

III. DETAILS OF CASE STUDY

The case study involves the construction of the Burn Brick Masonry for the structures. The operations involved are preparation of mortar, transportation of bricks, lying of bricks, checking horizontality and verticality, spreading mortar, filling, joints with mortar and finishing. Both the structures were constructed by a local contractor by using a non uniform work force available locally. The site staff consisted of a single project supervisor.

Project A:

The case study project is a three- story residential-building with 12 Flats constructed in Walwadi area of Dhule city. The building consists of a R.C.C. frame and brick facade. The plan of the building is attached. The total Built up area is 478.418 Sq M. The area available for the storage of construction material was limited.

Project B: The project B is also a three- storied residential building with 10 Flats and 8 shops at ground floor constructed on corner plot of Walwadi area of Dhule city. The building consists of R.C.C. frame and brick facade. The plan of the building is attached. Total built-up area is 557.303 Sq M. The area available for storage of construction material is more as compared to Project A.

IV. METHODOLOGY

The procedure used to calculate work- hour losses involves a comparison between the productivity on those days when adverse material- related conditions were present and the expected productivity had there been no adverse conditions present. The first step is to purge from the data set all days for which adverse conditions of any kind are reported. Next, the expected daily productivity is derived by fitting a curve through the remaining data points. This curve represents the best estimate of what would have occurred had there been no adverse conditions present. The last step involves subtracting the actual productivity from what was expected for each day affected by the material management practices. The difference is converted to work- hours, and the sum of the differences represents the total work-hour impact. Specifically, all impacts that occur during one day or for several consecutive days are removed prior to deriving the expected curve. Impacts that underlie the entire project, for example, poor supervision or an unmotivated work force are still present, but these are eliminated, by the subtraction process.

The expected curve for the case study Project A, was developed using data of Burn Brick Masonry from workdays 1-2,3-5,6-7,9-11,12-14,15-16, 17-21,25-27,28-31 and 32-35. The similar procedure was adapted to Project B.

The ineffective material management leads to the inefficient use of craft labour. Construction labour productivity is the measure of the effect. There is no standard definition of productivity but one can use construction labour productivity as

$$Labour\ Productivity = \frac{Labour\ cost\ /Work\ Hours}{Units\ of\ Output}$$

In general productivity signifies the measurement of how well an individual entity uses resources to produce out puts from inputs. The measurement scheme can be readily applied to task or crew level work.

V. DISCUSSION

For Project A, the construction of B.B. Masonry activity lasted 35 days and required 271.5 work-hours. Work-hours and quantity data were recorded daily and yielded the daily and cumulative productivity (total work-hours divided by total units of output) as shown in Table 1and 2. The same procedure was adopted for Project B also as shown in Table3 and 4. Then data was presented in the form of combined graph1 and 2 i.e. Daily productivity Vs. Work day and Cumulative productivity Vs. Work day, similarly in graph 3 and 4.

VI. RESULTS

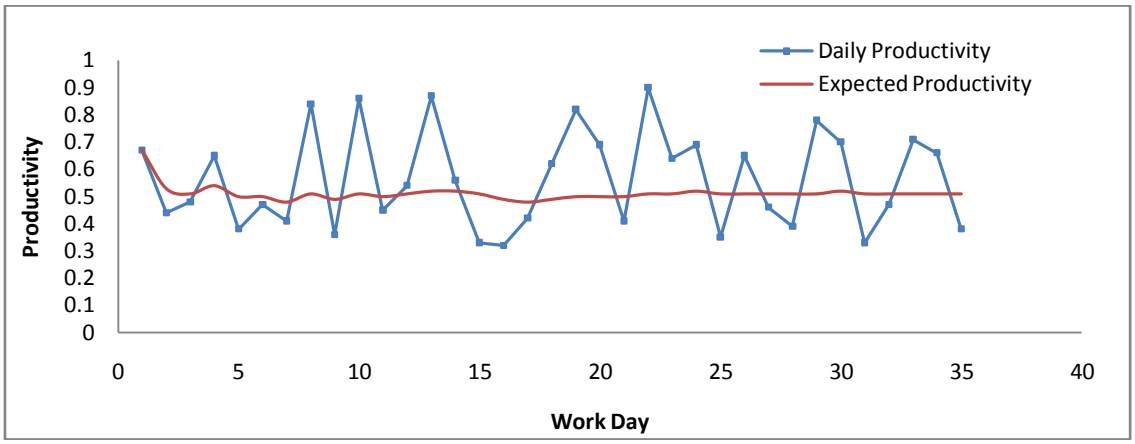
The distinct material-related conditions or events occurred during B.B.Masonry are:

1. Exhaust of material supply, and crew was sent to another project.
2. The lack of materials interrupted the normal pattern of the crew and resulted in the crew stretching the work.
3. Little or no work available which slows down the work.

4. Stock of materials in haphazard manner, with little consideration for the sequence of construction. The impact of the various material management conditions cited above is evident in Fig1and 2. As can be seen, almost all of the peak days on the curve representing major losses of productivity can be explained by the existence of these conditions.

Table 1. Cumulative Productivity for Project ***"A"*** (Burn Bricks Masonry)

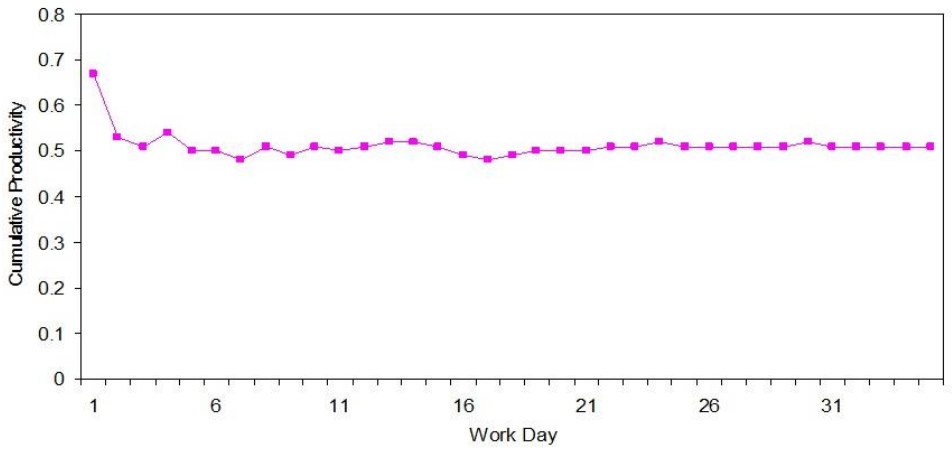
Date	Wd No.	Nom	No. of Labors	D wh.	D qty. (Sqm)	D. Prod (wh/ Sqm)	Cum. Dwh	Cum Dqty.	Dum Prod.
5/9/2007	1	2	2	7.5	11.13	0.67	7.5	11.13	0.67
5/10/2007	2	3	4	8	18.3	0.44	15.5	29.43	0.53
5/11/2007	3	3	4	8	16.5	0.48	23.5	45.93	0.51
5/12/2007	4	4	5	8	12.3	0.65	31.5	58.23	0.54
5/13/2007	5	4	6	7	18.4	0.38	38.5	76.63	0.50
5/14/2007	6	3	5	7.5	15.8	0.47	46	92.43	0.50
5/16/2007	7	4	6	8	19.6	0.41	54	112.03	0.48
5/17/2007	8	2	3	8	9.5	0.84	62	121.53	0.51
5/18/2007	9	4	6	8	22.46	0.36	70	143.99	0.49
5/19/2007	10	3	4	7.5	8.7	0.86	77.5	152.69	0.51
5/20/2007	11	3	5	7	15.7	0.45	84.5	168.39	0.50
5/21/2007	12	3	5	8	14.68	0.54	92.5	183.07	0.51
5/23/2007	13	2	4	8	9.21	0.87	100.5	192.28	0.52
5/24/2007	14	3	5	7.5	13.5	0.56	108	205.78	0.52
5/25/2007	15	4	6	8	23.89	0.33	116	229.67	0.51
5/26/2007	16	4	5	7	22.1	0.32	123	251.77	0.49
5/28/2007	17	4	5	8	18.93	0.42	131	270.7	0.48
5/29/2007	18	4	6	8	12.86	0.62	139	283.56	0.49
5/30/2007	19	3	5	6	7.35	0.82	145	290.91	0.50
5/31/2007	20	3	5	7	10.2	0.69	152	301.11	0.50
6/1/2007	21	4	6	8	19.53	0.41	160	320.64	0.50
6/3/2007	22	2	3	7.5	8.3	0.90	167.5	328.94	0.51
6/4/2007	23	3	5	8	12.43	0.64	175.5	341.37	0.51
6/5/2007	24	3	4	8	11.52	0.69	183.5	352.89	0.52
6/6/2007	25	4	6	8	22.6	0.35	191.5	375.49	0.51
6/8/2007	26	3	5	8	12.32	0.65	199.5	387.81	0.51
6/9/2007	27	3	4	8	17.3	0.46	207.5	405.11	0.51
6/10/2007	28	4	6	8	20.4	0.39	215.5	425.51	0.51
6/11/2007	29	3	5	8	10.23	0.78	223.5	435.74	0.51
6/12/2007	30	3	5	8	11.42	0.70	231.5	447.16	0.52
6/13/2007	31	4	5	8	24.2	0.33	239.5	471.36	0.51
6/15/2007	32	4	5	8	17.2	0.47	247.5	488.56	0.51
6/16/2007	33	3	4	8	11.3	0.71	255.5	499.86	0.51
6/17/2007	34	3	4	8	12.1	0.66	263.5	511.96	0.51
6/18/2007	35	4	6	8	21.3	0.38	271.5	533.26	0.51
		115	169	271.5	533.26	19.72	4850.5	9546.92	17.93



Graph. 1 Productivity of Project "A" (Burn Bricks Masonry)

Table 2. Summary of Work Hour Losses from Material Project "A" (Burn Bricks Masonry)

Wd. No.	Dwh.	D qty. (Sqm)	Actual Prod. Wh./Sqm.	Exp. Prod. Wh./Sqm.	Wh. Loss
4	8	12.3	0.65	0.46	2.34
8	8	9.5	0.84	0.4	4.20
10	7.5	8.7	0.86	0.4	4.02
13	8	9.21	0.87	0.4	4.32
18	8	12.86	0.62	0.4	2.86
19	6	7.35	0.82	0.4	3.06
20	7	10.2	0.69	0.4	2.92
22	7.5	8.3	0.90	0.39	4.26
23	8	12.43	0.64	0.39	3.15
24	8	11.52	0.69	0.39	3.51
26	8	12.32	0.65	0.38	3.32
29	8	10.23	0.78	0.38	4.11
30	8	11.42	0.70	0.38	3.66
33	8	11.3	0.71	0.38	3.71
34	8	12.1	0.66	0.38	3.40
Total lost work - hours					52.84



Graph. 2 Cumulative Productivity Project A B. B. Masonry

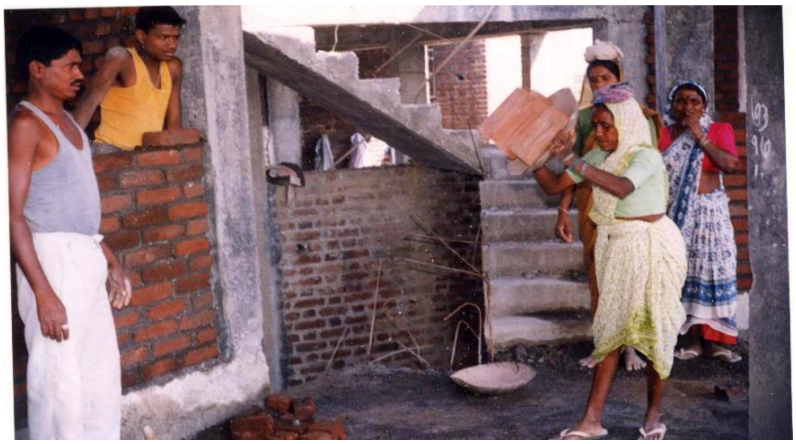


Fig 1 .Work loss

Fig 2 Improper stackig of brick

Table 3 Cumulative Productivity for Project ***"B"*** (Burn Bricks Masonry)

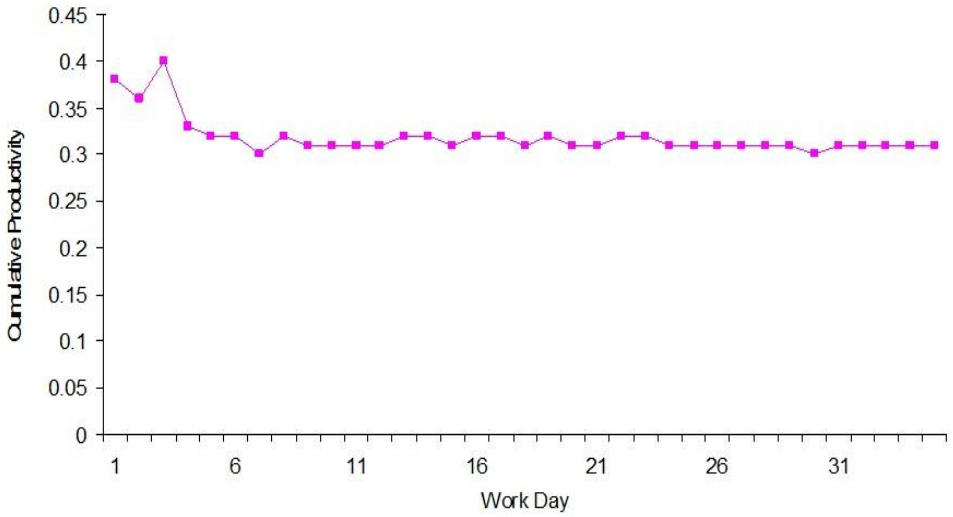
Date	Wd No.	Nom	No. of Labors	Dwh.	Dqty. (Sqm)	D. Prod (Wh/Sqm)	Cum. Dwh	Cum Dqty.	Dum Prod.
6/23/2007	1	3	4	8	21.3	0.38	8	21.3	0.38
6/24/2007	2	4	6	8	23.65	0.34	16	44.95	0.36
6/25/2007	3	3	4	8	14.85	0.54	24	59.8	0.40
6/26/2007	4	6	8	7.5	35.61	0.21	31.5	95.41	0.33
6/27/2007	5	4	6	8	26.32	0.30	39.5	121.73	0.32
6/28/2007	6	5	7	8	28.43	0.28	47.5	150.16	0.32
6/30/2007	7	4	6	8	35.4	0.23	55.5	185.56	0.30
7/1/2007	8	3	5	8	15	0.53	63.5	200.56	0.32
7/2/2007	9	4	6	7.5	28.43	0.26	71	228.99	0.31
7/3/2007	10	5	8	8	26.43	0.30	79	255.42	0.31
7/4/2007	11	4	4	7	19.21	0.36	86	274.63	0.31
7/5/2007	12	5	6	8	32.1	0.25	94	306.73	0.31
7/7/2007	13	3	4	8	14.2	0.56	102	320.93	0.32
7/8/2007	14	4	5	8	25.98	0.31	110	346.91	0.32
7/9/2007	15	5	7	8	32.33	0.25	118	379.24	0.31
7/10/2007	16	4	4	8	15.3	0.52	126	394.54	0.32
7/11/2007	17	5	5	8	29.46	0.27	134	424	0.32
7/12/2007	18	6	7	8	34.69	0.23	142	458.69	0.31

7/13/2007	19	4	5	8	15.65	0.51	150	474.34	0.32
7/15/2007	20	5	6	8	28.76	0.28	158	503.1	0.31
7/16/2007	21	4	6	8	31.64	0.25	166	534.74	0.31
7/17/2007	22	3	3	8	13.95	0.57	174	548.69	0.32
7/18/2007	23	4	6	8	28.95	0.28	182	577.64	0.32
7/19/2007	24	5	5	8	30.64	0.26	190	608.28	0.31
7/20/2007	25	4	5	8	29.43	0.27	198	637.71	0.31
7/22/2007	26	4	5	8	28.58	0.28	206	666.29	0.31
7/23/2007	27	5	7	8	34.12	0.23	214	700.41	0.31
7/24/2007	28	4	4	7.5	13.63	0.55	221.5	714.04	0.31
7/25/2007	29	5	5	8	31.58	0.25	229.5	745.62	0.31
7/26/2007	30	6	7	8	39.85	0.20	237.5	785.47	0.30
7/27/2007	31	4	5	8	14.96	0.53	245.5	800.43	0.31
7/29/2007	32	5	6	8	26.46	0.30	253.5	826.89	0.31
7/30/2007	33	4	6	8	27.15	0.29	261.5	854.04	0.31
7/31/2007	34	3	3	8	15.2	0.53	269.5	869.24	0.31
8/1/2007	35	4	6	8	28.67	0.28	277.5	897.91	0.31
		150	192	277.5	897.91	12.01	4981.5	16014.39	11.12

Graph. 3 Productivity of Project "B" (Burn Bricks Masonry)

Table 4. Summary of Work Hour Losses from Material Project "B" (Burn Bricks Masonry)

Wd.No.	Dwh.	Dqty. (Sqm)	Actual Prod. Wh./(Sqm.)	Exp. Prod. Wh./Sqm	Wh. Loss
3	8	14.85	0.54	0.38	2.36
8	8	15	0.53	0.28	3.80
13	8	14.2	0.56	0.25	4.45
16	8	15.3	0.52	0.25	4.18
19	8	15.65	0.51	0.24	4.24
22	8	13.95	0.57	0.24	4.65
28	7.5	13.63	0.55	0.23	4.37
31	8	14.96	0.53	0.23	4.56
34	8	15.2	0.53	0.22	4.66
				Total lost work - hours	37.26



Graph. 4 Cumulative Productivity of Project B (Burn Bricks Masonry)

Table 5 Comparison Summary for B. B. Masonry

	Project-A	**Project-B**
Activity Duration	35 Days	35 Days
Total Qty. Work	**533.26 Sqm.**	**897.91 Sqm.**
Total Work-Hours	271.5	277.5
Total Lost Work-Hours	**52.84**	**37.26**
Total labour	169	192
Total Mason	115	150
Work-Hour overrun = (Total Lost Work-Hours)/ (Total Work-Hours)*100	(52.84/271.5)x100=**19.46%**	(37.26/277.5)x100=**13.42%**
Time overrun	52.84 Hours is equivalent to approx. 7 days. (7/35)x100 = **20%**	37.26 Hours is equivalent to approx. 5 days. (5/35)x100 = **14.29%**
Percentage of Ineffective days	Out of 35 days 15 days are ineffectively used. (15/35)x100 = **42.86%**	Out of 35 days 9 days are ineffectively used. (9/35)x100 = **25.71%**

VII. CONCLUSIONS

The ineffective material management of Project A, was due to less area for storage, labour involved in shifting material to make construction activity possible material storage at place away from construction area more transportation cost in the form of labour. Also due to less available area more chances of accidents and lesser in safety. Additional labour force was used to expedite the transportation of materials. Travel time and human efforts can be reduced by simply providing chute so that bricks can move through chute up to each floor level, which will reduces distance of transportation and wastage due to double handling, mishandling resulting in both labour productivity as well as minimizing the waste. In case of commercial building construction ,the size of opening is kept uniform so it is better to use precast lintel which can be manufactured at the site if site layout permits or they can be manufactured at centr Work-Hour overrun ally located pre cast unit plant ,so that there will be reduction in transportation distance , time to move ,resulting in speedy construction . No use of proper methodology like Lean for A but used partially in B ..No proper discipline for the activities are made resulting Total Work-Hours 271.5 to 277.5, Total Lost Work-Hours52.84 to 37.26, Work-Hour overrun 19.46% to 13.42% Time overrun20% to 14.29% and Percentage of Ineffective days42.86% to25.71% .

VIII. RECOMMENDATIONS

Practically it is difficult task to improve labour productivity up to 100% but one can control and improve productivity up to large extent. Labour productivity can be broadly attributed to the low morale of the workers, poor pre-work preparation by the supervisor and the directional failure of the project management. Recommendations to increase labor productivity are

1) Employ competent supervisor
2) Improve working condition
3) Improve method of executing work; always find a better way of doing work.
4) Replace an inefficient working tool by appropriate efficient tool.
5) Replace labour by appropriate equipment if economically feasible.
6) Reduce unproductive time by constantly reviewing and minimizing causes responsible to unproductive time.

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