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A Case Study for Increasing the Productivity in a Construction Equipment Manufacturing Company

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***Abstract*— The globalization of Indian economy has faced a great challenge to the Indian industries in respect of productivity, quality, cost, delivery and so on. Productivity is very important factor for any firm to survive in this increasing competition and also to solve break through. The objective of this case study is to present the work done at a construction equipment company for improvement of productivity in its one of the products with the help of application of work study. The basic mindset was to reduce the time for the studied processes.**

***Keywords*— Productivity; Work Study; Time Reduction.**

I. INTRODUCTION

Productivity is a measure of how well the production unit uses the resources. We measure productivity as units of qualitative output per unit of input. Where output includes quality goods and services produced and sold. Input includes all of the materials, services, machinery usage and efforts expended in the production of the output. [1] Work study is a specific type of operations research used to measure work being performed in order to increase efficiency and productivity. It can also be defined as a generic term for those techniques, particularly method study and work measurement, which are used in the examination of human work in all its contexts, and which lead systematically to the investigation of all factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement. [3] The Study was carried out on the passenger material hoist (1-ton capacity) used at the construction sites, in Esquire Machines PVT.LTD. located near Vadodara.

II. PASSANGER MATERIAL HOIST

Hoist is a Rack and Pinion Lifting Hoist, used in construction site for transportation of personnel and materials. It can be installed and uninstalled conveniently. Height can be adjusted according to building height. The rack and pinion drive is inherently safer as there is a positive mechanical engagement between the drive system on the hoist cabin and the stationery hoist guide system. There is a Safety device in the cabin of a rack and pinion drives, where the hoist is brought gradually to a stop in the case of a drive motor brake failure. The cabin is totally enclosed with perforated sheet on side, and an imperforate roof. A trapdoor in the roof allows personnel to escape in the event of an emergency, but must stay closed at all other time.

III. ASSEMBLIEIS IN THE HOIST

PM hoist is the elevator which is used at the construction sites for carrying the material as well as the manpower to different height. This elevator has 14 in total assemblies in which 5 are made by the company itself as per the order and others are made in the lot as they are smaller and not affect the productivity. These are the assemblies which makes up the product as a whole when dispatched from the company.

1. Base Frame Assemblies
2. Cage with Ram Door
3. Cable trolley Base and Tower
4. Cable trolley
5. Mast Assemblies
6. Tien Assemblies
7. Lower Cable Assemblies
8. Upper Cable Assemblies
9. Terminal Block Assemblies
10. Tower Beam Assemblies
11. Ground Enclosure Assemblies
12. Erection Crane Assemblies
13. Drive Unit

Basically, our concern would be on the assembly which are entirely made by the company itself and not on that which are made in ample of amount once and kept on the assembly bay.

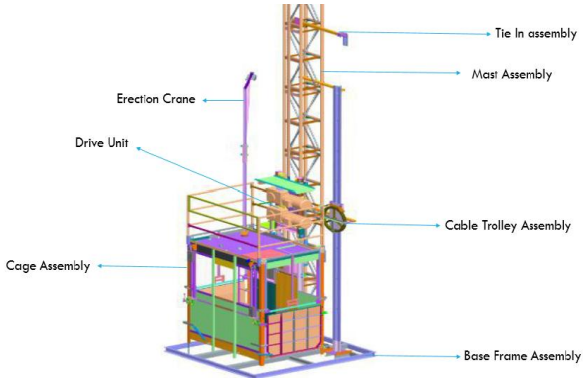

Fig.1. Labelled Diagram of Pm Hoist

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 04, April-2017

IV. OPERATION PROCESS CHART OF THE HOIST

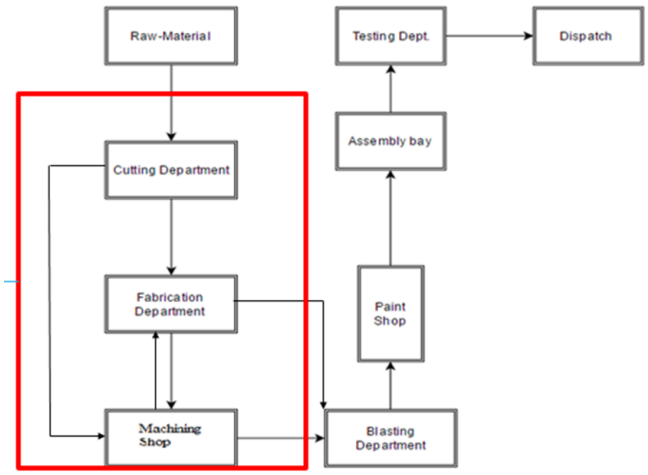

Fig.2 Operation Process Chart (Pm Hoist)

All the assembly noted above follows the same sequence generally and gather on the assembly bay for final assembly after moving from paint shop, blasting dept., machining shop and fabrication department for further final assembly and testing…
Our Main concern was in the cutting, fabrication and machining department for work-study of the assemblies which were separated out for observation.

V. WORK METHODOLOGY

Work study was performed on the assemblies which were purely mechanical in nature and were made as per the order by the firm.
Basically out of 14 assemblies of the product 8 assemblies are mechanical in nature and the rest 6 were electrical in nature. These 8 assemblies are described further.

1. Base Frame Assembly
2. Cage with Ram Door
3. Mast Assembly
4. Drive Unit
5. Ground Enclosure Assembly
6. Erection Crane Assembly
7. Tien Assemblies
8. Cable trolley assembly

There were in all 2 types of assemblies which are

1. Assemblies made in the bulk
2. Assemblies which were made as per order.

Work Study was performed only on the assemblies which are made as per the order as the assemblies made in bulk are stored on the assembly bay in hundreds and thus we found no concern on them.
Steps Conducted:

1. Understand the design of pm hoist.
2. Understand the working of the hoist.
3. Differentiated the assemblies to be worked on.
4. Collected the data (i.e., Processes Done, Time taken)
5. Prepared the Flow Process Chart for assemblies to be worked on.
6. Processes which took more time were identified.
7. Proposals were given.
8. Accepted proposals were implied and results were obtained.

VI. POROPOSALS GIVEN FOR PRODUCTIVITY IMPROVEMENT

Proposal were given by the team to the company after identifying the processes which can be modified from the flow process charts formulated from the data collected of the assemblies which were under work study.
3 out of 4 proposals were accepted and implemented by the company and on the remaining they had ensured to work in future by themselves. The Proposals given are listed below.

1. Template for marking process to be done on the drive unit for further drilling to be carried out.
2. Template for marking process at the base frame of the cage assembly as carpet sheet to be installed.
3. Designed fixtures must be used for the fabrication of the frames of the cage to reduce the time spent in fabrication instead of using the c-clamps and other supports.
4. Trolley to be made instead of transporting the machined pipe of mast from machining shop to fabrication area by crane.

VII. TEMPLATE FOR DRIVE UNIT ASSEMBLY

After forming the flow process chart for the assembly of the drive unit the marking process was identified for it was taking 46.45 minutes in all, this process was carried out for drilling out 10 hole on the drive unit section. Thus, template was made for marking process so that it can save the time and human effort required, results after using the template is shown further.

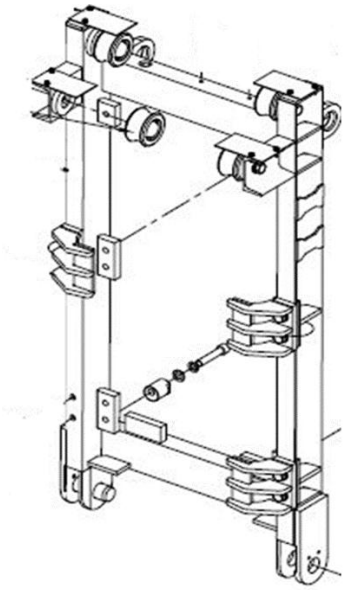

Fig.3 Drive Unit Assembly

VIII. TEMPLATE DESIGN

Sheet of 4mm was taken from the store at the company and as per the drawing provided sheet was formulated into the

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 04, April-2017

template with the help of the workers. The template was designed according to the controlled drawing provided by the company and help was taken from the design department for the purpose. The design is shown further.

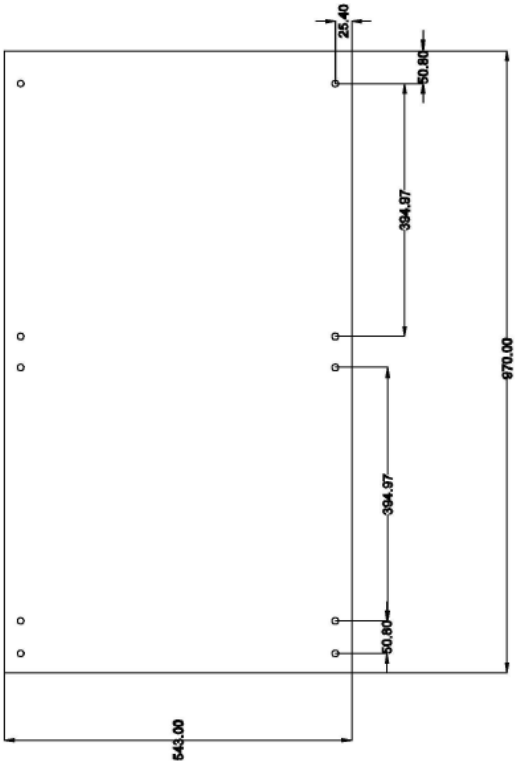

Fig.4 Design of Template (2d Drawing)

IX. RESULTS AFTER USING THE TEMPLATE

In Present Flow Process chart, the time take without the use of the template was in all 358 minutes for the assembly of the drive unit and after using the template for the marking process it took only 317.65 minutes for the whole process. Thus, this template has saved in all 40.35 minutes which counts 11.20% decrease in the total time of drive unit fabrication.

X. TEMPLATE FOR ASSEMBLY OF CAGE

During the cage formation the sheets were to be installed at the bottom half of the guide roller frame and mast side frame for which the marking process was identified consuming more time and thus the template was planned for saving the time and efforts required during the process.

The template is used for marking up the holes on two sites on the single frame for further drilling to be done for attaching the cover sheet on the frame and this template is used on two frames i.e. mast side frame and guide roller frame.

Mast side frame is the frame at the back side of the assembly and the guide roller frame is the frame at the front side of the same, the cover sheet is installed at the lower half of the frames. The figure described below can make the concept clear.

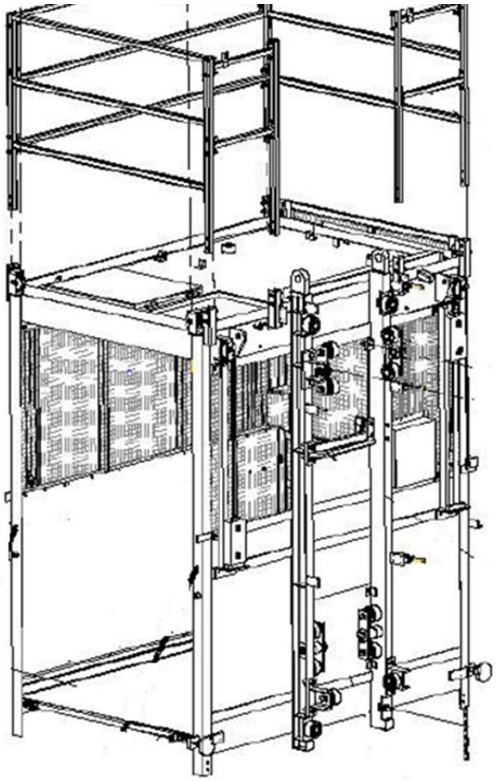

Fig.5 Cage Assembly

XI. TEMPLATE DESIGN

Sheet of 4mm was taken from the store at the company and as per the drawing provided sheet was formulated into the template with the help of the worker. The design is shown further.

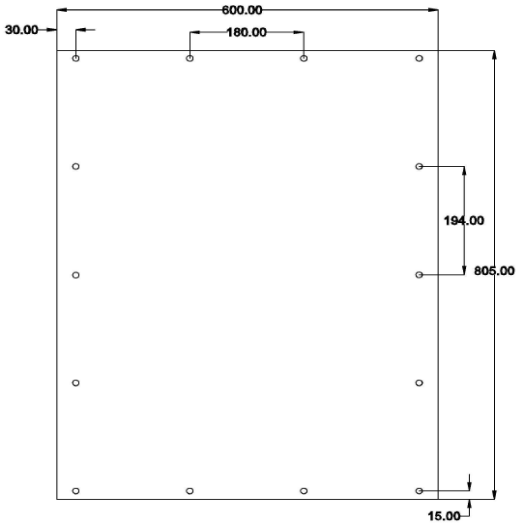

Fig.6 Design of Template (2d Drawing)

XII. RESULTS AFTER USING THE TEMPLATE

In Present Flow Process chart, the time take without the use of the template was in all 548.27 minutes for assembly of cage and after it took only 317.65 minutes for the whole process. Thus, this template has saved in all 40.35 minutes in the marking process which counts 11.20% of the total time of cage assembly.

International Journal of Engineering Research & Technology (IJERT)
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XIII. TROLLEY FOR MAST FABRICATION

During the mast fabrication, the pipes of 1512mm length was to be transported from the machining shop to the fabrication site and it was noted to be taking more time as it was handled by the crane which seems busy sometimes for some other purpose and thus proposal for the fabrication of the trolley was given instead of using the rack on the crane for the purpose.

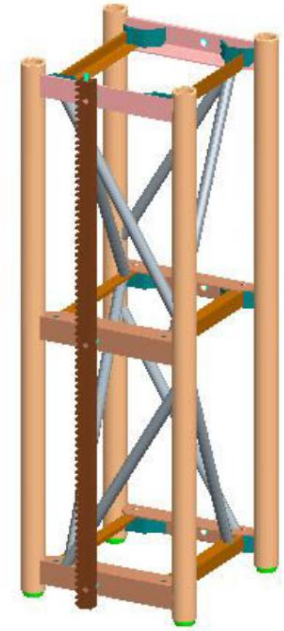

Fig.7 Mast Assembly

Flow process chart was formulated for the mast assembly to identify the processes which must be modified or eliminated for increasing the productivity and thus trolley was proposed and an intermediate process of grinding on the middle angle was eliminated with the help of quality department by contacting the vendor for suppling the angle (65*65*6) with proper finishing and minimum burrs.

XIV. DESIGN OF TROLLEY

Trolley was made from the scrap material at the company site with the help of the workers and was then tested for time reduction in transporting the pipes from the machining shop to the fabrication area and we were finally successful in reducing the time of transportation with this new method. Thus, the design of the trolley is described further.

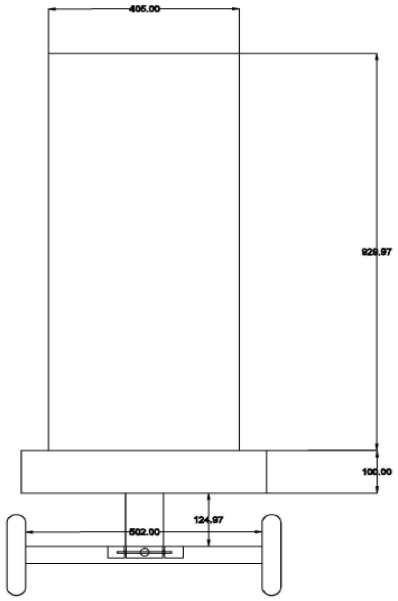

Fig.8 Design of Trolley For Mast Assembly
(Side View)

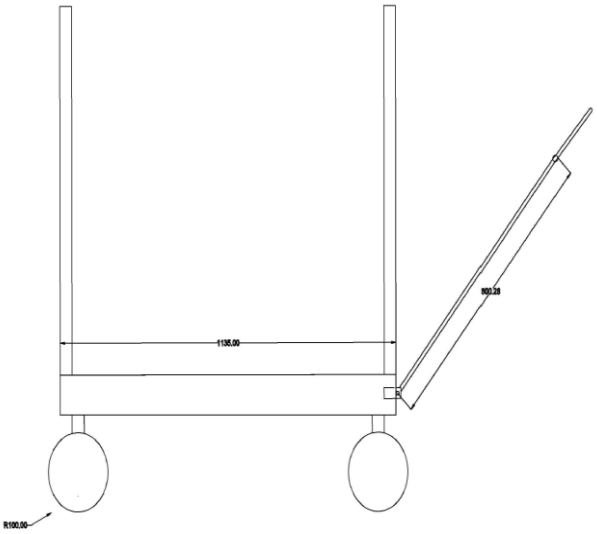

Fig.9 Design Of Trolley For Mast Assembly
(Front View)

XV. RESULTS AFTER USING THE TROLLEY

In the present Flow Process Chart, the time taken to fabricate one mast took 142.93 minutes and the crane was used for transportation of the pipe and also another problem was identified during the process that the channel which was to be welded at the middle of the mast assembly was taken for grinding process as it was not matching into the assembly due to burrs present on the edges and also due to little dimensional inaccuracy but it was solved with the help of the quality department of the company by providing the updated controlled drawing of the channel to the vendor providing the channels.

International Journal of Engineering Research & Technology (IJERT)
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Vol. 6 Issue 04, April-2017

Thus, in all we have saved 1 operation process and 1 transportation process from 59 and 13 counts respectively by solving the problem identified on channel welding and the trolley has reduced 10.15 minutes of the total process of mast fabrication from 142.93 to 132.78 minutes respectively which counts 7.10%-time reduction of the whole process.

XVI. CONCLUSION

Thus, from the above described results the overall result is considered by summing up the time taken before and after the modifications done for all the assemblies of the hoist for which the work study was performed and the difference obtained is described further.

SR.NO.	ASSEMBLY	BEFORE TIME(Min)	AFTER TIME(Min)	COMMENT
1	Drive Unit	358	317.65	Template Made
2	Mast Assembly	142.93	132.78	Trolley Made
3	Cage Assembly	548.27	489.57	Template Made
4	Top Side Cage Frame	150.86	150.86	No Changes Done
5	Bottom Side Cage Frame	179.08	179.08	No Changes Done
6	Guide Roller Frame	165.06	165.06	No Changes Done
7	Mast Side Frame	223.78	223.78	No Changes Done
**	Total Time (Minutes)	**1767.98**	**1658.78**	

Fig.10 Overall Time Resuts

Thus, from the above described data the time taken before the modifications done was 1767.98 minutes which is 29.466 hours and the time obtained after implementing the proposals was 1658.78 minutes which is 27.646 hours respectively. The overall difference is calculates obtained as 109.2 minutes which is 1.82 hours.

We can conclude that for every 29.46 working hours the proposals of the templates and trolley has saved 1.82 hours in the flow which can be also counted as at every 16.19 working days 1 whole working day is saved.

The overall productivity improvement in terms of time is calculated as 6.17% and so we can conclude that work-study definitely works as the productivity improvement tool though applied with very primary knowledge.

XVII. LIMITATIONS AND FUTURE SCOPE

Here, for this project we have worked upon only on the mechanical assemblies which are made as per the order but not on the assemblies which are made in the bulk and also the electrical assemblies are not taken into consideration in the data collection, this might be because of the time constraints or due to lack in our experience in the field but all the assemblies can be worked upon under the project and then we can get even more precise and accurate results than obtained.

The Proposal which was decided by the company to worked on by themselves can be worked on by the team. Further, we can also apply other productivity improvement tools for better results if applicable in our case, this may include tools like Lean Tools, Kaizen Methodology, Just in Time practice, SMED Technology, 5S Methodology and many more…

ACKNOWLEDGEMENT

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