JIT for Productivity Improvement in Indian Automobile Industries; Case Study

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Abstract- *Just-In-Time (JIT) has been a very useful method for increasing the productivity especially in growing automobile industries because of its success in various Japanese industries. The main objective of this research is to understand the present status of the Indian industry and then to improve the existing plan by model analysis for any automotive company. Or this purpose, Videos, images of operating machines (in movement) and interviews of skilled workers , groups were organized for the collection of desired data, environmental factors also considered with the particular aim of seeing the productivity. A case study has been considered for the same and analyzed using mathematical approach. The study uses a case-based qualitative approach. The conclusion of this research indicates that JIT system is successful, and by using this system productivity of industry can be improved.*

Keywords- Indian industries, JIT, Model analysis, Mathematical programming, case study.

I. INTRODUCTION

Just in Time (JIT), theory, which now operates widely in the automobile industries, with more and more applications can be found in many industries over the world [1]. The ideology of JIT is „producing the necessary items in a necessary quantity at the necessary time is an eternal diver of production and operations management" [2]. In addition to that, there are many production planning and control methods, like Kanban systems [3], have been developed in order to achieve the objectives of JIT.The basic objective of JIT is to enhance flexibility of the whole system, which is one of the competitive factors in future manufacturing and services systems [4,5].

There are various definition of JIT , which are quite consistent in many studies (or even textbooks) to the one mentioned in previous section. For example Bozarth & Handfield [6] define JIT as: „A philosophy of manufacturing based on planned elimination of all waste and on continuous improvement of productivity. In the broader sense, it applies to all forms of manufacturing and to many service industries as well". JIT requires elimination of wastes which aims that JIT systems could lead to delivery of „perfect" products or services at the„exact" time they are required [7]. In this connection, the main purpose of JIT systems is to identify and to eliminate as many kinds of wastes as possible through improving production activities, controlling the movement of machines within a company. Thus a JIT system is an „effective tool" for assisting a company to reduce cost and then to obtain higher profits [2, p. 1].

JIT can be considered as one of the important variants of the production, planning and control systems in a manufacturing industry, which play pivotal management rules for tools for satisfying increasingly high client demands and expectations in the business market [8], although traditional production planning and control systems are „push" in nature, which aims planning department decides the production schedule and transmits to all production processes according to forecast of the demand of market. Rhodes [7] has presented that a proper information system can facilitate JIT system by communicating quickly amongst various departments. Recently, electronic Kanban has become a trend in modern JIT system [9] and this study will also reveal how such a computer-based kanban system, and also information technology in general, can facilitate implementation of JIT.

It is a fact that the pull nature of JIT helps companies to reduce idle inventory, because of the collection of more accurate demand information. In other words, companies need not keep excessive inventory. Mc Lachlin [10] reported a list of advantages and benefits claimed for industries implementing JIT system. These include reduced lot sizes, lowered inventory, improved quality, reduced waste and rework, improved motivation, greater process yield, increased productivity, increased flexibility, reduced space requirement lower overhead, reduce manufacturing cost, reduced lead-time, elimination of certain trade noffs such as cost and quality and improved problem solving capabilities. However, a steady demand and production planning is almost a pre-requisite for any JIT systems. Thus, the practicability of steady production planning could affect the JIT performance. Therefore, another research objective in this study is to address whether or not steady production system is achievable in the case company. In addition, whether or not „zero inventory" can be achieved will be examined. Another important element in JIT systems is quality management [11]. Obviously, if many defective products are produced, that may affect normal production schedule, in order to correct the mistakes. This will definitely affect the requirement on steady production schedule as mentioned above. Therefore, the fourth research objective in this study is to understand how JIT can be implemented together with a good quality management system in the case company. This is also somehow related to the cooperation between the company and the suppliers since the quality of the final products may be affected by the sources of the components [10]. In addition, capability of the suppliers can also affect availability of the components. Thus how to maintain a good supplier relationship is another element that will be investigated in this study, which is the final research objective of this study.

This study aims at investigating the five issues, as mentioned above, surrounding a real-life implementation of JIT system. In this study, the JIT system of an international automotive company with a factory located in India, Omax Automovers, Lucknow, is considered and analysed. The objectives of this study includes identifying the profile of the JIT system in Omax automovers, Lucknow, examining their pre-implementation and implementation experiences, assessing the reasons for and the potential advantages associated with its adoption of JIT and highlighting the JIT practices targeted for future implementation.

The main objective of this research is to study the issues surrounding an implementation of a JIT system for an automotive company. The factory in question is located in India, one of the many branches of the aforementioned company. This study will reveal how the JIT system could improve the case company"s competitive strength, and how the company tackled various issues surrounding the implementation. In short, the study relates to the following research questions: (1) How is JIT system operating in the company? and (2) What are the benefits of employing the JIT system?

II. METHODOLOGY USED FOR CASE STUDY

As the growth of Indian manufacturing industry in the last two decades has increased considerably, it is not surprising that Indian manufacturers have realized the need to build advanced production systems like JIT in order to maintain, and even upgrade, their operations effectiveness. Before collecting data at the actual case site, automobile parts Products Company with some lean implementation was chosen. Since OMAX AUTOS LIMITED has got number of products for TATA motors and it has been studied that the different operations in existing layout and finally concluded to the point that the layout of machines are optimal hence our suggestions are not to shift to any machine to anywhere which may create lot of time in machining for other products but some important changes can occur so many conclusions is to reduce the existing machining time by modifying the material handling system so it is better to modify the handling equipment"s. Robson [12, p. 178] has defined case study, as „a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence". Saunders et al. [13] also summarized that the method of case study could answer the exploratory and descriptive or analytic research question- „why" and „how". In addressing the research objectives as mentioned in previous section, case study is thus employed for data collection so that interrelated elements as identified in Section I will be examined, as well as their influence on the performance of JIT system of Omax automovers, Lucknow.

This study used a case-based qualitative approach, i.e. data collection is in the form of words of people, labour, group or environment. More specifically, a single case is used in this study as Omax auto movers; Lucknow (India) is a good representative of a critical case that wants to improve its competitive strength through JIT system. In order to collect data, semi-structured interviews were organized, which is a very common method in the operations and supply chain management domain [14]. The purpose of interviewing is „to understand the experience of other people and the meaning they make of that experience" [15, p. 3]. The use of interviewing could help researchers gather valid and reliable date form interviewees that relate to research questions and objectives. Interviewees could give their personal experience to the author according their working experience. In addition, the interviewing will be progressed as one-by-one form which is the most appropriate method and relatively easy to arrange [16, 17]. There are five interviewees chosen from the case company who have professional experiences in managing or implementing JIT system of the company.

III. PROBLEM FORMULATION

Firstly a new mathematical model for a parallel machines scheduling problem with pre-emptive jobs in a JIT environment, which minimizes the total tardiness-earliness penalties. Then it is linearized with the nonlinear programming model.

A non-pre-emptive parallel machine scheduling problem is considered with N jobs on M parallel identical machines. Let, associated with each job be i, i = 1, . . . , N, are several parameters, let Pi, the processing time for job i; Dic, the due date for job i ; β, the tardiness cost per unit time if job i completes processing after Dic ; and earliness costs as Ei = max(0, Dis- Si) ; Si where is the start time of job i ;

Thus Dis=Dic-Pi+1 is the ideal start time for job i (that is the target start time); and αi , the earliness cost per unit time if job i starts processing before Dis. It is assumed that the processing times, start times and due dates are,ofcourse, integers. The following assumptions are considered in the presented model:

1. Processing times for all jobs are deterministic.
2. No job can be processed on more than one machine at a time and any machine can process any job.
3. Each machine can process only one job at a time and Pre-emption of jobs is possible.
4. All machines are identical and a job is processed by any free machine.
5. Completing jobs earlier than due dates is impossible.
6. Transportation time between machines is neglected.
7. Work-in-process inventory is considered and its associated costs are negligible.
8. Machine setup time is negligible and Machines are available throughout the scheduling period (i.e., no breakdown).

NOTATIONS SUBSCRIPTS

N= Number of jobs
J =Number of positions
M =Number of machines
i Index for job (i=1,2,…,N)
j Index for position (j=1, 2,…,J)
m Index for machine (m=1, 2,…,M)

INPUT PARAMETERS

Pi= Processing time of job i
D_i^c = Ideal completion time (or due-date) of job i
α_i= Unit earliness penalty of job i
$\beta_{i=}$ Unit tardiness penalty of job i
A= An arbitrary big positive number

DECISION VARIABLES

C_i =Completion time of job i
D_i^s= Ideal start time for job i
Ximj= 1 if job i on machine m in position j; otherwise, it is zero.
E_i= Earliness of job i T_i= Tardiness of job i
Si=Starting time of job i

MATHEMATICAL MODELLING

$min \sum_{i}^{N} \alpha_i E_i + \beta_i T_i$ [1] Subject to:

$\sum_{m=1}^{M} \sum_{j=1}^{J} X_{imj} = P_i \quad \forall i;$ [2]
$\sum_{i=1}^{N} X_{imj} \leq 1 \quad \forall m, j;$ [3]
$\sum_{m=1}^{M} X_{imj} \leq 1 \quad \forall i, j;$ [4]
$T_i \geq C_i - D_i^c \quad \forall i;$ [5]
$E_i \geq D_i^s - S_i \quad \forall i;$ [6]
$C_i = max_m[max_j(j \times X_{imj})] \quad \forall i;$ [7]
$S_i = min_m[min_j\{j + A(1 - X_{imj})\}] \quad \forall i;$ [8]
$X_{imj} \in \{0,1\} \quad \forall i, m, j;$ [9]
$T_i, E_i \quad Y \quad \forall i;$ [10]

The objective is to minimize the total weighted earliness and tardiness cost for all jobs. The constraints ensure that jobs start at or after their respective ready times and that jobs do not overlap. Equality (2) guarantees that the number of positions of all machines in which job *i* is processed is equal to the processing time of job *i*. Inequality (3) necessitates that in position *j* on machine *m* only one job can be processed and Inequality (4) ensure that job *i* in position *j* only one machine can be processed. The tardiness and earliness of each job are calculated by Constraints (5) and (6). Equation (7) and (8) presents the completion time and start time of each job. Constraints (9) and (10) provide the logical binary and non-negativity integer necessities for the decision variables.

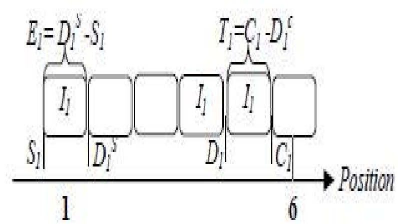

Figure1. Earliness and Tardiness cost

Figure shows an example to illustrate the calculation way of earliness and tardiness in the first component of objective function and related constraints (4) and (5). As we can see, the completion time of job 1 (C_1) happens after its due date (D_1^c). As a result, tardiness of job 1 happens and its value is equal to $T_1 = C_1 - D_c^1$. Also, the starting time of job 1 (S_1) happens before its ideal starting time (D_1^s). Therefore, earliness of job 1 happens and its value is equal to $E_1 = D_1^s - S_1$. The cost resulted from E/T is obtained by product unitary E/T penalty and the related E/T quantities.

GENERAL ENVIRONMENT OF THE INDUSTRY

In Industry of Omax Automovers there are various press machines which are assembled parallel way for different operation are done by these machines. The spacing is sufficient for the work .

Figure 2.Press Machines in Industry

IV. RESULTS AND DISCUSSION

The study considers four different machines for the purpose of analysis, whose objective is to minimize the total weighted earliness and tardiness cost for operation. The earliness and tardiness for the machines i.e Machine 1, Machine 2, Machine 3, and Machine 4 are recorded in a table and firstly compared with standard ideal values.

The punching operation in machine no-1 has different stages of working . The readings are taken based on images and video shoot of running machines and presented in table. The values of tardiness and early start are presented with E/T ratios in Table 1 as samples

Figure3. Working Sample on Machine 1 (Sample)

Similarly, machine 2 is a Double die bending operation machine , which is considered for the study. Different stages of working and their readings are taken by a video shoot of running machines and snaps

In machine 3 Notching operation is done and machine 4 is used for bending operation also recorded, for different stages of working the readings taken by a video shoot of running machines and snaps of camera sample figure given below in Fig 4: Table 2

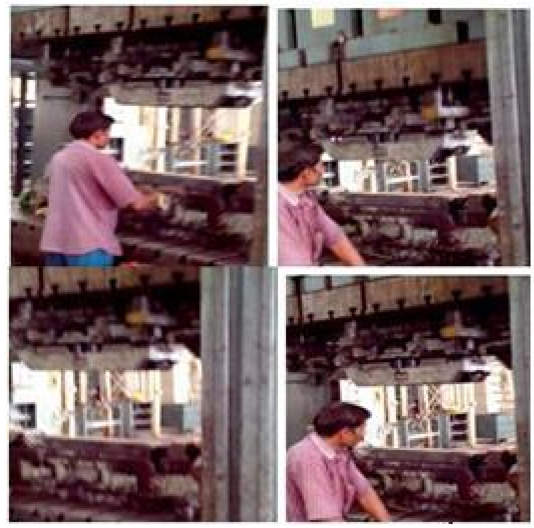

Figure4. Working on Machine 4 (Sample)

Table No.1 Readings and calculation of Machine1

Machine No.-1								
JOB No.	Starting time	Finish time	Ideal Start time	Ideal completion time	Earliness	Tardiness	Ratio E/T	
1	0	9	0	10	0	-1	0	
2	10	21	10	20	0	1	0	
3	22	31	20	30	-2	1	-2	
4	33	42	30	40	-3	2	-1.5	
5	42	46	40	50	-2	-4	0.5	
6	50	58	50	60	0	-2	0	
7	60	69	60	70	0	-1	0	
8	72	78	70	80	-2	-2	1	max
9	79	85	80	90	1	-5	-0.2	
10	90	98	90	100	0	-2	0	

Table 2 Readings and calculation of Machine no-3

Machine No.-3								
JOB No.	Starting time	Finish time	Ideal Start time	Ideal completion time	Earliness	Tardiness	Ratio E/T	
1	0	7	0	8	0	-1	0	
2	8	15	8	16	0	-1	0	
3	16	22	16	24	0	-2	0	
4	24	30	24	32	0	-2	0	
5	35	42	32	40	-3	2	-1.5	
6	40	46	40	48	0	-2	0	
7	48	54	48	56	0	-2	0	
8	55	62	56	64	1	-2	-0.5	
9	63	71	64	72	1	-1	-1	
10	73	78	72	80	-1	-2	0.5	max

Various graphs are plotted to see the time gap and the curve being traced by earliness and tardiness. The E/T gives the average necessary time for each cutting so that the maximum value of E/T can decrease the tardiness on the machines so maximum value can give the better relation for increasing the productivity. The maximum value of E/T ratio is 1,1,0.5, 0.4 for the machines 1, machine 2, machine 3, machine 4 respectively for various jobs. Various plots show the magnitude of time being used. Besides that the %age comparison of time gap for all the jobs is also presented for machine 2 and 4 in figure 9 and 11 respectively.

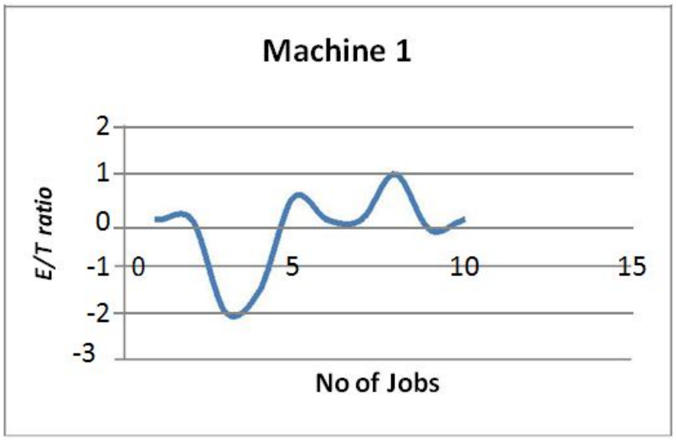

Figure 5: E/T ratio for Machine 1

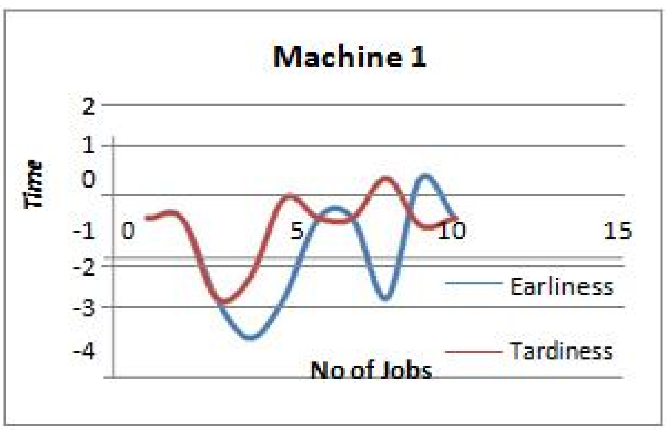

Figure 6; Time gap for machine 1

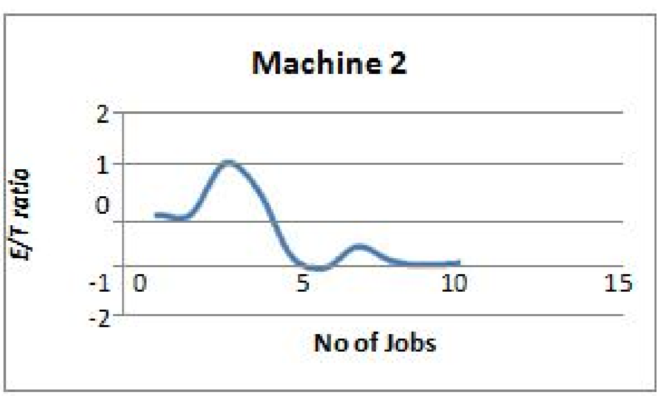

Figure 7: E/T ratio for Machine 2

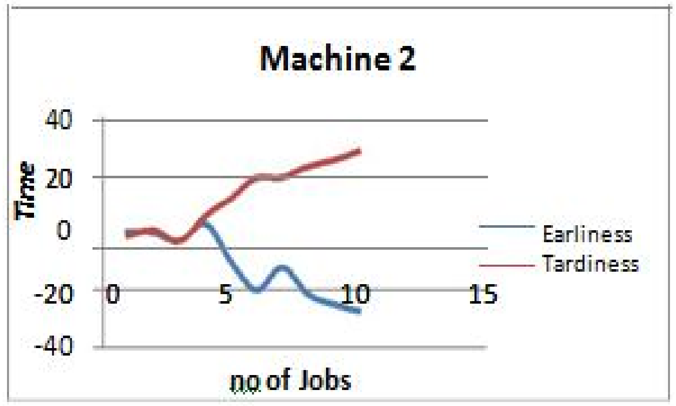

Figure 8 Time gap for machine 2

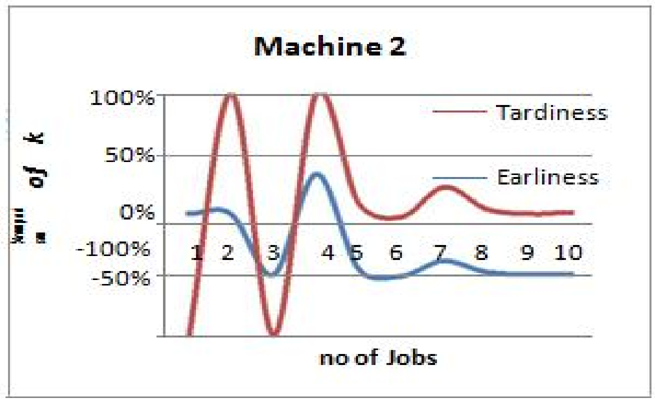

Figure 9; % comparison of work for machine 2

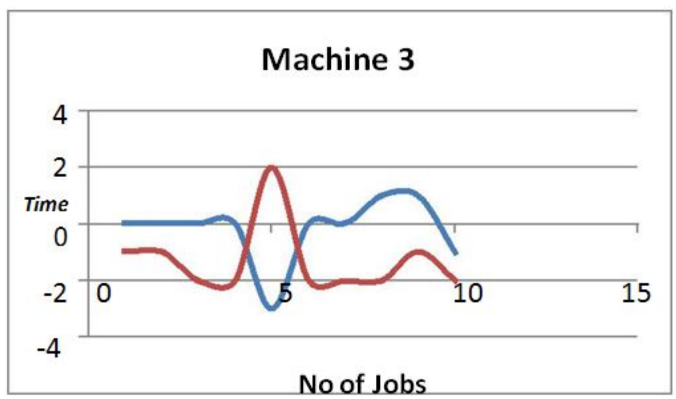

Figure 10; Time gap for machine 3

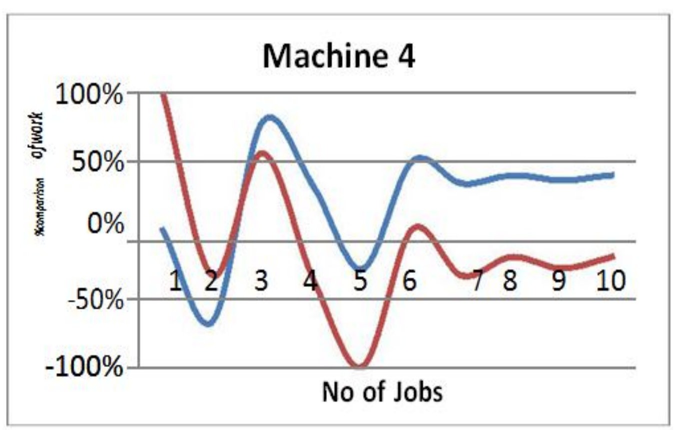

Figure 11; % comparison of work for machine 4

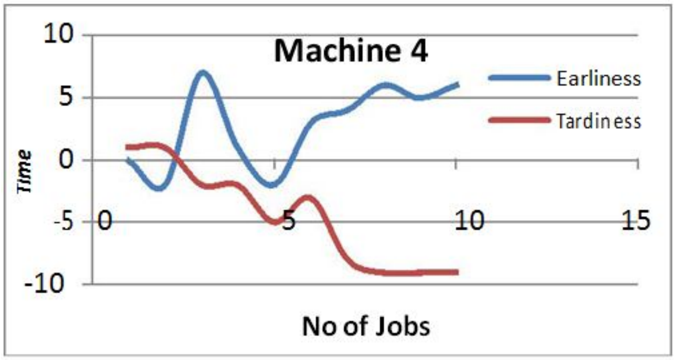

Figure 12; Time gap for machine 3

V. CONCLUSION

A new non-linear programming model for a parallel identical machines scheduling problem, with pre-emptive jobs, in just-in-time (JIT) environment has been represented successfully. The nonlinear formulation of the proposed model was linearized using an innovative procedure. The performance of the model was illustrated by a numerical example. E/T ratio represents the performance measure inside the industry, which also is helpful to change the existing layout of the industry so that productivity can be increased. An attractive future research trend is to investigate the pre-emptive jobs in JIT with parallel uniform or different machines. Also it would be appropriate to consider the problem studied here with the addition of some other assumptions like sequence dependent setup times. It is also interesting to develop heuristics or meta-heuristic algorithms to solve the proposed model for large-sized problems. Machine 2 and machne 4 in figure 9 and figure 11 show quite good nature of time gap of %age of work as it moves from job 1 to 10. The E/T ratio almost tends to 0 as is depicted in figure 5 and figure7. This is because when a machine and labour attain a rhythm of work it automatically reduces the time of work.

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