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Use of Project Management and Lean Manufacturing Tools in SMEs: A Case Study

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Abstract: ***In this article, we have implemented Lean tools on a project, as a result of the competitive environment in small enterprises, it's obligatory to complete projects in time. Effective project management is necessary to reduce the lead time of the project and to complete a project without delay with available resources, in this study we have used project management technique like CPM and PERT to find the critical path and the buffering time of the project. We have also implemented lean tools such as Kanban, Multi-Activity Chart, PPC to reduce the lean waste. At the end of the study the result will be analyzed, In this study tools like Gantt chart, Manual dot entry, Fever Chart are used to track the progress of the project.***
Keywords: Lean Manufacturing, Project Management, CPM, PERT, SME.

I. INTRODUCTION

In the last years so called SME, small and medium sized enterprises, moved into the focus of many authors in their scientific work. The reason for this trend is based on the fact, that micro, small, and medium-sized enterprises are numerous and usually the backbone of the economy.[1] As lean reduces the cost of the production along with increasing the quality hence improves profit. In a perfect world, organizations have come to realization that when waste are reduced through Lean Manufacturing there is increase in overall profit and quality of the product. Goal of any SME is mainly to value customer, to have perfect process.

The systematic implementation of Lean Manufacturing in SMEs will yield huge benefits such as quality improvement, cycle time reduction and good customer responsiveness. [2] The best practices which can be implemented are use of Kanban card for information sharing between supplier and customer. Completing a project in SME on time and within budget is not an easy task. In spite of advances in the field of project management today, most projects in SME today face cost and time over-runs which increases with the increase in complexity of the project involved. A large number of factors contribute to delays. This is because some project activities are critical in the sense that delays the overall project completion time. Therefore proper planning and scheduling of project is important to overcome the delays.[3]

A project can defined as a set of activities performed in a certain sequence determined technologically, in our case the project is a press tool die.

The two approaches that have been proved for planning, scheduling and finding the critical path and the buffering time of the project are Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT). This activities help to evaluate the start time and the earliest finish time, slack time, define critical path of the project which helps in evaluate the overall project duration.

The analysis used in both techniques is very similar. The major difference is that. In CPM activity times are assumed proportional to the amount of resources allocated to them, and by changing the level of resources the activity times and the project completion time can be varied. Thus CPM assumes prior experience with similar projects from which the relationships between resources and job times are available. On the other hand, PERT incorporates uncertainties in activity times in its analysis. It determines the probabilities of completing various stages of the project by specified deadlines. It also intends the expected time to complete the project. An important and extremely useful by product of PERT analysis is its identification of various bottlenecks in a project.

II. OBJECTIVES

Objectives of this study are to:

1) Implement and develop a model of lean technique for industry
2) Solving problem of industry by implanting Project Management and lean tools
3) Reduce defects
4) Reduce lead time of the project
5) Improve labour productivity
6) Increase output
7) Effective Utilization of resources.

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III. SURVEY

What were the problems for the Growth of SME?

1) High project lead time of 22 days
2) No awareness of concept of Elimination of Waste
3) No formal training system on Lean
4) No scientific production planning
5) Demand is more than Supply.

IV.METHODOLOGY

Target: To reduce production time from 22 days to 18 days.

Preceding activities

1) Study all the processes.
2) To find alternate solutions.
3) Problems faced while production.
4) Finding key activity responsible for time loss.

A. CPM and PERT

In this study, CPM and PERT, which are project management techniques, will be used to improve lead time of the project.

CPM (Critical Path Method) and PERT (Programme Evaluation and Review Technique) are the scheduling techniques which are used to plan, schedule, and control a project consisting of number of interrelated activities. These techniques provide a frame which defines the job to be done, integrates them in a logical sequence and provides a system of control over the progress of the plan. [4]

The PERT technique is a method of minimizing trouble spots, programed bottlenecks, delays and interruptions by determining critical activities before they occur so that various activities in the project can be coordinated.

$$\text{Expected Time } (T_e) = \frac{T_o + 4\,T_m + T_p}{6}$$

Where,

T_o is the Optimistic time,

T_m is the most likely time,

T_p is the Pessimistic time.

B. Manual Dot Entry

Manual dot entry is a tool used to track the progress of the project. In which the blank box represents that the work has not been started, single dot represents that the work is in progress, and two dots in the box represent that the work is completed. Use of the manual dot entry is easy and it easily shows the progress of the project.

C. Multi Activity Chart

Multiple Activity Charts (or Multi-Activity Charts) are a very useful tool for understanding the flow of work in a cyclical process and as a consequence understanding which resource is controlling the overall progress of the work. The tool can be used to model different scenarios to determine the optimum mix of resources for the work. The example below is based on using a tower crane to lift concrete from the street to a high floor for placing. Each resource is represented by a column; time is on the vertical axis.[5]

D. Kanban System

Kanban system is one of the tools under lean manufacturing system that can achieve minimum inventory at any one time. Kanban system provides many advantages in managing operations and business in the organization. Using Kanban system is a strategic operational decision to be used in the production lines. It helps to improve the company's productivity and at the same time minimize waste in production

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V. RESULTS AND ANALYSES

A. *CPM Before Implementation*

The Figure shows the processes to manufacture a blanking press tool die. In which spacer plate takes the maximum time to get manufactured. Spacer plate manufacturing being the critical path of the project taking time of 22 days.

Table I

Description	Activity	Predecessor	Start Date	End Date	Duration	Path
VD19008-Bottom Plate-Design	A	-	08-Jan-19	12-Jan-19	4	te1
VD19008-Bottom Plate-RM Purchase	B	A	12-Jan-19	14-Jan-19	3	te12
VD19008-Bottom Plate-Turning/Milling	C	B	13-Jan-19	13-Jan-19	1	te13
VD19008-Bottom Plate-Grinding	D	C	13-Jan-19	16-Jan-19	4	te14
VD19008-Bottom Plate-DRO/Jig Boring	E	D	16-Jan-19	19-Jan-19	3	te15
VD19008-Bottom Plate-Verification	F	E	19-Jan-19	19-Jan-19	1	te16
VD19008-Die Plate-Design	G	-	08-Jan-19	11-Jan-19	4	te1
VD19008-Die Plate-RM Purchase	H	G	11-Jan-19	16-Jan-19	6	te22
VD19008-Die Plate-Turning/Milling	I	H	16-Jan-19	16-Jan-19	1	te23
VD19008-Die Plate-Grinding	J	I	16-Jan-19	16-Jan-19	1	te24
VD19008-Die Plate-HT	K	J	17-Jan-19	18-Jan-19	2	te25
VD19008-Die Plate-Spl. M/c	L	K	19-Jan-19	19-Jan-19	1	te26
VD19008-Die Plate-Verification	M	L	19-Jan-19	19-Jan-19	1	te27
VD19008-Pad-Design	N	-	08-Jan-19	11-Jan-19	4	te1
VD19008-Pad-RM Purchase	O	N	11-Jan-19	16-Jan-19	6	te32
VD19008-Pad-Turning/Milling	P	O	16-Jan-19	16-Jan-19	1	te33
VD19008-Pad-Grinding	Q	P	17-Jan-19	17-Jan-19	1	te34
VD19008-Pad-HT	R	Q	17-Jan-19	19-Jan-19	2	te35
VD19008-Pad-Spl. M/c	S	R	20-Jan-19	20-Jan-19	1	te36
VD19008-Pad-Verification	T	S	20-Jan-19	20-Jan-19	1	te37
VD19008-Spacer plate-Design	U	-	08-Jan-19	11-Jan-19	4	te1
VD19008-Spacer plate-RM Purchase	V	U	13-Jan-19	18-Jan-19	6	te42
VD19008-Spacer plate-Turning/Milling	W	V	18-Jan-19	18-Jan-19	1	te43
VD19008-Spacer plate-Grinding	X	W	20-Jan-19	22-Jan-19	3	te44
VD19008-Spacer plate-DRO/Jig Boring	Y	X	22-Jan-19	22-Jan-19	1	te45
VD19008-Spacer plate-Spl. M/c	Z	Y	22-Jan-19	23-Jan-19	2	te46
VD19008-Spacer plate-HT	AA	Z	24-Jan-19	26-Jan-19	2	te47
VD19008-Spacer plate-Verification	AB	AA	26-Jan-19	26-Jan-19	1	te48
VD19008-Punch-Design	AC	-	08-Jan-19	12-Jan-19	4	te1
VD19008-Punch-RM Purchase	AD	AC	12-Jan-19	17-Jan-19	6	te52
VD19008-Punch-Turning/Milling	AE	AD	17-Jan-19	17-Jan-19	1	te53
VD19008-Punch-Grinding	AF	AE	17-Jan-19	17-Jan-19	1	te54
VD19008-Punch-HT	AG	AF	18-Jan-19	20-Jan-19	2	te55
VD19008-Punch-Spl. M/c	AH	AG	21-Jan-19	21-Jan-19	1	te56
VD19008-Punch-Verification	AI	AH	21-Jan-19	21-Jan-19	1	te57
VD19008-Top Plate-Design	AJ	-	08-Jan-19	12-Jan-19	4	te1
VD19008-Top Plate-RM Purchase	AK	AJ	12-Jan-19	17-Jan-19	6	te62
VD19008-Top Plate-Turning/Milling	AL	AK	17-Jan-19	17-Jan-19	1	te63
VD19008-Top Plate-Grinding	AM	AL	17-Jan-19	19-Jan-19	2	te64
VD19008-Top Plate-DRO/Jig Boring	AN	AM	20-Jan-19	20-Jan-19	1	te65
VD19008-Top Plate-Verification	AO	AN	20-Jan-19	20-Jan-19	1	te66
VD19008-Die-Validation	AP	F,L,T,AB,AI,AO	27-Jan-19	27-Jan-19	1	te2
VD19008-Die-Dispatch	AQ	AP	28-Jan-19	28-Jan-19	1	te3
					101	

Fig. I

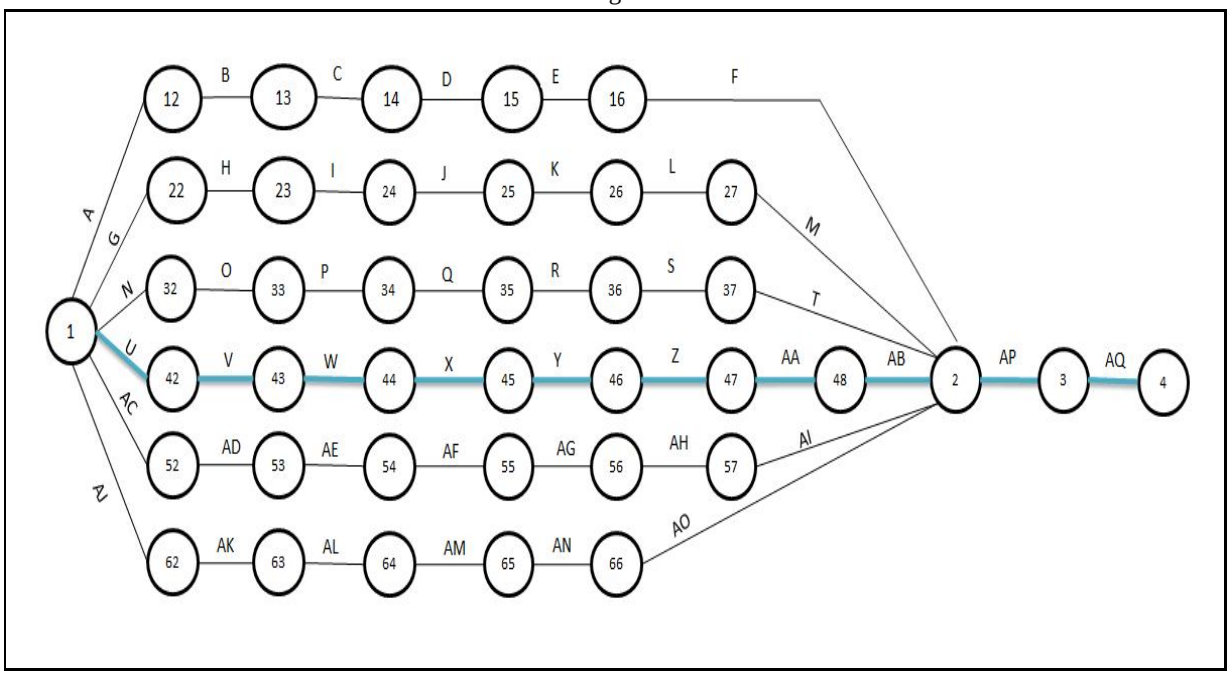


Table III

Path	Lead Time	Float
A-B-C-D-E-F-AP-AQ	18	4
G-H-I-J-K-L-M-AP-AQ	18	4
N-O-P-Q-R-S-T-AP-AQ	18	4
U-V-W-X-Y-Z-AA-AB-AP-AQ	22	0
AC-AD-AE-AF-AG-AH-AI-AP-AQ	18	4
AJ-AK-AL-AM-AN-AO-AP-AQ	17	5

Critical Path= 22 DAYS

This data shows that the path U-V-W-X-Y-Z-AA-AB-AP-AQ has maximum lead time and it is the critical path. From table it is seen that design and raw material purchase are common activities in all the processes and in all kind of manufacturing, as there is no constant and mirror production the main focus of the project should be on design and raw material purchase. As design phase is taking 4 days to make complete design and raw material purchase is taking 3 to 6 days these paths should be optimized and lead time should be reduced.

B. CPM After Implementation

As the design and Raw material procurement was common in all the process. So we focused on reducing the time in material procurement by first designing the assembly design and producing the bill of material in 1 day so that the material can be ordered earlier. Due to which the detail design and material procurement is going simultaneously which reduces the lead time. The other method used to reduce the lead time is finding alternate vendors who can complete the processes within minimum time. The below figure shows the CPM after implementing the above points.

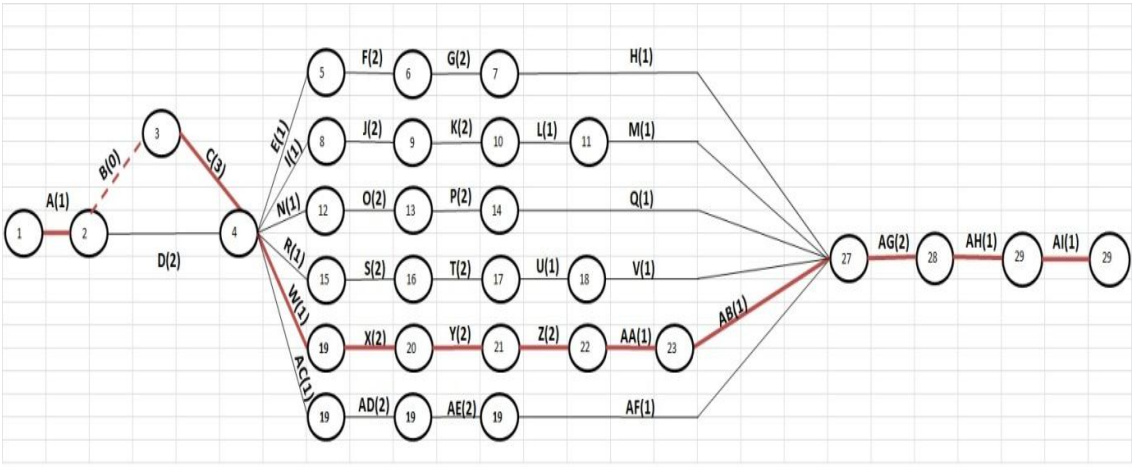
Table IIIII

Description	Activity	Predecessor	Start Date	End Date	Duration
VD19021-Assembly Design	A	-	02-Feb-19	02-Feb-19	1
VD19021-RM Order	B	A	03-Feb-19	03-Feb-19	0
VD19021-RM Purchased	C	B	03-Feb-19	05-Feb-19	3
VD19021- Detail Design	D	A	03-Feb-19	04-Feb-19	2
VD19021-Bottom Plate-Turning/Milling	E	C,D	05-Feb-19	05-Feb-19	1
VD19021-Bottom Plate-Grinding	F	E	06-Feb-19	07-Feb-19	2
VD19021-Bottom Plate-DRO/Jig Boring	G	F	08-Feb-19	09-Feb-19	2
VD19021-Bottom Plate-Verification	H	G	10-Feb-19	10-Feb-19	1
VD19021-Die Plate-Turning/Milling	I	C,D	05-Feb-19	05-Feb-19	1
VD19021-Die Plate-Grinding	J	I	06-Feb-19	07-Feb-19	2
VD19021-Die Plate-HT	K	J	08-Feb-19	09-Feb-19	2
VD19021-Die Plate-Spl. M/c (WC)	L	K	10-Feb-19	10-Feb-19	1
VD19021-Die Plate-Verification	M	L	11-Feb-19	11-Feb-19	1
VD19021-Punch holder-Turning/Milling	N	C,D	05-Feb-19	05-Feb-19	1
VD19021-Punch holder-Grinding	O	N	06-Feb-19	07-Feb-19	2
VD19021-Punch holder-DRO	P	O	08-Feb-19	09-Feb-19	2
VD19021-Punch holder-Verification	Q	P	10-Feb-19	10-Feb-19	1
VD19021-Stipper plate-Turning/Milling	R	C,D	05-Feb-19	05-Feb-19	1
VD19021-Stipper plate-Grinding	S	R	06-Feb-19	07-Feb-19	2
VD19021-Stipper plate-DRO/Jig Boring	T	S	08-Feb-19	09-Feb-19	2
VD19021-Stipper plate-Spl. M/c (WC)	U	T	10-Feb-19	10-Feb-19	1
VD19021-Stipper plate-Verification	V	U	11-Feb-19	11-Feb-19	1
VD19021-Punch-Turning/Milling	W	C,D	05-Feb-19	05-Feb-19	1
VD19021-Punch-Grinding	X	W	06-Feb-19	07-Feb-19	2
VD19021-Punch-DRO/Jig Boring	Y	X	08-Feb-19	09-Feb-19	2
VD19021-Punch- HT	Z	Y	10-Feb-19	11-Feb-19	2
VD19021-Punch-Spl. M/c (WC)	AA	Z	12-Feb-19	12-Feb-19	1
VD19021-Punch-Verification	AB	AA	13-Feb-19	13-Feb-19	1
VD19021-Top Plate-Turning/Milling	AC	C,D	05-Feb-19	05-Feb-19	1
VD19021-Top Plate-Grinding	AD	AC	06-Feb-19	07-Feb-19	2
VD19021-Top Plate-DRO/Jig Boring	AE	AD	08-Feb-19	09-Feb-19	2
VD19021-Top Plate-Verification	AF	AE	10-Feb-19	10-Feb-19	1
VD19021-Die-Validation	AG	H,M,Q,V,AB,AF	14-Feb-19	15-Feb-19	2
VD19021- Trial & Rework	AH	AH	16-Feb-19	16-Feb-19	1
VD19021-Die-Dispatch	AI	AH	17-Feb-19	17-Feb-19	1
					51

Table IVV

Path	Est. Path Lead Time
A-B-C-E-F-G-H-AG-AH-AI	14
A-B-C-I-J-K-L-M-AG-AH-AI	15
A-B-C-N-O-P-Q-AG-AH-AI	14
A-B-C-R-S-T-U-V-AG-AH-AI	15
A-B-C-W-X-Y-Z-AA-AB-AG-AH-AI	17
A-B-C-AC-AD-AE-AF-AG-AH-AI	14
A-D-E-F-G-H-AG-AH-AI	13
A-D-I-J-K-L-M-AG-AH-AI	14
A-D-N-O-P-Q-AG-AH-AI	13
A-D-R-S-T-U-V-AG-AH-AI	14
A-D-W-X-Y-I-AA-AB-AG-AH-AI	16
A-D-AC-AD-AE-AF-AG-AH-AI	13

Fig. II



It is observed from the data that after implementation critical path reduces from 22 days to 17 days by optimizing time required for design and material purchase. To reduce time we have followed following procedure.

1) When customer actually places an order then only assembly drawing should be prepared. It should take nearly one day.
2) On the same day B.O.M. should be prepared and sent to material supplier.
3) Supplier takes minimum 3 to 4 days to send material.
4) In period of these 3 to 4 days detail drawing of die should be prepared. In this way critical path is reduced from 22 days to 17 days.

C. Programme Evaluation and Review Technique (PERT)

In this PERT we find the trouble spots and the bottleneck activies, we found the buffering time to be 0.8 which is equivalent to 1 day. So buffering time of 1 day should be considered before giving the expected finish time of the project, i.e. the expected time to finish the project is 18 days.

Table V

Description	Activity	Predecessor	t0	tm	tp	te	sd	sd2
VD19021-Assembly Design	A	-	1	1	2	1.17	0.17	0.028
VD19021-RM Order	B	A	0	0	1	0.17	0.17	0.028
VD19021-RM Purchased	C	B	3	3	4	3.17	0.17	0.028
VD19021- Detail Design	D	A	2	2	3	2.17	0.17	0.028
VD19021-Bottom Plate-Turning/Milling	E	C,D	1	1	2	1.17	0.17	0.028
VD19021-Bottom Plate-Grinding	F	E	2	2	3	2.17	0.17	0.028
VD19021-Bottom Plate-DRO/Jig Boring	G	F	2	2	3	2.17	0.17	0.028
VD19021-Bottom Plate-Verification	H	G	1	1	2	1.17	0.17	0.028
VD19021-Die Plate-Turning/Milling	I	C,D	1	1	2	1.17	0.17	0.028
VD19021-Die Plate-Grinding	J	I	2	2	3	2.17	0.17	0.028
VD19021-Die Plate-HT	K	J	2	2	4	2.33	0.33	0.111
VD19021-Die Plate-Spl. M/c (WC)	L	K	1	1	2	1.17	0.17	0.028
VD19021-Die Plate-Verification	M	L	1	1	2	1.17	0.17	0.028
VD19021-Punch holder-Turning/Milling	N	C,D	1	1	2	1.17	0.17	0.028
VD19021-Punch holder-Grinding	O	N	2	2	3	2.17	0.17	0.028
VD19021-Punch holder-DRO	P	O	2	2	3	2.17	0.17	0.028
VD19021-Punch holder-Verification	Q	P	1	1	2	1.17	0.17	0.028
VD19021-Stipper plate-Turning/Milling	R	C,D	1	1	2	1.17	0.17	0.028
VD19021-Stipper plate-Grinding	S	R	2	2	3	2.17	0.17	0.028
VD19021-Stipper plate-DRO/Jig Boring	T	S	2	2	3	2.17	0.17	0.028
VD19021-Stipper plate-Spl. M/c (WC)	U	T	1	1	2	1.17	0.17	0.028
VD19021-Stipper plate-Verification	V	U	1	1	2	1.17	0.17	0.028
VD19021-Punch-Turning/Milling	W	C,D	1	1	2	1.17	0.17	0.028
VD19021-Punch-Grinding	X	W	1	2	3	2.00	0.33	0.111
VD19021-Punch-DRO/Jig Boring	Y	X	1	2	3	2.00	0.33	0.111
VD19021-Punch- HT	Z	Y	2	2	4	2.33	0.33	0.111
VD19021-Punch-Spl. M/c (WC)	AA	Z	1	1	2	1.17	0.17	0.028
VD19021-Punch-Verification	AB	AA	1	1	2	1.17	0.17	0.028
VD19021-Top Plate-Turning/Milling	AC	C,D	1	1	2	1.17	0.17	0.028
VD19021-Top Plate-Grinding	AD	AC	2	2	3	2.17	0.17	0.028
VD19021-Top Plate-DRO/Jig Boring	AE	AD	2	2	3	2.17	0.17	0.028
VD19021-Top Plate-Verification	AF	AE	1	1	2	1.17	0.17	0.028
VD19021-Die-Validation	AG	H,M,Q,V,AB,AF	1	2	3	2.00	0.33	0.111
VD19021- Trial & Rework	AH	AH	1	1	2	1.17	0.17	0.028
VD19021-Die-Dispatch	AI	AH	1	1	2	1.17	0.17	0.028

D. Manual Dot Entry

The Table VI shows the data obtained from the Manual Dot Entry, in which all the dots show that the project is completed. The data obtained is plotted on the graph in Fig. III.

Fig. III

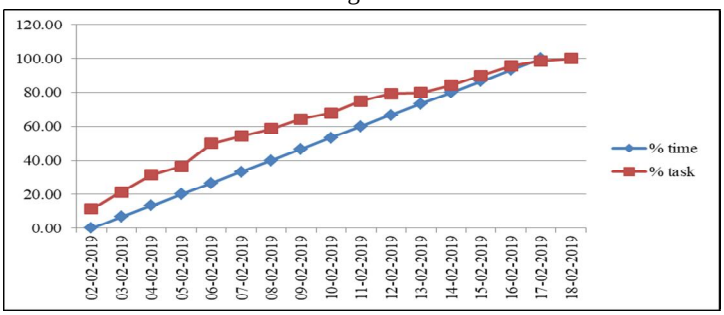


Table VI

Process Monitoring Chart

Die Name: Blanking Die

Part \ Process	Assembly Design	RM Order	Design	RM Purchased	Milling	Grinding	DRO	HT	Wire Cut	Verification	Validation	Trail	Change	Dispatch
Bottom Plate														
Die Plate														
Punch Holder														
Stipper plate														
Punch														
Top Plate														
Die Set Assly														
Final Assly														

E. Multiple activity Chart

The Table VII shows the planning done to allocate the jobs on a particular machine. Which helps the forecasting of production plan easily, Quick response to customer for delivery, Production loss is reduced as pre planning is done and Machine load is easily visible.

Table VVI

MACHINE TIME	VMC 1	VMC 2	VMC 3	VMC 4	VMC 5
07:00 - 08:00	CONT.	CARRIER 60 NOS	KTD STIPPER	KTD LOWER INSERT(2)	JP TRIMMING DIE
08:00 - 09:00	RESTING BLOCK J2				
09:00 - 10:00					
10:00 - 11:00	GPD PUNCH TOP			MOUNT TUBE TRIMMING DIE	K4 TRIMMING DIE QTY 3, JG TRIMMING DIE QTY 1, TOP & BOTTOM SIDE
11:00 - 12:00					
12:00 - 13:00					
13:00 - 14:00					
14:00 - 15:00					
15:00 - 16:00	GPD PUNCH BOTTOM			AUTO TRIMMING DIE	
16:00 - 17:00					
17:00 - 18:00			TOOL TECH DPN PLUG POINT		
18:00 - 19:00					

F. Kanban

Kanban system is a tool which comes under lean manufacturing. It helps in managing the operations of the job. We used the Kanban chart to as the part production report which included the part name and detail of the particular job. The kanban card easily showed the processes on the job and which machine and operator is allotted to do the job. It also showed the start and end time of the process and the total time needed to complete the job. In the other table it showed the characteristics of the job i.e. length, width and height of the job. It showed the tolerance of the job. Due to the use of this card it is easy to do the processes according to the plan and would manufacture defect free product. Here, the kanban card not only shows the quantity of the product and helps to control the inventory but also the characteristics which is an added benefit.

Fig. IV

KANBAN CARD

Part Production Report

Part Name: VD19048 – Blanking Die – Housing. Detail No: VD19048

Sr. No.	Process Name	Machine	Operator	Start		End		Duration
				Date	Time	Date	Time	
1	Milling	VTS	Kasale.	12/03	10:15	12/03	11:30	1:15
2	Grinding	SANKET	—	12/03		13/03		
3	VMC	VTS	Jagtap	13/03	22:50	14/03	3:05	3:15
4	DRO	S.Ganesh.		14/03	9:30	13/03	10:00	
5								
6								

Tool (Part) Verification Report

Sr. No.	Characteristicks	Dimension	Tollarance	Inspection Method / Instrument		Actual	Remark
1	Length.	420	± 1mm	V.C		421.3	
2	Width	255	± 1mm	V.C		255.6	
3	Height	50	±0.5mm	V.C		49.5	
4	Depth	20 mm	±0.5mm	V.C		20.00	
5	Face Hole Counter	13X19 mm	±0.5mm	V.C		13X19	
6	Dowel hole	12.mm	±0.01mm	D.V.C.		OK	
7	Dowel hole	10	±0.01mm	D.V.C		OK	
8	Tapping hole.	M10	±0.1mm	D.V.C.		OK	
9	Tapping	M10	±0.01mm			OK	
10							
11							
12							
13							
14							
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VI. CONCLUSIONS

This Study addressed the implementation of lean and project management tools on manufacturing of press tool dies. Using CPM where our project took actual 22 days to complete, by crashing and applying lean tools to the project without incurring additional cost and with the same resources can be completed within 18 days. This is 4.5% decrease in project duration and productivity increased by 18.18%. Reduced lead time ensures fast delivery and satisfaction to the customer. Increase in productivity improves the cash flow so there is a reduction in cost. Implementation of project management and lean tools to all the projects can increase the turn over by 15-20% in the same resources. From the results we thus conclude that the schedule proposed by reduces lead time of the project as compared to the actual time taken by the project and paves the way for use of CPM scheduling for Press tool Die.

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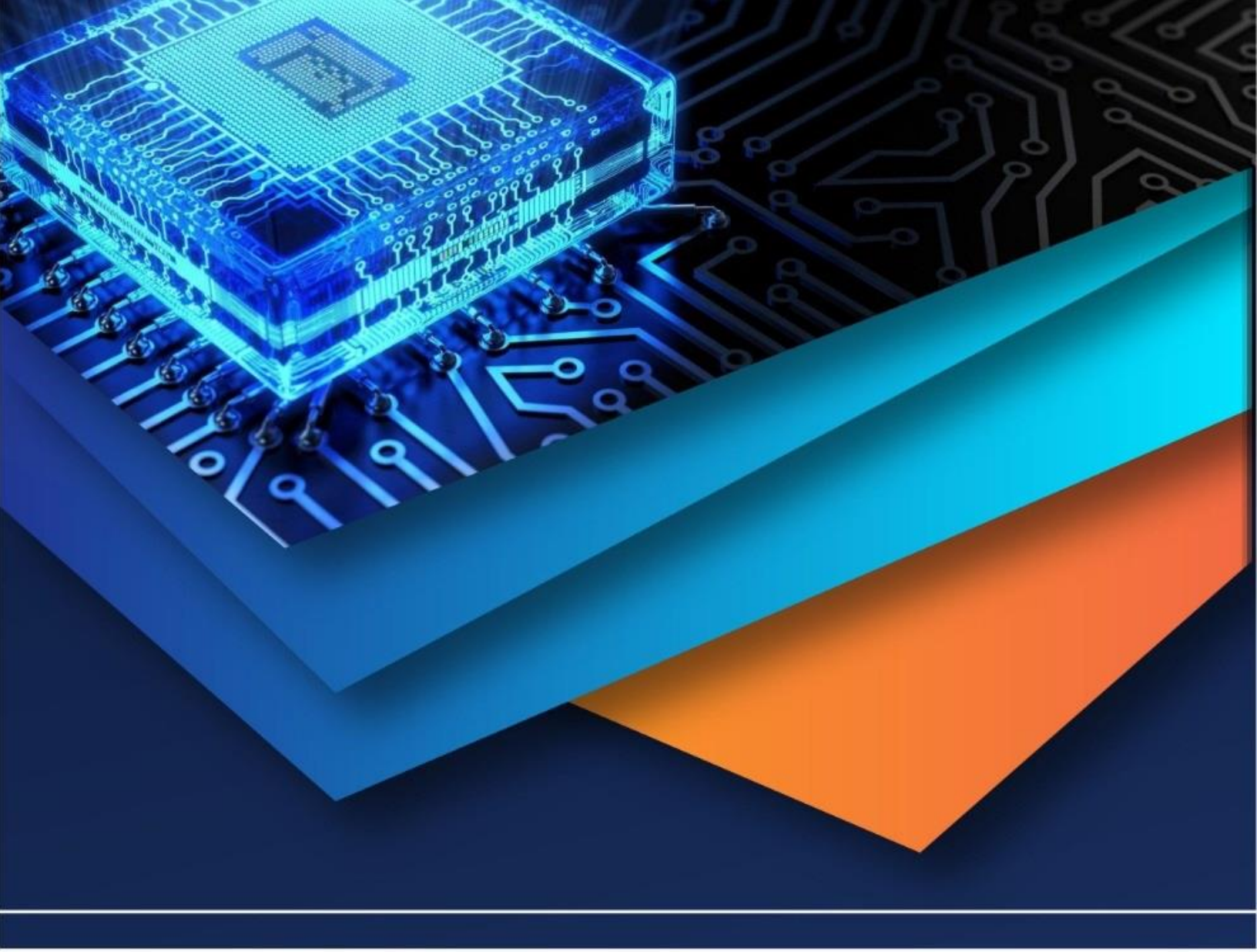

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