FEASIBILITY STUDY OF PROPOSED MANUFACTURING LAYOUT RE-DESIGN TO IMPROVE PROCESS CAPACITY AND REDUCE CYCLE TIME OF A DOWNSTREAM OPERATION OF PRODUCT A

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Abstract

Lean Six Sigma tools and methodologies are widely used in today's work environments. The use of a Lean Six Sigma approach provides organizations more flexibility and efficiency to improve their competitiveness. At the present time, with the high market changes environment, is crucial for industries to improve their processes to fulfill their customers' needs. One key area for Manufacturing Operations is their production layout design. This article will discuss the use of DMADV (Define, Measure, Analyze, Design, & Verify) methodology to complete, and evaluate a feasibility study of a manufacturing layout re-design proposal. The project concluded that the proposed manufacturing layout re-design will represent a reduction of approximately 29-36% of the current process cycle time and represent a potential increase in production capacity of approximately 15-25%. These benefits identified during the feasibility study activities can lead to improve the company's competitiveness and obtain financial benefits.

Introduction

Manufacturing industries and operations are facing more challenges to adapt to the constantly changing market requirements, customer demands and needs. Organizations must evaluate and apply different quality concepts, tools, and methodologies to maintain their competitiveness, provide quality products to their customer, and earn profits. Lean Six Sigma is one of those operational excellence approaches used in the work environments to adapt and improve organizations, processes, and quality systems.

Background

(D) Define – This stage provides the introduction of the business case and the problem statement definition. A Project Charter, Business Case, SWOT Analysis, and the identification of the Project Objectives are common tools and information used for the define stage.

(M) Measure – This stage provides the methods and data gathering of current state of the studied process. During this step of DMADV, the focus is on describing the methods, data collection plans, and variables that are going to be analyzed to gain a deeper understanding of the process current performance.

(A) Analyze – This stage provides information, data comparison, and evaluation of the current state versus the future state of the project scope. In this stage of the DMADV.

(D) Design – During this stage, the design of new process, products, services, or requirements are developed and tested thru simulations, small scale experiments, or design of experiments.

(V) Verify – This stage will focus on the verification and evaluation of the design proposed during the project.

Problem Statement

The current layout create space constrain between the unit operations used at the beginning and the final steps of the downstream operation of product A. Improvements in the layout design will provide more flexibility and process capacity to fulfill future demand of company products, more weeks or manufacturing windows to implement projects, opportunity for new product introduction, and improve the company operations competitiveness.

Methodology

(D) Define –A Project Charter, and Business Case are the tools that are going to be used for the define stage. The information identified during this step will help to establish and define the project objective and goals.

(M) Measure – This stage will provide the methods and data gathering of current state of the studied process. During this step of DMADV, the focus is on describing the methods, data collection plans, and variables that are going to be analyzed to gain more understanding of the current performance. The different performance and process variable analysis will give a deeper understanding of the requirements to evaluate the manufacturing layout re-design proposal that could fulfill those needs and increase production.

(A) Analyze – After the data gathering process, the analyze stage will provide information, data comparison, and evaluation of the current state versus the future state of the project scope. In this stage of the DMADV, the proposed manufacturing layout re-design proposal will be analyzed to determine if it will fulfill the process requirements.

(D) Design – During this stage, the design of new process, products, services, or requirements are developed and tested thru Manufacturing Schedule Production (MPS) simulations to test the new proposed manufacturing layout.

(V) Verify – This stage will focus on the verification and evaluation of the manufacturing layout re-design proposed during the project and their simulations results. A summary of the feasibility study, results, and the conclusions will be discussed with management to make the business decision if the implementation of the project will be pursued.

Results and Discussion

(D) Define – Project Charter tool was completed during this stage. Improvements in the manufacturing operation layout will prevent space constraint within unit operations and provide more flexibility and process capacity to fulfill future demand of the company products, more weeks or manufacturing windows to implement projects

The following project objectives and goals were defined:

- Complete a feasibility study of a manufacturing layout re-design proposal.
- Reduce process cycle time and increase process capacity.

Project Charter			
Project Title	Feasibility study of proposed manufacturing layout re-design to improve process capacity and reduce cycle time of a Downstream Operation of Product A	Project Manager	Lyanne Aponte Santiago
Start Date	10/01/2022 End Date 02/06/2023	Project Sponsor	Edgar Acevedo
Business Need	The feasibility study will provide data to understand, identify, and recommend changes to the actual manufacturing layout where we can be able to reduce cycle time of the process and increase process capacity. The current layout create space constrain between the unit operations used at the beginning and the final steps of the downstream operation of product A. Improvements in the layout design will provide more flexibility and process capacity to fulfill future demand of company products, more weeks or manufacturing windows to implement projects, opportunity for new product introduction, and improve the company operations competitiveness.		
Project Scope			
In-Scope	Manufacturing Downstream Operation of Product A.	Out- Scope	Other products and manufacturing processes.
Risk and Issues	Time constrain of project implementation, and project cost.		
Financial Impact	Business continuity and improve process capacity.		
Milestones and Deliverables	Feasibility Study Completion, Final Assessments completed, Present Findings to Management		
Goal	Complete the feasibility study and present assessments to management for project approval, funding request and implementation strategy definition during next year 2023.		
Team Members	Manufacturing Staff, Manufacturing Management, Process Owner, System Owner, Quality Representative, Engineering SME, Process Development SME		
Resources Required	External Company for the completion of the feasibility study for the project constructions requirements.		

Figure 1: Project Charter

(M) Measure – meetings with a cross functional team were held to gather information of the current state, and to design and formalize the manufacturing layout re-design proposal.

The current state of the Downstream Operation of Product A includes eight (8) operational units and steps represented by the numbers from one (1) to eight (8), and two (2) manufacturing suites (suite A and suite B), refer to Figure 2.

Currently, two different equipment's are required to execute step 3 and step 7 for the manufacturing of Product A and this two equipment's occupy the same footprint within Manufacturing Suite A; therefore, an equipment movement (swap) is needed creating a constraint to increase production, adding cycle time for equipment movement and limitation to execute parallel preparatory activities.

Results and Discussion

The manufacturing layout re-design proposal consists in the relocation of the operational unit and process step seven (7) of the Downstream Operation of Product A to the Manufacturing Suite C, refer to Figure 2. The plant already counts with a third manufacturing suite (Manufacturing Suite C), however the footprint was underutilized and allowed for the relocation of process step 7 with a capital investment to adapt the operational unit (manufacturing equipment and utilities).

In addition, to support the feasibility study, an external company was hired to provide SME's input regarding the construction requirements and cost with the proposed manufacturing layout re-design for operation unit number seven (7) of Product A.

(A)Analyze – During the analyze stage the project team supported on site visits and provided additional information of the process flow to the external company. The external company presented the initial assessments regarding the construction requirements of the project scope and submitted a proposal to the team for revision and approval.

From the manufacturing process perspective, the project team and SMEs concluded that the manufacturing layout re-design of the operational unit and step seven (7) will fulfill the requirements and will not represent a major impact to the current standard operating procedures (SOP's), electronic batch records (EBR's), process bill of materials (BOM), and regulatory commitments since the project scope will not change the manufacturing equipment or any of the operational parameters of the current validated process.

(D) Design – For the design process of the new layout proposal were held brainstorming meetings for the identification of process constrains, manufacturing suites space constrains, manpower needs to changeover activities, and the risk of ergonomic or injures for manufacturing personnel due to the heavy equipment movement requirements in the current layout design.

Other benefit identified during the meetings was the ability of the re-design layout proposal to provide flexibility to the operation to perform activities in parallel which will result in decreasing the process cycle time. Refer to Figure 3 for the main benefits comparison between current and future state of the manufacturing layout design for Product A.

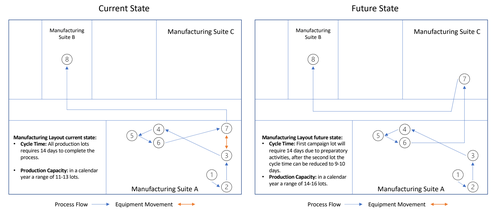

Figure 3: Main benefits comparison between current and future state of manufacturing layout for Product A.

Manufacturing Schedule Production (MPS) simulations were performed and analyzed with the Scheduling and Planning personnel. From the assessments, it was determined that the manufacturing layout re-design could result in a production capacity increase within a range of 14-16 lots per calendar year due to a reduction of time between lots of Product A from every 14 days to every 7 days.

The re-design layout proposal provide flexibility to the process because when the production of a lot is in the step four (4) in the manufacturing suite A can allow to start another lot in step one (1) in the same suite manufacturing suite A, because the completion of the first lot will be moved and performed in manufacturing suite C. There is no longer space constrains for the step seven (7) since it would not require the equipment movement and same space uses.

(V) Verify – during this final stage of the DMADV methodology all the information and data obtained and discussed in the previous stages of the project was gathered and presented to the project team and SMEs. Documentation and tracking of the feasibility study was updated and presented to management, the project team, and SMEs.

Conclusion

In conclusion, this process feasibility study of the proposed manufacturing layout re-design of the Downstream Operation of Product A provided key information of the benefits and viability of the project. The project output concluded that the proposed manufacturing layout re-design will provide and represent a potential reduction of approximately 29-36% of the current process cycle time between lots. At the same time this represents an increase in production capacity per calendar year of approximately 15-25%. These main benefits can lead to improve the company's competitiveness and obtain financial benefits. Other benefits that could be obtained from the project implementation would be a reduction of potential ergonomic injuries and reduce manpower efforts due to the reduction in equipment movement and changeover activities requirements.

Furthermore, this project design will help to present this proposal and project benefits to management and executive personnel of the company for project approval and to continue with the next steps for funding and implementation. In addition, the second phase of the feasibility study will include the completion of the construction requirements assessments and project costs estimate with the external company. The DMADV methodology used during the completion of the process feasibility study provided crucial information about the manufacturing process in scope and improvements opportunities identified during the assessments and completion of project activities.

Future Work

A second phase of the feasibility study will include the completion of the construction requirements assessments and project costs estimate with the external company.

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