Manufacturing Process Coordination through Visual Analytics Tools

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Abstract

This research project was focused in the identification of requirements and the design of a software application toolset, that facilitates and improve the coordination of pharmaceutical manufacturing production steps. The objective was to increase the percentage of successfully completed production batches as established in the production plan. This improvement will be achieved by providing the real time generated knowledge that will enable take faster, accurate and reliable actions based on data.

In order to create this new software application toolset, the DMADV[1] methodology was used. DMADV is an important Design for Six Sigma methodology used for developing a new or substantially innovate product, service, or process.

This research project will provide the tools to a new assisted way, to coordinate the manufacturing process using a DMADV.

Introduction

Modern Pharmaceuticals Manufacturing Industry are continuously challenged by the changes in product manufacturing demands. Dynamic of the market including the incorporation of Make to order (MTO) compares to Make to Stock (MTS) made the coordination of the manufacturing process even more critical than in the pass. Manufacturing includes all task that directly or indirectly impact the manufacturing flow (MF). MF could be divided in three major manufacturing phases: Plan, Build, Release (PBR).

In order to be successful a manufacturing facility needs to be very efficient coordinating the PBR activities. The coordination for each phase consists on aligning the resources available (Materials, Equipment, People) in the most effective way to achieve the production goals. The alignment is better achieved by understanding the requirements (Key Business Questions (KBQ)) that needs to be answer in order to take the proper decisions and path.

This research project was focused on identifying the requirements or Key Business Questions (KBQ) and design a collaboration tool that identify, collects and transform the data into actionable knowledge required to answer those KBQ.

Problem

The successful coordination of Manufacturing activities is one of the key contributing factors to comply with the product manufacturing demands. The goals to a successful coordination are achieved by aligning the resources (Materials, Equipment, People) effective and efficiently to complete the production as scheduled. This research projects will identify several gaps that caused ineffective production coordination and provide a software solution to systematically close those gaps.

Methodology

A structured and well-defined approach needs to be used as a methodology to achieve the goals of the project. DMADV[2] methodology and tools were selected in order to achieve the goal of developing an application to improve the collaboration effectiveness.

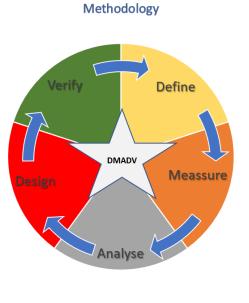## Methodology

See figure 1 DMADV Cycle.

Figure 1
DMADV Cycle

The following will be the tools used during each DMADV phase.
At the Define steps the following tools were used:

- Project charter[3] – A Project Charter is a short document that explains the project in clear, concise wording for high level management. Project charters outline the entirety of projects to quickly help to understand the goals, tasks, timelines, and stakeholders.
- Survey[3] – A survey is a tool used to collect information from potential stakeholders. For our design project, the survey will provide the data used to identified what information is required by the customers to achieve better alignments and collaborations.
- VOC[3] - Voice of the Customer is a market research technique that produces a detailed set of customer wants and needs, organized into a hierarchical structure, and then prioritized in terms of relative importance and satisfaction with current alternatives.

At the Measure steps VOC and MultiStage Plan tools were used.

- Multistage Plan (MP)[3]– This tool is used to specifies the phases to implement the coordination tool. The cell of the MP matrix describes the features of the designed tool in each time period for each customer segment (PLAN, BUILD, RELEASE). This approach help to:
  - o Deal with the risk associated as well as help.
  - o Maintain the project contained and manageable.
  - o Ensure that the first generation of the design get to the customers within the specified time window.
  - o Learn from customers reaction at each phase of the design/deploy process.

At the Analyze step additional Survey and VOC were used.
At the Design and Verify steps a combination of modeling and piloting were implemented.

Results and Discussion

The results obtained through the five phases of the DMADV methodology follows.
Define – As part of the define phase the Project Charter tool was performed in order to clearly identify the business problem, goal, project scope, available resources, and high-level project timeline. The second tool used was a Survey. This survey collects the following information:

- Stakeholder Manufacturing Phase
- Needs for knowledge (KBQ).

KBQ were focused to get the knowledge that each of them would require in order to expedite their decisions and adjust the tasks to comply with the production schedule. The information collected was then used to create and populate a VOC. See Table 1.

Results and Discussion

Table 1
Voice of the Customer

Measure - The purpose of the Measure phase is to clearly understand the customer's requirements and develop the critical to quality (CTQs) to address those requirements. The expected results of a good collaboration tool is an increment of the schedule attainment (SA) performance indicators. This project

As part of this Measure phase the VOC and a Multistage Plan tool were used.
Through the VOC, Supervisors and Managers, from the three segments, identified, organized and weighted KBQ for each business functions. VOC were organized in two (2) parts. The first part is about what the coordination team needs to KNOW. The second part is about what needs to be communicated.
On the first part, KNOW, the analysis direct me to focus on four specific business functions. See Table 2. VOC, also revealed the KBQ to be priorities. See Table 3.

Table 2
Voice of the Customer

Business Area	Business Function
BUILD	Production Execution
PLAN	Production Scheduling
BUILD	Material Management
BUILD	Equipment Management

Table 3
Key Business Questions (KBQ)

Priority	Business Function
1	What product needs to be manufactured?
2	Which work centers or lines will be impacted by the production?
3	My equipment or area is ready to receive the production order?
4	Do I have enough material to start my production?
5	My equipment or area is ready to receive the production order?

All these KBQ focused on assuring readiness of two elements: Materials and Equipment.

The information of the VOC was then used to develop a Multi Stage Plan Matrix (MSPM)[3]. See Table 4.

Table4
Mullti Stage Plan Matrix

Analyze Phase – In this phase, the design concepts to address the voice of the customer demands (CTQ) were developed. For each area (PBR) a set of data was identified (including the data source), organized and a visual representation were proposed. A survey was issued to determine which data representation were preferred by the customers to answer their KBQ. Table 5 shows the survey template send.
Design and Validate (D&V) Phases – Two (2) D&V stages were performed as proposed in the MSP. The first stage produced a Manual populated tools. See Table 5-6. The second stage produced a semi automatic Populated Tool with visual graphical representation of the data. See Figures 2-3. Impact of the use of this tools is shown in Figure 4. A continues improvement was manifested through the period observed.
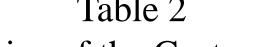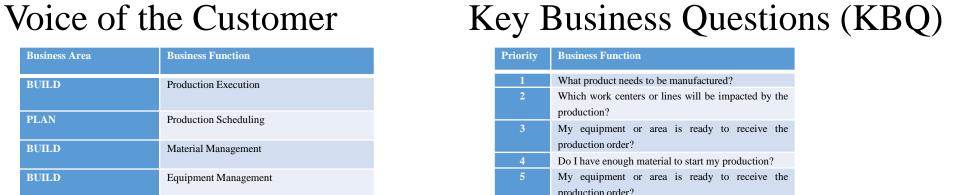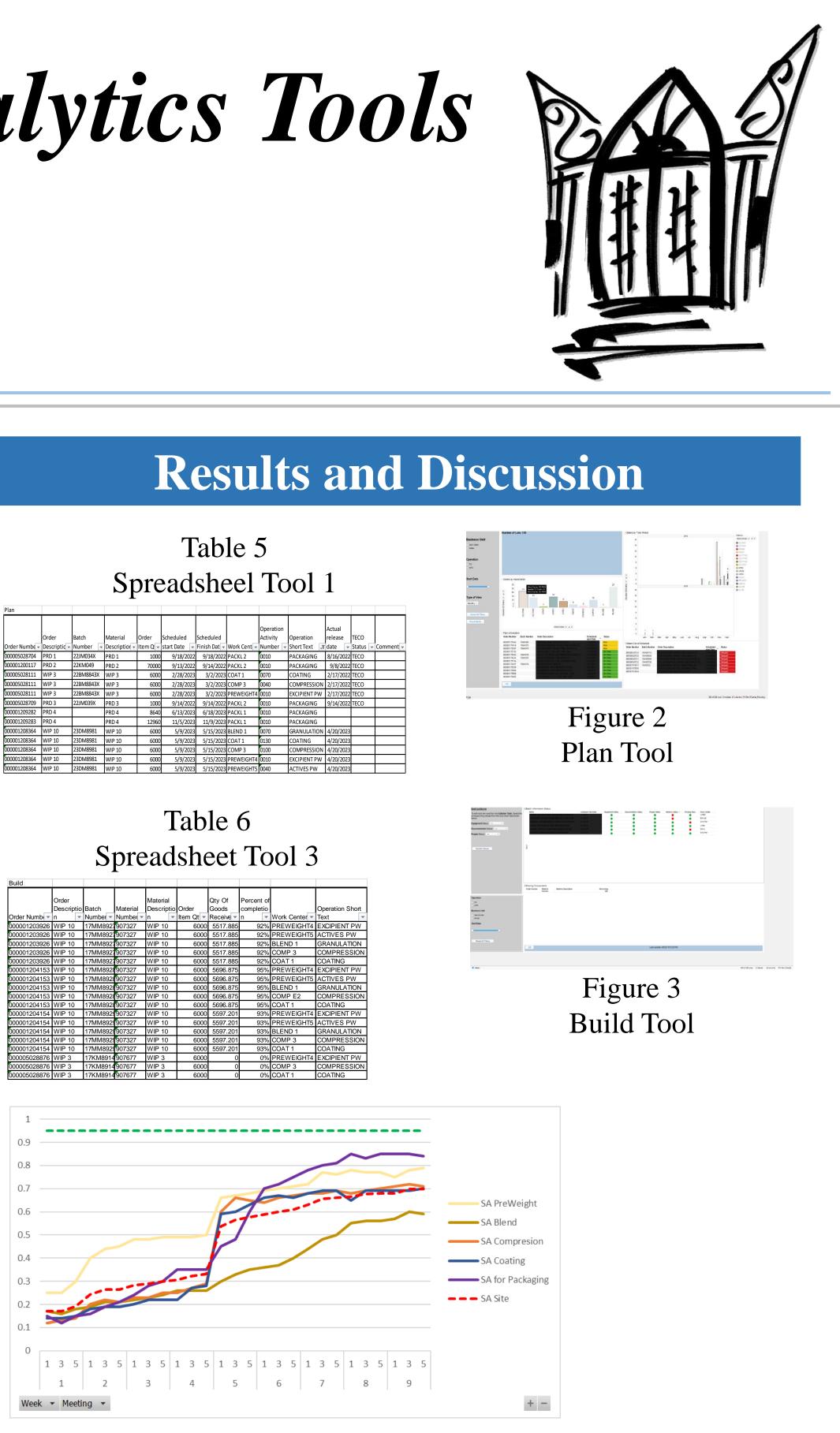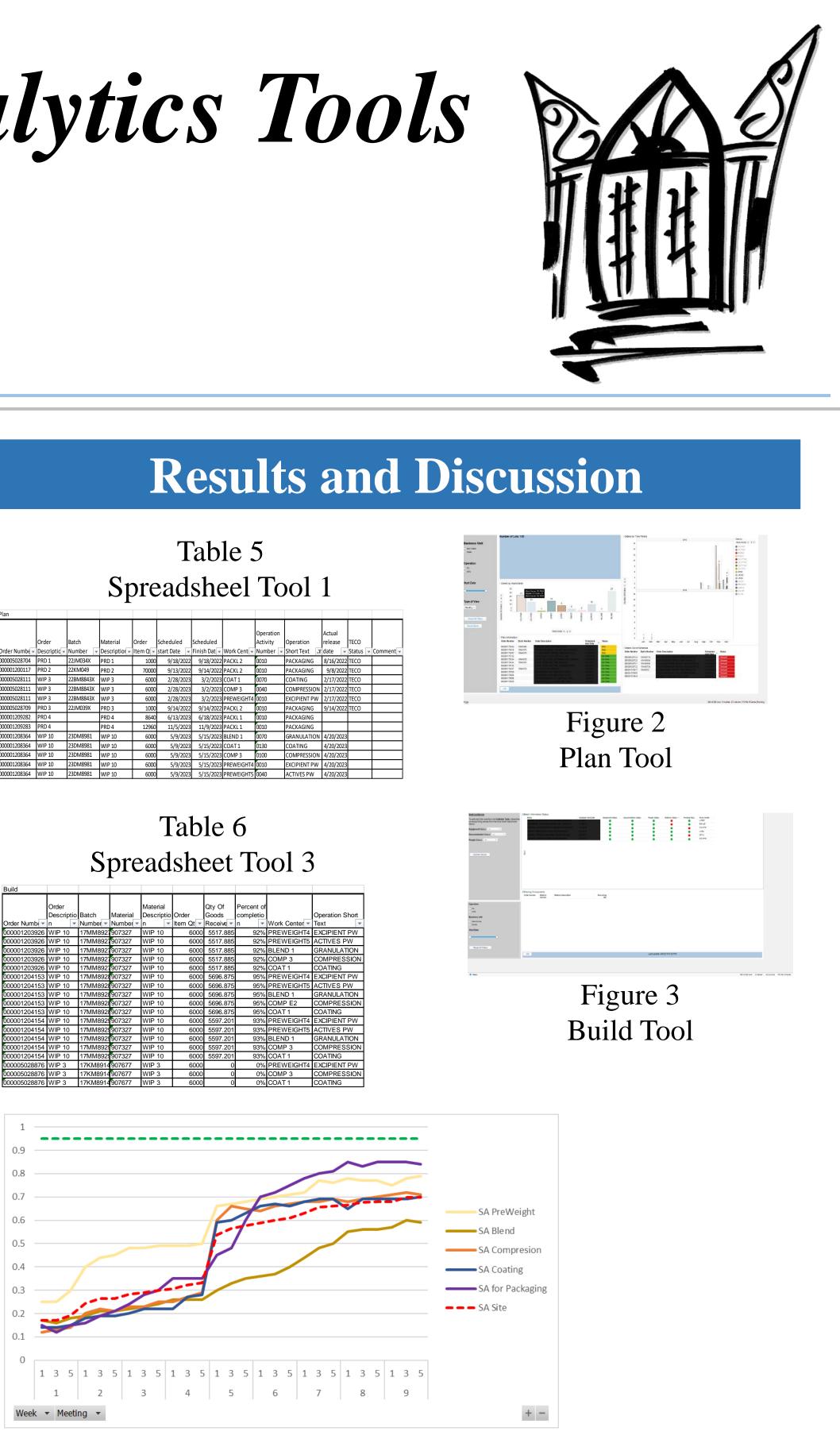
Results and Discussion

Table 5
Spreadsheel Tool 1

Figure 2
Plan Tool

Table 6
Spreadsheet Tool 3

Figure 3
Build Tool

Figure 4
Schedule Attainment Trend

Conclusions

Coordination and collaborations tools had demonstrated to provide great benefits on the organization where this application toolset was deployed. Schedule attainment metrics increase dramatically from a starting value of 17% to a fairly consisting 70%. Even when we can't credit 100% of this improvement to just the collaboration tool, is safe to conclude that was a major contribution factor. The development of the tool through DMADV methodology provided the tools (VOC, Surveys, Multi Stage Plans, piloting, etc.) to identify customer and customer's requirement, risks, measurements and expected results. Also, allowed to dynamically adjust the design due to lessons learn at each step of the process.

References

[1] Juran, J,M, & Defeo, J, Juran's Quality Handbook: "The Complete Guide to Performance Excellence©", Six Edition, May 19, 2010.
[2] What Is DMADV? [Online] Retrieved on 8-17-2022. https://kanbanize.com/lean-management/six-sigma/dmadv
[3] Ginn, Dana; Streibel, Barbara; Varner, Evelyn, The Design for Six Signa Memory Jogger Tools and Methods for Rubust Process and Products ©, First Edition GOAL/QPC (2016)