Improving Worker Utilization and Flow of Defective Material Through the Analysis Line

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Abstract- Due to a reduction in build volume at the Motorola Solutions Elgin Facility, the worker headcount at the defect analysis line requires re-evaluation. However, due to a lack of data available for the analysis process, making decisions on headcount is difficult. Throughout the Senior Design Project, numerous time studies have been collected along with the use of other analytical tools to develop a better understanding of the current state and requirements of the Analysis Line. Based on the findings, a capacity model has been created to suggest appropriate headcounts for the Analysis Line while also suggesting improvements to the Analysis processes themselves so that the goal of improving worker utilization may be better realized.

Keywords- Time Studies, Capacity Analysis, Spaghetti Diagrams

I. INTRODUCTION

Motorola Solutions provides communications and security solutions to a variety of customers both in the public and private sector. Two of the main products produced at the Motorola Solutions facility in Elgin, Illinois are portable radios and mobile radios. The major production lines and areas of operation involved in manufacturing these two products are categorized into “Value Streams” within the facility; Portable Radios or “Portables” are included in “Value Stream 1” while Mobile Radios & Consolettes or “Mobiles” are included in “Value Stream 2”. Furthermore, the production of both VS1 (Value Stream 1) and VS2 (Value Stream 2) products occurs in two types of lines: Build Lines, where the products are manufactured almost entirely in-house, and Customization Lines, where products are assembled according to the customers’ specifications while utilizing pre-made parts from external suppliers. Prior to consolidation, if a product fails testing in any of the production lines, it will be sent to the Analysis Line in order to determine the root cause of the defect with the goal of sending the product back to the line for reassembly as soon as possible. There are currently three Analysts per Value Stream stationed at the Analysis Line. However, due to recent reductions in Build Line volume, the current headcount requires re-evaluation.

II. PROJECT OBJECTIVES

The company has no data of the analysis process of the VS1 and VS2 products. The goal of this senior design project is to provide Motorola Solutions with time studies data of the analysis process, and use them to determine an optimal headcount that accurately reflects the demand and capacity of the facility. Furthermore, conducting time studies will also allow the team to examine the process in detail and determine possible areas of improvement within the analysis processes for both Value Streams. This allows for improved worker utilization. Furthermore, there is currently a lack of information regarding the flow of defective materials between the Analysis Line and the Material Review Board (MRB), where defective parts are stored to either be sent back to the suppliers or sent back to the analysis line for deeper analysis. Providing insight into the movement of product between these two areas may be beneficial to how Motorola structures their remediation of defective material.

III. METHODS

In order to investigate potential areas of improvement within the analysis process and to ultimately establish an accurate headcount, several analytical tools were utilized:

A. Time Studies

While observing the analysts in the Analysis Line, 15 time studies were collected for VS1 and 23 time studies were collected for VS2. Individual processes were separated into three categories: Value Added (VA), Non-Value Added (NVA), and Essential Non-Value Added (ENVA). A sample of the time study sheets is shown in table 1 below.

<table>
<thead>
<tr>
<th>Step</th>
<th>Activity description</th>
<th>Time (sec)</th>
<th>Distance (ft)</th>
<th>Value Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>strengthen the base</td>
<td>0.20</td>
<td>0</td>
<td>VA</td>
</tr>
<tr>
<td>2</td>
<td>repair the hole</td>
<td>0.20</td>
<td>10</td>
<td>NVA</td>
</tr>
<tr>
<td>3</td>
<td>attach the base</td>
<td>0.20</td>
<td>0</td>
<td>VA</td>
</tr>
<tr>
<td>4</td>
<td>ultimately</td>
<td>1.00</td>
<td>50</td>
<td>NVA</td>
</tr>
<tr>
<td>5</td>
<td>examine the hole</td>
<td>0.20</td>
<td>0</td>
<td>VA</td>
</tr>
<tr>
<td>6</td>
<td>strengthen the base</td>
<td>0.20</td>
<td>0</td>
<td>VA</td>
</tr>
<tr>
<td>7</td>
<td>ultimately</td>
<td>1.00</td>
<td>50</td>
<td>NVA</td>
</tr>
<tr>
<td>8</td>
<td>examine the hole</td>
<td>0.20</td>
<td>0</td>
<td>VA</td>
</tr>
<tr>
<td>9</td>
<td>strengthen the base</td>
<td>0.20</td>
<td>0</td>
<td>VA</td>
</tr>
<tr>
<td>10</td>
<td>ultimately</td>
<td>1.00</td>
<td>50</td>
<td>NVA</td>
</tr>
</tbody>
</table>

TABLE 1 - SAMPLE OF TIME STUDIES SHEET UTILIZED

B. Spaghetti Diagram

The movement of the employees while they performed analysis was tracked along with common material flow routes throughout the facility. A digital measuring wheel was also utilized to measure travel distances. Spaghetti diagrams were created accordingly to better understand the current flow of defective material while suggesting alternate routes.
C. Process Maps

As there is currently a lack of detailed documentation regarding the analysis processes, process maps were created for both VS1 and VS2. Individual steps in analysis vary greatly between Value Streams as they encompass two different categories of products. A process map was also created for the material flow between the Analysis Line and the MRB area as there is also a lack of documentation in this regard.

D. Capacity Analysis

A proprietary capacity model was provided by Motorola Solutions that calculates daily production for the VS1 and VS2 Customization Lines. The proprietary model was incorporated into a capacity analysis model that was created by the team. The created model outputs the number of Analysts required per Value Stream for a range of possible defect percentages. The results are further divided between “best case” and “worst case” scenarios depending on time taken for analysis; best case analysis time is the average analysis time below the median analysis time while worst case is the average analysis time above the median time. See Table 2 below for a sample of the capacity analysis model.

What is immediately noticeable is their high variance in cycle time compared to the other categorized time. As analysis is conducted on a variety of products, often with their own unique analysis methodologies, analysis time may vary significantly one to another. Conversely, NVA and ENVA tasks exhibit significantly lower variance as many of these processes remain constant regardless of product type (e.g. reaching for tools and opening analysis software). A variance analysis was also conducted for VS2 yielding similar results, see Figure 2 below.

In general, VS1 analysis took longer to complete compared to VS2. A contributing factor was the longer distances and frequency of travel required during VS1 analysis.

V. CONCLUSIONS

Utilizing both time studies and production data, a Capacity Analysis tool was created and provided to Motorola, allowing them to make data-driven decisions for headcount in the Analysis Line.

Furthermore, through the team’s observations and created spaghetti diagrams, several alternative routes were suggested so that travel distance for the Analysts may be minimized – most notably, creating an open path in the middle of the Analysis Lines and Production Lines so that workers may freely walk through instead of having to circle around the peripheries to enter each line.

With the creation of Process Maps, a better understanding for the intricacies of the analysis processes was established. Based on the team’s observations, improvements to some areas of the processes themselves were documented and suggested to Motorola Solutions.

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