IV Bag Fill Volume Project

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Abstract

Accurate filling of intravenous (IV) bags is a critical aspect of healthcare, ensuring patients receive the precise medication dosage while minimizing wastage and reducing costs. The existing IV bag filling process often suffers from excessive solution filling volumes, increasing expenses. This paper aims to optimize the IV bag filling process by identifying and minimizing waste while enhancing efficiency. The objective is to develop a robust and reliable process that ensures accurate IV bag filling, reducing waste and increasing cost savings.The Lean Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) methodology is employed in this project. The first step involves defining the problem and understanding the current performance of the IV bag filling process. Measurement techniques are utilized to gather data and assess the existing process's strengths and weaknesses. The data is then analyzed to identify the root causes of waste and inconsistencies.Based on the analysis, targeted improvements are implemented to enhance the IV bag filling process. These improvements may include the introduction of automated systems, optimization of filling parameters, or the utilization of advanced sensing technologies. These solutions aim to achieve accurate and consistent filling volumes, thereby reducing waste and associated costs.

Introduction

In the healthcare industry, IV (intravenous) bags are used extensively to administer fluids, medications, and nutrients to patients. Filling these bags with the right amount of solution is crucial for patient safety and well-being. However, the IV bag filling process has its challenges.

To begin with, the IV bag filling process involves several steps. First, the solution is mixed in a tank and then transferred to the filling machine. The filling machine then fills the bags (See Figure 1) with the solution and seals them. Finally, the filled bags are inspected for quality control before being sent out for use in patient care.

The filled weight in our current process suffers from excessive solution filling volumes. To address this issue, the filled volume reduction project was initiated. The project aims to maximize the capacity of mixing solution tanks by reducing the amount of solution during the filling process.

Background

In the field of process improvement and statistical analysis, various studies have contributed to the understanding and application of methodologies such as design of experiments (DOE), industrial statistics, and Lean Six Sigma. These studies have provided valuable insights into optimizing processes, reducing waste, and improving quality in different industries. Montgomery's book, "Design of Engineering Experiments," in Engineering Statistics, 5th edition, has been a widely recognized reference in the field of DOE, providing a comprehensive guide to experimental design and analysis.

Another significant resource in the field of industrial statistics is the book "Industrial Statistics with Minitab® ®" by Cintas, Almagro, and Llabres. This book focuses on the practical application of statistical techniques using Minitab® software, which is widely used for data analysis in industry. It offers guidance on how to effectively analyze data, interpret results, and make informed decisions to improve process performance.

Furthermore, the "Lean Six Sigma Pocket Toolbook" by George, Maxey, Rowlands, and Upton is a valuable resource for understanding Lean Six Sigma principles and tools. It provides a concise compilation of tools and techniques that can be applied to streamline processes, eliminate waste, and enhance overall efficiency. This work highlights the importance of combining Lean principles (focused on waste reduction and process flow) with Six Sigma methodologies (focused on minimizing process variation and defects) to achieve significant process improvements.

By integrating the knowledge and insights from these studies, this research aims to contribute to the existing body of literature on process optimization and statistical analysis in the context of IV bag filling. The focus will be on utilizing the statistical software Minitab® to analyze one-year historical data of multiple manufacturing codes, industrial statistics, and Lean Six Sigma methodologies. By drawing on these established approaches and best practices, this research seeks to identify the potential manufacturing codes that significantly impact the filled volume of each IV bag and develop optimization strategies to maximize the filled volume while ensuring quality and safety standards are met.

Problem

IV bag filling issues include excessive solution in the manufacturing process.. This research optimizes IV bag filling to solve the issue. To maximize IV bag filled volume while maintaining quality and safety, identify manufacturing codes that significantly affect filled volume and adopt targeted improvement measures. This research uses Minitab® , industrial statistics, and Lean Six Sigma to improve IV bag filling accuracy, efficiency, and cost.objectives are generally presented in this section.

Methodology

The DMAIC (Define, Measure, Analyze, Improve, Control) methodology is a structured problem-solving approach widely used in process improvement initiatives. In the context of optimizing the IV bag filling process, each phase of DMAIC can be explained as follows:

Define: The Define phase focuses on clearly defining the project's scope and objectives. The stakeholders involved in the IV bag filling process are identified. Their requirements and expectations regarding accurate medication dosages, waste reduction, and cost-effectiveness are gathered and considered. The project's scope is explicitly defined as the IV bag filling process, outlining the key areas and parameters to be addressed.

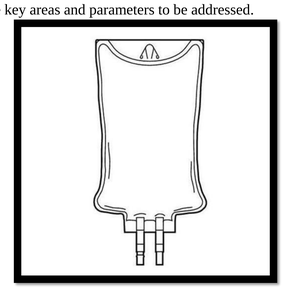

Figure 1
IV bag Sketch

Measure: The Measure phase involves collecting data to establish a baseline and measure the performance of the IV bag filling process. Key metrics and indicators, such as filling volume accuracy, wastage rates, and cost analysis, are identified and measured. Data is collected from historical records. This data provides insights into the current state of the IV bag filling process and serves as a benchmark for future improvements.

Figure 2
Filling Nozzle

Analyze: In the Analyze phase, the collected data is analyzed to identify opportunities for improvement within the IV bag filling process. Statistical analysis techniques using Minitab® ® ® are applied to pinpoint the factors contributing to inconsistent filling volumes and excessive waste (See Figure 2). Understanding the underlying causes, potential solutions, and improvement strategies can be identified and prioritized.

Improve: Based on the analysis conducted in the previous phase, the Improve phase focuses on implementing solutions to address the identified problems or opportunities. This may involve introducing automated filling systems, optimizing filling parameters, standardizing procedures, or enhancing training programs. The solutions should be tailored to the specific needs and requirements of the IV bag filling process. Piloting and testing the proposed improvements are essential to validate their effectiveness and feasibility before implementing them on a larger scale.

Control: The Control phase ensures that the improvements achieved in the IV bag filling process are sustained over time. This phase involves developing and implementing control measures to monitor and manage the process. Standard operating procedures (SOPs) may be modified to incorporate the improvements and ensure consistent adherence. Ongoing performance measurement, quality assurance checks, and staff training are integral to the control phase to maintain the gains achieved and continuously improve the IV bag filling process.

Results and Discussion

After gathering data and analyzing the IV bag fill process, the results have shown significant opportunities for improvement. The process was carefully examined to identify critical codes that can be maximized to optimize the fill weight target. This analysis recommends a new fill weight target based on its financial benefit and process capability (See Table 1).

Table 1
Potential Codes and Savings

Code	Mean fill	Target reduction	New fill target mean	Ave. Yearly Demand	Additional bags/year with reduction	Cost/bag filled	Cost Saving/year with reduction
2G3504	53.19	0.8	52.39	1,440,000	21,989	1.8386	$ 40,428.85
2G3576	53.18	0.8	52.38	9,800,000	149,675	1.3294	$ 198,978.54
2G3577	103.6	0.8	102.8	3,200,000	24,903	1.3921	$ 34,667.08
2G3579	103.6	0.8	102.8	740,000	5,759	4.6189	$ 26,599.11

To begin with, it is essential to understand the IV bag fill process in detail. This process involves filling IV bags with a specific amount of fluid. The fill weight target is critical in this process as it determines the amount of fluid filled in each bag. The goal is to achieve a consistent and accurate fill weight target each time to ensure the IV bags meet the required specifications.

In the Capability Analysis performed for the given codes, the results indicate the following:

Code 2G3504:

- It could potentially have a fill volume reduction of 0.8 ml, resulting in a new fill volume of 52.39 ml.
- The Cpk value obtained for this code is 1.36. See Figure 3

Code 2G3576:

- It could potentially have a fill volume reduction of 0.8 ml, resulting in a new fill volume of 52.38 ml.
- The Cpk value obtained for this code is 1.66. See Figure 4

Code 2G3577:

- It could potentially have a fill volume reduction of 0.8 ml, resulting in a new fill volume of 102.8 ml.
- The Cpk value obtained for this code is 2.14. See Figure 5

Code 2G3579:

- It could potentially have a fill volume reduction of 0.8 ml, resulting in a new fill volume of 102.8 ml.
- The Cpk value obtained for this code is 1.76. See Figure 6

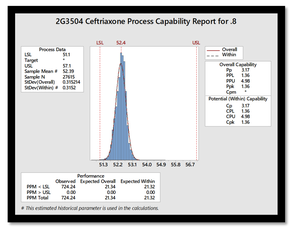

Figure 3
Code 2G3504

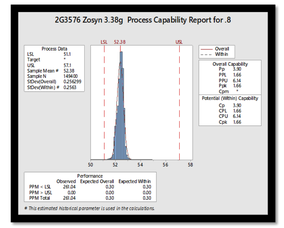

Figure 4
Code 2G3576

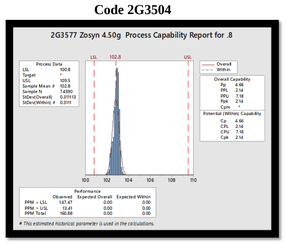

Figure 5

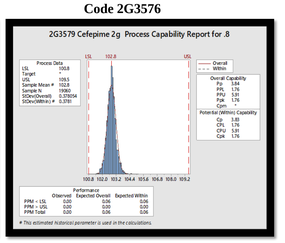

Figure 6

Conclusions

In conclusion, the accurate filling of IV bags is crucial to patient care, ensuring proper medication administration while minimizing waste and associated costs. The current process often needs help with excessive solution-filling volumes. By applying the Lean Six Sigma DMAIC methodology, this study aims to optimize the IV bag filling process, leading to enhanced accuracy, reduced waste, and improved cost-effectiveness.

The project involved conducting a Capability Analysis using Minitab® ® for four codes: 2G3504, 2G3576, 2G3577, and 2G3579. The primary objective was to evaluate fill volume reduction's benefits in producing more bags with the same amount of solution in the mixing tank, ultimately benefiting patients.

The analysis revealed that implementing a fill volume reduction of 0.8 ml across the codes could substantially improve bag production. Code 2G3504 could generate an additional 21,989 bags per year, while code 2G3576 could yield an impressive 149,675 additional bags annually. Code 2G3577 and 2G3579 also showed notable increases in bag production, with 24,903 and 5,759 additional bags per year, respectively.

These increases in bag production not only result in higher output but also offer significant cost savings. The project estimated cost savings of $40,428.85, $198,978.54, $34,667.08, and $26,599.11 for codes 2G3504, 2G3576, 2G3577, and 2G3579, respectively.

Future Work

In future work, the focus will be on implementing a continuous monitoring process to ensure the sustained effectiveness of the optimized IV bag filling process. This will involve regularly collecting and analyzing data on filled volume, waste reduction, and cost savings. The aim is to identify any deviations or potential areas for improvement and promptly address them. Additionally, the methodology developed through this research will be extended across all manufacturing codes within the site, ensuring consistency and uniformity in the filling process. By leveraging continuous monitoring and expanding the methodology, this research aims to establish a robust and standardized IV bag filling process with long-term benefits for patient care, resource optimization, and cost reduction.

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