Weight Variation Reduction for Baby Lido Products through Six Sigma Methodology and Tools

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Abstract

This article presents weight reduction for Baby-Lido products at a Jordanian manufacturing company using Six Sigma methodology, Specifically, the Define, Measure, Analyze, Improve, Control (DMAIC) methodology The study show that the company currently working at a 2.04 sigma level with 292167 DPMO. Therefore, different tools have been used to identify the root causes of the problem such as project charter, high level and detailed process map, cause and effect matrix, Failure Mode and Effect Analysis (FMEA) and other tools. Thorough investigations revealed that the root causes of the problem are related to the Sap, Fluff and pulp.

Keywords
Six Sigma; DMAIC methodology; Baby Lido Products, Weight variation

1. Introduction

The globalization of world markets has put today's organizations to venture into new strategic practices in order to sustain the level of competition in the market place. Today's competition is on product variety, innovation, cost and time. Furthermore these companies not only had to worry about being the best in their business but also need to be the first to bring their edge into the market. In the early days of globalization, its influence is more noticeably felt in the large scale industry sectors such as automobile and airlines. Gradually its influence has started to spread over the entire supply chain which includes small and medium sized companies. Small and medium size companies do not have the resources and time required to tune to automation nor the level of integration required for such efforts to improve their processes and productivity. Therefore the global competition made more pressures over small and medium sized companies (than larger scale industries) to meet customer requirements in a short period of time or lose market share. These small and medium size companies are under tremendous pressure to improve productivity and at the same time bring one of a kind product to the market with relatively short lead times.

Today, Six Sigma is viewed as formidable strategic weapons to succeed in such increasingly competitive markets. The main benefits of Six Sigma are that it creates a system for everyone in the organization to collect, analyze, and display data in a consistent manner (Maleyeff and Kaminsky, 2002). Six Sigma helps organizations to achieve company's strategic goals through project driven approach (Coronado and Antony, 2002). Watson (2006) has characterized Six Sigma as the latest management trend for improving tools and techniques. Six Sigma implementations depends on a systematic methodology of five steps known as DMAIC (Define, Measure, Analyze, Improve, and Control) methodology, Pyzdek (2003) or Keller (2005) provided a comprehensive description of this methodology. Yang and El-Haik (2003) defined Six Sigma as a "scientific" theory comprising fundamental knowledge areas in the form of understandings and perceptions of different fields, and the relationships between these fundamental areas. The concept of quality in Six Sigma implies that customers receive exactly what they want, without defects (Stapenhurst, 2005). From a statistics point of view, Six Sigma's goal is to eliminate defects up to 3.4 defects per million opportunities (DPMO) (Allen, 2006).

Six Sigma either alone or combined with other tools such as lean have been implemented successfully in the manufacturing and service sectors to optimize different performance measures. Linderman et al. (2003) pointed out that Six Sigma could be implemented to the processes of producing manufacturing goods, business trade, executive management, and services. Recent research papers include improving operational safety (Cournoyer et al., 2010), enhancing the assembly efficiency of military products (Cheng 2005), increasing customer loyalty in the banking sector for Bank of America and Citigroup ((Rucker, 2000; Roberts, 2004), reducing patients' waiting time and length of stay (Mandahawi et al., 2010), reducing length of stay for Ophthalmology Day Case Surgery (Mandahawi et al., 2011) and increasing productivity for paper manufacturing company (Mandahawi et al., 2011).

2. Case Study

Since the 1970s, disposable diaper technology has continued to evolve. In fact, nearly 1,000 patents related to diaper design and construction have been issued. Today's diapers are not only highly functional, but also, they include advanced features; such as special sizing and coloring for specific gender and age, color change indicators to show when the child is wet, and re-attachable Velcro TM-type closures. These innovations have enabled disposables to capture a large share of the diaper market. This research illustrates the application of Six Sigma DMAIC model for Baby Lido Medium Disposable Diaper products to minimize weight variation at a Jordanian manufacturing company. The following subsection illustrates how the DMAIC cycle is used to minimize weight variation.

3. Define

Due to customer complaints, lab tests, and production observation the primary objective of the project is set to reduce weight variation for product Baby Lido – Medium produced by specified machine to increase process sigma level. Furthermore, to identify the most critical products, ABC analysis is performed based on company historical data and revealed that Baby Lido – Medium are the most frequent which is widely produced in machine one. In the define phase, the project scope and objectives, team, stakeholders, and work schedules are clearly defined. Project charter has been used in this phase not only to mention these points, but also to be the reference of the project to prevent any conflict that may occur between the team members. A set of brainstorming sessions have been held by the Six Sigma team leaders in order to identify project primary objectives, project milestones dates, stakeholders departments, project scope, project team members which include project champion; certified Six Sigma black belt; process owners, project leaders, and core team members, and supporting team members.

4. Measure

The first step in the measure phase is to identify the initial capability of the process, a random sample of 510 baby diapers have been collected and weighted for two months period over the three shifts. The data has been analyzed using MINITAB software to calculate current sigma level, defect per million opportunities (DPMO), mean and process variation. Capability analysis reveals that the current process output involves a 292167 DPMO. Consequently, the current sigma level is 2.04. Furthermore, process variation was wider than specification limits and the mean was shifted from its original target where the Pp and Ppk values were 0.35 and 0.16 respectively. To have a clear high level view of the main stages required to produce Baby Lido – Medium products a high-level process map has been drawn as shown in Figure 1.

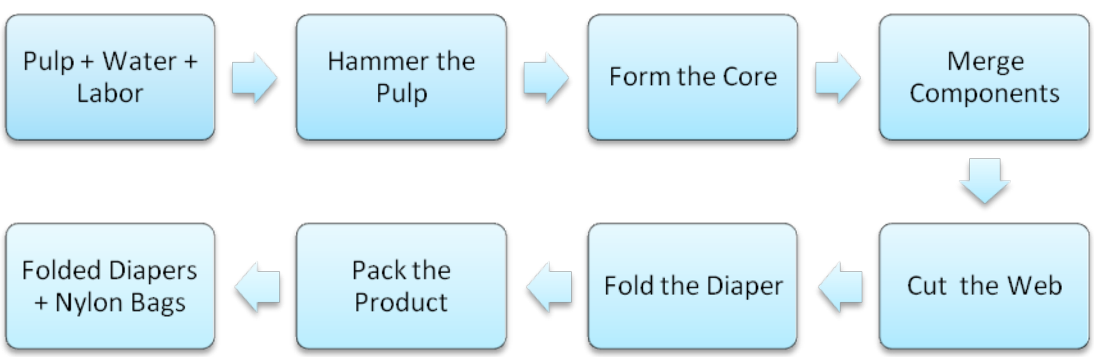

Figure 1: High-Level Process Map for SSP1

The primary Y's for this study are sigma level and Cp value. Y's are affected by many variables: X's, which is mainly the inputs for each stage within the production process. Therefore, the DMAIC team draws a detailed process map showing the inputs for each stage which have been identified after a set or brainstorming sessions as shown in Figure 2.

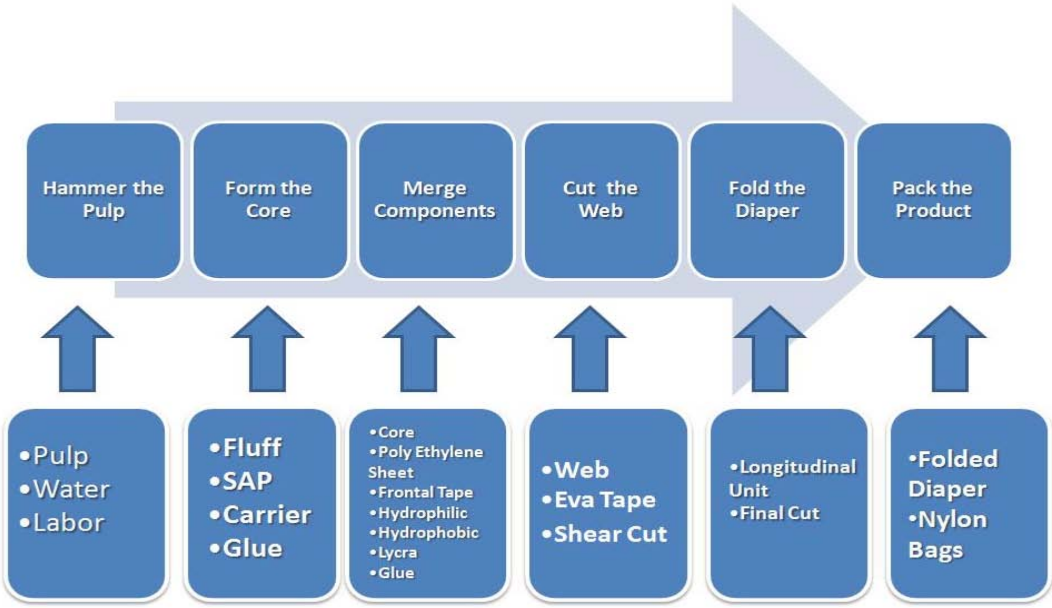

Figure 2: Detailed Process Map for Baby-Lido Production on Machine One

Furthermore, in order to identify which X variables have the highest impact on Y's factors, Cause-and-Effect Matrix has been used. Within this matrix the team included in addition to the weight variation the effect that this parameter may have on the performance of production and the cost which are the project counter balance parameters as shown in Table 1. The results show that the most important parameters which may have a direct effect of the project primary and counter balanced objectives are Pulp, SAP (Super Absorbable Polymers), Fluff, and Core. Before proceeding to the analysis phase the results have been presented to the top managers to get their opinion and it has been approved by them as critical parameters which may have direct effect on the weight variation problem.

Table 1: Cause & Effect Matrix for Baby Lido Medium

	Rating of Importance	10	7	4	
Process Step	**Process Input**	**Weight Variation**	**Performance of Product**	**Cost Reduction**	**Total**
Hammer the Pulp	Pulp	9	9	3	165
Hammer the Pulp	Water	1	0	0	10
Hammer the Pulp	Labor	1	0	0	10
Form the Core	Fluff	9	9	3	165
Form the Core	SAP	9	9	3	165
Form the Core	Carrier	1	0	1	14
Form the Core	Glue	0	9	3	75
Merge Components	Core	9	9	3	165

Merge Components	Poly Ethylene Sheet	0	1	1	11
Merge Components	Frontal Tape	0	0	1	4
Merge Components	Hydrophilic	0	9	3	75
Merge Components	Hydrophobic	0	9	3	75
Merge Components	Lycra	0	3	1	25
Merge Components	Glue	0	9	3	75
Cut the Web	Web	0	1	0	7
Cut the Web	Eva Tape	0	1	1	11
Cut the Web	Shear Cut	0	3	1	25
Fold the Diaper	Longitudinal Unit	0	1	0	7
Fold the Diaper	Final Cut	1	3	0	31
Pack the Product	Folded Diaper	0	3	0	21
Pack the Product	Nylon Bags	0	0	1	4

5. Analysis

Based on the Cause-and-Effect Matrix, the four main inputs which are concluded to have direct effect on weight variation problem are Pulp, SAP, Fluff, and Core. At this stage, the team will collected more data in order to identify the root causes that these parameters will have an effect on the weight variation problem in order to proceed to the improve phase. The DMAIC team decided to use Failure Mode and Effect Analysis (FMEA) tool instead of the Multi-Vari Test. On the Failure Mode and Effect Analysis (FMEA) tool the potential failure mode for each parameters have been pointed, which are mainly shortage and excess, furthermore potential failure effects, potential causes and current control for each parameter have been identified The overall summary of the FMEA table has been summarized on Table 2. Furthermore, the outcomes from this phase have been presented to the senior top managers and got their approval.

Table 2: List of the Potential Failure Causes

Main Cause	Failure Mode	Potential Failure Causes
Fluff	Excess	1- The duct gap was closing. 2- Disturbance in the filtering operations (OSPREY Room).
Pulp	Excess or shortage	Amount of the Moistening water.
Sap	Excess by 50% or more	Calibration errors.

6. Conclusion

The paper presents a DMAIC procedure to minimize weight variation for Baby Lido–Medium products produced in one of the Jordanian manufacturing companies which has a high demand in the market. The current state shows that the company current sigma level does not exceed 2.04 with DPMO of 292167; therefore there is a vital needs to minimize product current variation in order to meet customer specifications limits. Through detailed process map and cause and effect matrix the DMAIC team was able to identify the main input parameters that affect the product final weight. Afterward, at the analysis phase the team identified the potential failure causes in addition to the failure mode. These finding should be enhanced at the improve phase with a set of recommendations at the control phase in order to minimize DPMO which will results in increasing product final quality.

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