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PDCA APPLIED TO PRINTING SECTOR OF GHANAIAN TEXTILE INDUSTRY

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PDCA Applied to printing sector of Ghanaian Textile Industry

por

JAEL YANKSON

Este Trabalho de Conclusão de Curso foi apresentado aos vinte e cinco dias de novembro de dois mil e dezenove, às treze horas, como requisito parcial para a obtenção do título de bacharel em Engenharia Têxtil do curso de Engenharia Têxtil da UTFPR – Universidade Tecnológica Federal do Paraná. O candidato foi arguido pela banca examinadora composta pelos professores abaixo assinado. Após deliberação, a banca examinadora considerou o trabalho aprovado.

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“Everybody is a genius .But if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid.”

Albert Einstein

ABSTRACT

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Ghanaian textile industry has been collapsing since late 1980s. In addition, there has been a decline in most textile products in Ghana due to competition with Chinese products, known for their lower prices compared to home-made textile products. In order to provide engineering-based solutions this research aims to apply the PDCA method to reduce the 6,5% of rejected finished products at the printing sector of Akosombo Textile Limited of Ghana. The work intends to apply the first stage of the PDCA which is P (plan), with the support of quality tools like Brainstorming, Flowchart, Checklist, Sequential graphics, Pareto chart, Cause and Effect diagram, GUT Matrix, BASICO solutions and 5W2H. This work was able to bring out Action Plan, which whether applied it may reduce the 6,5% to 1,95% reducing about 70% of the 10.833,33 yards rejected monthly with an estimated gaining of US $17.062,42 out of losing of US $24.374,89 monthly. This method applies to all processes to control the production quality, and to reduce and eliminate waste. Moreover, this could also deliver a better reliability and confidence before the clients, elimination of rework, economize energy, time and resources.

Keywords: Ghana textile industry. PDCA. Printing sector. Quality tool.

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SUMMARY

1 INTRODUCTION

Ghanaian textile industry has been through a process of collapse since the late 1980s (QUARTEY, 2006). In addition, there has been a decline of most textile product in Ghana due to competition with the Chinese products, due to their lower prices compared to home-made textile products (ADIKORLEY, 2013). In order to understand the collapse of the Ghanaian textile industry, a look back in time is necessary.

Ghana was the first African country to gain independence from the British colonization in 1957 by the leadership of Osagyefo Dr. Kwame Nkrumah. Ghana was first called the Gold Coast based on its natural resources, such as gold, diamonds, and cocoa. The word Ghana derives from the ancient Ghana Empire that means “Warrior King”.

In 1959 after the independence, the Ghana’s first President promoted the development of a local textile industry which he established the state-owned industry for spinning and printing cotton. The Ghanaian textile industry gained its prominence in the mid-1960s with over 20 large-scale textile industries that employed more than 25,000 workers operating at 60% plant capacity and accounting for 27% of total manufacturing employment nationwide. This was one of the most important sources of foreign exchange in Ghana from the early 1970s to the middle of the 1980s (QUARTEY, 2006).

The collapse of the Ghanaian textile industry occurred during the late 1980s. Until this decade, there were 15 Textile Manufacturing industries, which included the following: Juapong Textile Limited, Akosombo Textile Limited, Tema Textiles Limited, Ghana Textiles Company Limited (Ghana Textile Product), Ghana Textiles Manufacturing Company, Freedom Textiles Industries Limited, Millet Textiles Corporation, Spintex Ghana Limited (Printex), Ghana Blanket Factory, Ghana Cotton Company, Kumasi Jute Factory, Tarpaulin and Polypropylene Industries Limited, Commodore Textile milling Limited, Ghana Umbrella Factory and Garment Manufacturing Companies. According to the Institute of Statistical, Social and Economic Research (ISSER), - published in Legon (2006), only four major textile industries remained, namely Ghana Textile

Manufacturing Company (GTMC), Akosombo Textile Limited (ATL), Ghana Textile Product (GTP), and Printex. These four major surviving manufacturing companies have about less than 2,500 workers and are unstable in terms of competition and production due to low productivity over the years (QUARTEY & ABOR, 2011). Most of the factors responsible for the collapse in the Ghanaian textile industries include: smuggling of textile materials into the country, obsolete machinery production, poor management, poor attitude of workers, high cost of utility and finally the high cost of the Value Added Tax (VAT).

The best performing textile industries in Ghana are Ghana Textiles Product (GTP), with an annual production of 30.7 million yards[1], this is followed by Ghana Textile Manufacturing Company (GTMC) with 15 million yards, Akosombo Textile Limited with about 13 million yards and Printex with 6 million yards annual production in the year 2000 (Quartey, 2006). Besides, statistics shows that there has been a decline in textile production in Ghana from 129 million yards in 1977 to 44 million yards in 2009 and has further decline to 42 million yards in 2011 (TEGLEU, 2012).

Taking Akosombo Textile Limited as the specific object of investigation here, their main problems were based on the high amount of rejected finished products identified at the quality control sector. It was pointed out that about 6,5% monthly of finished products are rejected resulting about 0,22% daily due to printing errors.

Considering actual annual production of two million yards, an estimated profit is approximately US $4.500.000. A monthly production is approximately 166.666,67 yards losing about 10.833,33 yards with an estimated loss of US $24.374,89 monthly. Since the industry have a quality policy of tolerance of 1,5% monthly maximum resulting to 0,017% daily, that is, they are 5% above the goal stated.

The decline of most textile product in Ghana is based on the fact that most Ghanaian middle to lower-class citizens (majority of the people) prefer buying textile clothes from foreign countries, mostly China, than those made in

[1] In Ghana, Yard is a form used to measure fabrics. 1 Yard = 0,9144m.

Ghana. Their main reason for the preference of foreign textiles over home-made textiles is based on the high price of the final domestic product sold in the market.

According to Ghanatrade (2018) the price of Ghana Textile Product (GTP) is approximately US$ 45 per 12 yards; Akosombo Textile Limited (ATL) is approximately US$ 43 per 12 yard; and, the Chinese cloth is approximately US$ 18 per 12 yards. This raises another important concern because the Chinese product cheaper.

According to Quartey (2006), the main reasons why the Chinese products are cheaper due to illegal smuggling of the textile product into the country without paying of the requisite taxes involved and the use of lower standards of processing the fabric. Other factors responsible for the lower price of Chinese textiles compared to Ghanaian local goods include:

- The Chinese textile markets use modern equipment with high efficiency for production which reduces the waste of time;
- The production of textiles in a large quantity;
- Dedicated worker and qualified personnel or trainee;
- Qualified administrators to manage and control the process.

In recent years the application of PDCA method integrated with quality tools has been gaining prominence in the industrial sphere due to its effectiveness, accuracy and positive results. It also monitors the process and provides suggestion for improvement eliminates all unnecessary process and eventually reduces the costs. Many researchers have also testified to these facts, as in Machado L, G (2007), Vasconcelos et al (2009), Silva & Sartoni (2014), and Martins et al (2017).

1.1 RESEARCH QUESTION

Due to the presented issues, the Research Question that arises is as follows: **How to reduce the amount of rejected finished products generated at the printing sector of Akosombo Textile Limited in Ghana?**

That main question is unfolded into three supportive questions as follow:

- What are the characteristics of the printing processes of Akosombo Textile Limited in Ghana?
- What are the main causes of mistakes generated during printing production of ATL?
- What actions can be taken on the view of the employees of the printing sector to improve the production processes?

1.2 GENERAL OBJECTIVE

In order to answer to the research question stated, this project seeks to apply the first stage of PDCA method which is Plan in order to reduce the amount of rejected finished products generated at the printing sector of Akosombo Textile Limited in Ghana.

2 THEORETICAL REFERENCE

This section presents a review of the concept of quality, the concept of printing with its production processes of textile industry and the literature on the PDCA method.

2.1 CONCEPT OF QUALITY

The word quality comes from the Latin qualitas or qualitatem. The basis of the word is quails which means of what nature, that is the natural property or condition of persons or objects by which are used to differentiate from each other (MOURA, 1997). The most classic definition of quality is cited by Crosby, Deming, Feigenbaun, Ishikawa and Juran, popularly known as Quality Gurus of quality management and control.

Quality can be defined as the absence of defects in products, with the price compatible with the income of the consumer (WERKEMA, 1995). In addition, the final product must adequately fulfill the function for which it was designed and be safe.

According to Garvin (2002), quality can be seen by five different approaches, but they must be combined to improve the production process: trying to obtain excellence in terms of product specification, concern with user requirements, based on the best process productive, in the characteristics that add value to the product and finally based on the value that is the quality based on cost and price.

According to Melo (2001), quality does not only mean excellence or another attribute of a certain final product, it is the ultimate goal of a company and it is also what consumers expect from a product. However, quality cannot be defined simply as an absence of defect, because a product without defect, but with a high price will not meet the expectations of customers, since nobody will be willing to buy it.

Quality management also involves a set of practices that emphasizes among other things continuous improvement, meeting customer requirements, reducing rework, increasing employee involvement and teamwork, competitive benchmarking, and relationships with suppliers (POWELL, 1995).

2.2 PRODUCTION MANAGEMENT

The production management brings together the resources for the production of goods and services (SLACK, 2006). This term is used for the activities, decisions, and the responsibilities of production managers. Production management can be defined as the process of converting manpower, machines, raw material and capital which are all input to come out with an output like a finished product or services. This is achieved by passing through a transformation or processing unit.

The Figure 1 shows the main components of a system

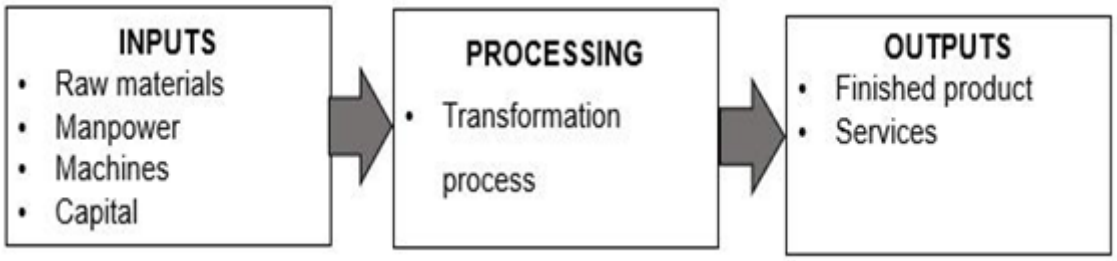

Figure 1 - The main components of a system
Source: Elaborated.based on SLACK (2006)

2.3 PRINTING

Print work literally means painted work or patterns printed on fabrics (YAMANE, 2008). Textile printing can be defined as a process that consists of procedures used to obtain a pattern, in one or more colors, that is repeated regularly over the background (POMPAS, 1994). Print-based finishes are an important means of adding value to plain fabrics and attractive.

Printing is the designing of fabrics, where the designer is concerned with the creation of patterns suitable for technical processes. The earliest prints

appeared before the Christian era and were made in India and Indonesia. The Egyptians created the prints in the Eoptic period in the V and VI centuries BC. It was a combination of painting and embossing reserves with models, which were highly, appreciated engraved wooden blocks.

The Phoenicians produced the first printed fabrics, using the block method and the printing worked in yarns of various colors forming prints much appreciated by the market. Another method used was the stencil, in different prints, in addition to embroidery in rich and vibrant colors (YAMANE, 2008).

In the 1930s, the screen system was adopted industrially due to its low cost, enabling the production of smaller amounts of fabric and more variation of designs. After the war, development of semi-continuous automatic screen machines, the advantages of low cost and high quality have been matched by the increased print production rate.

2.4 PDCA METHOD

PDCA method is one of the most popular tools used by most industry to solve most problems and can be repeated continuously in any process. It was developed in the 1930s by the American statistician Walter A. Shewart but his biggest promoter was Deming.

The PDCA cycle is defined as a managerial decision-making method, composed of four steps, to ensure that the company achieves its objectives necessary for the survival of the company (WERKEMA, 1995). According to Marshall Junior (2010), the PDCA cycle, presents four phases.

The Figure 2 shows the complete PCDA cycle.

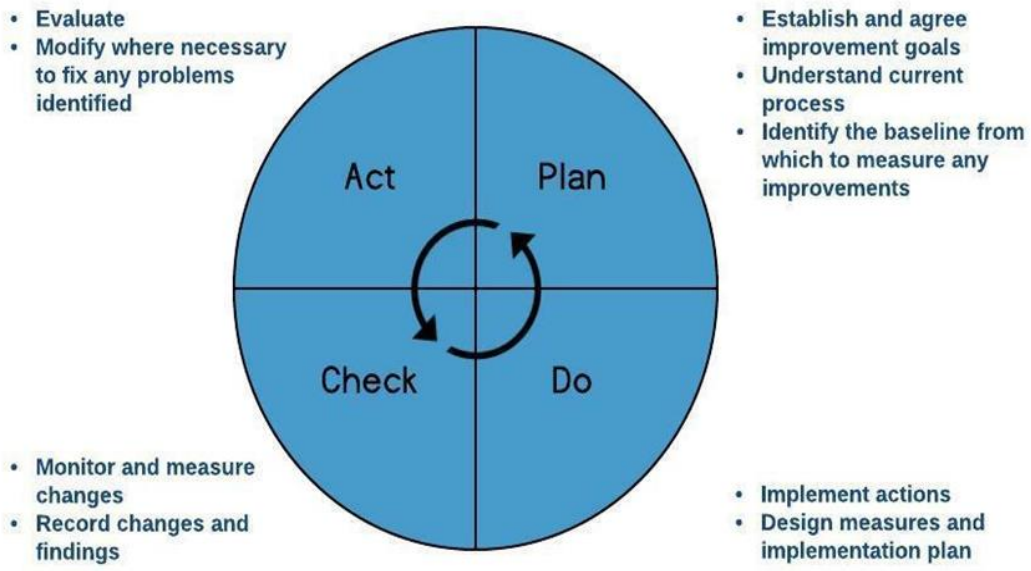

Figure 2 - The PDCA cycle
Source: Image from the internet by MEON (2009)

- **1st phase** – Plan (Planning): It defines the objectives and goals that it intends to achieve, define the problem or issue, data collection to determine the problem. For this, the goals must be well defined.
- **2nd phase** – Do (Execution): In this stage, the main aim is to put what you planned in practice and data is collected for the next stage analysis. Training, education and initiative are necessary at this stage.
- **3rd phase** – Check: This stage is verification of what was planned through the goals established and the result achieved. If the goal has not been achieved, one must return to the phase of observation of the planning stage, analysis the problem more carefully and elaborate a new plan of action.
- **4th phase** – Act: This is the final stage where to discover the root cause of the problem as well as the purpose of preventing the reproduction of any unexpected result in case of what as planned was not achieved. And also, at this stage, follow the sketch of the first one but should be differentiated if the goals established have been achieved. The table below is the summary of the PDCA cycle.

Werkema emphasizes that to be clear the understanding of the PDCA cycle is important the knowledge of the two types of goals to be achieved:

- **Goals to Maintain**: The goal to maintain consists of an acceptable range of values for the considered control item. Therefore, they are goals to be maintained.
- **Goals for Improvement**: improvement goals come from the idea that the market always wants better, cheaper, shorter-term products. The entry of new competitors and the emergence of new technologies lead to the need for improvement targets. Improvement goals are goals that must be achieved, and for that to be possible it is necessary to change the current form of work.

When using the PDCA cycle management method it may be necessary to employ several tools, known as quality tools. (WERKEMA,1995).

2.5 CASES WITH PDCA METHOD AND QUALITY TOOL APPLICATION

The PDCA method with integrated quality tool is already applied in most case studies with the aim of solving problems, giving suggestions, and improving process in the textile industry. Moreover, it is widely shown in most national literature. This work has the main objective to present a cost reduction proposal by reducing the amount of rejected finished products generated at the printing sector of Akosombo Textile Limited in Ghana using integrated PDCA tools.

A bibliographical review was carried out, aiming to make a survey of the researchers in the last 12 years on the application of PDCA method focusing on the printing sector of textile industry, presenting the problems and how the use of integrated quality tool actually provided solutions to the problem and gave suggestions on how to improve most processes.

A Table 1 was also prepared in order to summarize the main information of the mentioned publications:

Authors	Problems	Phases of PDCA	Tools	Causes	Proposed solutions	Obtained results
Machado L G (2007)	The amount of waste material produces from the production sector	Plan(P) was just applied	Stratification, Pareto's diagram, Contro diagram	Lack of raw materials, defective machinery, lack of yarns	The industry would have to plan and change many of his actions to adopt to their reality, adapting to the concept of PDCA	This work combined the PDCA methodology with tools to show how it is possible to work preventively in the solutions of the problems
Vasconcelos et al. (2009)	Inadequacy of the raw material, lack of maintenance for the machinery, deficits in the training and culture of the loom operators	All the phases of the PDCA was applied	Brainstorming, Checklist, Pareto's diagram, Flowchart, GUT diagram, Ishikawa diagram	Mechanical and Electrical defect	Maintenance of the equipment, 100%sample inspection for the raw materials before going through for production	This study confirms that the application of quality tools can helpful to most organizations to identify problems, identify causes and plan actions to eliminate them
Silva &Sartoni (2014)	Poorly centered tampon, loose yarn in sock, wrong composition label	All the phases of the PDCA was applied	Checklist, Pareto's diagram, Histogram, Stratification, Ishikawa diagram, 5W2H	Unqualified operators	Efficient training for the operators	The PDCA method presented in this work was successful and suggested that most industries can actually adopt it
Martins et al. (2017)	Contamination of the molding sector	All the phases of the PDCA was applied	Brainstorming, Ishikawa diagram, Checklist, Pareto's diagram, Stratification, Histogram	Fabric defect, different color, dirt short board, hole in the foam, cracked wrinkle	Search for standardization of the processes, details the way the operators should work weekly	The execution of the quality cycle and tools proved to be efficient and enabled good results

Table 1 - Summary on PDCA method applied in case study
Source: Elaborated by the author (2019)

The first case study was published by Machado (2007) that presented a problem of a large amount of waste material from the production sector the main objective was to identified the main causes of the waste material produces during the production of the product. This work applied the first phase of the PDCA P (plan). With the application of quality tools like sequential graphic, stratification, Pareto's diagram, cause and effect diagram, histogram, dispersion diagram and control graphic, this enabled it to detect the cause of the problem. Some causes identified were lack of raw material, defective machinery, lack of yarn in drawing lack of yarn in body, lack of yarn in beak, hole in heel, hole in wrist etc. The researcher concluded that applying the PDCA method was very successful and the use of PDCA method integrated with quality tool is very effective and can help solve and prevent problem in general situations faced by most textile industries.

The second case study was published by Vasconcelos et al. (2009), that presented a problem of inadequacy of the raw material, lack of maintenance for the machinery, deficits in the training and culture of the loom operators. The main objective was to give suggestion on how to improve the processes of printing sector and also demonstrate how to approach and work more effectively. This work applied all the phases of the PDCA cycle. Quality tools like brainstorming, checklist, Pareto's chart, flowchart, GUT diagram and ishikawa diagram were applied to identify all the causes of this problem which was mechanical and electrical defect. The general proposal suggested was to keep maintenance of the equipment, 100% sample inspection for the raw material before going through for production. Also concluded that the application of quality tools can helpful to most organizations to identify problems, detect the main causes and moreover, provide the necessary step or plan on how to solve or eliminate these problems.

The third case study was published by Silva and Sartori (2014), that presented a problem of loose yarn found in the sock, wrong composition label poorly and centered tampon. The main objective was to identify the main causes of these problems during the production of the sock produced. This work also applied all the phases of the PDCA cycle. Quality tools like checklist, Pareto's chart, histogram, stratification, cause and effect diagram and 5W2H.

was applied to identify the causes. The main cause of this problem was due to unqualified loom operator. The general proposal suggested was to efficient trainings for the operators. And also concluded that the tool presented in this article, the PDCA methods gave out positive results.

The fourth case study was published by Martins et al. (2017) that presented a problem of contamination at the molding sector. The main aim was to seek on how to improve the quality of product and processes within the molding sector of a textile industry. All the phases of the PDCA cycle were applied in that work. Quality tools like brainstorming, cause and effect diagram, checklist, Pareto's chart, stratification and histogram was applied to detect all the causes of this contamination. The main cause found was fabric defect, different color, dirt, short board, hole in the foam, cracked, wrinkle etc.

The work resulted that, the average defects in relation to the production of the components before the implanted method corresponds to 0.9373%. After the improvements were put into practice, a reduction of this average was observed, which reached 0.6742%, proving the positive effect of the implanted solution. In addition to the averages, the in-line graph it illustrated the reduction over time of the reduction of contamination defects. The defects that began with an index of 0.87%, reaching its apex in May 2015 with 1.24% of contamination, were reduced to 0.48%. This had significant improvements there was a financial improvement in the company. Also concluded that the use of PDCA method and quality tools proved to be very efficient.

Based on these studies, it was observed that all these researchers had some quality tools in common like the used of cause and effect diagram, Pareto's graphic, stratification, checklist, histogram and brainstorming. And also, in 75% of the publications, researchers applied all the phases of PDCA cycle. Moreover, they all concluded that the application of the PDCA method can detect the causes of problems which were evident in all their work.

Therefore, with the case studies of this work it is more convincing that the application of PDCA method integrated with quality tools which were used by the researchers can also be adopted to solve or provide suggestion on this work

problem about how to improve the printing sector of Akosombo textile limited product of Ghana to reduce the costs the printing sector. It is important to state that in the search carried out on the application of PDCA method there were not found any publications applied to textile industry in Ghana.

3 METHODOLOGY

In order to achieve the goals and objective of this work, a case study will be perform in a Ghanaian textile industry, which will be at Akosombo Textile Limited.

According to Yin (2015), the case study can be defined as an empirical investigation that seeks to investigate a contemporary phenomenon inserted in some real-life context. The case study can be used in exploratory, descriptive and explanatory research.

> "It is also considered as a frame of reference of complex sociocultural conditions that involve a situation and both portrays a reality and reveals the multiplicity of global aspects present in a given situation" (CHIZZOOT 1998, p.102).

3.1 COMPANY DESCRIPTION

Akosombo Textile Limited (ATL) is one of the surviving textile factories in Ghana, established in 1967 and became part of Cha Textiles Group of companies in 1999 as a purpose to distribute their product throughout Africa. Today, ATL company has about 1,650 workers, located at Akosombo at the Eastern Region with its sales and administrative office in Accra (ATL WEBSITE, 2013).

The company vision is: “We intend to consolidate our position as the leading textiles manufacturer in Ghana and to further establish our brands in markets throughout Africa in the next five years to the provision of excellence in the quality of our products, design and product innovation. We are dedicated to excellence in service to our customers” (ATL WEBSITE, 2013). Their missions are:

- Aim to remain as the leading textile manufacturer in Ghana.
- To serve as a main conduit in textile production within a friendly environment.
- To establish ATL brands throughout the Economic Community of West African States (ECOWAS) Sub-region and beyond.

- To distribute excellent quality, fashionable Guaranteed Wax and Fancy Prints at reasonable prices in Ghana, West Africa and beyond for both
- Every day wear and special occasions like Funerals, Weddings, Outdooring and Engagement among others.

The productive process of the company is spinning, printing, dyeing, and finishing capacities all on one site. But the case of study will be focusing on the productive process of the printing sector using the application of PDCA method integrated with quality tool.

3.2 PROCEDURES

The procedures on how this case study will be executed, focusing on the printing sector of the company (ATL) is shown in Table 2.

PDCA	FLOW	STAGE	GOAL	QUALITY TOOL
P	**1**	Identification of the problem	Clearly defining the problem and understanding its importance	Brainstorming, Flowchart
	2	Observation	Investigating specific characteristics of the problem	Checklist, Pareto`s chart
	3	Analysis	Discovering basics causes	Ishikawa diagram, GUT Matrix, BASICO Matrix
	4	Action plan	Blocking the basics causes	5W1H

Table 2 - The PDCA method detailed
Source: Elaborated based on MOEN (2009)

This work will only focus on the first phase of the PDCA method –P (planning). The stages in which this work will be executed are as follow:

In the first stage, the main aim is to clearly identify the problem and understand all the process involved at the printing sector. A flowchart to sketch out the process and the technique of Brainstorming with the managers, employees and technicians or engineers responsible at the printing sector will be required.

According to Marshall (2010), the purpose of brainstorming is to expose and detail ideas by focusing on some aspect, being the original ideas and in an environment without inhibitions. Is technique use to get information or ideas from different people without criticizing any opinion. Brainstorming is a method for producing group ideas involving a short time and the contribution of all the members in order to obtain innovative and creative solutions to the problem (MEIRELES, 2001).

Flowchart is a quality tool use to understand the process of production. It represents algorithm, showing the steps by steps in boxes or symbols of several species connected by arrow of the process flow path. The flowchart graphically assists in understanding the possible sources of variations, in order to facilitate the understanding of its operation (WERKEMA, 1995).

In the second stage the focus is on the collection of historic data or actual data of the company. After defining the problem, there will be an observation of the problem. The use of checklist and Pareto graph will be adapted to checkout specific problems and help to facilitate the visualization and prioritization of problems.

Checklist is a quality too uses to organize a data collection process in order to optimize the subsequent analysis of data been collected (WERKEMA, 2006). According to Vieira (2014), the check sheet is used to record data obtained by judgment, measurement, test or observation. The data collection does not follow any pre-established standard and may be appropriate according to the particularities of the company's manufacturing process. The important thing is that each company develops its data registration form that allows those responsible to understand when using it in order to get the right measurement and information. (MARTINS JR, 2002).

Pareto's chart is a quality tool that provides information in vertical graphic format to facilitate the visualization and prioritization of problems. It is based on the principle that relates to problems and can be classified as vital or trivial. This chart analysis can be used to identify the major causes of problems, or the few causes of the problems to help eliminate all the small causes immediately. A

possibility in the application of Pareto graphs like the Pareto chart splitting, where priority categories selected in the first graph are taken as new problems to be analyzed, whereby the major problems can be separated into smaller and more focused problems.

In the third stage, the focus is on the analysis of all the data collected. After the observation of the problem, this stage will be responsible to analysis and bring out the main root of what causes the problem with the use of Ishikawa diagram (cause and effect diagram), GUT Matrix and BASICO Matrix. Through Brainstorming with the operators and manager will find out all the necessary information needed to eliminate the sources of the problem. BASICO Matrix will prioritize the solutions.

Cause and effect diagram (ishikawa diagram) is a quality tool similar to a fishbone use to present the relationship between the result of a process(effect) and the factors (causes) of the process which may affect the expectance result. For an efficient application of this tool, a Brainstorm and Ask Why is involved, whereby it allows structuring the reasoning of the people to discover the main causes of the problem. With this diagram it is possible to group the causes and the sub-causes, dividing them as machine, method, manpower, raw material, environment and measurement (TOLEDO ET.AL, 2014). The structure of the cause and effect diagram is illustrated below in Figure 3.

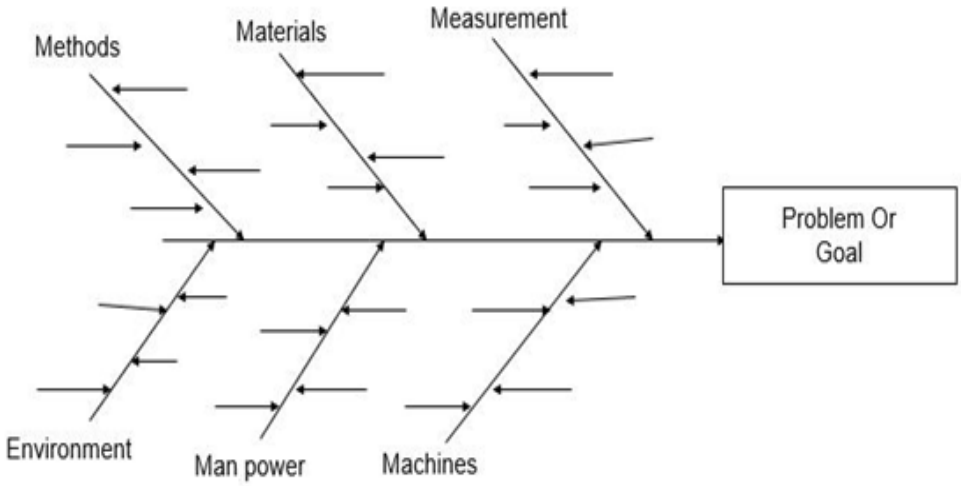

Figure 3 - The cause and effect diagram
Source: Elaborated based on MARIANI (2005)

According to Bezerra et al. (2012) GUT Matrix is a tool that seeks answer questions rationally for problem separation and prioritization in order to solve them. Actions should be prioritized at the organizational level according to the Gravity, Urgency and Trend (GUT) of what occurred in the company. So the element severity refers to damage to outcomes that may arise in the medium to long term, Urgency has as its main determinant the pressure of time for resolution of the problems, and the Trend is about the growth potential of the situation that can evolve with time.

The great advantage of using the GUT Matrix is that it helps the manager to quantitatively assess company problems, making it possible to prioritize corrective and preventive actions (PERIARD, 2011).

Usually, an integer between 1 and 5 is assigned to each of the dimensions (G, U and T), with 5 being the highest intensity and 1 being the lowest and multiplying the values obtained for G, U and T a to obtain a value for each problem or risk factor analyzed. The problems or risk factors that obtain the highest score will be treated as a priority (Marshall, 2008). The Table 3 shows an example of GUT Matrix.

Problems marks	Gravity	Urgency	Trends
5	Extremely gravity	Extremely urgency	Will get worse quickly
4	Very gravity	Very urgency	Will get worse a short time
3	Gravity	Urgency	Will get worse
2	Less gravity	Less urgency	Will get worse in a long time
1	No gravity	No urgency	Nothing will change

Table 3 - The GUT Matrix
Source: Elaborated based on MARSHALL (2008)

BASICO Matrix was developed based on the balance Costs, Benefits, Feasibility and seeks to cover all types of clients and organizations (BRASIL, 2015). For each strategic there is given grade that can vary from 1 to 5 in each of the 6 evaluated criteria, being 1 for a very negative feeling and 5 for a very positive feeling. The criteria evaluated are as follows: Organizational Benefits,

Scope, Internal Customer Satisfaction, Required Investments, Satisfied External Customer, and Operationalization.

Attribute B (Benefits) refers to the impact of the analyzed solution on the process results, such as: cost reduction generated, increase in production and reduction of defects. Attribute A (Coverage) addresses the amount of the organization that will benefit from the improvement of the process in question. Internal Customer Satisfaction (S) corresponds to the degree of satisfaction to be generated in the members of the organization that have some relationship with the process whose improvement is being studied.

The Investments (I) required consider the amount of resources that will be required to effect the improvement of the process in question. The satisfied external Clients (C) understands the impact that the process improvement will have on the external customer. Finally, Operationalization (O) means the feasibility of improving the process under study, taking into account aspects such as: resistance to change, social, cultural, legal impediments, mastery of the required technology, simplicity of implementation and ease of use the strengths of the organization. The Table 4 shows an example of BASICO Matrix.

Marks	Benefits	Coverage	Satisfaction	Investment	Clients	Operational
5	Vital importance to the company's business or even its survival	Covers from 70 to 100% the organization	Very high degree of satisfaction	There is minimal spending and most resources already exist	Has a big positive impact on the company's image with consumers	The company will be very easy to develop operations
4	Big benefits that can generate profit and technological innovation	Large coverage of 40 to 70% of the organization	Great satisfaction being able to generate demonstration of recognition at work	Is there any expenditure within the area budget and use of own resources	Big direct reflections on supporting processes	Ease of developing the operation may require assistance from others
3	Has a reasonable impact on change performance	Reasonably covers the organization (20-40%)	Average satisfaction that can be noticed by co-workers	Spending beyond area budget but still within company budget	Good reflections on support processes	Medium ease depending on technology knowledge and market availability
2	Some operational benefit that can already be quantified	Small range of 5 to 20% in the organization	There is average satisfaction but not noticed by co-workers	Requires approval of board resources because it requires reallocation of funds	Little impact on end processes with customers	Poor ease of operations depending on changes in organizational culture
1	Benefit of little impact but that contributes in some way to the organization	Minimum coverage in the organization of a maximum of 5%	Satisfaction degree small but it can contribute to the development of the company	Expenditures far beyond budget that require new strategic planning	It has no reflection on the company's image with the customer	Operations that are difficult to perform that exceed the limits of company authority

Table 4 - The BASICO Matrix
Source: Elaborated based on BRASIL (2015)

The final stage is the action plan. A standard operating procedure will be created, which will detail the way the operators of the sector of printing should work. With the use of 5W2H and brainstorming to help the operators involved know the processes, identify the elements, activities, products and services and the standards associated with them. There will be a recommendation or proposal which will be a new flowchart to the company on how best they can benefit from this work, solve their problem on high costs and also how to manage their system of operation well to avoid any rework, reduce cost and increase their productivity.

5W1H and 5W2H is one of the important tools of quality to determine the operationalization of the solutions through questioning. It consists of asking questions such as; what will be done (step); how it will be done (method); why it should be done (justification); when the task will be executed (time); who will perform the task (responsible); and how much each task will cost (DAYCHOUW, 2007). The 5W1H and 5W2H is a checklist of activities that need to be developed with the highest level of clarity for better understanding to all the employees of the company.

According to Daychouw (2007), using the 5W2H method for quality planning allows you to identify which quality standards are relevant to the project and determine how to satisfy them. It is of fundamental importance that the people involved know the processes, identifying the elements, activities, products and services and the standards associated with them. Knowing the processes means that those involved are familiar with their planning, production and how they are delivered. The Figure 4 shows an example of 5W2H.

WHAT?	What will be done?
WHO?	Who will do it?
WHEN?	When will it be done?
WHERE?	Where it will be done?
WHY?	Why is it done?
HOW?	How will it be done?
HOW MUCH?	How much will cost?

Figure 4 - The 5W2H tool
Source: Elaborated based on MATTA (2013)

4 RESULTS

4.1 PRINTING PROCESS

To understand the production characteristics of this sector, there is a need to meet on the work process at Akosombo Textile Limited (ATL). The printing sector produces three types of printing which are the ATL's Guaranteed Wax Prints, Fancy Prints and Institutional Prints. The printing production sector works every day 24 hours a day and has two working shifts that take turns every twelve hours. The day shifts consist of ten employees with two or more different teams based on the demand required from their clients, which consists of four operators, two supervisors, one mechanic, two quality control personnel and a factory manager at the night shifts they are staffed by eight employees.

Cylindrical stamping is type adopted by the industry because of its advantage in higher production with a higher speed to print, as a consequence, higher footage per day (cost x benefit). And also, can print continuous stripes, that is, in the sense of warp. Figure 5 shows the flowchart of printing sector.

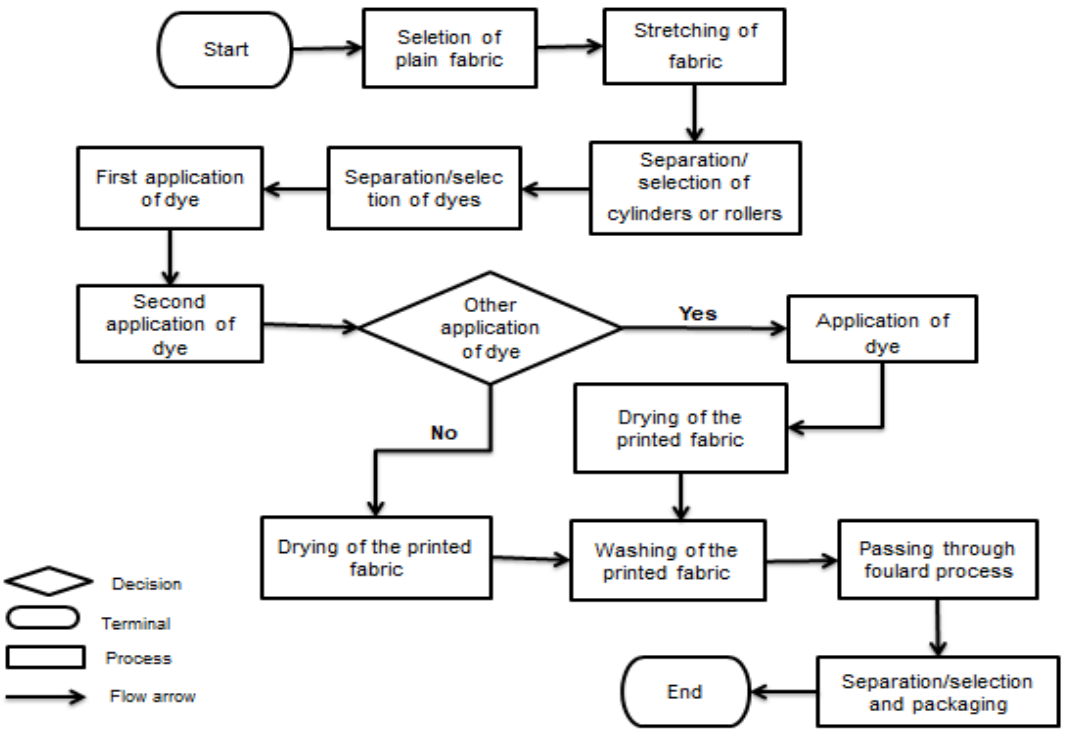

Figure 5 - Plain fabric
Source: Elaborated by the author (2019)

The following are the procedures adapted at the printing sector of ATL Company. The first stage is the selection and separation of the plain fabric. Figure 6 illustrates:

Figure 6 -Plain fabric
Source: Elaborated by the author (2019)

After the selection, the plain fabric is been stretched with a rolling machine. Figure 7 illustrates:

Figure 7 - Stretching before printing
Source: Elaborated by the author (2019)

After the plain fabric has been stretched, then the operators select and separate the cylinders that will be used for printing of the designs. Figure 8 illustrates:

Figure 8 - Selecting of graved cylinder
Source: Elaborated by the author (2019)

The cylinders are being selected according to the design demanded by the clients or programmed for the day. After that, the dyes are been mixed and the cylinders are been mounted on a mat in which the fabric will be printed. The paste and the slip are placed inside the cylinders where the cylinders are in contact with the fabric. The ratchet (inside of the cylinder) is pulled against the mat by an electromagnetic field when the machine is started the belt moves and the cylinders rotate. Figure 9 illustrates this process:

Figure 9 - First application of dye
Source: Elaborated by the author (2019)

The slip forces the colored paste out and prints the fabric cylinders are placed horizontally on a mat. At this stage, there is another addition of color added to the fabric. Figure 10 illustrates the second application of dye:

Figure 10 - The second application of dye
Source: Elaborated by the author (2019)

The number of (color) cylinders range from one to four colors, where each cylinder corresponds to one color. The cylinders need to be adjusted so that the design fits one another, after the application of the second color the fabric is finally printed out. Figure 11 illustrates the printed fabric:

Figure 11 - The printed fabric
Source: Elaborated by the author (2019)

After the fabric is printed, these fabrics are washed and dried. Figure 12 and 13 illustrate this process:

Figure 12 - Waste water from the polymerized process
Source: Elaborated by the author (2019)

Figure 13 - Drying of the printed fabric
Source: Elaborated by the author (2019)

After washing and drying of the printed fabric, its then pass through a foulard process to finalize it. Figure 14 illustrate below:

Figure 14 - Foulard process
Source: Elaborated by the author (2019)

Then the fabric are separated and selected for packaging, Figure 15 illustrate this process:

Figure 15 - Finished printed fabric
Source: Elaborated by the author (2019)

4.2 (P-PLAN): PROBLEM IDENTIFICATION

At the first stage of using the PDCA continuous improvement cycle, our problem identification was based on brainstorming with production process employees of the printing sector, supervisors and factory managers with his assistance. At this result, we identified three main problems which are causing the 6,5% monthly rejection of finished products.

These problems are the breakdown of machine, ununiformed color, and printing of a wrong design.

4.3 (P-PLAN): OBSERVATION

At this stage after identifying the three main problems, with the help of the supervisors responsible for production, a checklist was adapted and was given to the two team leaders of the two groups to register the frequency of this problem during production for a month. Based on this, a Pareto chart was sketched to facilitate the visualization and prioritization of the problems identified. The Figure 16 illustrates the Pareto's chart:

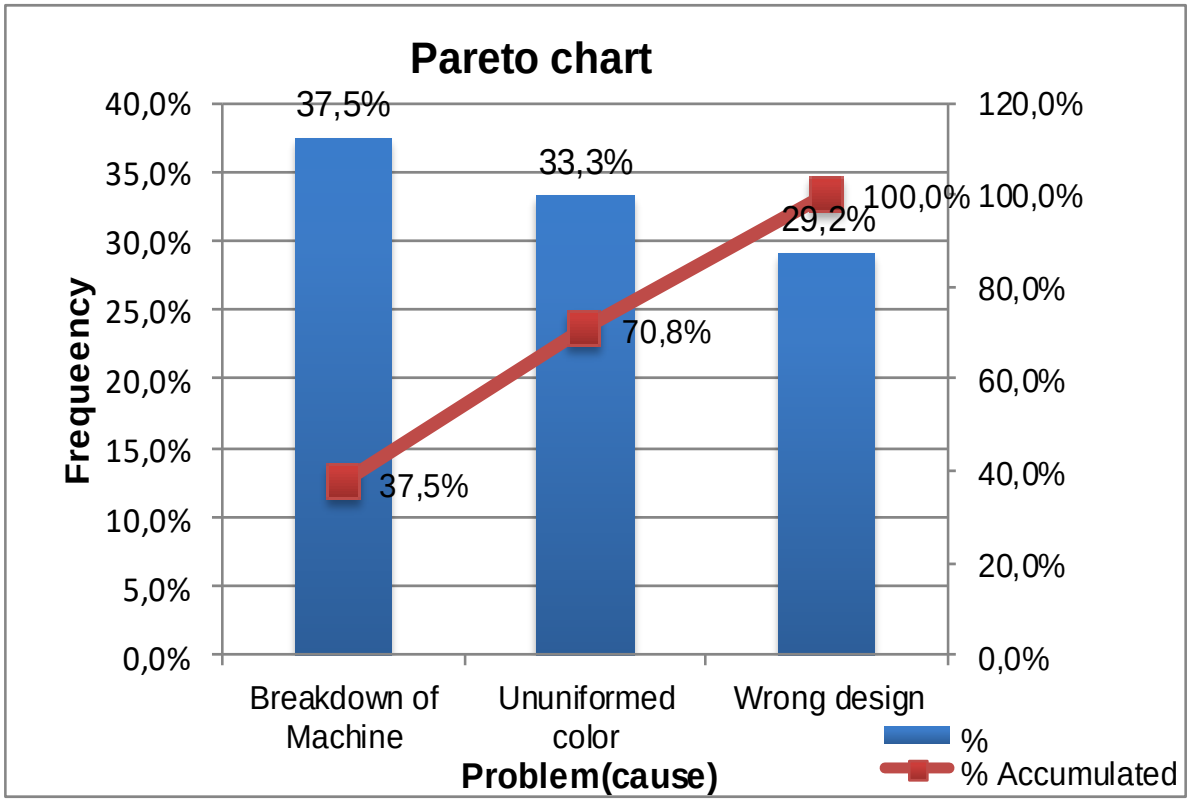

Figure 16 - Pareto's chart
Source: Elaborated by the author (2019)

Using the results above, we noticed that 70,8% of these problems lies between Breakdown of machine and Ununiformed color, which are the mains two problems responsible for the high increase of rejected finished products. With this data, we can focus its scarce resources in addressing the top two problems which are:

- Breakdown of machine and
- Ununiformed color

And this will effectively resolve 70,8% of the 10.833,33 yards which will be gaining of 7583,33 yards resolving about 4,55% out of 6,55% rejected monthly with an estimated gaining of US $17.062,42 out of losing the US $24.374,89 monthly.

4.4 (P-PLAN): ANALYSIS

At this stage after the observation, there was the need to prioritize the two of these problems. Through brainstorming with the operators responsible for production, we are able to bring out some of the causes of these problems through the Ishikawa tool. Moreover, with the completion of the Ishikawa diagram there was a need to draw two different causes and effect diagram, this separation was necessary to facilitate the understanding of each problem. The structure of the Ishikawa diagram is illustrated in these two figures 17 and 18:

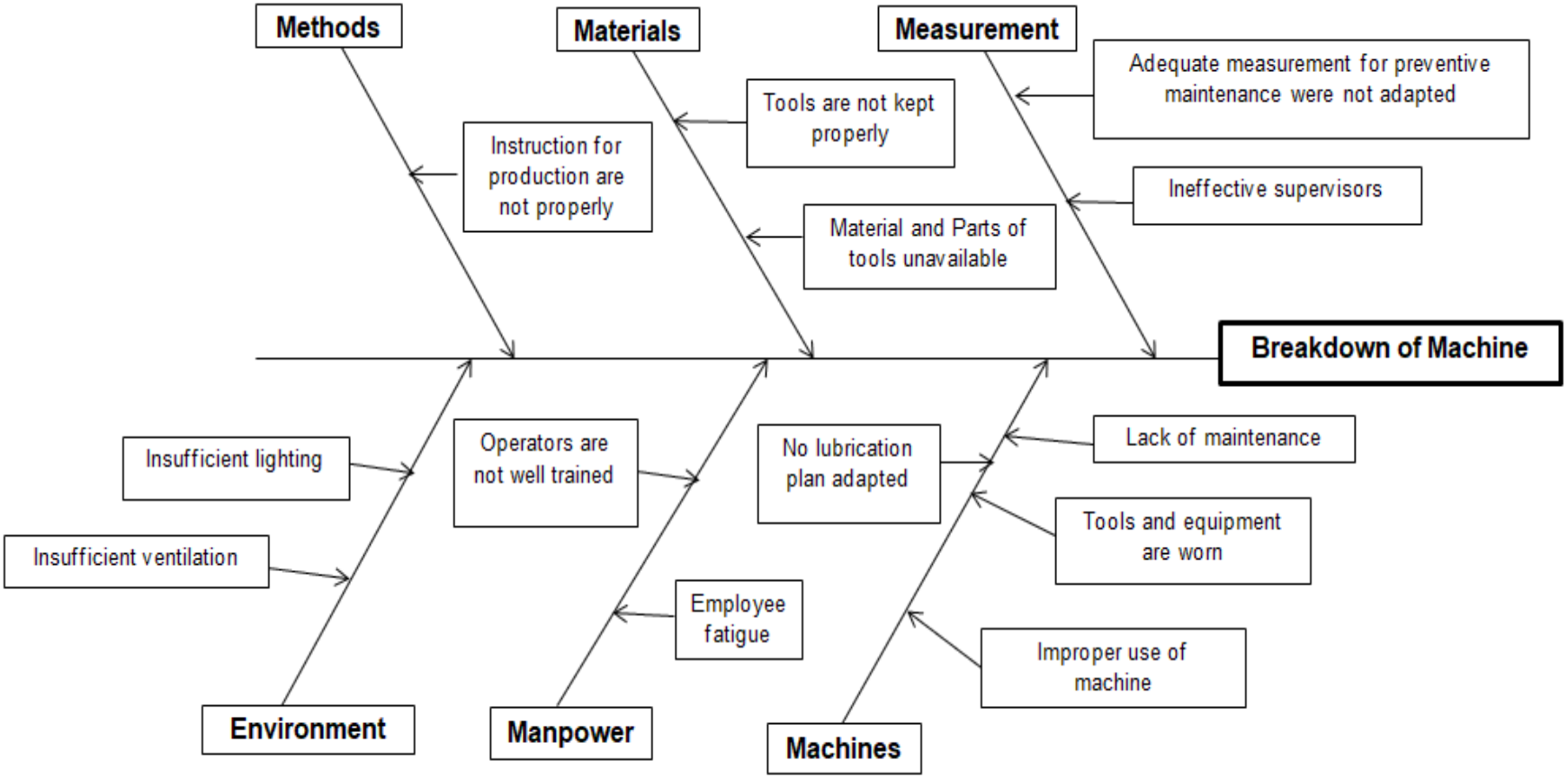

Figure 17 - Ishikawa diagram on the Breakdown of Machine
Source: Elaborated by the author (2019)

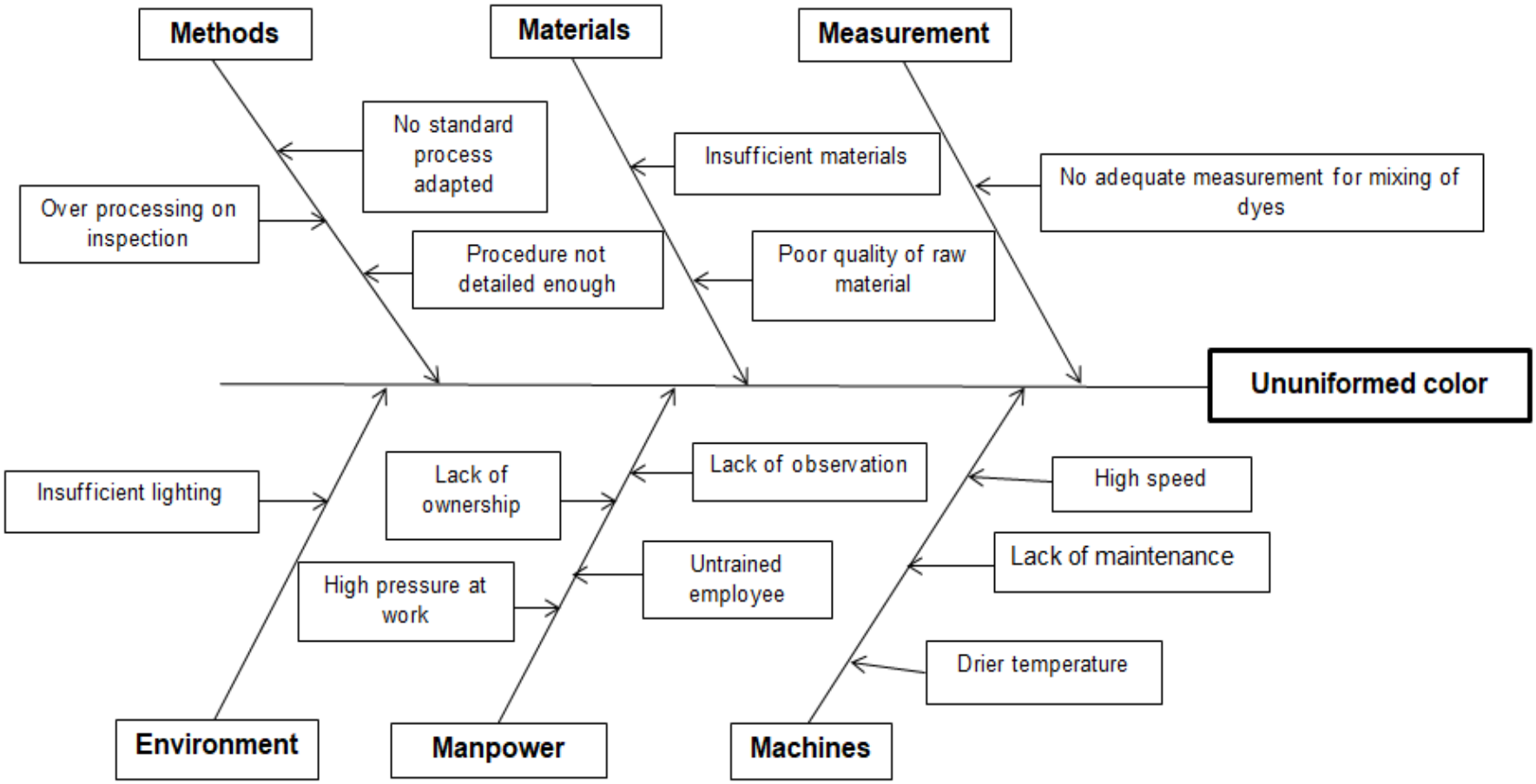

Figure 18 - Ishikawa diagram on Ununiformed color
Source: Elaborated by the author (2019)

After this analysis of the main causes with the help of the Ishikawa diagram, a GUT Matrix was used to prioritize the impacts of these causes. We can observe the results in the Figure 19:

Causes	G	U	T	GxUxT	Level of priorization
No standard process adapted	5	5	5	125	**1st**
Insufficient materials	5	5	5	125	**1st**
Lack of maintenance	5	4	5	100	**2nd**
Untrained employee	4	5	5	100	**2nd**
Adequate measurement for preventive maintenance were not adapted	4	5	4	80	3rd
No adequate measurement for mixing of dye	4	5	4	80	3rd
Improper use of machine	5	4	4	80	3rd
Instruction for production are not properly followed	3	5	5	75	4th
Lack of observation	4	4	4	64	5th
Material and parts of tools unavailable	4	5	3	60	6th
Employee fatigue	3	4	4	48	7th
Procedure not detailed enough	4	3	4	48	7th
Poor quality of raw material	4	3	4	48	7th
No lubrication	4	5	2	40	8th
Ineffective supervisors	3	4	3	36	9th
Operators are not motivated	4	4	2	32	10th
Tools and equipment are worn	4	3	2	24	11th
Over processing on inspection	3	2	4	24	11th
High speed	3	2	3	18	12th
Tools are not kept properly	2	2	2	8	13th
Insufficient lighting	2	2	2	8	13th
Insufficient ventilation	3	2	1	6	14th
High pressure of work	2	1	2	4	15th

Figure 19 - The GUT Matrix
Source: Elaborated by the author (2019)

After using GUT Matrix to prioritize the causes of the problem, a brainstorming was used to bring out possible solutions to the first- four causes identified. The Table 5 illustrates the solutions with the cause of the problem.

Cause	Solutions
No standard process adapted	Adaption of standard process and strictly following it
	Elaborating a simple and understandable mixing of dye guide for the operators
	Effective orientation and observation before production
	Effective study and analyses of process
	Critical study and analysis on demands

Cause	Solutions
Insufficient materials	Adaption of a control system on stocks
	Buying of new tools and equipment
	Purchasing of good raw materials
	Analyzing on stock weekly for production
	Have a reliable and confident supplier for materials

Cause	Solutions
Lack of maintenance	Elaborating an effective cleaning and lubrication plan
	Introduction of predictive maintenance
	Regular regulation of machines
	Separation and organization of tools and equipment
	An experienced technicians or engineer should always be available for corrective maintenance

Cause	Solutions
Untrained employee	Training of employee
	Adaption an effective instruction guide for operation of machine
	Communication between employee and factory manager
	Instructive guide on operation of machine
	Motivating and encouraging the experienced employees to train the inexperienced operators

Table 5 - The Solution
Source: Elaborated by the author (2019)

After bringing out the possible solutions through brainstorming with the supervisors, BASICO Matrix was drawn to prioritize the solutions above. Table 6 illustrates:

Solutions	B	A	S	I	C	O	Total marks	Priority
1. Adaption of standard process and strictly following it	5	5	5	3	2	5	25	3rd
2. Elaborating a simple and understandable mixing of dye guide for the operators	5	4	5	5	3	5	27	2nd
3. Effective orientation and observation before production	5	5	5	5	4	5	29	**1st**
4. Effective study and analyses of process	5	4	3	4	2	5	23	4th
5. Critical study and analysis on demands	3	4	1	3	2	4	17	5th

Solutions	B	A	S	I	C	O	Total marks	Priority
1. Adaption of a control system on stocks	5	5	5	2	1	3	21	3rd
2. Buying of new tools and equipment	4	3	5	1	2	4	19	4th
3. Purchasing of good raw materials	5	5	5	1	5	2	23	2nd
4. Analyzing on stock weekly for production	3	4	2	5	1	5	20	4th
5. Have a reliable and confident supplier for materials	5	5	2	5	2	5	24	**1st**

Solutions	B	A	S	I	C	O	Total marks	Priority
1. Elaborating an effective cleaning and lubrication plan	5	5	4	5	3	5	27	**1st**
2. Introduction of predictive maintenance	5	5	5	2	3	2	22	4th
3. Regular regulation of machines	5	5	5	5	1	4	25	2nd
4. Separation and organization of tools and equipment	5	3	5	5	1	4	23	3rd
5. An experienced technicians or engineer should always be available for corrective maintenance	3	3	5	3	1	5	20	5th

Solutions	B	A	S	I	C	O	Total marks	Priority
1. Training of employee	5	5	5	4	3	4	26	**1st**
2. Adaption an effective instruction guide for operation of machine	4	3	5	3	1	4	20	3rd
3. Communication between employee and factory manager	4	3	5	5	2	5	24	2nd
4. Instructive guide on operation of machine	4	4	5	5	1	5	24	2nd
5. Motivating and encouraging the experienced employees to train the inexperienced operators	5	3	5	4	1	2	20	3rd

Table 6 - The BASICO Matrix
Source: Elaborated by the author (2019)

4.5 (P-PLAN): ACTION PLAN

At the final stage of step P (Plan) of the cycle, the action plan was elaborated granting a plan to block the main causes already presented in the Ishikawa diagram and GUT Matrix. For the elaboration of the action plan, BASICO Matrix was used to prioritize the solutions mentions. Table 7 illustrated below summarizes the action plan with the use of the 5W1H quality tool:

ACTION PLAN	WHAT	WHEN	WHERE	WHO	WHY	HOW
1	Effective orientation and observation	Before production	At the industry	Experienced supervisor or responsible leader	To minimize errors during production and to help the operators to understand the process	Through a flowchart and instructive guide chart
2	Have a reliable and confident supplier for materials	During purchasing	From a outsourced company	Workers at the Resources department	To avoid shortage of materials, tools and equipment during production	Through research and historic data from the company
3	Elaborating an effective cleaning and lubrication plan	As soon as possible	All the machine for production	Experienced operators or specialized technicians	To decrease corrective maintenance and increase machine reliability	Through cleaning and lubrication instruction guide
4	Training of employee	After recruitment	At the industry	Factory manager; trained supervisor or experienced operator	To reduce the mistakes and loss of time; improve on quality of work	Through internship training

Table 7 - 5W1H diagram
Source: Elaborated by the author (2019)

5 DISCUSSIONS

In this study, in order to discuss the results obtained, there is the need to critically compare the results of others researchers who applied this methods. The table 8 summarized the quality tools used by this study with the other authors of the PDCA improvement method:

Case study based on Theoretical References	PDCA P(Plan)			
	P- Identification of the problem	**Observation of the problem**	**Analysis of the problem**	**Action Plan**
Machado L G (2007)			Pareto's diagram, Stratification, Control graphic	
Vasconcelos et al. (2009)	Brainstorming, Flowchart	Brainstorming, Checklist	Pareto's diagram, Ishikawa diagram, GUT Matrix	
Silva & Sartoni (2014)	Checklist	Pareto's diagram	Ishikawa diagram, Stratification, Histogram	5W2H
Martins et al. (2017)	Brainstorming, Flowchart	Checklist	Stratification, Pareto's diagram, Ishikawa diagram	Brainstorming
This study (2019)	Brainstorming, Flowchart	Checklist, Pareto's chart	Ishikawa diagram, GUT Matrix, BASICO Matrix	5W1H

Table 8 - Summary on Quality tool used with application on PDCA method
Source: Elaborated by the author (2019)

With this study, it was noted that identifying the problem conducted through brainstorming and flowchart, resulted in a good understanding of the process involved and was able to address the issue at hand. Whiles with the other author Machado L G (2007), used documented problem which was already identified by the industry and able drawn out the process involved.

It was observed that the use of a checklist was effective and was adopted by three of the authors to get a clear view of the problem identified. Even though, this study used Pareto's chart to prioritize the problem which is causing about 70,8%. Three researchers actually used this tool to analyze the problem which was quite different and surprising, but it was also able to bring out positive results.

It was possible that the cause and effect diagram was able to bring out all the possible causes of the problem and seem more probably that three the researchers applied this tool and it’s was successful. Although Machado L G (2007) suggested that, control graphic can also be used for analysis. According to Silva & Sartoni (2014) and Martin et al. (2017) proved that stratification also provides a clear analysis of the problem, which this study actually didn’t adopt this tool. But applied GUT Matrix to prioritize the problem and BASICO Matrix to prioritize the solution given.

The action plan elaborated on this study was suggested by Silva & Sartoni (2014), which tends that 5W1H was able to bring out solutions and also provides how to solve these solutions. There is also the possibility of using Brainstorming shows by Martins et al. (2017), to elaborate an action plan to solve problems and minimize or reduce these problems.

6 CONCLUSIONS

The findings from this study suggest that the application of the PDCA methods may reduce the amount of rejected finished product at the printing sector of Akosombo Textile Limited in Ghana. The goal of reducing the percentage of rejected finished products could be challenging in every industry. Implementing a PDCA cycle initially required finding the opportunity to minimize problems, which systematically identifies and manages the processes that combine the quality tools and the interactions between the processes. This method applies to all processes to control the production quality, to reduce and eliminate waste.

The Akosombo Textile Limited was identified as one of the surviving textile industry in Ghana, contributing to the national resource revenue and also competing with other textile industries including China. However, there have been challenges on how to reduce the amount of rejected products produced the application of the PDCA improvement cycle was used to minimize this issue.

A company will commercially survive in the world market as long as his product best satisfies his clients at the rate they are prepared to pay with a quality standard required. As a textile industry, there have always been internal and external challenges, as results to that, there is a need to elaborate a good and effective action plan to continuously improve on their production processes in order to minimize or reduce the waste produced.

There are several limitations of this study. Though this study was able to identify the three main problems, prioritize the two problems that need to solved, identified the causes of these problems and providing solutions which are the action plans to blocks these causes. There may be other important problems that were not included since the industry didn’t have an indicator system with historic data to record the frequency of problems faced by the industry. And also, since this study was not applied, it important to reinforce that not all the actions plan given will be easy to apply or will be 100%

successful in the first attempt. But with the correct use of the PDCA method, good results can be achieved.

This work is actually the first study that is being carried out with the application of the first phase of PDCA methods to Akosombo Textile Limited in Ghana. There is a good opportunity for further studies to seeks to apply the other phases of the PDCA improvement methods to gain better results and provides accurate actions plan for improvement to the industry.

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