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IMPLEMETATION OF A QUALITY CONTROL TOOL TO REDUCE THE REWORK ON A CLOTHING INDUSTRY, A CASE STUDY.

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Abstract*: The present article is will present an implementation of a quality tool that uses as programming based on data of an very useful program known as Excel. The implementation was made on a determinate industry of clothes which is characterized by the model of the society as small industry, situated on the south of Minas Gerais, whose nome is WF Uniforms. The main point is to reduce the time spend on the production and the cost of the rework ono vestments with problems , was applied an tool where was tested the control on a stastical level , for that , all the clothes that presents an issue they were classified in levels and different weights according to the rework , so we can measure the time wasted to rebuild the piece of clothes and also the cost of the rework , than removing a certain amount of money in determinate part charged by the tertiary industry for providing products with a high indicator level of rework for each piece that present an level of issue. Consequently the use of the efficient tool could be a significant drop the rate of clothes that are defective and can thus save some money that is used for the cost of rework and redirect the money elsewhere in the company, along with the time that would be lost in the process, now can be used to produce more , allowing maximize profit even more. In other words both the customer and the company will haves satisfied results because both parties will benefit from the application of the tool, than the client will have a quality piece and the company will be able to save time and money in the process.*

Keywords*: Control, Statistical, Rework, Quality.*

1. INTRODUCTION

The research object of this work is the observation of the application of a tool as a way to control the quality of a manufacturer of clothing in the textile industry in its "external" production. The work is based on a study by an organization, WF Uniforms, located in Itanhandu, Minas Gerais, which produces and sells clothing in general. The company studied is small, employs about 90 internal employees and about 15 external factions (outsourced), with approximately 50 employees in total.

According to the relevance of this study, we notice the fact that it is difficult for a small garment industry in the implementation of planning and production control by having a wide range of models, where usually the products enter the production process for That are produced in small quantities. This fact complicates the continued progress of the production due to the high number of setup, what most often leads to delays in the process of manufacture of the products, therefore in delays in deliveries. In addition, increasing the difficulty regarding quality control of various products to be distributed to the market.

Note that the consumer market, have not been willing to pay for the inefficiencies embedded in the management and production processes of the companies. So every day we face increased competition in the business world, where organizations are under pressure to reduce costs and improve the quality and efficiency of operations.

It is possible to highlight as a means of production of a company the outsourced production method, is the company conducts the primary service like lifting raw materials, shopping, modeling, cutting clothes, customization and finally the expected time of production for the purpose research, is the place where the featured problem, where through an outsourced production could notice the problem concerning the quality of services and additional costs due to rework.

Through this work will be shown an applied quality control model, where for a spreadsheet created in Excel, widely used in today's job market tool, with the implementation carried out has generated a significant improvement to organizing, achieving better results in the quality department together to garments produced, in addition, reducing rework costs. The obtained results are meant to demonstrate that the quality can be statistically controlled by a simple tool, Excel, and through a simple plan can achieve great results in this case the reduction in rework and financial recovery values that were spending unnecessarily.

Returning to the textile production segment, it can be said that the clothing industry to be competitive must evaluate the market, find out what your target audience and their needs, seeking to be updated with the trends, speed and delivery

reliability, quality in products, seek to have a good relationship with customers that are fundamental to get a result in sales. "Being competitive is being able to beat the competition on those aspects of performance that targeted niche markets value most" (Correa; Gianesi; CAON, 2007).

2. THEORITCAL FOUNDATION

It possible to say that the quality is a word with multiple meanings both in business and in people's lives. For some organizations it may mean a competitive edge or minimum qualification to compete with the labor market. At first moment Biégas and Cardoso (2005) consider that "Quality System in the garment industry is a set of information of technical specifications for materials and processes that guide the inspection and control, defined during the product development" and that there are programs and tools that contribute to the practical analysis and quality specifications. Secondly, in an attempt to identify the tools used in the the clothing industry, Cardoso et al (2009) observed that the practice performed in the apparel industries in the "Fashion Hall" shows low use of the management tools that contribute to quality.

According Coral (1996) and Sakurai (1997), the quality issue has gained ground in the companies only in the 80's, given that the Japanese products won the market with lower prices and higher quality than the competition. Thus, companies began to realize that the quality contributes to obtain and sustain a competitive advantage.

A Total Quality and all the tools that complement are accessible to all businesses, including small ones. Through the research conducted it was found that Campos (1999) said that the TQC (Total Quality Control) is the sum of the total control to total quality. Thus, it is observed that the total control exercised by everyone in the company through appropriate tools and a systematic way and the overall quality placed as the goal of any human organization focused on meeting people, generates an efficiency covering everyone involved in the midst of processes. Based on the quality pointing, it is possible to measure this values by software, for example Excel where therethrough, develop charts, pivot tables, spreadsheets with conditional formatting, among other means.

When data in a particular control means of Excel spreadsheets can be seen that a given process is stable, ie, no presence of special causes of variation acting on it, in other words, it is observed that quality control of a particular process is good. According to Ramos (2000), for a process to be considered statistically stable, the points at control charts should distribute randomly around the midline without strange type patterns, increasing or decreasing trends, cycles, laminates or mixtures outside points the control limits.

A certain process stable or under an statistical control presents a certain prediction of future values and data in the short or even long-term, which varies for each process and its subaerial, however it is possible that even a process with little variability produces defective items or non-compliant. After stabilization of a process, the analysis of the same capacity will provide guidelines for decision as the change or not of the production system, according to the case found (Santos & Batista, 2005).

2.1 The evolution of Quality

With the evolution and technological development advancing day by day it can divide the evolution of quality in six periods, according Paladini (1995). The first period also featured as antiquity, can be described by high quality and for fundamental discoveries in the field of mathematics. In the second period or the Middle Ages, they were the first quality control operators, through the diversification of small business production lines. Between 1900 and 1930 the third period, it emerged the quality control supervisors and also the first methods of statistical quality control. In the fourth period, which includes the 1930 and 1940s, statistics applications were developed in manufacturing processes, based on control charts and acceptance sampling. In the 1950s, or fifth period, the quality can be characterized by the spread of existing systems, such as sampling plan. In the same period, the methods and the conceptual essence of quality control have been recognized. In the sixth and last period, covering the years 1960, 1970 and 1980, there was the extension of the basic concept of quality for new expansions, because of the emergence of the concept of Total Quality Control (TQC) and the creation of Zero Defect Model. Even in the sixth period, but more specifically in the 1980s, the computer allow to become easier to use statistical techniques to the consumer and production laws were created.

In Figure 1 below can be seen a demonstration of the quality eras the course of time:

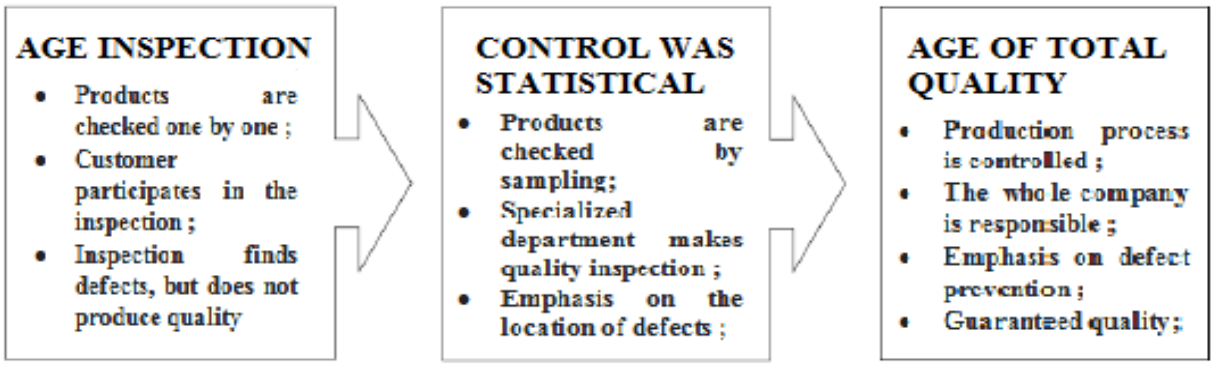

Figure 1 - Source: OLIVEIRA (2011), Quality Eras

Based on the above developments, according to Costa (2013), the quality has become for organizations, synonymous with survival in the competitive market, since customers and the market itself are increasingly demanding as to the characteristics of the products they purchase. Also for Barreto (2008), the quality has thus become part of the management of companies and the process by your search is through the analysis of quality costs, which provides the identification of improvement opportunities through the problems viewing.

2.2 Costs of Quality

It can be said that the costs of quality are the costs for obtaining and maintaining the quality of products or provision of services. Coral (1996), Quality Cost definition depends on the quality definition adopted by the organization, which leads to different applications and interpretations. Already, Juran and Gryna (1991) conceptualize quality as fitness for purpose and, according to Albright and Roth (1992), the Quality Cost is defined as the costs incurred by the fact that there is poor quality. These costs ensure that quality standards are met.

As each day passes the market have required a greater degree of involvement and commitment of all, so the organization can remain active, directly linked to this is the quality factor, which is responsible for growth and development. An undertaking performing as a whole with quality achieves its objectives and goals but be an organization of excellence is the challenge and the desire of achievement for all. In addition to hard work, we need perseverance and a systematic process. In this sense the human being is the fundamental workpiece and motivated for success of this process.

Below the chart can be seen the relationship between the cost of quality, according Juran and Gryna (1980):

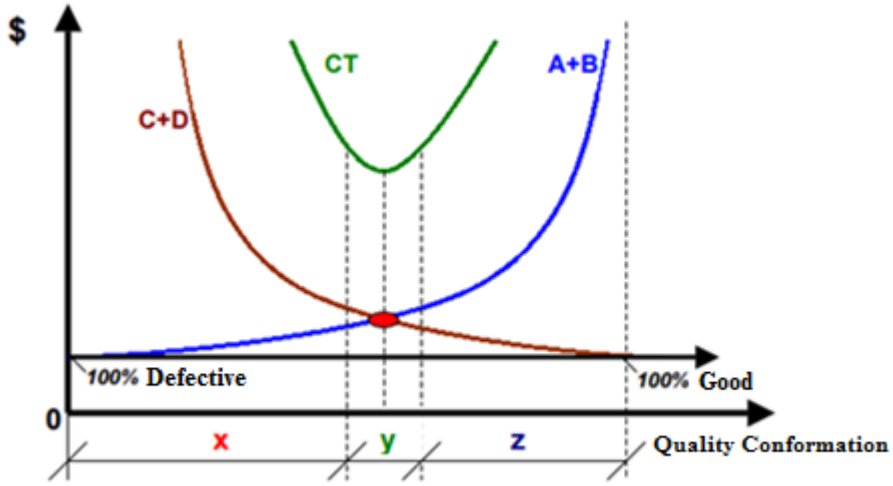

Figure 2: Source - Adapted from Juran and Gryna (1980)

We can data from this chart:
A + B = Cost for obtaining quality
C + D = Failure Cost
CT = Total Cost
X = Improvement Zone (costs of failures> 70%)
Y = Indifference Zone (Cost of Failure = 50%)
Z = perfectionism Zone (Cost of Failure <40%)

Based on this chart above, it is observed that: when prevention costs (A) and Evaluation (B) tend to zero or the item produced will be 100% defective, in this context, the failure costs (C + D) tend to be very high. On the other hand, when the manufactured item is 100% in the quality conformation, ie no faults, the cost of evaluation prevention and tend to be very high. The idea then, is who is a "point great or ideal "that this chart is represented by point Y and the total cost (CT). In this area of failure costs They are about half the costs of quality, while prevention is about 10% of quality costs.

To Özkan and Karaibrahimoglu (2013) consider that quality problems are subject to prejudice the competitive position and reputation of the organization. For a company to measure the quality costs are needed accurate cost information. It is said that the traditional cost accounting, can vary the costs if incorrectly measured.

2.3 Quality tools

According Seleme and Stadler (2008, p. 24) method is "the logical sequence employed to achieve the desired goal, while the tool is the resource used in the method." The integrated use of the method and tools form the sum of these synergistic. So the organizations will follow a proper quality management required the joint use of methods and tools, thus ensuring bigger and better results. In this topic the subject matter will describe some tools used for quality control.

Among the methods, it is possible to describe:

- Statistical Process Control (SPC) and as a set of on-line quality monitoring tools. With this tool, you achieve a detailed description of the process behavior by identifying their variability and enabling the control over time through ongoing data collection and analysis and blocking of possible special causes responsible for the instability of the process under study as Alencar research data (2004) and also confirmed by Cortivo (2005). The Statistical Process Control covers the collection, analysis and interpretation of data in order to solve a particular problem.
- The Histogram seconds Veres (2009) is a tool that allows to know the characteristics of a process or a batch of products permitting an overview of changes in a data set, showing the shape of the set of data distribution, the location value central and dispersion. The Histogram is a graphical representation of various data collected by frequency conventions. Are graphics that allow us to see how repeating events vary over time, also allows the interpretation of a large volume of data.
- The cause and effect diagram for Kaoru Ishikawa was developed in 1953 at the University of Tokyo, to represent the relationship between some effects that could be measured and the set of possible causes which produce the effect (Andrade 2013). In the description of Mello et al. (2009) this tool may be used for analyzing problems in typical situations and operations of a process.
- In Leite's description (2013), "MASP is based on obtaining data, which justify or prove facts previously raised and prove the causes of problems." It consists of a systematic with several steps where possible, by application of specific tools; identify opportunities for improvement and outline a correction plan, implementation and monitoring. Understanding how to solve a problem, the use of a stepwise process can better evaluate and manage time to be invested in a solution.
- For Borges, Oliveira e Oliveira (2013) the PPA (Process Point Analysis) is applied when, the problems related to an item, several different jobs have already been applied without however to have reached the "Zero" problems. Search the exact spot of this problems that contribute to achieve the result.

3. Characterization of the problem

The company studied operates in the clothing sector and is located in MG and the problem discussed here can be applied in various other sectors. Basically the weak point to be described in question comes to flaws in product quality, either at the time of industrialization or even in early stages of creation.

The company has an external / outsourced production with about 15 factions of sewing and one of the tasks for the CFP department is to plan and control the production of each party individually, and when one of the tasks is to control, it is necessary to highlight the products for meet the needs of the customers, products have to be manufactured with quality.

In this context the company had been facing a number of problems related to products that were manufactured externally, but were delivered to conduct review and finish with a series of defects, thereby causing the need to carry out rework, generating more costs and more time production, thus often delaying the delivery of products. Below can be seen a picture related to the flow chart of the processes in the studied company.

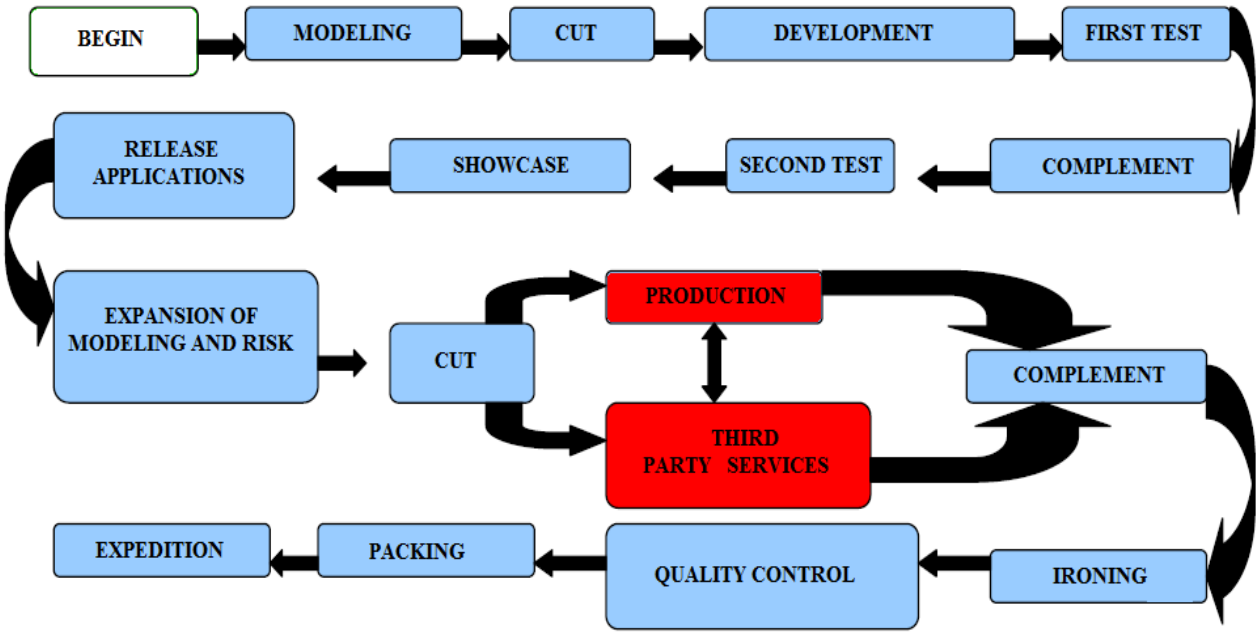

Figure 3 - Company Process Flow Chart

This year 2015, more specifically in making an analysis of the situation was noted that it would be necessary to make a record of these data to argue against with the factions responsible for the production of clothing. Thus, there was a study of tools that could be developed to remedy the problems.

Below it can be seen in Table basically the description of the factions (no real data of exposure) as well as their respective production monthly basis of an arithmetic average of six months of production.

Table 1: Balance of situation - 3 months

Factions	Average Production (Parts)	Average Rework (Parts)	Média Rework (%)
Faction X1	825	115	13,94%
Faction X2	1000	112	11,20%
Faction X3	788	86	10,91%
Faction X4	980	167	17,04%
Faction X5	914	78	8,53%
Faction X6	1096	98	8,94%
Faction X7	650	67	10,31%
Faction X8	856	98	11,45%
Faction X9	710	59	8,31%
Faction X10	777	56	7,21%
Faction X11	854	45	5,27%
Faction X12	1013	49	4,84%
Faction X13	899	90	10,01%
Faction X14	723	112	15,49%
Faction X15	688	87	12,65%

Based on these data presented was obtained as an internal record an overall rate of 10.41% rework in 3 months, and it was decided in internal meetings of the organization than the standard maximum rate acceptable to rework would be 3,09%.

4. Materials and methods

By the issue that was identified in the theoretical framework, the research method led to the construction guidelines that make up the management model of quality businesses. From the point of view of the nature of research, ranks this research as a case study, based on real events, which can be refined and further developed in the near future.

The article in question presents the study in a small company in the textile industry which has a non-active control rework, it not makes the monetization of the losses and quality costs.

Through the data presented in the previous section, it can be noted that it would be necessary to adopt a kind of method to correct the company's quality standards and its correlation with external production. After studying cases of companies that have faced some similar problems, it was proposed the board of the company a quality cost control tool for each faction responsible for production.

Thus, through the Excel was created one statistical control sheet, which through this it would be possible to classify the pieces that would rework for 1st, 2nd and 3rd degree.

From this it was called the 1st degree repairs those that are easier to fix as fallen stitches, pies labels without labels parts, faults in the seam. Already the 2nd grade was defined by default those that are harder to fix, like crooked pockets, ask the parts without finalizing, without sheaths, shares traded in the assembly presenting irregularities in accordance with labeling and finally the appointment of 3rd degree, those parts for careless reasons, inattention or even human error, generate a total loss of the piece.

Below can be seen in Figure 1, the internal control sheet quality, where are the results of each external faction described, detailing the parts and products needed to pass by a rework in order to facilitate the control of the external quality and also generating a survey of additional costs so as to be discounted after the payment of each faction responsible. Also, making a note of which foreign production lines require a strict quality control.

QUALITY CONTROL - MONTH:										NAME:
ORDER	CLIENT/ITEM	PRODUCT	TOTAL AMOUNT	DATA ENTRADA	FIRST REPAIRS	SECOND REPAIRS	THIRD REPAIRS	TOTAL REPAIRS	DATA OUTPUT	OBSERVATIONS

First-degree repairs - are those easiest to fix as pieces without labels, fallen points.
Second-degree repairs - are those that require a bit more work (counter of parts, crooked pockets (height), wrinkled cuffs, waistband of another color.)
Third-degree repairs - those who are preventing parts from being marketed (oil dirt / grease, cut in pieces, seams out of standard.)
In the case of first or second degree repairs will be deducted from 5% to 10% respectively of the value of the parts.
In case of third degree repairs, will be deducted from the workpiece.

Figure 4 - Internal Control Factions Sewing

From the creation of this internal control sheet, every end of month it was possible to generate a statistical report, which is shown the percentage of rework each faction, as well as the amounts to be deducted from the monthly payment of external factions.

As some factions produce more than others, so it was necessary to make an adjustment in the final report that the percentages of rework were consistent among all contract factories. This adaptation can be explained by a calculation with different weights, ie, they are assigned the values 1, 2 and 3 degrees different amounts, thereby adjusting the percentage of each faction.

When a particular line of external production (x1) produces 1000 pieces and this ends up generating 100 pieces rework 1st degree, you can sort as 10% of rework being all 1st degree, though, and if another production line (x2) It produces 2000 pieces, but only has 100 pieces of rework and these reworks are 2nd degree, the calculation with specific weights faction (x2) would have the same 10% of rework and thus presenting an equal result in percentage faction (x1) and worse in quality. This example can be exemplified in Table 2 below:

Table 2: Example - Quality Percentage with Weights

Factions	Produced Parts	Repairs 1°	Repairs 2°	Repairs 3°	Total Weight	Percentage
X1	1000	100			100	10,00%
X2	2000		100		200	10,00%

Based on this chart was found that the calculation weighing takes the final result to the nearest as possible to reality, the basic calculations primarily to these presented data was as follows, 1st degree Weight 1, 2 degree, weight 2, 3 grade 3 weight, thereby calculating the X1 faction was 100 rework multiplied by 1 resulting in 100 thereof, which is basically a 10% faction 1000. Since X2 rework had 100 multiplied by 2, resulting in 200, which is 10 % in 2000. in percentage factions showed the same results, but in quality X2 faction left to be desired knowing that the 2nd grade are repair more serious errors.

5. RESULTS.

After six months of application of this internal quality control and the discounts made in payments of people of factions, the result was absurdly positive. By having this internal noted and be controlling factions closely, making the discounts, it is believed that external employees left the convenience and began to better review the product after termination thereby generating a repair rate of around 2.1 % which is within the target presented by the company.

With the development of this internal tool through Excel, the first monthly report is shown below where it is observed high values for rework rate:

Table 3: First Monthly Report - Rework

Rework report/Quality - March									
Factions	**Produced Parts**	**Repairs 1°**	**Repairs 2°**	**Repairs 3°**	**Total Weight**	**Percentage**	**Notes**	**Total Value of Discounts**	
X1	900	78	34		146	16,22%	BAD	R$	43,80
X2	976	45	26		97	9,94%	BAD	R$	29,10
X3	815	78	4	4	98	12,02%	BAD	R$	49,80
X4	1002	134	34		202	20,16%	BAD	R$	60,60
X5	915	35	16	2	73	7,98%	BAD	R$	32,10
X6	1075	56	13		82	7,63%	BAD	R$	24,60
X7	665	34	24		82	12,33%	BAD	R$	24,60
X8	860	78	9	3	105	12,21%	BAD	R$	46,80
X9	750	22	12		46	6,13%	BAD	R$	13,80
X10	809	45	9		63	7,79%	BAD	R$	18,90
X11	855	47	9	3	74	8,65%	BAD	R$	37,50
X12	1036	24	9		42	4,05%	BAD	R$	12,60
X13	887	80	25		130	14,66%	BAD	R$	39,00
X14	701	88	10	5	123	17,55%	BAD	R$	62,40
X15	699	56	7		70	10,01%	BAD	R$	21,00
TOTAL	**12945**	**900**	**241**	**17**	**1433**			**R$**	**516,60**

Based on this chart we observe the high turnover of rework, where the organization had to bear all the costs of repairs, but this first month of application generated a financial return of R$ 516.60, which for a size of a company small makes all the difference. However, the real return for company came to be seen in the following months, this non-financial, but rather quality of the company's overall performance in relation to the quality of its products.

In the table is possible to analyze a column described as notes where these were performed by an Excel formula condition, the SE, to make it possible, the conditions adopted for this report are described in Chart 4 below.

Table 4: Quality Appointment

GREAT	**between**	**0,0%**	**e**	**1,0%**
GOOD	**between**	**1,1%**	**e**	**3,0%**
BAD	**more**	**3,1%**		

At first balance sheet information is noted that the quality of all the sewing factions was "BAD", but for the first report this was expected, but need to be improved this condition amid the coming months. Over the months the results start to improve, according to the internal notes of the actions was adopted a new position front to the rework and this generated a significant result the organization studied further reduced the cost of rework and thus decreasing the discounts from the producers factions payments.

The application of the 6 months report can be seen in the chart below and note the immeasurable difference from the first month of application.

Table 5: First Monthly Report – Rework

Rework report/Quality - September									
Factions	Produced Parts	Repairs 1°	Repairs 2°	Repairs 3°	Total Weight	Percentage	Notes	Total Value of Discounts	
X1	850	13	5		23	2,71%	GOOD	R$	6,90
X2	1006	12	9		30	2,98%	BAD	R$	9,00
X3	865	24	4	1	35	4,05%	BAD	R$	15,60
X4	960	17	6		29	3,02%	GOOD	R$	8,70
X5	935	8	4	1	19	2,03%	GOOD	R$	10,80
X6	1095	5	2		9	0,82%	GREAT	R$	2,70
X7	685	7			7	1,02%	GREAT	R$	2,10
X8	840	11	3	1	20	2,38%	GOOD	R$	11,10
X9	750	2		1	5	0,67%	GREAT	R$	6,60
X10	839	16			16	1,91%	GOOD	R$	4,80
X11	833	7	3	1	16	1,92%	GOOD	R$	9,90
X12	1036	5			5	0,48%	GREAT	R$	1,50
X13	910	16	5		26	2,86%	GOOD	R$	7,80
X14	877	14	4	1	25	2,85%	GOOD	R$	12,60
X15	734	15	4		23	3,13%	BAD	R$	6,90
TOTAL	13215	172	49	6	288			R$	117,00

Based on this the last monthly report it was noted that the desired results were achieved, both in the percentage monthly rework, as for the internal quality, wasted time and cost of production. Through the graphic below can be seen the reduction of line month after month, certainly through this internal control, aiming to collect and motivate external factions to increased review of products in order to avoid discounts on monthly payments expected result was achieved.

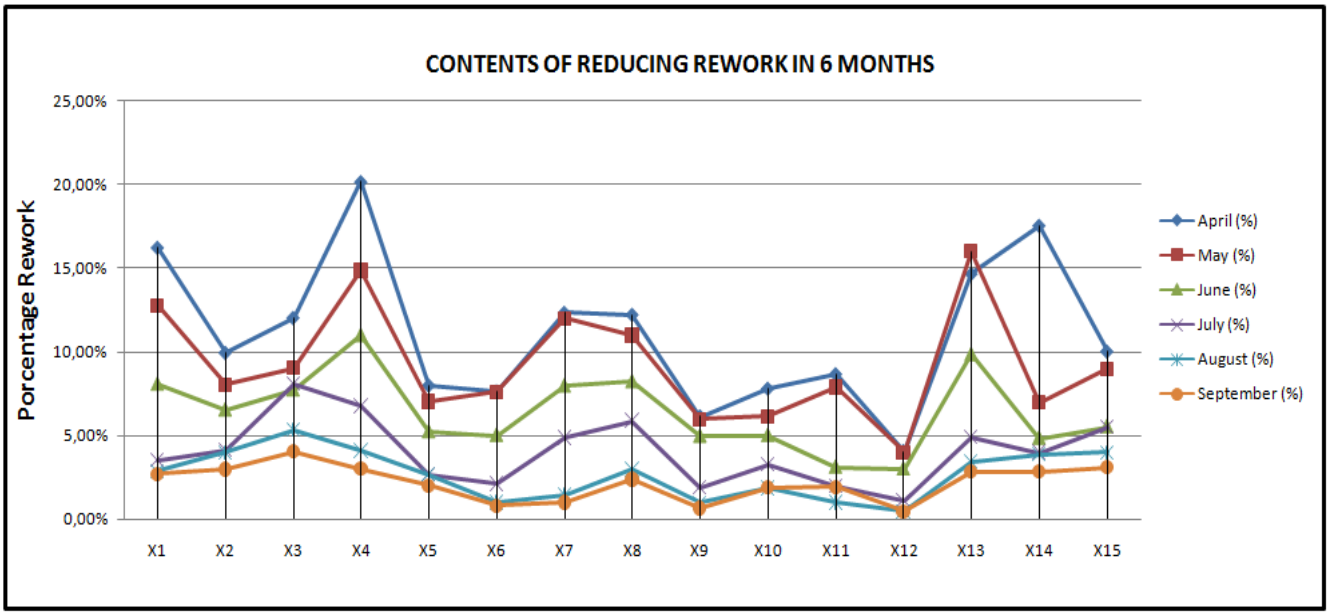

Figure 5: – Overall result

6. Final Considerations

Based on the conducted case study and application of statistical control in the field of textile industry it was possible to note a considerable decrease of defective parts that needed to be reworked (around 60%), which favored the development and prosperity of the company, allowing to cut unnecessary costs.

With the use of programming in a multitasking program called Excel was possible to develop a method that is able to measure all defective parts and their repair costs, as it was used a system to discount a certain amount of money to tertiary company per clothing unit to present a certain degree of fault. As a consequence the company that supplied the clothes started to provide a much smaller amount of defective garments with a view that it would be financially penalized for every mistake.

With the significant decrease in problems regarding rework units with problems, the company in question has benefited in several ways:

First and most important of all the aspects, was the result generated by the application of the control of production allowed to cut the money of the rework on possible problems concert in the product which can vary from a simple defect that can be solved by the company or serious errors that have damaged the product completely giving total loss and the reduction of this cost was able to increase the company's profit.

Another Important factor that has been enhanced with the application of statistical control was the time that the company won with decreasing reworked parts. From then this industry will be able to invest the time that was spent on rework some pieces to redirect the focus to produce more products or apply other necessary area and thereby achieving further increase its profit margin.

Finally the money that was invested in the rework parts can be reused and be invested in another sector of the company to present a deficit which could possibly generate a bottleneck in production, this has generated even greater assistance in the industry favoring immensely growth and then undergo an expansion in its production to new regions and cover even more areas.

It was concluded that the concerned tool successfully fulfilled its task of generating cutting costs and increasing the company's profit. Consequently all parties benefited: The customer will receive a quality product and a lower error rate, the supplier had produced a product of superior quality and will also have an increase in your profit box given that it will have to go through a more rigorous quality inspection, not to take losses and also had saved time it would take to fix one particular batch of clothing.

Through this case study, it was concluded that the company did not have a cost system that provides information to support planning and decision-making; the cost of quality not affected the company's profits, causing an increase in production costs and consequently a decline in profits; the costs of prevention accounted for only 3.2% of revenues, which characterize a need for increased investment to the prevention of quality, in order to reduce the costs of failure, this percentage rose to 8.4%. The quality of the final product cost much to this company.

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