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Diagnosis of quality problems in a small business

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Abstract

This article presents the results of a study conducted in a small textile company. The study aimed to characterize the state of quality management in the company highlighting weaknesses and areas for improvement. The methodology employed makes use of a set of tools for data collection and analysis such as interviews, flowcharts, process analysis diagrams, defects registry matrix, Failure Modes and Effects Analysis (FMEA) and cause-effect matrix. Based on the gathered data, the company procedures in quality management and the production process performance are described and analyzed. Besides reflecting the quality state in the organization, the study also allowed to prioritize the elimination of causes that are responsible for poor performance.

Keywords: Self-assessment, Diagnosis, Quality Management, Continuous Improvement, SMEs.

1 Introduction

Quality management self-assessment is a useful tool for supporting the continuous improvement of organizations (Benavente et al., 2005). The ISO 9004 (2009) defines self-assessment as a comprehensive and systematic review of an organization's activities and results, referenced against a chosen standard. Ahmed *et al.* (2003) emphasize the holistic nature of the self-assessment process. It must be implemented to improve the overall performance of the organization and not only to improve the products or services quality (Zink and Schmidt, 1998). Through self-assessment the organization is constantly questioning the way things are being done, which helps to keep up the company competitive level (Benavente *et al.*, 2005). Thus, an organization should use self-assessment to identify improvement and innovation opportunities, set priorities and establish action plans with the goal of sustained success (ISO 9004, 2009).

Self-assessment reports should focus on weaknesses and relevant causes, since the aim is to plan remedies (Conti, 1997). The information obtained from self-assessment can also be used to stimulate comparisons and share learning across the organization. Comparisons can be made between the processes of the organization, between its different units or with other organizations (ISO 9004, 2009).

According to Conti (2007), self-assessment conducted by organizations autonomously, to achieve their own purposes and following their own rules, is divided into two kinds: management audits and diagnostic self-assessment. Karapetrovic and Walter (2002) stress that the traditional audit methodology designed to test the quality assurance systems falls far short of enabling continuous improvement. In turn, Conti (2007) emphasizes that diagnostic self-assessment aims performance improvement. This author also points out that self-assessment should never be enslaved to the Excellence Models rules.

Most of self-assessment tools available (surveys, audit list, etc.) do not enjoy universal acceptance, since they are developed based on the requirements of a particular type of industry and their assessment criteria are derived from specific quality models advocated by a quality specialist or a combination of quality models (Lee and Quazi, 2001).

Conti (2007) underlines that excellence requires differentiation and competition also in the area of organizational assessment models and argues that, even if starting with a "standard" model, the adaptation to the characteristics of the organization should be always pursued. In other words, the models should be customized.

The choice of self-assessment approach depends on diverse factors such as the time that the company wants to spend, the monetary cost it is willing to accept, the quality of the results, the company's culture or the objective to be achieved by this exercise (Benavente *et al.*, 2005). These factors are particularly important when intending to apply self-assessment in SMEs context.

Sturkenboom *et al.* (2001) highlight that the self-assessment instruments to evaluate the performance of SMEs should not be too complex. According to these authors, in order to develop an assessment instrument appropriate to SMEs the following have to be considered:

- The larger the number of key elements, the more complex becomes the instrument;
- The more criteria of the instrument are related to the "ideal TQM" organization, the larger the gap between the criteria used and the current situation;
- Most SMEs do their job pretty well, however, their definition of quality is more or less static, aimed at satisfying their current customers.

The adequacy of self-assessment based on Excellence Models to the reality of SMEs, companies that often reveal low maturity in quality management has been questioned by several authors. According to Biazzo and Bernardi (2003) the adoption of this type of self-assessment is an inappropriate choice for SMEs due to their level of complexity. After carrying out a study in seven SMEs in northern England, Wilkes and Dale (1998) concluded that the language of the EFQM Excellence Model needs to be simplified to better fit the SMEs specific characteristics and observed that these companies do not know how to take advantage of self-assessment based on its criteria. Sturkenboom *et al.* (2001) stress that the self-assessment tools based on Excellence Models are too sophisticated for most SMEs due to the informal way that quality related initiatives are developed in this type of organizations. Sometimes, less experienced organizations tend to attribute too high scores, creating an optimistic image, or may be discouraged by obtaining low scores (Van der Wiele and Williams, 2000).

In this article, the state of quality of a non certified small business is depicted through the use of a set of tools that provides a quick and easy reading of the data. The main goal was to identify gaps that must be resolved primarily in order to increase the level of quality and achieve cost reduction.

The presented study was undertaken as part of the Master's thesis in Industrial Engineering concluded at University of Minho (Teixeira, 2011). The study uses a set of processes and sub-processes to analyze companies' performance in quality planning, control and improvement (Juran Trilogy). Based on the literature review, it was found that there is a very small number of quality management diagnostic models adapted to the specific needs of SMEs. Therefore, it is expected that the methodology used in this study may contribute to achieve progress in this area. It should be noted that the study focuses only on quality management and not on the entire business process.

At first, a survey of all relevant information about the company was conducted, including the number of employees, the main sections and departments, the types of products manufactured, the raw materials used and the main activities (operations and controls) of the production process. Flowcharts, diagrams of process analysis, defects registry matrix have been drawn, after understanding the sequence and the relationship between productive activities. Then, individual interviews were conducted to a group of employees. Interview guides were created from the list of quality management processes for analysis, previously defined. During the distribution of the questions, the functions performed by the interviewee were taken into account. Later, some of the quality management processes and sub-processes have been subject to a FMEA analysis. Based on the information collected through the FMEA form, cause and effect matrices were developed, in order to summarize the causes and effects of failures (problems) and prioritize the elimination of the causes. Finally, the description and analysis of the information gathered through several tools was performed.

The study description begins with a brief presentation of the company and its production process.

2 Company and production process presentation

This work was performed in a small company that manufactures and sells woven fabrics. The firm has 13 employees in its workforce. The organizational chart presented in Figure 1, shows the departments in which the company is divided and the main activities undertaken in each department.

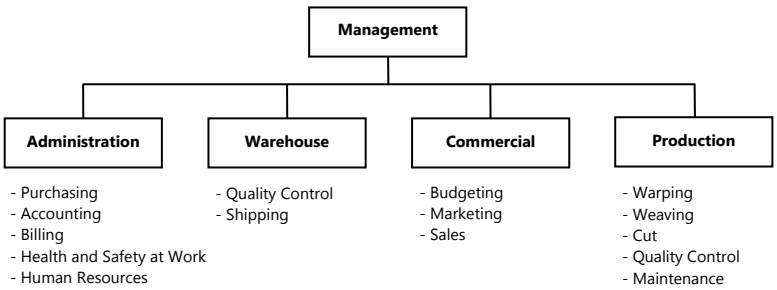


Figure 1 – Organizational chart.

The company produces Tulles and Laces. While in Tulle the woven is smooth, the structure of lace fabrics may have several types of drawings. Tulles and Laces are usually sold unfinished, in rolls of 200 meters with the width of the loom. However, the Laces can also be cut into strips or bands with variable width and length. The raw materials used in production process may include yarn with different measures, compositions and properties. Polyamide, polyester and cotton yarns are the most frequently used.

The Lace strips process production flowchart is presented in Figures 2.

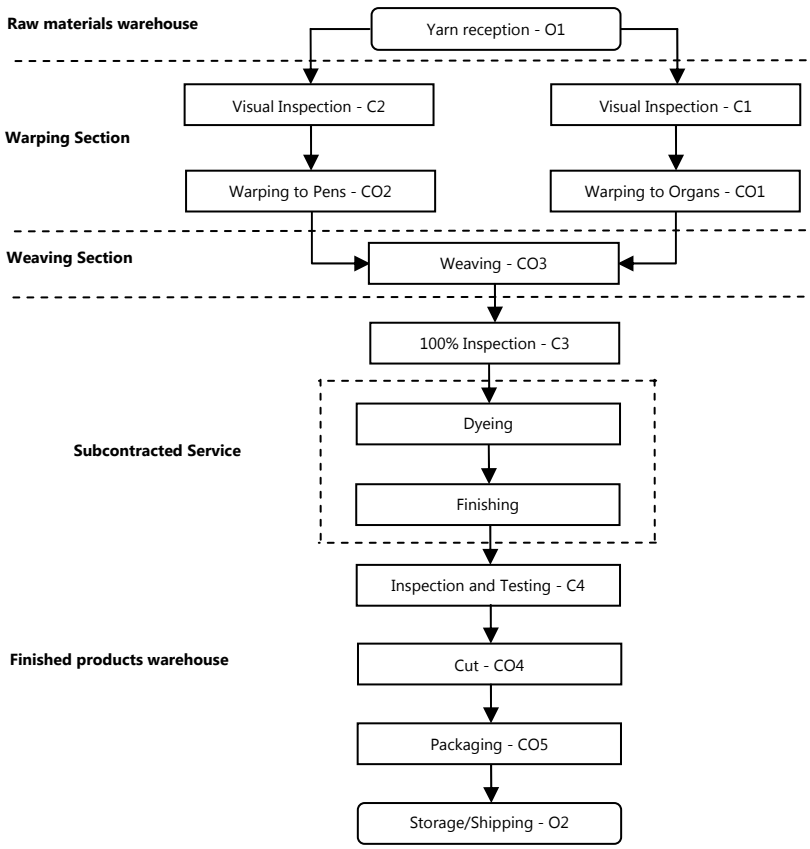


Figure 2 – Lace strips production process flowchart.

The flowchart shows the main activities of the production process. These activities can be classified into three types: operations (O), controls (C) and combined operations (CO). The activities illustrated in the

flowchart are sequentially numbered by type. All product realization activities are combined operations, in other words, operations in which quality control actions are performed while the product is manufactured. These operations are Warping, Weaving and Cut. The remaining operations include tasks that do not modify the raw material or the product, such as Yarn reception, Packaging and Storage/Shipping. In the flowcharts, activities in which only control actions occur (C) are also represented, namely the visual inspection of the raw material, the visual inspection of the final unfinished products (Tulles and Laces) and the inspection and testing of the finished products (Laces) before starting the cut. In addition to the visual inspection for verification of color and design, the control actions of the finished product may involve tests to determine the percentage of shrinkage, the width measurement and the grammage (weight per m^2).

3 Quality Management Processes

The quality management processes have been defined with reference to the Juran Trilogy (Table 1). These processes are used to analyze the company performance in Quality Planning, Quality Control and Quality Improvement.

The information concerning the processes of quality management was collected through interviews. The interviewees were the manager, the administration employee, the Commercial Department employee, the Warehouse Responsible and the Production Responsible.

Table 1 – Considered processes for quality management

Quality Planning	**Quality Control**	**Quality Improvement**
A.1. Suppliers qualification	B.1. Planning of inspection and testing in the production	C.1. Identification of improvement opportunities
A.2. Definition and communication of the raw materials/components or subcontracted services requirements to the supplier	B.2. Inspection and testing of raw materials/components and control of subcontracted services	C.2. Priorities definition
A.3. Definition of the specifications/acceptance criteria and critical features of the product	B.3. Calibration /verification of measurement, inspection and testing equipments	C.3. Analysis of opportunities for improvement
A.4. Customer requirements survey and product features validation to meet customer requirements	B.4. Identification and treatment of nonconforming product	C.4. Definition and planning of improvement actions
A.5. Survey and verification of the compliance with the statutory and regulatory requirements applicable to the product	B.5. Corrective actions to sporadic problems	C.5. Verification/ monitoring of the effectiveness of improvement actions
A.6. Preliminary studies on the processes capacity (products) or aptitude (services) and operating conditions	B.6. Verification of the process capability	
A.7. Ensure that who is involved in the processes have the necessary capabilities and knowledge to the products realization		
A.8. Identification of potential problems (that may arise in the product realization) and solutions		

Despite not having a formal quality management system, the company shows efforts in order to carry out an effective quality control during and at the end of the production process.

The collected data show that the quality planning tasks are mostly defined and disclosed in an informal way by the company's Management. It was found that documented procedures or work instructions are not used by the company. Although the quality planning is being considered relevant by the main company's employees, the time dedicated to it is far less than the time spent on quality control activities. The main reason for this fact is related to the human resource costs. Employees would have less time to perform other tasks considered as priority by the company's Management.

It was found that the organization does not establish mechanisms for the evaluation and classification of its suppliers. Raw materials and subcontracted services approval requirements are not documented, nor are defined acceptance criteria or specifications. In addition, the acceptance criteria and the critical features of the products manufactured by the company are also not recorded. Employee performance is continuously evaluated under operating conditions. However, the evaluation results are not registered, nor is it evaluated the effectiveness of the training initiatives. Physical and human factors that can affect product conformity, and solutions that minimize or eliminate these problems, are identified on a daily basis. Nevertheless, registries of such cases are not kept.

Quality control is mostly seen as a critical process to the company's success. The control actions aim to identify and prevent the occurrence of defects. When defects are identified in the production phase the

causes are investigated. During the product control actions defects registry forms are filled, however, the recorded data are not statistically treated and no records of corrective actions are maintained. It was also found that the company does not have an Inspection and Test Plan (ITP), nor documented procedures describing the control actions. In addition, the planning of calibration/verification is not being performed and, although the calibration certificates are archived, the obtained results are not verified in order to demonstrate whether the measurement, inspection and testing equipments (MITEs) works within the defined limits.

During the interviews, it was found that the quality improvement concept is still poorly understood by most employees, since the corrective actions have sometimes been mistaken for improvement actions. Nevertheless, it was observed that the company strives to continually improve its performance (reducing the number of defects and improving productivity) through machine testing and through the increase of employees' awareness of the need to prevent problems. After the improvement actions implementation, their effectiveness is verified, however, no records are maintained.

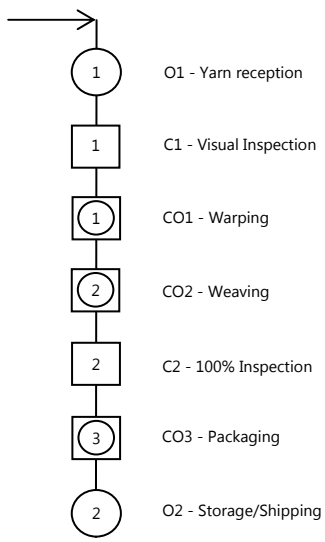
The analysis of the quality management processes allows to obtain a deeper understanding of the company which was useful to carry out one of the step of diagnosis study, the FMEA (section 5).

4 Defects registry matrix

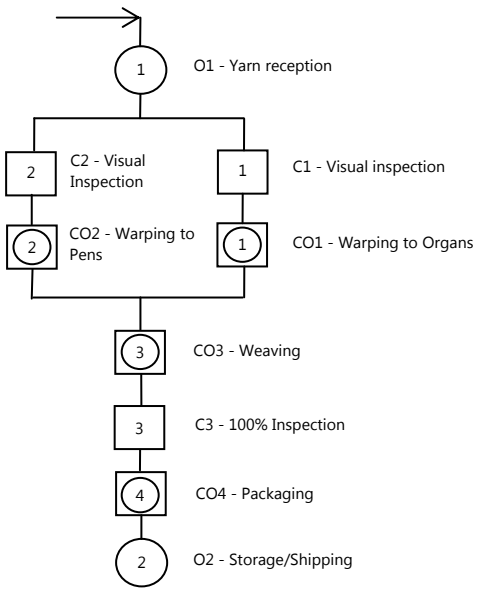
A Matrix designated by defects registry matrix was used in order to represent, for a given period, the number of defects caused by each workplace or activity and by the company's suppliers, as well as the sites where the defects are detected.

The first step was to collect information about defects in the different control workplaces of the process. Once the defect records available in the company did not provide enough information, the origin, the nature and the detection location of each defect identified in the company products were registered during three days in the workplaces where production is controlled in order to completely fill the matrices. In the data collection period, the company did not produce Lace strips, ***therefore only the Tulle and Lace defects were recorded. The*** process analysis ***diagrams of Tulles and Laces are presented in Figures 3.***

After compiling the data, defects registry matrices were filled (Figure 4 and 5), in order to get an overview of how defects are distributed throughout the production process. The matrices columns present the locations or activities where defects are caused, whereas in the rows are the locations or activities where defects are usually detected.



Tulle



Lace

Figure 3 – Tulle and Lace process analysis diagrams.

The defects identified by visual inspection of raw material were soiled yarn bobbin ***and damaged*** bobbin***. It was identified that these defects have been generated by the supplier or during the yarn transportation. Yarn breaks occurred both in the warping to organs and warping to pens. The yarn breaks are usually related to the quality of the yarn, therefore they were registered in the external suppliers column. Defects such as missing yarn, bites and holes were detected both during the products weaving and the 100% inspection. The missing yarn resulted from yarn breaks occurred in the yarn warping, whereas the bites and the holes that are found in the woven fabric are caused by failures during the looms operation.***

NONCONFORMITIES MADE BY / NONCONFORMITIES DETECTED BY	UPSTREAM → Analyzed process					
	External Suppliers	**O1**	**CO1**	**CO2**	**CO3**	**O2**
C1	1 Soiled yarn bobbin/ 120 Organs 3 Damaged bobbins/120 Organs					
CO1	10 Yarn breaks/120 Organs					
CO2			1.10 Missing Yarn/ Roll 0.76 Missing Yarn /100 m 0.42 Missing Yarn /100 m^2	1.50 Holes / Roll 1.04 Holes /100 m 0.57 Holes /100 m^2 0.50 Bites / Roll 0.35 Bites /100 m 0.19 Bites /100 m^2		
C2			0.50 Missing Yarn / Roll 0.35 Missing Yarn /100 m 0.19 Missing Yarn /100 m^2	2.90 Holes / Roll 2.01 Holes /100 m 1.11 Holes /100 m^2		
CO3						
External Customers						

Analyzed process ↓ DS

Figure 4 – ***Tulle defects registry matrix.***

The data concerning defects identified during both the Weaving and the 100% inspection, refer to ten rolls of Tulle (2610 m^2 of fabric) and ten rolls of Lace (2288 m^2 of fabric).

NONCONFORMITIES MADE BY / NONCONFORMITIES DETECTED BY	UPSTREAM → Analyzed process						
	External Suppliers	**O1**	**CO1**	**CO2**	**CO3**	**CO4**	**O2**
C1	1 Soiled yarn bobbin/ 120 Organs 3 Damaged bobbins/120 Organs						
CO1	10 Yarn breaks/120 Organs						
C2	2 Soiled yarn bobbin /53 Pens 4 Damaged bobbins /53 Pens						
CO2	7 Yarn breaks /53 Pens						
CO3				0.90 Missing Yarn / Roll 0.82 Missing Yarn /100 m 0.39 Missing Yarn /100 m^2	2.20 Holes / Roll 2.00 Holes /100 m 0.96 Holes /100 m^2 0.10 Bites / Roll 0.09 Bites /100 m 0.04 Bites /100 m^2		
C3				1.00 Missing Yarn / Roll 0.91 Missing Yarn /100 m 0.44 Missing Yarn /100 m^2	3.70 Holes / Roll 3.36 Holes /100 m 1.62 Holes /100 m^2 0.10 Bites / Roll 0.09 Bites /100 m 0.04 Bites /100 m^2		
CO4							

Analyzed process ↓

DS	**External Customers**							

Figure 5 – ***Lace defects registry matrix***.

In the case of raw material defects, the matrices show the ratio of the number of defective yarn bobbins per number of organs, the ratio of the number of defective yarn bobbins per number of pens, the ratio of the number of yarn breaks per number of organs, and the ratio of number of yarn breaks per number of pens. The values concerning soiled yarn bobbin, damaged bobbin and yarn breaks during Warping to organs that are shown in the Tulle matrix (Figure 4) and those found in the Lace matrix (Figure 5) were obtained in the same way, since the organs can be used in both manufactured product families. Regarding the defects identified during both the Weaving and the 100% inspection, the matrices present the number of defects per roll, per 100 meters of product and per 100 m^2 of product.

During the defect registration period, neither defects were identified during the product packaging, nor occurred customer complaints concerning product defects. Therefore, the matrix rows corresponding to the Packaging ***and the External costumers appear blank.***

The analysis of the matrices data reveals that the number of defects detected in the Laces Weaving and 100% inspection is higher than those that were detected in the Tulle products during the same activities. However, both in the Tulle and Lace the defects average per linear meter of product is below the maximum number of defects allowed by the company (1 defect per 10 meters of fabric). This requirement is the same for all the company products, regardless of the woven fabric width.

Although the inspected products have a number of defects lower than the maximum number of defects allowed, it is considered that the company should make efforts to reduce the number of defects. All defects have associated costs, namely inspection costs and defects correction costs. Looms are monitored by the production inspectors while the weaving is being performed, in order to identify any defects in the product. When a defect is found, the loom is turned off and the causes that originated such defect are determined. However, some problems are only identified later, after verifying, during the 100% inspection that a product contains an excessive number of defects. For this reason is important to prevent inspector's inattention. The most frequent problems are generated by poor quality yarn, loom failures and too high or too low operating temperatures. ***It should be noted that during the data collection period the production process worked under favorable temperature and relative humidity conditions.***

5 FMEA

In order to measure the company procedures effectiveness, some of the quality planning and quality control processes and sub-processes (Table 2) were subjected to a FMEA. This analysis has counted with the contribution of all the interviewees. For each of the analyzed processes and sub-processes failure modes were determined, as well as their effects, causes and frequency. The selected processes and sub-processes are those that are related to more practical aspects of the companies' performance and at the same time, those that represent tasks (repeatedly or periodically executed in the products development) which if not well executed might have a negative effect on the product quality. As an example, Table 3 presents the FMEA of the sub-process A.1.2. (Implementation of suppliers qualification method).

Table 2 - Processes and sub-processes to be considered in FMEA

Quality Planning	**Quality Control**
A.1. Suppliers qualification	B.1. Planning of inspection and testing in the production
A.1.2. Implementation of suppliers qualification method	B.1.3. Capacity verification of measurement, inspection and testing equipment
A.2. Definition and communication of the raw materials/components or subcontracted services requirements to the supplier	B.2. Inspection and testing of raw materials/components and control of subcontracted services
A.2.3. Communication of the raw materials/components requirements to the supplier	

A.2.4. Communication of the subcontracted services requirements to the supplier	B.2.1. Inspection and testing of raw materials/components
A.6. Preliminary studies on the processes capacity (products) or aptitude (services) and operating conditions	B.2.2. Control of subcontracted services
A.7. Ensure that who is involved in the processes have the necessary capabilities and knowledge to the products realization	B.3. Calibration /verification of measurement, inspection and testing equipments
A.8. Identification of potential problems (that may arise in the product realization) and solutions	B.3.2. Implementation of the calibration / verification plan
	B.3.3.Validation of the calibration /verification results
	B.4. Identification and treatment of nonconforming product
	B.4.1. Identification of nonconforming product
	B.4.2. Treatment of nonconforming product
	B.6. Verification of the process capability

Since the company does not maintain records of occurrences affecting the product quality, the frequency of each failure mode was determined based on employee opinions. Therefore, in some cases the values can be imprecise. The failure modes that are both considered most frequent and of the most concern to the company are "non detection of noncompliance or incomplete services in the finished product, before it is sent to the customer", and "to operate in ***inadequate*** temperature or ***relative humidity conditions***". As noted above, the first failure mode is due to the fact that the company did not conduct a 100% inspection of the finished product in order to avoid damaging the fabric. The second failure mode takes place mainly in the summer and winter months, when heat or cold peaks occur. At this point, the number of defects may significantly increase. Acquiring an equipment to assist the finished product inspection and installing an air conditioning system are solutions that are being considered by the company.

Table 3 - FMEA of the sub-process A.1.2.

Process or Sub-process	Failure Modes	Failure Effects	Failure Causes	Frequency
A.1.2. Implementation of suppliers qualification method	Acquisition of poor quality raw materials.	Increase of the yarn breaks during the Warping; Increase of the number of defects in the Weaving; Downtime increase; Production breaks.	Absence of a supplier's qualification method; Fault of the raw materials supplier.	About 1 occurrence per year.
	Poor quality subcontracted services.	Finishing with imperfections (e.g. stained or burned fabric); High shrinkage percentage; The color does not match with the request; The drawing does not match with the request; Incorrect width; Changed grammage.	Absence of a supplier's qualification method; Fault of the subcontracted supplier.	About 1 occurrence per month.
	Delays in the delivery of raw materials.	Failure to meet the deadlines agreed with the customer; Orders cancellation; Renegotiation of the product sale price.	Absence of a supplier's qualification method; Fault of the raw materials supplier.	About 2 occurrences per year.
	Delays in the delivery of subcontracted services.	Failure to meet the deadlines agreed with the customer; Orders cancellation; Renegotiation of the product sale price.	Absence of a supplier's qualification method; Fault of the subcontracted supplier.	About 1 occurrence per month.

6 Cause and effect matrix

In this study the cause and effect matrix is used as a synthesis tool, which aims to identify areas for improvement through the analysis of the root causes that are responsible for performance gaps and prioritizing the elimination of the causes.

The causes and effects identified in the FMEA analysis were represented in a cause and effect matrix. An extract of the resulted matrix is presented in Table 4. The matrix presents the scores assigned by the company manager to each effect and cause and effect relationship. The effects were scored according to the severity level, using the weights 1 (low), 3 (middle) and 9 (high). In the case of the cause and effect relationships, the degree of the relationship between the effect and each one of the causes associated with it was scored using again the weights 1 (weak relationship), 3 (average relationship) and 9 (strong relationship). Afterwards, a rating named the cause elimination priority level (EPL) was calculated. This indicator is determined by multiplying the weight assigned to each effect by the weights located in the same row of the matrix and the values are then summed column by column. The causes ELP results are presented in the last matrix row.

Table 4 – Extract from the cause and effect matrix

Failure Effects	Failure Causes	Absence of a supplier's qualification method	Fault of the raw materials supplier	Fault of the subcontracted supplier	Defective analysis of the customer sample	Lack of knowledge about the characteristics of the looms	Incorrect evaluation of the operating conditions	Absence of an air conditioning system	Admission of workers unable to perform the assigned tasks	Survey of training needs is not made	The workers do not receive adequate training	The training effectiveness is not evaluated	Absence of written instructions identifying problems and solutions	Overconfidence in the workers capabilities and /or skills	The measuring equipment does not have the necessary precision	Absence of an equipment for the finished product inspection	Absence of a documented ITP	Inadequacy of the inspection and testing procedures	Absence of documented inspection and testing procedures	Lack of understanding of the inspection and testing procedures	Absence of the MITEs calibration/verification planning	The MITEs calibration/verification is not considered relevant	Serious finishing defects in the product	Tight deadlines	Inspectors' inattention
Service repetition	3			3												3	1	1	3	3			9	3	
Failure to meet the deadlines agreed with the customer	9	3	3	3																			3		
Return the order to the supplier	3		3																						
Waste of raw materials	3				9	3	9	1					1	1			3	3	3	3					3
Delay in the production order	1				3	3																			
Losses resulting from the occupation of people and machines	3				9	3	9	3																	
Increase of the consumption of wear material	3								1	1	1	3	3	3											
Mechanical failures in the equipment	3								1	1	1	3	3	3											
Errors in the verification of the received yarn quantities	3														1						3	3			
Errors in determining the grammage	3														1						3	3			
Errors in determining the shrinkage percentage	3														1							3			
Errors in the quantities sent to the costumer	3														1						3	3			
Errors in monitoring the operating conditions	3																					3			
		129	**117**	**138**	**57**	**21**	**63**	**39**	**24**	**24**	**24**	**36**	**33**	**33**	**19**	**90**	**87**	**87**	**135**	**135**	**27**	**45**	**162**	**87**	**117**

In the last row of the matrix, the cells were flagged with the yellow, orange and red colors. Table 5 establishes the correspondence between the colors and results for this case study.

Table 5 – Color codification based on Elimination Priority Level

Result	Priority Level	Color
1-50	Low	Yellow
50-100	Average	Orange
> 100	High	Red

The cause and effect matrix showed that "serious finishing defects in the product" is the cause which has the higher EPL. This cause is related with some high severity effects, such as "failure to meet the deadlines agreed with the customer" and "orders cancellation", both of which can result in significant losses to the company.

The other high EPL causes are the following:

- Absence of a supplier's qualification method;
- Fault of the raw materials supplier;
- Fault of the subcontracted supplier;

- Absence of documented inspection and testing procedures;
- Lack of understanding of the inspection and testing procedures;
- Inspectors' inattention.

These causes have in common the fact that they all can lead to the defects appearing in the product. Some occurrence such as "serious finishing defects in the product" may appear as both a cause and an effect.

7 Conclusion

The present study intended to characterize the quality state in a small company. The tools used in this diagnosis study highlighted strengths, weaknesses and areas for improvement in the way the company manages quality.

The processes and sub-processes for the quality planning and control analysis, which concern more practical aspects were subject to a FMEA process aimed at determining failure modes in the company's performance, as well as the respective effects, causes and frequency. However, it is considered that this analysis can be improved if records of occurrences that affect the product quality are maintained. Based on the cause and effect matrix, it is possible to see simply and directly all the cause and effect relationships revealed by the FMEA and prioritize the elimination of the causes. However, it should be noted that the scores presented in the matrix resulted from a subjective evaluation performed by the company manager. Therefore, the matrix should be periodically reviewed by the manager, involving also each department responsible. Thus, this tool can provide important guidelines towards the organization performance improvement.

The company evaluates the production process performance based on the records of the defects found in the control actions. However, the data are not statistically analyzed. The defect registry matrices show the main defects found in the raw materials and products, as well as the sites where defects are caused and detected. Based on this information, it is possible to conclude that the production process is generating an acceptable number of defects when considering the company goals. However, the data collection time period should be longer in order to obtain a more complete and reliable representation.

The approach used in this study is substantially different from most assessment models available in the literature, since its purpose is not to score the organizations performance, nor determine their maturity level. It is intended that its implementation will mainly contribute to highlight weaknesses, particularly the performance gaps that can affect product quality and their causes, providing companies with information to enable them to set priorities for improvement.

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