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TOWARDS A NEW FORMULATION OF THE MAINTENANCE PROCESS QUALITY RATE USING THE AHP AND SIX-SIGMA METHODS

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ABSTRACT

This work proposes an approach based on methods Analytical hierarchy process (AHP) and Six sigma in order to formulate a new maintenance process quality rate and led to raise up the quality process's performance. Steps of this approach will be illustrated by industrial applications. It proposes an approach based on a combination of methods: Analytical hierarchy process (AHP) and Six sigma. This approach is based on a new formulation of a Maintenance process quality rate and led to improve maintenance's performance.

This approach led to apply easily improvement maintenance by using combination of methods: Analytical hierarchy process (AHP) and Six sigma. In the industrial application, this approach helps us to improve the maintenance's process quality rate. After following the steps simulated by the proposed approach, the quality rate will be deducted and illustrated by the industrial's application. At present, there is not explicit improvement quality maintenance process based on quality rate, to lead to specific maintenance actions on maintenance's process.

Keywords: *Improvement Maintenance, Maintenance Process, Maintenance Process Quality Rate, Six Sigma, Analytical Hierarchy Process.*

1. INTRODUCTION:

I.1. Method of evaluating the activities's maintenance quality:

I.1.1- Definition:

This International Standard [5] describes the fundamental concepts and principles of quality management which are universally applicable to the following:
—Organizations seeking sustained success through the implementation of a quality management system;
—Customers seeking confidence in an organization's ability to consistently provide product s and services conforming to their requirements;

I.1.2- methods of quality assessment:

To be of quality, a system or process must be efficient. This means that it must achieve its objectives. Thus, effectiveness can only be described in relation to the process's goals.

The typologies of quality can be summarized by:
• Expected quality: what the customer wants
•Quality required: that the supplier has planned to do
•Quality achieved: translates what has been achieved
• Perceived quality: what the customer sees
According to (Boehm.2007), the internal quality factors relating to manufacturing activities are:
Portability, Traceability, Verifiability, Integrity, Reliability, Documentation, Testability, Modularity: Understandability, Modifiability, Clarity.
On the other hand, the ISO19011:2012,[6] quality audit standard sets out the broad lines for an audit to be carried out using a range of audit methods. The figure below provides an explanation the method's audit used.

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	Presence's place of the auditor	
	On-site	**Remote**
Interaction humaine	Conduct of interviews. - List information And questionnaires with the Participation of the auditee. -Review of documents with the Participation of the auditee. - Sampling.	By means of Interactive communication: - Conducting interviews; - information on List and questionnaires; -review of documents with The participation of the auditee.
No human interaction	Review of documents (by Example records, analysis Data). -Observation of the tasks performed. - Site visit. - Information on standard lists. -Sampling (for example products).	Review of documents (by Example records, data analysis). - Observation of tasks Carried out by means of Control, taking account of Social requirements and legal. - Data analysis.

Figure.1.1. Applicable Audit Methods

With regard to the realization of the review of documents or documentary maintenance, the auditors should take into account the following elements (ISO 19011:2011):
The information contained in the documents provided is:
- complete (all the intended content is provided in the document);
- correct (content complies with other reliable sources, such as standards and regulations);
- coherent (the document is coherent in itself and in relation to the associated documents);
- updated (the content is updated);
The documents reviewed cover the scope of the audit and provide sufficient information to support audit objectives;

I.2. Process's approach:

The work of Meddaoui and Bouami (2014) ,[8] highlights three types of processes, process management, process production, also called operational processes, and the third type, which concerns process support.

They specify that the maintenance sub-processes can be explained into several main activities (Figure 1. 2) in order to achieve the expected results. It should be said that whatever the type of industry, three types of maintenance processes Parida, A. and Kumar, U. (2006),[10].

corrective maintenance			
Process	**Sub-processes**		**Activity**
corrective Maintenance	Reception, Assignment, Analysis and recording	M01	DT Reception and Data Entry
		M02	On-site analysis
		M03	Assignment of missions and resources
		M04	Recording
	palliative Maintenance	M05	Rapid Maintenance Operation
		M06	Test and start-up support
	curative Maintenance	M07	preparation
		M08	Consignment and Security
		M09	Programming and waiting
		M10	Launch of the TO
		M11	Technical diagnostics
		M12	Intervention, dismantling, exchange
		M13	Reassembly, rests
		M14	Testing, inspection, adjustment,
		M15	tagout
		M16	Operational equipment, reporting

Figure.1.2. Corrective Et Preventive Process Maintenance (Meddaoui Et Bouami (2014)

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preventive maintenance			
Process	**Sub-processes**		**Activity**
preventive Maintenance	General order	M17	Planning of periodic shutdowns
		M18	General Stop Planning
		M19	Tracking Data Records
	Maintenance of round	M20	Preparation of the round visit
		M21	Round Operation
		M22	Drafting of visit reports
		M23	Preventive Maintenance Preparation
		M24	Maintenance and replacement operation
		M25	Test and start-up support
		M26	Technical preparation for shutdown
		M27	Technical diagnostics
		M28	Maintenance and replacement operation
		M29	Test and start-up support

Figure.1.2. Bis. Corrective Et Preventive Process Maintenance (Meddaoui Et Bouami (2014)

I.3. Quality Rating:

Quotient between the number of good parts and the number of parts produced or between the useful time and the net time (AFNOR, 2002).

Quality Rating: TQ = D/C

C: Net operating time

D = time useful (which produces only good sets)

I.4. Six-sigma method:

Six Sigma is a method of quality improvement that reduces process variation, [1]. This method is a performance indicator whose ultimate goal is to realize that 3,34bad parts in a million. The approach is described by Coronado, R. and Antony, J. (2002) ,[3]:

a) A philosophy geared towards customer satisfaction

b) A performance indicator measuring quality

c) A problem solving method to reduce variability

d) An organization of competence and responsibility for the resources of the company.

e) A management mode for quality

Most companies are at a level equivalent to 3 Sigma. The quality level indicates the effectiveness of this process. Zu, X., Fredendall, L. and Douglas, T. (2008). The higher the quality level (2σ, 3σ, 4σ, etc.), the better the process.

In effect, Sigma measures the process's ability to produce defects. The Six Sigma quality approach is based on the normal distribution. Most outputs of the process will meet the specifications. But some will become, to a variable extent, measured by the standard deviation (σ). So some output units will be produced in the X± σ1 gamme range, some X± 2σ and some in X±3σ. This variable quality problem of the production unit is approached by the Six Sigma methodology in two ways, Frank, S. (2003) ,[4].

First, it increases the design width, stretching the upper part and lower specification limits so that even if the output unit is produced in the X ± 3 gamme range, it will work properly. Second, Six Sigma provides tools for analyzing and rewriting the process so that the sigma value drops, so if the upper and lower specification limits were initially at 3σ, they will automatically be held at ±6 now. Vote, D. and Huston, J. (2005) ,[15]. Six Sigma focuses all functions on "processes". Each process / procedure is expected Result / measurement called "average". Each result / measurement has a certain variation and the measurement of this variation is called sigma.

Wang, F., Du, T. and Li, E. (2004) ,[16], Six Sigma is a structured, data-driven approach and a methodology for eliminating defects.

The usual measurement of defects is carried out in DPMO (defects per million occurrences). How many defects per million occurrences?

To calculate it, it would be necessary

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to: Gijo, E. and Rao, T. (2005) ,[7],

Step 1: Define Critical To Quality (CTQ). Each CTQ gives a default opportunity

Step 2: Determine the total number of opportunities by multiplying the number of CQQ by the number of opportunities
Step 3: Quantify faults in units. If for a unit there are 3 errors for 3 CTQ, count 3 defects for the unit
Step 4: Calculate Defects by Millions of Opportunities
The DPMO gives a sigma equivalence: 66807 DPMO = 3 sigma, 22750 DPMO = 3.5 sigma, 6210 DPMO = 4 sigma, 1350 DPMO = 5 sigma, 3.4 DPMO = 6 sigma.

6σ	***3,4 defect /million***	***Perfection's rate : 99,9997 %***
5σ	***233 defect /million***	***Perfection's rate : 99,977 %***
4σ	***6210 defect /million***	***perfection's rate : 99,38 %***
3σ	***66810 defect /million***	***Perfection's rate : 93 %***

Figure.1.2. Six-Sigma And Perfection's Rate

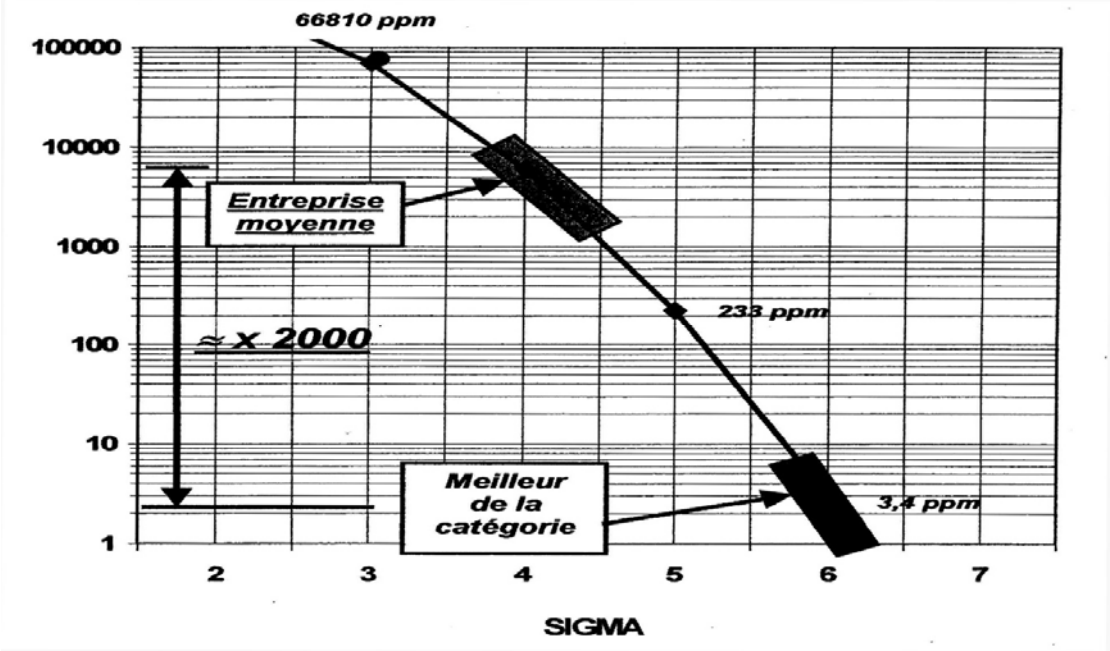

Figure.1.3 Sigma Calculation Table In DPMO Function

I.5. Analytical hierarchy process (AHP)

It is a multi-criteria decision support method developed by Thomas Saaty in the late 1970,[12]. It has been vestment choices, etc. The steps to use successfully in planning areas such as: strategic planning, project selection, in solve a multi criteria problem using the AHP method are:

Step 1: Hierarchical decomposition: Hierarchy is an abstraction of the structure of the problem used to study the interaction between the components of the problem and their effect on the final solution.

Step 2: Quantification of the problem: The AHP method proposes to evaluate a vector of weight W = (w1, w2, ..., wn) associated to the problem criteria using binary comparisons according to a scale proposed by Saaty (1977) ,[13] In 9 levels represented in the following Table.1.1:

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aij equal to	When the criterion i compared to j is
1	Also important
3	Slightly more important
5	Notably important
7	Much more important
9	Indisputably more important
2.4.6.8	Intermediate values between two judgments used when necessary for Refine the judgment

Table1.1. Échelle Proposed By Saaty (1977)

I.5.1. The AHP approach

The AHP approach is composed of four major phases (Saaty T. L., 1996) ,[12]: hierarchy of indicators by importance from the most important to the least important; Constructing a matrix from the comparison of the indicators two by two; Determining the weights associated with each indicator by a method of calculating the eigenvectors; And finally checking the consistency of the results.

A) Prioritization of indicators by importance.

This step involves prioritizing indicators belonging to the same criterion according to the principle of importance. Let I1, I2, ..., Ii ... .., In the set of indicators whose weighting coefficient is sought. According to the principle of hierarchization, I1 is more important than I2 which is more important than Ii-1, which is more important than Ii. At the end, In is the least important indicator.

B) Comparison of indicators by importance.

In order to establish preferences, a scale of values should be chosen to specify the degree of importance of one indicator relative to another. We adopt the value scale from 1 to 9 (Saaty, 1977, Harker, 1989), making it possible to introduce the decisions of the decision-maker closer to reality. The comparison between all the indicators gives the following matrix (Equation 1):

$$w_i = \frac{\sum_{i=1}^{n}\left[a_{il} / \sum_{k=1}^{n} a_{kl}\right]}{n}$$

aij is the intensity of the importance of Ii on Ij and wi the weighting coefficient associated with Ii.

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1i} & a_{1j} & \cdots & a_{1n} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{i1} & \cdots & a_{ii} & a_{ij} & \cdots & a_{in} \\ a_{j1} & \cdots & a_{ij} & a_{jj} & \cdots & a_{jn} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{n1} & \cdots & a_{ni} & a_{nj} & \cdots & a_{nn} \end{bmatrix} \quad (1);\ \text{Avec } aij = \frac{w_i}{w_j} \text{ et } a_{ii} = 1$$

C) Determination of the weights associated with each indicator.

In this step, we compute the vector of the weighting coefficient W = {w1; w2; ... ... wn}. To do this, we divide each aij by the sum of the values of the corresponding column and then we do an average per line. Thus, each coefficient wi is obtained by the equation below. The sum of wi must be 1**:**

D) Verification result's consistency.

A great advantage of the method is that it calculates a CR coherence ratio, which makes it possible to evaluate the calculations performed. In other words, it makes it possible to check whether the values of the scale (1-9) allocated by the decision-maker are coherent or not. It provides a measure of the probability that the matrix was completed purely randomly.

To calculate the coherence ratio CR, the consistency index CI is divided by a value RI (CR = CI / RI) depending on the number of indicators n given by the tables below.

The consistency index CI is calculated by the formula: CI = (λ max-n) / (n-1).

The value of λ max is the result of the average of the values found from the multiplication of the elements of the priority vector by the matrix A.

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Taille de matrice (n)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.53	1.56	1.57	1.59

Table.1.2. Value Du Coefficient De RI (Saaty, 1996)

2. PROPOSED METHODOLOGY

2.1. Evaluation quality maintenance process methodology:

The aim is to design a model to evaluate the overall quality of the two corrective and preventive maintenance processes according to a concept using criteria scaled by indicators making it possible to measure the relative contribution of the quality of an activity Mi at different times and according to preferences chosen beforehand

2.1.1. Steps in deploying the method:

Phase 1: Identify the activities of corrective and preventive maintenance processes.
Phase 2: concept quality's criteria for the prioritization of activities..
Phase 3: Identify the evaluation's indicators of the acquired quality and the rating grid related to it.
Phase 4: Determine using the AHP method the criterion's weight and the quality's relative contribution of the each activity to criterion j.
Phase 5: Assign the judgments for each activity and deduct the number of defects related to them.
Phase 6: Determine the level of sigma for each activity of the two process to calculate the DPMO * according to the six-sigma method
Phase 7: Convert the sigma level to perfection rate TpMi (Q) for each activity of the two processes.
Phase 8: Determine the new quality rating using the reliability calculation methods.

Table. 2.1. Steps For Deploying The Quality Assessment Method

Phase 1- Identify the activities of the maintenance's processes:
The identification of activities related to the corrective and preventive maintenance processes was discussed in the previous paragraph as part of the process approach.

Phase 2- Concept quality's criteria:
The objective is to present the steps that led to the construction of the quality criteria on which will be assessed the overall quality of the two corrective and preventive maintenance processes as well as the construction of the scales. The conceptual model must first of all reflect the perception of quality through production. This is tantamount to identifying the components of quality to be taken into account, the nature of their dependencies and their interactions, but above all, Identify and then integrate important perceptual factors into the model.
The second concern in the construction of this model is to ensure that it is able to formalize the specifications of maintenance managers in terms of quality so that the overall evaluation provided by the tool corresponds to the desired target.

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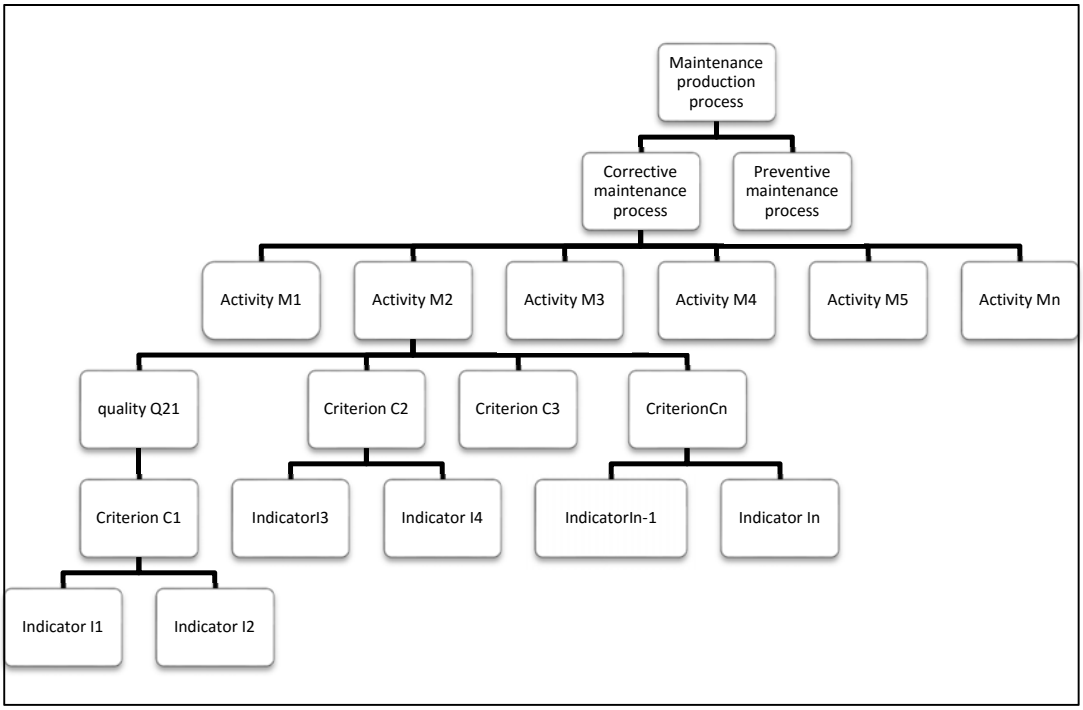

Figure.2.1.Modèle conceptuel de qualité globale

Ci-dessous les différents niveaux du modèle obtenu (Table. 2.2) :

A. level 1

The decomposition of the overall quality of the maintenance processes was done on the basis of the two production processes: Corrective and preventive maintenance.

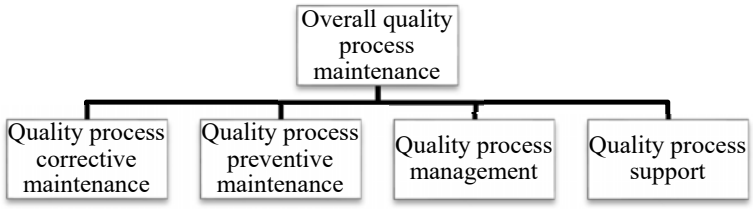

Figure.2.2. First level of the hierarchy of the global quality conceptual model

It should be noted that our study will be limited to the processes of realization corrective maintenance and preventive maintenance.

B. Second level: decomposition of quality corrective and preventive process

We have decomposed the quality of the two corrective and preventive processes into the type of activities that technicians and maintenance operators practice

For quality corrective and preventive process, we have retained the activities specified in the paragraph

C. Third level:

The perception of the quality of the maintenance processes is different depending on the maintenance sub-processes, such as corrective maintenance, fast or complex.

D. Fourth level:

The fourth level consists of the components that affect quality in the practice of corrective or preventive maintenance activities (see Figure 2.3 in Chapter 1). The evaluation of the quality of a technician in the practice of an activity will therefore be based on the components identified in the cause-effect diagram (Ishikawa) whose importance and associated scales Scale or values of perceptual data) may vary depending on the activity.

We have grouped the components of quality into six modalities that coincide with the 6Ms: documentation, workforce, material, method

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and environment. (Table.2.2). As for the indicators of measurement of the different modalities are explained by the (Table.2.3).

D.1.The documentation modality:

There are several indicators to measure the contribution of documentation to the quality of a maintenance activity. Indeed, the ISO19011:2012 quality audit standard proposes a certain type of indicators: documentation that is complete, correct, consistent with practice and updated.

D.2.The labor modality:

Labor force indicators aim to measure the poor quality caused by absences, non-qualification, lack of competence, motivation and / or lack of training.

D.3.Modality of work:

The purpose of these indicators is to measure the degree of maturity of the supply operations, the quality of storage at the store and the ability to meet the need for production in terms of machine availability by eliminating sources of waste And expectations. The corresponding indicators are: availability to stock, form, adequate, handling (congestion, heavy, light, etc.) and transport time at the workplace.

D.4.The method:

It is the criterion that has a significant weight compared to other criteria, in fact it is the core of the maintenance work for this purpose the chosen indicators will concern the preparation of work, the existence of procedures, respect Procedures and the rate of execution.

D.5.The material:

The purpose of these indicators is to measure the quality of supply to the maintenance operation by the equipment and intervention equipment, in terms of availability, conformity, suitability, handling, transport time and Flexibility of adaptation.

D.6. The Environnement mode:

It is a criterion that concerns the ergonomic aspect relating to the working environment or takes place the maintenance operation in terms of temperature, humidity, lighting, risk of accident, and access path.

	level 1	level2(les activités)	level 3	level 4(les modalités)
The overall maintenance quality	process corrective maintenance	DT Reception and Data Entry	Fast, Complex	Documentation
		On-site analysis		Middle / Environment
		Assignment of missions and resources		Workforce
		Recording		Object of work
		Rapid Maintenance Operation		Equipment
		Test and start-up support		Method
		preparation		
		Consignment and Security		
		Programming and waiting		
		Launch of the TO		
		Technical diagnostics		
		Intervention, disassembly; exchange		
		Reassembly, rests		
		Testing, inspection, adjustment,		
		tagout		
		Operational equipment, reporting		
	process preventive maintenance	Planning of periodic shutdowns	Round, general, preventive	Documentation
		General Stop Planning		Middle / Environment
		Tracking Data Records		Workforce
		Preparation of the round visit		Object of work
		Round Operation		Equipment
		Drafting of visit reports		Method
		Preventive Maintenance Preparation		Middle
		Maintenance and replacement operation		
		Test and start-up support		
		Technical preparation for shutdown		
		Technical diagnostics		
		Maintenance and replacement operation		
		Test and start-up support		

Table.2.2. Decomposition Maintenance's Quality According To 5M

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Phase 3: Identify the evaluation's indicators of the acquired quality and the rating grid related to it.

level 4(indicators)	level 5(indicators)	Satisfactory	Unsatisfactory	Poor
Documentation	Full	0,25	0,125	0
	correct	0,25	0,125	0
	Consistency with practice	0,25	0,125	0
	Updating and Updating	0,25	0,125	0
manpower	available	0,25	0,125	0
	formed	0,25	0,125	0
	competent	0,25	0,125	0
	qualified	0,25	0,125	0
matériel	available in stock	0,25	0,125	0
	true	0,25	0,125	0
	adequate	0,25	0,125	0
	handling	0,25	0,125	0
Méthod	work procedure	0,25	0,125	0
	Preparation of work	0,25	0,125	0
	Values of the tasks perform	0,25	0,125	0
	Compliance procedure	0,25	0,125	0
Environnement	Risk of accident	0,25	0,125	0
	temperature	0,25	0,125	0
	humidity	0,25	0,125	0
	lighting	0,25	0,125	0
machine	available	0,25	0,125	0
	true	0,25	0,125	0
	adequate	0,25	0,125	0
	handling	0,25	0,125	0

Table.2.3. Criteria-Indicator Correspondence

Phase 4: Determine using the AHP method the criterion's weight and the quality's relative contribution of the each activity to criterion j.

In order to determine the relative contribution of each activity of each maintenance process with respect to each one of the two processes, it is necessary to make a study using the AHP method, Pintelon, L. and Gelders, L. (1992). Criterion j (documentation, manpower, material, method, material and environment)

	Documentation	Manpower	Matériel	Machine	Méthod	Environement	Moy	Moy geo	weight (Wi)
Documentation									
Manpower									
Matériel									
Machine									
Méthod									
Environement									
Total columns									

Table.2.4. Determination Criteria's Weight

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Code	Criterion: j Activity	DT Reception and Data Entry	On-site analysis	Assignment of missions and resources	Recording	Rapid Maintenance Operation	Test and start-up support	preparation	Consignment and Security	Programming and waiting	Launch of the TO	Technical diagnostics	Intervention, disassembly; exchange	Reassembly, rests	Testing, inspection, adjustment,	tagout	Operational equipment, reporting	Moy geometric	Weight Wi
M01	DT Reception and Data Entry																		
M02	On-site analysis																		
M03	Assignment of missions and resources																		
M04	Recording																		
M05	Rapid Maintenance Operation																		
M06	Test and start-up support																		
M07	preparation																		
M08	Consignment and Security																		
M09	Programming and waiting																		
M10	Launch of the TO																		
M11	Technical diagnostics																		
M12	Intervention, disassembly; exchange																		
M13	Reassembly, rests																		
M14	Testing, inspection, adjustment,																		
M15	tagout																		
M16	Operational equipment, reporting																		

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Table.2.5 Example Canvas Quality's Relative Contribution Of The Activity (MC) For Criterion J.

Code	Activity	C1-documentation	VC1	Qi1 R	φ1(x1)	Numbre activity's defect	C2-Manpower	VC2	Qi2 R	φ2(x2)	Numbre activity's defect	C3-Méthode	VC3	Qi3 R	φ3(x3)	Numbre activity's defect	C4-Materiel	VC4	Qi4 R	φ4(x4)	Numbre activity's defect	C5-Machine	VC5	Qi5 R	φ5(x5)	Numbre activity's defect	C6-Environnment	VC6	Qi6 R	φ6(x6)	Numbre activity's defect	quality's relative contribution	Numbre operation's defect	quality's contribution x nbr of defect	DPM	level sigma	perfection's rate (TpMi)
M01	DT Reception and Data Entry																																			
M02	On-site analysis																																			
M03	Assignment of missions and resources																																			
M04	Recording																																			
M05	Rapid Maintenance Operation																																			
M06	Test and start-up support																																			
M07	preparation																																			
M08	Consignment and Security																																			
M09	Programming and waiting																																			
M10	Launch of the TO																																			
M11	Technical diagnostics																																			
M12	Intervention, disassembly; exchange																																			
M13	Reassembly, rests																																			
M14	Testing, inspection, adjustment,																																			
M15	tagout																																			
M16	Operational equipment, reporting																																			

Table.2.6 . Example De Canvas Calculation Sigma's Level And Perfection's Rate Of Each Activity (MC).

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II.2.Procedure for calculating the contribution relating to the quality's realization according to the chosen preferences of the activities at times previously fixed.

From the above, the weight wi of each criterion is now known as well as its relative contribution of the quality Qij,

The aggregation of the preferences is then carried out by judging the quality achieved in each step of the maintenance process and it follows that the quality's relative contribution of the activity Mi will be given by: Qij= Σwj* Qij(t)* Ø(xj) (J = 1 to j = J) (i = 1; ... i = I)

With:

•Qij: relative contribution with respect to the process of the activity Mi for each criterion j, with 0 ≤ Qij≤ 1 with I: number of activity.

• wj: relative importance of criterion j.

• Qij (t): contribution of quality to a given criterion.

• Ø (xj): Assignment of a judgment based on the work performed, Xj: Result obtained for criterion j

• Ø (xj) = 0.5, for a good result regardless of the control time.

• Ø (xj) = 0.125 for a partially achieved result xj obtained at different times

• Ø (xj) = 0 for a bad result xj obtained at different times (see Table.2.3 above).

Phase 5: Assign the judgments for each activity and deduct the number of defects related to them.

It is a question of assigning for each maintenance activity a judgment sanctioned by the number of defects.

Ø (xj): Assignment of a judgment based on the work performed, Xj: Result obtained for criterion j

• Ø (xj) = 0.5, for a good result regardless of the control time.

• Ø (xj) = 0.125 for a partially achieved result xj obtained at different times

• Ø (xj) = 0 for a bad result xj obtained at different times (see Table.2.3 above).

					Activity M1		Activity M2		Activity M3		Activity M4		Activity M5		Activity M6		Activity M7		Activity M8		Activity M9		Activi
level 4(indicators)	level 5(indicators)	Satisfactory	Unsatisfactory	Poor	Result	Nbr of defect	Result	Nbr of defect	Result	Nbr of defect	Result	Nbr of defect	Result	Nbr of defect	Result	Nbr of defect	Result	Nbr of defect	Result	Nbr of defect	Result	Nbr of defect	Result
Documentation	correct	0,25	0,125	0																			
	Consistency with practice	0,25	0,125	0																			
	Updating and Updating	0,25	0,125	0																			
	available	0,25	0,125	0																			
Manpower	formed	0,25	0,125	0																			
	competent	0,25	0,125	0																			
	qualified	0,25	0,125	0																			
	available in stock	0,25	0,125	0																			
Materiel	true	0,25	0,125	0																			
	adequate	0,25	0,125	0																			
	handling	0,25	0,125	0																			
	work procedure	0,25	0,125	0																			
method	Preparation of work	0,25	0,125	0																			
	Values of the tasks perforr	0,25	0,125	0																			
	Compliance procedure	0,25	0,125	0																			
	Risk of accident	0,25	0,125	0																			
Environnement	temperature	0,25	0,125	0																			
	humidity	0,25	0,125	0																			
	lighting	0,25	0,125	0																			
	available	0,25	0,125	0																			
Machine	true	0,25	0,125	0																			
	adequate	0,25	0,125	0																			
	handling	0,25	0,125	0																			
	manutention	0,25	0,125	0																			

Table.2.7 Example de Canvas Assign the judgments for each activity and deduct the number of defects (MC)

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Phase 6: Determine the level of sigma for each activity of the two process to calculate the DPMO * according to the six-sigma method:

The level of sigma for each activity will be calculated by multiplying the relative contribution of the quality by the number of defects found during our judgment at the instant t for the activity Mi in question and subsequently the number of defects per million d 'opportunity DPMO*.

DPMO* = ((Qij x NdMi)/C) x 1000000,

C: The number of features; in our case C=24;

NdMi: Number of defects related to activity Mi; The Figure.2.3. Gives the level of sigma, either nS.

Phase 7: Convert the sigma level to perfection rate TpMi (Q) for each activity

The level of sigma of the activity will be converted into a quality perfection rate (TpMi (Q)).

This will allow migrating towards the calculation perfection's rate (TpMi) of the activity Mi.

The perfection rate TpMi (Q) will therefore be deduced as:

$$\text{TpMi(Q)} = \text{Probabilité}\left(Z < (n - 1.5)\right) = X\%$$

With: X% will be read on the table of the normal centered reduced law taking into account the sigma offset.

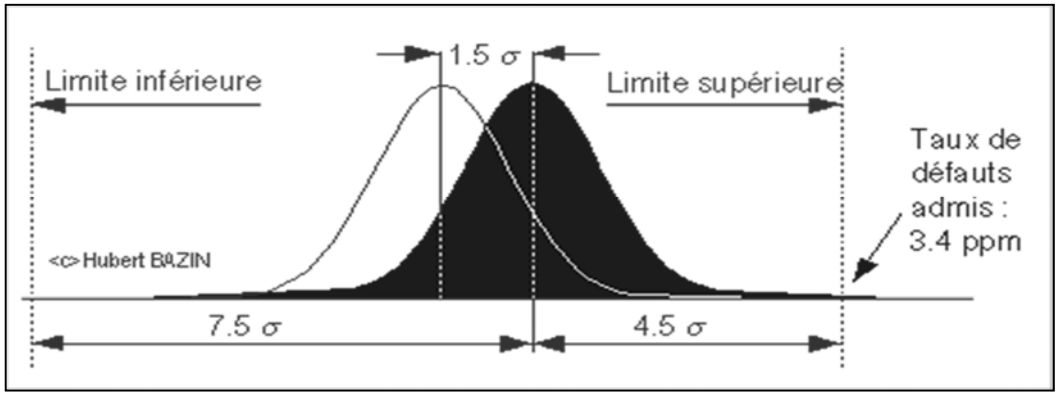

Figure.2.3. Decentring's Six-sigma 1.5s

Phase 8: Determine using the reliability calculation methods the new quality rate:

To calculate the quality rate of the corrective and preventive maintenance process, the methods based on the reliability given by the following formula will be applied by analogy:

$$TQMC = \prod_1^3 TpMi * \left[\left(1 - \left(1 - \prod_4^6 TpMi\right)\right) * \left(1 - \left(\prod_7^{14} TpMi\right)\right)\right] * \prod_{15}^{16} TpMi$$

$$TQMP = \prod_{17}^{19} TpMi * \left[\left(1 - \left(1 - \prod_{20}^{22} TpMi\right)\right) * \left(1 - \left(\prod_{23}^{28} TpMi\right)\right)\right] * TpM29$$

Avec :

$$\text{TpMi(Q)} = \text{Probability}\left(Z = \frac{(S - Qm)}{\sigma} < (n - 1.5)\right) = X\%$$

The new process quality rate will be TQ :

$$TQ = TQMC * TQMP$$

TQ: Quality's rate

TQMC: Quality's rate process corrective maintenance

TQMP: Quality's rate process preventive maintenance

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III. APPLICATION

As explained above, it is necessary to implement the eight phases in order to calculate the new quality rate; Steps of this approach will be illustrated by industrial applications:

Phase 1- Identify the activities of the maintenance's processes:

Maintenance processes are already identified, the scope of the study will concern only corrective and preventive maintenance processes.

Phase 2- Concept quality's criteria:

The construction phase of the criteria for the prioritization of activities is already explained in the previous paragraph.

Phase 3: Identify the evaluation's indicators of the acquired quality and the rating grid related to it.

	Documentation	Manpower	Matériel	Machine	Méthod	Environement	Moy	Moy geo	weight (Wi)
Documentation	1	0,20	1,00	3,00	0,33	2,00	0,40	0,86	0,11
Manpower	5,00	1	3,00	5,00	7,00	7,00	3675,00	3,93	0,49
Matériel	1,00	0,33	1	1,00	2,00	3,00	1,98	1,12	0,14
Machine	0,33	0,20	1,00	1	0,20	3,00	0,04	0,58	0,07
Méthod	3,00	0,14	0,50	5,00	1	1,00	1,05	1,01	0,13
Environement	0,50	0,14	0,33	0,33	1,00	1	0,01	0,44	0,06
Total columns	10,83	2,01	6,83	15,33	11,53	17,00		7,94	1,00

Table.2.8. Prioritization of criteria using the AHP method

Phase 4: Determine using the AHP method the criterion's weight and the quality's relative contribution of the each activity to criterion j.

The relative quality contribution of each activity of the corrective and preventive maintenance processes is described by six tables describing the measure against the criteria: documentation, subject matter; Material, labor, environment and method. The following is the result:

Code	Criterion: j documentation Activity	DT Reception and Data Entry	On-site analysis	Assignment of missions and resources	Recording	Rapid Maintenance Operation	Test and start-up support	preparation	Consignment and Security	Programming and waiting	Launch of the TO	Technical diagnostics	Intervention, disassembly; exchange	Reassembly, rests	Testing, inspection, adjustment,	tagout	Operational equipment, reporting	Moy geometric	Weight Wi
M01	DT Reception and Data Entry	1	3	0,3	0,3	0,14	3	3	3	0,3	0,2	0,2	0,2	0,2	3	3	1	0,71	0,036
M02	On-site analysis	0,3	1	0,2	0,3	0,14	3	0,2	3	3	0,2	3	0,3	3	0,2	3	3	0,76	0,038
M03	Assignment of missions and resources	3	5	1	0,3	0,14	3	3	3	0,3	5	5	5	5	3	3	1	1,90	0,095
M04	Recording	3	3	3	1	0,2	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,2	0,92	0,046
M05	Rapid Maintenance Operation	7	7	7	5	1	5	5	7	5	7	3	7	7	5	7	7	5,29	0,264
M06	Test and start-up support	0,3	0,3	0,3	3	0,2	1	3	3	0,3	5	5	5	5	3	3	1	1,41	0,070
M07	preparation	0,3	5	0,3	3	0,2	0,3	1	3	0,3	5	5	5	5	3	3	1	1,46	0,073
M08	Consignment and Security	0,3	0,3	0,3	0,3	0,14	0,3	0,3	1	0,3	5	5	5	5	3	3	1	0,90	0,045
M09	Programming and waiting	3	0,3	3	5	0,3	3	3	3	1	7	3	0,2	3	0,3	3	0,2	1,41	0,071
M10	Launch of the TO	5	5	0,2	0,3	0,14	0,2	0,2	0,2	0,1	1	3	3	3	0,3	5	5	0,81	0,040
M11	Technical diagnostics	5	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	1	1	5	3	1	0,2	0,54	0,027
M12	Intervention, disassembly; exchange	5	3	0,2	5	3	0,2	0,2	0,2	5	0,3	1	1	3	0,2	3	3	1,07	0,053
M13	Reassembly, rests	5	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	0,2	0,3	1	0,2	3	1	0,41	0,021
M14	Testing, inspection, adjustment,	0,3	5	0,3	3	5	0,3	0,3	0,3	3	3	0,3	5	5	1	0,2	0,3	0,98	0,049
M15	tagout	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,2	1	0,3	0,3	5	1	3	0,47	0,023
M16	Operational equipment, reporting	1	0,3	1	5	0,3	1	1	1	5	0,2	5	0,3	1	3	0,3	1	0,97	0,048

Table. 2.9. Quality's relative contribution "corrective maintenance process for criterion "Documentation"

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Code	Criterion: j Manpower Activity	DT Reception and Data Entry	On-site analysis	Assignment of missions and resources	Recording	Rapid Maintenance Operation	Test and start-up support	preparation	Consignment and Security	Programming and waiting	Launch of the TO	Technical diagnostics	Intervention, disassembly; exchange	Reassembly, rests	Testing, inspection, adjustment,	tagout	Operational equipment, reporting	Moy geometric	Weight Wi
M01	DT Reception and Data Entry	1	3	0,3	0,3	0,14	3	3	3	0,3	5	5	5	5	3	3	1	1,59	0,080
M02	On-site analysis	0,3	1	0,3	0,3	0,14	3	0,2	3	3	0,2	3	0,3	3	0,2	3	3	0,78	0,039
M03	Assignment of missions and resources	3	3	1	0,3	0,14	3	3	3	0,3	0,2	5	5	5	3	3	1	1,50	0,076
M04	Recording	3	3	3	1	0,2	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,2	0,92	0,046
M05	Rapid Maintenance Operation	7	7	7	5	1	5	5	7	5	7	3	7	7	5	7	7	5,29	0,266
M06	Test and start-up support	0,3	0,3	0,3	3	0,2	1	3	3	0,3	5	5	5	5	3	3	1	1,41	0,071
M07	preparation	0,3	5	0,3	3	0,2	0,3	1	3	0,3	5	5	5	5	3	3	1	1,46	0,073
M08	Consignment and Security	0,3	0,3	0,3	0,3	0,14	0,3	0,3	1	0,3	5	5	5	5	3	3	1	0,90	0,045
M09	Programming and waiting	3	0,3	3	5	0,3	3	3	3	1	7	3	0,2	3	0,3	3	0,2	1,41	0,071
M10	Launch of the TO	0,2	5	5	0,3	0,14	0,2	0,2	0,2	0,1	1	3	3	3	0,3	5	5	0,81	0,041
M11	Technical diagnostics	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	1	1	5	3	1	0,2	0,44	0,022
M12	Intervention, disassembly; exchange	0,2	0,3	0,2	5	3	0,2	0,2	0,2	5	0,3	1	1	3	0,2	3	3	0,76	0,038
M13	Reassembly, rests	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	0,2	0,3	1	0,2	3	1	0,34	0,017
M14	Testing, inspection, adjustment,	0,3	0,3	0,3	3	5	0,3	0,3	0,3	3	3	0,3	5	5	1	0,2	0,3	0,82	0,041
M15	tagout	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,2	1	0,3	0,3	5	1	3	0,47	0,024
M16	Operational equipment, reporting	1	0,3	1	5	0,3	1	1	1	5	0,2	5	0,3	1	3	0,3	1	0,97	0,049

Table.2.10. Quality's relative contribution «corrective maintenance process" for criterion « Manpower »

Code	Criterion: j Method Activity	DT Reception and Data Entry	On-site analysis	Assignment of missions and resources	Recording	Rapid Maintenance Operation	Test and start-up support	preparation	Consignment and Security	Programming and waiting	Launch of the TO	Technical diagnostics	Intervention, disassembly; exchange	Reassembly, rests	Testing, inspection, adjustment,	tagout	Operational equipment, reporting	Moy geometric	Weight Wi
M01	DT Reception and Data Entry	1	3	0,3	0,3	0,2	3	3	3	0,3	5	0,2	0,2	0,2	3	3	1	0,89	0,046
M02	On-site analysis	0,3	1	3	0,3	0,14	3	3	3	3	0,2	3	0,3	3	0,2	3	3	1,07	0,056
M03	Assignment of missions and resources	3	0,3	1	0,3	0,2	3	3	3	0,3	0,2	5	5	5	3	3	1	1,33	0,069
M04	Recording	3	3	3	1	0,2	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,2	0,92	0,048
M05	Rapid Maintenance Operation	5	7	5	5	1	5	5	7	5	7	3	7	7	5	7	7	5,07	0,264
M06	Test and start-up support	0,3	0,3	0,3	3	0,2	1	3	3	0,3	5	5	5	5	3	3	1	1,41	0,073
M07	preparation	0,3	0,3	0,3	3	0,2	0,3	1	3	0,3	5	5	5	5	3	3	1	1,22	0,064
M08	Consignment and Security	0,3	0,3	0,3	0,3	0,14	0,3	0,3	1	0,3	7	7	7	7	3	3	1	0,97	0,051
M09	Programming and waiting	3	0,3	3	5	0,3	3	3	3	1	7	3	0,2	3	0,3	3	0,2	1,41	0,074
M10	Launch of the TO	0,2	5	5	0,3	0,14	0,2	0,2	0,14	0,1	1	3	3	3	0,3	5	5	0,79	0,041
M11	Technical diagnostics	5	0,3	0,2	0,3	0,3	0,2	0,2	0,14	0,3	0,3	1	1	5	3	1	0,2	0,53	0,028
M12	Intervention, disassembly; exchange	5	0,3	0,2	5	3	0,2	0,2	0,14	5	0,3	1	1	3	0,2	3	3	0,91	0,047
M13	Reassembly, rests	5	0,3	0,2	0,3	0,3	0,2	0,2	0,14	0,3	0,3	0,2	0,3	1	0,2	3	1	0,40	0,021
M14	Testing, inspection, adjustment,	0,3	0,3	0,3	3	5	0,3	0,3	0,3	3	3	0,3	5	5	1	0,2	0,3	0,82	0,043
M15	tagout	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,2	1	0,3	0,3	5	1	3	0,47	0,024
M16	Operational equipment, reporting	1	0,3	1	5	0,3	1	1	1	5	0,2	5	0,3	1	3	0,3	1	0,97	0,050

Table. 2.11. Quality's relative contribution "corrective maintenance process" for criterion « Méthod »

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Code	Criterion: j Materiel Activity	DT Reception and Data Entry	On-site analysis	Assignment of missions and resources	Recording	Rapid Maintenance Operation	Test and start-up support	preparation	Consignment and Security	Programming and waiting	Launch of the TO	Technical diagnostics	Intervention, disassembly; exchange	Reassembly, rests	Testing, inspection, adjustment,	tagout	Operational equipment, reporting	Moy geometric	Weight Wi
M01	DT Reception and Data Entry	1	3	0,3	0,3	3	3	3	3	0,3	5	0,2	0,2	0,2	3	3	1	1,06	0,061
M02	On-site analysis	0,3	1	3	0,3	3	3	3	3	3	0,2	3	0,3	3	0,2	3	3	1,30	0,074
M03	Assignment of missions and resources	3	0,3	1	0,3	5	3	3	3	0,3	0,2	5	5	5	3	3	1	1,63	0,094
M04	Recording	3	3	3	1	5	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,2	1,13	0,065
M05	Rapid Maintenance Operation	0,3	0,3	0,2	0,2	1	5	5	7	5	7	3	7	7	5	7	7	2,34	0,134
M06	Test and start-up support	0,3	0,3	0,3	3	0,2	1	3	3	3	5	5	5	5	3	3	1	1,63	0,094
M07	preparation	0,3	0,3	0,3	3	0,2	0,3	1	3	3	5	5	5	5	3	3	1	1,41	0,081
M08	Consignment and Security	0,3	0,3	0,3	0,3	0,14	0,3	0,3	1	3	7	7	7	7	3	3	1	1,13	0,065
M09	Programming and waiting	3	0,3	3	5	0,3	0,3	0,3	0,3	1	7	3	0,2	3	0,3	3	0,2	0,92	0,053
M10	Launch of the TO	0,2	5	5	0,3	0,14	0,2	0,2	0,14	0,1	1	3	3	3	0,3	5	5	0,79	0,045
M11	Technical diagnostics	5	0,3	0,2	0,3	0,3	0,2	0,2	0,14	0,3	0,3	1	1	5	3	1	0,2	0,53	0,031
M12	Intervention, disassembly; exchange	5	0,3	0,2	5	3	0,2	0,2	0,14	5	0,3	1	1	3	0,2	3	3	0,91	0,052
M13	Reassembly, rests	5	0,3	0,2	0,3	0,3	0,2	0,2	0,14	0,3	0,3	0,2	0,3	1	0,2	3	1	0,40	0,023
M14	Testing, inspection, adjustment,	0,3	0,3	0,3	3	5	0,3	0,3	0,3	3	3	0,3	5	5	1	0,2	0,3	0,82	0,047
M15	tagout	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,2	1	0,3	0,3	5	1	3	0,47	0,027
M16	Operational equipment, reporting	1	0,3	1	5	0,3	1	1	1	5	0,2	5	0,3	1	3	0,3	1	0,97	0,056

Table. 2.12. Quality's relative contribution «corrective maintenance process" for criterion « Materiel »

Code	Criterion: j Machine Activity	DT Reception and Data Entry	On-site analysis	Assignment of missions and resources	Recording	Rapid Maintenance Operation	Test and start-up support	preparation	Consignment and Security	Programming and waiting	Launch of the TO	Technical diagnostics	Intervention, disassembly; exchange	Reassembly, rests	Testing, inspection, adjustment,	tagout	Operational equipment, reporting	Moy geometric	Weight Wi
M01	DT Reception and Data Entry	1	3	0,3	0,3	3	5	3	3	0,3	5	5	0,2	0,2	3	3	1	1,33	0,075
M02	On-site analysis	0,3	1	3	0,3	3	5	3	3	3	0,2	5	0,3	3	0,2	3	3	1,38	0,078
M03	Assignment of missions and resources	3	0,3	1	0,3	5	5	3	3	0,3	0,2	5	5	5	3	3	1	1,68	0,095
M04	Recording	3	3	3	1	5	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,2	1,13	0,064
M05	Rapid Maintenance Operation	0,3	0,3	0,2	0,2	1	5	5	7	5	7	3	7	7	5	7	7	2,34	0,132
M06	Test and start-up support	0,2	0,2	0,2	3	0,2	1	3	3	3	5	5	5	5	3	3	1	1,51	0,085
M07	preparation	0,3	0,3	0,3	3	0,2	0,3	1	3	3	5	5	5	5	3	3	1	1,41	0,080
M08	Consignment and Security	0,3	0,3	0,3	0,3	0,14	0,3	0,3	1	3	7	7	7	7	3	3	1	1,13	0,064
M09	Programming and waiting	3	0,3	3	5	0,3	0,3	0,3	0,3	1	7	3	7	3	0,3	3	0,2	1,14	0,065
M10	Launch of the TO	0,2	5	5	0,3	0,14	0,2	0,2	0,14	0,1	1	3	7	3	0,3	5	5	0,83	0,047
M11	Technical diagnostics	0,2	0,2	0,2	0,3	0,3	0,2	0,2	0,14	0,3	0,3	1	1	5	3	1	0,2	0,42	0,024
M12	Intervention, disassembly; exchange	5	0,3	0,2	5	3	0,2	0,2	0,14	0,14	0,14	1	1	3	0,2	3	3	0,69	0,039
M13	Reassembly, rests	5	0,3	0,2	0,3	0,3	0,2	0,2	0,14	0,3	0,3	0,2	0,3	1	0,2	3	1	0,40	0,023
M14	Testing, inspection, adjustment,	0,3	0,3	0,3	3	5	0,3	0,3	0,3	3	3	0,3	5	5	1	0,2	0,3	0,82	0,047
M15	tagout	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,2	1	0,3	0,3	5	1	3	0,47	0,026
M16	Operational equipment, reporting	1	0,3	1	5	0,3	1	1	1	5	0,2	5	0,3	1	3	0,3	1	0,97	0,055

Table. 2.13. Quality's relative contribution «corrective maintenance process" for criterion « Machine »

Code	Criterion: j Environnement Activity	DT Reception and Data Entry	On-site analysis	Assignment of missions and resources	Recording	Rapid Maintenance Operation	Test and start-up support	preparation	Consignment and Security	Programming and waiting	Launch of the TO	Technical diagnostics	Intervention, disassembly; exchange	Reassembly, rests	Testing, inspection, adjustment,	tagout	Operational equipment, reporting	Moy geometric	Weight Wi
M01	DT Reception and Data Entry	1	3	0,3	0,3	5	5	3	3	0,3	5	5	0,2	0,2	3	3	1	1,38	0,077
M02	On-site analysis	0,3	1	3	0,3	5	5	3	3	3	0,2	5	0,3	3	0,2	0,2	0,2	1,02	0,057
M03	Assignment of missions and resources	3	0,3	1	0,3	5	5	3	3	0,3	0,2	5	5	5	3	3	1	1,68	0,094
M04	Recording	3	3	3	1	5	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,2	1,13	0,063
M05	Rapid Maintenance Operation	0,2	0,2	0,2	0,2	1	5	5	7	5	7	3	7	7	5	7	7	2,22	0,124
M06	Test and start-up support	0,2	0,2	0,2	3	0,2	1	3	7	3	5	5	5	5	3	3	1	1,59	0,089
M07	preparation	0,3	0,3	0,3	3	0,2	0,3	1	7	3	5	5	5	5	3	3	1	1,49	0,083
M08	Consignment and Security	0,3	0,3	0,3	0,3	0,14	0,14	0,14	1	3	7	7	7	7	3	3	1	1,02	0,057
M09	Programming and waiting	3	0,3	3	5	0,3	0,3	0,3	0,3	1	7	3	7	3	0,3	3	0,2	1,14	0,064
M10	Launch of the TO	0,2	5	5	0,3	0,14	0,2	0,2	0,14	0,1	1	3	7	7	0,3	5	5	0,88	0,049
M11	Technical diagnostics	0,2	0,2	0,2	0,3	0,3	0,2	0,2	0,14	0,3	0,3	1	1	7	3	1	0,2	0,43	0,024
M12	Intervention, disassembly; exchange	5	0,3	0,2	5	3	0,2	0,2	0,14	0,14	0,14	1	1	7	0,2	7	3	0,77	0,043
M13	Reassembly, rests	5	0,3	0,2	0,3	0,3	0,2	0,2	0,14	0,3	0,14	0,14	0,14	1	0,2	7	1	0,38	0,021
M14	Testing, inspection, adjustment,	0,3	5	0,3	3	5	0,3	0,3	0,3	3	3	0,3	5	5	1	7	0,3	1,23	0,068
M15	tagout	0,3	5	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,2	1	0,14	0,14	0,14	1	3	0,41	0,023
M16	Operational equipment, reporting	1	5	1	5	0,3	1	1	1	5	0,2	5	0,3	1	3	0,3	1	1,16	0,064

Table. 2.14. Quality's relative contribution «corrective maintenance process" for criterion « Milieu»

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Code	Critére: Documentation Activity process preventive Maintenance	Planning of periodic shutdowns	General Stop Planning	Tracking Data Records	Preparation of the round visit	Round Operation	Drafting of visit reports	Preventive Maintenance Preparation	Maintenance and replacement operation	Test and start-up support	Technical preparation for shutdown	Technical diagnostics	Maintenance and replacement operation	Test and start-up support	Moy géométric	Weight Wi
M17	Planning of periodic shutdowns	1	3	0,3	0,3	0,3	3	3	3	0,3	5	5	5	5	1,59	0,109
M18	General Stop Planning	0,3	1	0,2	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,73	0,050
M19	Tracking Data Records	3	5	1	0,3	0,3	3	3	3	0,3	5	5	5	5	1,97	0,135
M20	Preparation of the round visit	3	3	3	1	0,2	0,3	0,3	3	0,2	3	3	0,2	3	1,04	0,071
M21	Round Operation	3	3	3	5	1	3	0,2	3	3	0,2	3	0,3	3	1,58	0,108
M22	Drafting of visit reports	0,3	0,3	0,3	3	0,3	1	3	3	0,3	5	5	5	5	1,33	0,091
M23	Preventive Maintenance Preparation	0,3	5	0,3	3	5	0,3	1	3	0,3	5	5	5	5	1,72	0,117
M24	Maintenance and replacement operation	0,3	0,3	0,3	0,3	0,3	0,3	0,3	1	0,3	5	5	5	5	0,78	0,053
M25	Test and start-up support	3	0,3	3	5	0,3	3	3	3	1	7	3	0,2	3	1,74	0,119
M26	Technical preparation for shutdown	0,2	5	0,2	0,3	5	0,2	0,2	0,2	0,1	1	3	3	3	0,68	0,046
M27	Technical diagnostics	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	1	1	5	0,38	0,026
M28	Maintenance and replacement operation	0,2	3	0,2	5	3	0,2	0,2	0,2	5	0,3	1	1	3	0,81	0,055
M29	Test and start-up support	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	0,2	0,3	1	0,27	0,019

Table. 2.15. Quality's relative contribution «preventive maintenance process" for criterion « Documentation»

Code	Critére: Manpower Activity process preventive Maintenance	Planning of periodic shutdowns	General Stop Planning	Tracking Data Records	Preparation of the round visit	Round Operation	Drafting of visit reports	Preventive Maintenance Preparation	Maintenance and replacement operation	Test and start-up support	Technical preparation for shutdown	Technical diagnostics	Maintenance and replacement operation	Test and start-up support	Moy géométric	Weight Wi
M17	Planning of periodic shutdowns	1	3	0,3	0,3	0,3	3	3	3	0,3	0,2	5	5	5	1,24	0,086
M18	General Stop Planning	0,3	1	0,2	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,73	0,050
M19	Tracking Data Records	3	5	1	0,3	0,3	3	3	3	0,3	5	5	5	5	1,97	0,137
M20	Preparation of the round visit	3	3	3	1	5	0,3	0,3	3	0,2	3	3	0,2	3	1,33	0,092
M21	Round Operation	3	3	3	0,2	1	3	0,2	3	3	0,2	3	0,3	3	1,24	0,086
M22	Drafting of visit reports	0,3	0,3	0,3	3	0,3	1	3	3	0,3	5	5	5	5	1,33	0,092
M23	Preventive Maintenance Preparation	0,3	5	0,3	3	5	0,3	1	3	0,3	5	5	5	5	1,72	0,119
M24	Maintenance and replacement operation	0,3	0,3	0,3	0,3	0,3	0,3	0,3	1	0,3	5	5	5	5	0,78	0,054
M25	Test and start-up support	3	0,3	3	5	0,3	3	3	3	1	7	3	0,2	3	1,74	0,121
M26	Technical preparation for shutdown	5	5	0,2	0,3	5	0,2	0,2	0,2	0,1	1	3	3	3	0,87	0,060
M27	Technical diagnostics	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	1	1	5	0,38	0,027
M28	Maintenance and replacement operation	0,2	3	0,2	5	3	0,2	0,2	0,2	5	0,3	1	1	3	0,81	0,056
M29	Test and start-up support	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	0,2	0,3	1	0,27	0,019

Table. 2.16. Quality's relative contribution «preventive maintenance process" for criterion « Manpower»

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Code	Critére: Method Activity process preventive Maintenance	Planning of periodic shutdowns	General Stop Planning	Tracking Data Records	Preparation of the round visit	Round Operation	Drafting of visit reports	Preventive Maintenance Preparation	Maintenance and replacement operation	Test and start-up support	Technical preparation for shutdown	Technical diagnostics	Maintenance and replacement operation	Test and start-up support	Moy géométric	Weight Wi
M17	Planning of periodic shutdowns	1	0,3	0,3	0,3	0,3	3	3	3	0,3	0,2	5	5	5	1,04	0,073
M18	General Stop Planning	3	1	0,2	0,3	0,3	3	0,2	3	3	0,2	0,3	0,3	3	0,73	0,051
M19	Tracking Data Records	3	5	1	0,3	0,3	3	3	3	0,3	5	5	5	5	1,97	0,138
M20	Preparation of the round visit	3	3	3	1	5	0,3	0,3	3	0,2	3	3	0,2	3	1,33	0,093
M21	Round Operation	3	3	3	0,2	1	3	0,2	3	3	0,2	3	0,3	3	1,24	0,087
M22	Drafting of visit reports	0,3	0,3	0,3	3	0,3	1	3	3	0,3	5	5	5	5	1,33	0,093
M23	Preventive Maintenance Preparation	0,3	5	0,3	3	5	0,3	1	3	0,3	5	5	5	5	1,72	0,120
M24	Maintenance and replacement operation	0,3	0,3	0,3	0,3	0,3	0,3	0,3	1	0,3	5	5	5	5	0,78	0,055
M25	Test and start-up support	3	0,3	3	5	0,3	3	3	3	1	7	3	0,2	3	1,74	0,122
M26	Technical preparation for shutdown	5	5	0,2	0,3	5	0,2	0,2	0,2	0,1	1	3	3	3	0,87	0,061
M27	Technical diagnostics	0,2	3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	1	1	5	0,46	0,032
M28	Maintenance and replacement operation	0,2	3	0,2	5	3	0,2	0,2	0,2	5	0,3	1	1	3	0,81	0,057
M29	Test and start-up support	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	0,2	0,3	1	0,27	0,019

Table. 2.17. Quality's relative contribution «preventive maintenance process" for criterion « Méthod»

Code	Critére: Materiel Activity process preventive Maintenance	Planning of periodic shutdowns	General Stop Planning	Tracking Data Records	Preparation of the round visit	Round Operation	Drafting of visit reports	Preventive Maintenance Preparation	Maintenance and replacement operation	Test and start-up support	Technical preparation for shutdown	Technical diagnostics	Maintenance and replacement operation	Test and start-up support	Moy géométric	Weight Wi
M17	Planning of periodic shutdowns	1	0,3	0,3	0,3	0,3	3	3	3	0,3	0,2	5	5	5	1,04	0,073
M18	General Stop Planning	3	1	0,2	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,87	0,061
M19	Tracking Data Records	3	5	1	0,3	0,3	3	3	0,3	0,3	5	5	5	5	1,65	0,116
M20	Preparation of the round visit	3	3	3	1	5	0,3	0,3	3	0,2	3	3	0,2	3	1,33	0,094
M21	Round Operation	3	3	3	0,2	1	3	0,2	3	3	0,2	3	0,3	3	1,24	0,087
M22	Drafting of visit reports	0,3	0,3	0,3	3	0,3	1	3	3	0,3	5	5	5	5	1,33	0,094
M23	Preventive Maintenance Preparation	0,3	5	0,3	3	5	0,3	1	3	0,3	5	5	5	5	1,72	0,121
M24	Maintenance and replacement operation	0,3	0,3	3	0,3	0,3	0,3	0,3	1	0,3	5	5	5	5	0,93	0,066
M25	Test and start-up support	3	0,3	3	5	0,3	3	3	3	1	7	3	0,2	3	1,74	0,123
M26	Technical preparation for shutdown	5	5	0,2	0,3	5	0,2	0,2	0,2	0,1	1	3	3	3	0,87	0,061
M27	Technical diagnostics	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	1	1	5	0,38	0,027
M28	Maintenance and replacement operation	0,2	3	0,2	5	3	0,2	0,2	0,2	5	0,3	1	1	3	0,81	0,057
M29	Test and start-up support	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	0,2	0,3	1	0,27	0,019

Table. 2.18. Quality's relative contribution «preventive maintenance process" for criterion « Materiel»

	Critére: Machine Activity process preventive Maintenance	...nning of perio...ic ...tdowns	...eral Stop Plan...ing	...cking Data ...cords	...paration of th... ...nd visit	...und Operation	...fting of visit ...orts	...ventive ...intenance ...paration	...intenance and ...lacement oper...tion	...t and start-up ...port	...hnical prepara...ion ...shutdown	...hnical diagno...tics	...intenance and ...lacement operation	...t and start-up ...port	...y géométric	...ight Wi

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Table. 2.19. Quality's relative contribution «preventive maintenance process" for criterion « Materiel»

Code	Critére: Environnement Activity process preventive Maintenance	Planning of periodic shutdowns	General Stop Planning	Tracking Data Records	Preparation of the round visit	Round Operation	Drafting of visit reports	Preventive Maintenance Preparation	Maintenance and replacement operation	Test and start-up support	Technical preparation for shutdown	Technical diagnostics	Maintenance and replacement operation	Test and start-up support	Moy géométric	Weight Wi
M17	Planning of periodic shutdowns	1	3	0,3	0,3	0,3	0,3	3	3	0,3	0,2	5	0,2	5	0,81	0,056
M18	General Stop Planning	0,3	1	0,2	0,3	0,3	3	0,2	3	3	0,2	3	0,3	3	0,73	0,050
M19	Tracking Data Records	3	5	1	0,3	0,3	3	3	3	0,3	5	5	5	5	1,97	0,136
M20	Preparation of the round visit	3	3	3	1	5	0,3	0,3	3	0,2	3	3	0,2	3	1,33	0,092
M21	Round Operation	3	3	3	0,2	1	3	0,2	3	3	0,2	3	0,3	3	1,24	0,085
M22	Drafting of visit reports	3	0,3	0,3	3	0,3	1	3	3	0,3	5	5	5	5	1,59	0,110
M23	Preventive Maintenance Preparation	0,3	5	0,3	3	5	0,3	1	3	0,3	5	5	5	5	1,72	0,119
M24	Maintenance and replacement operation	0,3	0,3	0,3	0,3	0,3	0,3	0,3	1	0,3	5	5	5	5	0,78	0,054
M25	Test and start-up support	3	0,3	3	5	0,3	3	3	3	1	7	3	0,2	3	1,74	0,121
M26	Technical preparation for shutdown	5	5	0,2	0,3	5	0,2	0,2	0,2	0,1	1	3	3	3	0,87	0,060
M27	Technical diagnostics	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	1	1	5	0,38	0,027
M28	Maintenance and replacement operation	5	3	0,2	5	3	0,2	0,2	0,2	5	0,3	1	1	3	1,04	0,072
M29	Test and start-up support	0,2	0,3	0,2	0,3	0,3	0,2	0,2	0,2	0,3	0,3	0,2	0,3	1	0,27	0,019

Table. 2.20. Quality's relative contribution «preventive maintenance process" for criterion « Milieu»

Checking the consistency of the matrices:
The tables below represent the final calculation of RC for each matrix.

Matrix

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	Critères	MC /documentation	MC/Materiel	MC/Manpower	MC /Méthod	MC /Machine	MC /Environnement
CI	0.0135	0.0107	0.0156	0.0119	0.0694	0.0676	0.0121
RI	1.24	1.24	1.24	1.24	1.24	1.24	1.24
C	0.011	0.087	0.013	0.096	0.056	0.049	0.098

Table 2.21. Consistency Ratio "CR" for the matrices studied (MC).

Matrix

	Critères	MP /documentation	MP/Materiel	MP/Manpower	MP /Méthod	MP /Machine	MP /Environnement
CI	0.0135	0.0109	0.0126	0.083	0.0359	0.0582	0.0110
RI	1.24	1.24	1.24	1.24	1.24	1.24	1.24
C	0.011	0.088	0.054	0.067	0.029	0.047	0.089

Table 2.22. Consistency Ratio "CR" for the matrices studied (MP).

The assignment of weights is considered acceptable if CR is less than 0.1. Otherwise, the procedure must be applied again.
Note that we have found for the matrix criteria of CR ~ = 0.35 and CR ~ = 0.29
Indeed, the judgment procedure was redone to elaborate a new notation for each matrix.

Phase 6: Determine the level of sigma for each activity of the two process to calculate the DPMO * according to the six-sigma method:
After calculating the contribution of quality for each activity Mi of the two corrective and preventive maintenance processes, the next step is to evaluate and judge the activities using the rating adopted for each indicator in relation to the corresponding criterion In this case to estimate the number of faults or malfunctions observed.
It is pointed out that this is a very delicate step in judging the quality of the activities of the two maintenance processes, for example for an activity if the four indicators are scored at the maximum scores then in this case The number of defects is zero, otherwise it depends on the notation of the indicators where a malfunction or malfunction has been found.

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Corrective Maintenance					Activity M1		Activity M2		Activity M3		Activity M4		Activity M5		Activity M6		Activity M7		Activity M8		Activity M9		Activity M10		Activity M11		Activity M12		Activity M13		Activity M14		Activity M15		Activity M16	
Level 4(Critéria)	level 5(Indicators)	Satisfactory	Unsatisfactory	low	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect
Documentation	Full	0,25	0,125	0	0,25	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	correct	0,25	0,125	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
	Consistency with	0,25	0,125	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0
	Updating and	0,25	0,125	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
					0,625	2	0,625	2	0,625	2	0,5	3	0,625	2	0,625	2	0,5	3	0,625	2	0,625	2	0,625	2	0,625	2	0,5	3	0,625	2	0,625	2	0,5	3	0,625	2
Manpower	available	0,25	0,125	0	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,125	1	0,25	0	0,125	1	0,25	0	0,25	0	0,25	0
	formed	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	competent	0,25	0,125	0	0,25	1	0,125	1	0,125	1	0,25	1	0,125	1	0,125	1	0,25	1	0,125	1	0,125	1	0,125	1	0,125	1	0,25	1	0,125	1	0,125	1	0,25	1	0,125	1
	qualified	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
					0,75	3	0,625	3	0,5	4	0,75	3	0,625	3	0,5	4	0,75	3	0,625	3	0,5	4	0,625	3	0,5	4	0,75	3	0,5	4	0,625	3	0,75	3	0,625	3
Matériel	available in stock	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	true	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	adequate	0,25	0,125	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
	handling	0,25	0,125	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0
					0,625	3	0,75	2	0,75	2	0,625	3	0,75	2	0,75	2	0,625	3	0,75	2	0,75	2	0,75	2	0,75	2	0,625	3	0,75	2	0,75	2	0,625	3	0,75	2
Méthod	work procedure	0,25	0,125	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
	Preparation of work	0,25	0,125	0	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,25	0	0,125	1	0,25	0	0,125	1	0,125	1	0,125	1
	Values of the tasks	0,25	0,125	0	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1
	Compliance	0,25	0,125	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
					0,875	1	0,75	2	0,875	1	0,875	1	0,75	2	0,875	1	0,875	1	0,75	2	0,875	1	0,75	2	0,875	1	0,875	1	0,875	1	0,75	2	0,875	1	0,75	2
Environnement	Risk of accident	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,25	0
	temperature	0,25	0,125	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
	humidity	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,25	0	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0
	lighting	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,25	0
					0,625	3	0,625	3	0,625	3	0,625	3	0,625	3	0,625	3	0,625	3	0,625	3	0,625	3	0,625	3	0,75	2	0,625	3	0,75	2	0,625	3	0,625	3	1	0
Machine	available	0,25	0,125	0	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,25	0	0,125	1	0,25	0	0,125	1	0,125	1	0,125	1
	true	0,25	0,125	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0
	adequate	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	handling	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
					0,5	4	0,625	3	0,75	2	0,5	4	0,625	3	0,75	2	0,5	4	0,625	3	0,75	2	0,625	3	0,75	2	0,5	4	0,75	2	0,625	3	0,5	4	0,625	3

Table.2.23. Estimated defect's number or malfunctions by each process activity (MC)

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Preventive Maintenance					Activité M17		Activité M18		Activité M19		Activité M20		Activité M21		Activité M22		Activité M23		Activité M24		Activité M25		Activité M26		Activité M27		Activité M28		Activité M29	
Level 4(Critéria)	level 5(Indicators)	Satisfactory	Unsatisfactory	low	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect	Result	Nbr de defect
Documentation	Full	0,25	0,125	0	0,25	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	correct	0,25	0,125	0	0	1	0	1	0	1	0	1	0,125	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
	Consistency with	0,25	0,125	0	0,25	0	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0	1	0,25	0	0,25	0	0,125	1	0,25	0
	Updating and	0,25	0,125	0	0,25	0	0,125	1	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0	1	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
					0,75	1	0,5	3	0,5	3	0,5	3	0,75	2	0,5	3	0,5	3	0,375	3	0,375	3	0,625	2	0,625	2	0,5	3	0,625	2
Manpower	available	0,25	0,125	0	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,125	1	0,25	0	0,125	1
	formed	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0	1	0,125	1	0	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	competent	0,25	0,125	0	0,25	1	0,125	1	0	1	0,25	1	0,125	1	0,125	1	0,25	1	0,125	1	0,125	1	0	1	0,125	1	0,25	1	0,125	1
	qualified	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,25	1	0,125	1	0,125	1	0,25	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
					0,75	3	0,625	3	0,375	4	0,875	3	0,5	3	0,5	4	0,75	3	0,625	3	0,5	4	0,5	3	0,5	4	0,75	3	0,5	4
Matériel	available in stock	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	true	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	adequate	0,25	0,125	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
	handling	0,25	0,125	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,25	0	0,25	0	0,125	1	0,25	0
					0,625	3	0,75	2	0,75	2	0,625	3	0,625	2	0,75	2	0,625	3	0,75	2	0,75	2	0,75	2	0,75	2	0,625	3	0,75	2
Méthod	work procedure	0,25	0,125	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
	Preparation of work	0,25	0,125	0	0,125	1	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,25	0	0,125	1	0,25	0
	Values of the tasks	0,25	0,125	0	0,25	0	0	1	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,125	1	0,125	1	0,25	0	0,125	1
	Compliance	0,25	0,125	0	0,25	0	0	1	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
					0,875	1	0,375	3	0,875	1	1	0	0,75	2	0,875	1	0,875	1	0,75	2	0,875	1	0,75	2	0,875	1	0,875	1	0,875	1
Environnement	Risk of accident	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	temperature	0,25	0,125	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0	0,25	0
	humidity	0,25	0,125	0	0,25	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	lighting	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
					0,75	2	0,625	3	0,625	3	0,625	3	0,625	3	0,625	3	0,5	4	0,625	3	0,625	3	0,625	3	0,625	3	0,625	3	0,625	3
Machine	available	0,25	0,125	0	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,125	1	0,25	0	0,125	1	0,25	0	0,125	1	0,25	0
	true	0,25	0,125	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,125	1	0,25	0	0,25	0	0,25	0	0,25	0	0,125	1	0,25	0
	adequate	0,25	0,125	0	0,125	1	0,25	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
	handling	0,25	0,125	0	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1	0,125	1
					0,5	4	0,75	2	0,75	2	0,5	4	0,625	3	0,75	2	0,5	4	0,625	3	0,75	2	0,625	3	0,75	2	0,5	4	0,75	2

Table.2.24. Estimated defect's number or malfunctions by each process activity (MP)

Phase 7: Convert the sigma level to perfection rate TpMi (Q) for each activity Mi

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Code	Activity	C1-documentation	VC1	Q1R	φ1(x1)	Numbre activity's defect	C2-Manpower	VC2	Q2R	φ2(x2)	Numbre activity's defect	C3-Method	VC3	Q3R	φ3(x3)	Numbre activity's defect	C4-Materiel	VC4	Q4R	φ4(x4)	Numbre activity's defect	C5-Machine	VC5	Q5R	φ5(x5)	Numbre activity's defect	C6-Environment	VC6	Q6R	φ6(x6)	Numbre activity's defect	quality's relative contribution	Numbre operation's defect	quality's contribution x nbr of defect	DPM	level sigma	perfection's rate (TpMI)
			0,11					0,49					0,13					0,14					0,07					0,06									
M01	DT Reception and Data Entry			0,036	0,625	2			0,080	0,75	3			0,046	0,875	1			0,061	0,625	3			0,075	0,5	4			0,077	0,625	3	0,0480	16	0,7679	31995	3,3S	0,9641
M02	On-site analysis			0,038	0,625	2			0,039	0,625	3			0,056	0,75	2			0,074	0,75	2			0,078	0,625	3			0,057	0,625	3	0,0335	15	0,5022	20924	3,5S	0,9772
M03	Assignment of missions and resources			0,095	0,625	2			0,076	0,5	4			0,069	0,875	1			0,094	0,75	2			0,095	0,75	2			0,094	0,625	3	0,0513	14	0,7181	29920	3,4S	0,9713
M04	Recording			0,046	0,5	3			0,046	0,75	3			0,048	0,875	1			0,065	0,625	3			0,064	0,5	4			0,063	0,625	3	0,0354	17	0,6014	25060	3,45S	0,9744
M05	Rapid Maintenance Operation			0,264	0,625	3			0,266	0,625	3			0,264	0,75	2			0,134	0,75	2			0,132	0,625	3			0,124	1	0	0,2218	11	2,36	98207,8	2,4S	0,8189
M06	Test and start-up support			0,070	0,625	3			0,071	0,5	4			0,073	0,9	1			0,094	0,75	2			0,085	0,75	2			0,089	0,625	3	0,0669	13	0,84	35176,98	3,25S	0,9599
M07	preparation			0,073	0,5	3			0,073	0,75	3			0,064	0,875	1			0,081	0,625	3			0,080	0,5	4			0,083	0,625	3	0,0512	17	0,8696	36235	3,2S	0,9554
M08	Consignment and Security			0,045	0,625	2			0,045	0,625	3			0,051	0,75	2			0,065	0,75	2			0,064	0,625	3			0,057	0,625	3	0,0335	15	0,5030	20960	3,5S	0,9772
M09	Programming and waiting			0,071	0,625	2			0,071	0,5	4			0,074	0,875	1			0,053	0,75	2			0,065	0,75	2			0,064	0,625	3	0,0419	14	0,5869	24455	3,4S	0,9713
M10	Launch of the TO			0,040	0,625	2			0,041	0,625	3			0,041	0,75	2			0,045	0,75	2			0,047	0,625	3			0,049	0,625	3	0,0280	15	0,4193	17469	3,6S	0,9821
M11	Technical diagnostics			0,027	0,625	2			0,022	0,5	4			0,028	0,875	1			0,031	0,75	2			0,024	0,75	2			0,024	0,75	2	0,0160	13	0,2086	8693	4,6S	0,9990
M12	Intervention, disassembly, exchange			0,053	0,5	3			0,038	0,75	3			0,047	0,875	1			0,052	0,625	3			0,039	0,5	4			0,043	0,625	3	0,0298	17	0,5069	21122	3,5S	0,9772
M13	Reassembly, rests			0,021	0,625	2			0,017	0,5	4			0,021	0,875	1			0,023	0,75	2			0,023	0,75	2			0,021	0,75	2	0,0125	13	0,1630	6792	3,9S	0,9918
M14	Testing, inspection, adjustment,			0,049	0,625	2			0,041	0,625	3			0,043	0,75	2			0,047	0,75	2			0,047	0,625	3			0,068	0,625	3	0,0298	15	0,4468	18618	3,7S	0,9861
M15	tag out			0,023	0,5	3			0,024	0,75	3			0,024	0,875	1			0,027	0,625	3			0,026	0,5	4			0,023	0,625	3	0,0168	17	0,2863	11928	3,8S	0,9893
M16	Operational equipment, reporting			0,048	0,625	2			0,049	0,625	3			0,050	0,75	2			0,056	0,75	2			0,055	0,625	3			0,064	1	0	0,0353	12	0,4235	17647	3,6S	0,9821

Table.2.25. Quality Measurement Performed by Each Process Activity Corrective Maintenance

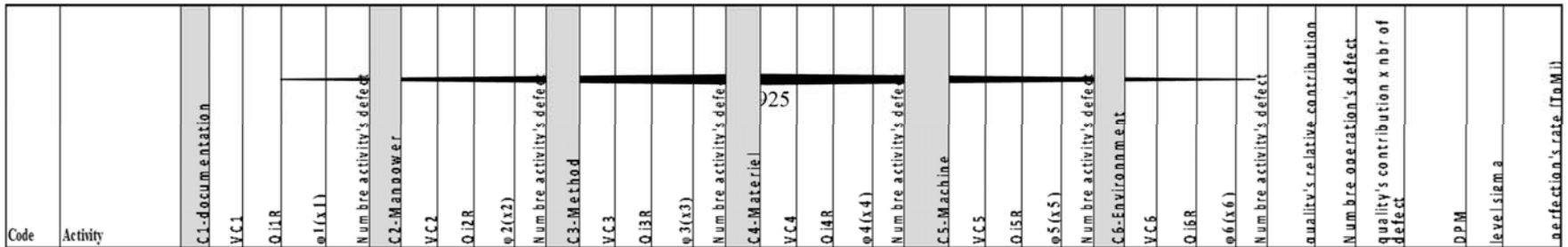

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Table. 2.26. Quality Measurement Performed by Each Process Activity preventive Maintenance

Phase 8: Determine using the reliability calculation methods the new quality rate (TEC01)

Quality block of activities
(corrective Maintenance Process)

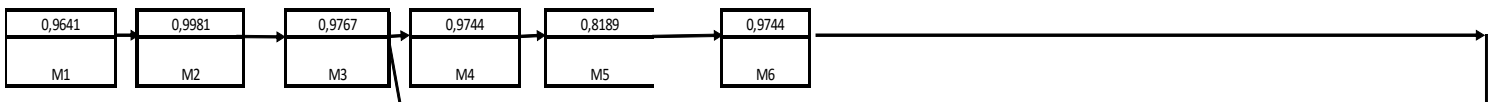

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Table. 2.27. Measurement of process quality Corrective maintenance using quality blocks

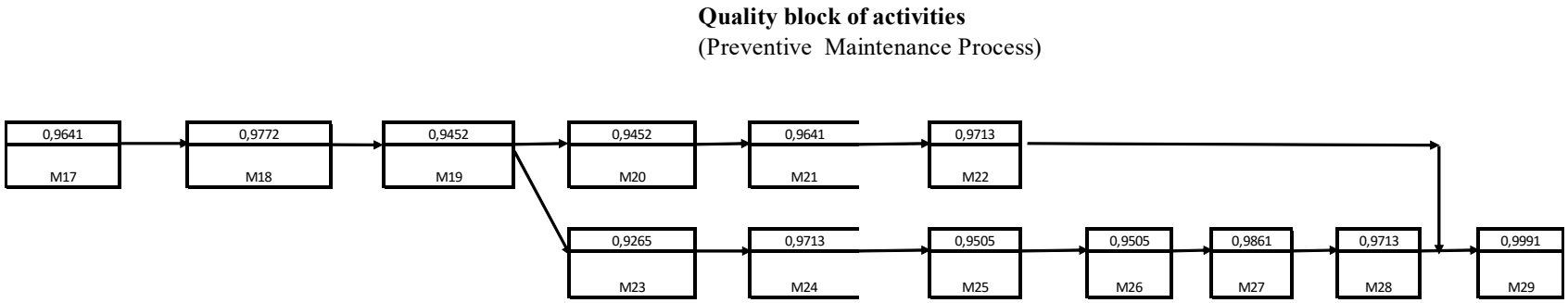

Table. 2.28. Measurement of process quality preventive maintenance using quality blocks

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This involves determining a quality rate of both corrective and preventive maintenance processes:

- corrective Maintenance Process:

$$TQMC = \prod_{1}^{6} TpMi * \left[\left(\left(\prod_{1}^{3} TpMi\right) * \left(\left(\prod_{7}^{16} TpMi\right)\right)\right)\right]$$

The quality rating TQMC=81.31%

- preventive Maintenance Process:

$$TQMP = \prod_{17}^{22} TpMi * \left[\left(\left(\prod_{17}^{19} TpMi\right) * \left(\left(\prod_{23}^{28} TpMi\right)\right)\right)\right] * (TpMi)^2$$

The quality rating TQMP=78.99%

And so : TQ= TQMC x TQMP = 64.22%

IV. CONCLUSION

At the end of the case study, we can confirm without much risk that the new formula for calculating the quality of the corrective and preventive maintenance processes makes it possible to measure the intrinsic and extrinsic quality of the activities of the maintenance The occurrence is a performance indicator to look for improvement actions to be implemented, which requires a good mastery of the maintenance and feedback techniques.

The only limitation we can find is the step of measuring the quality by resorting to the judgment of the maintenance activities. It is therefore a very delicate step in the judgment of the quality of the activities of the two maintenance processes

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