Bibliographical Review About Quality Cost Management Systems in the Moroccan Market

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***Abstract*— Quality management (QM) has become an undeniable issue for companies of different sizes, given all the advantages it offers them in terms of competitiveness in the international market. It boosts brand image and authorities' confidence in the organization's practices. However, quality cost management system (QCMS) is not practiced as much due to several factors. This article presents the works done on QCMS in the Moroccan Market and shows the beneficial impact on the strategy and sustainability of companies.**

***Keywords*–** *quality cost management systems, Moroccan market, quality, bibliographical review, manufacturing societies, quality cost.*

1. Introduction :

"We doesn't fully know a science until we know its history" Auguste Comte. In effect, the notion of quality is not a recent thought, but rather it dates back a long time, we can even say that it is a concept that has always accompanied human activity. This is proven by the Code of Hammurabi, a Babylonian legal text dated around 1750 BJC, where its article 233 announces the following: "if an architect has built a house for someone but has not executed his work according to the norms and if a wall is leaning, this mason, at his own expense, will reinforce the wall" [1]. This notion was not limited to the work of architects, but also to doctors and any individual exercising a job.

It is true that the concept of quality is very old, but if we look up for the quality cost or the non-quality cost or even imperfection cost as other authors call it. This concept has appeared for the first time in 1951 with JURAN Joseph in his book "Quality Control Handbook" [4]; from there several authors have shown their interest in this subject. Then in 1970, Deming redefined the term quality by integrating the concept of costs, so that the definition of quality becomes Quality = Result of the work done / Total cost. This last definition, and according to Deming, affirms that if the organization focuses mainly on the quality implicitly the costs will decrease. Nevertheless, if the organization focuses all its interest on the decrease of the costs it will end up by losing the quality of the product or the service. In 1970, Crosby popularized the concept of the cost of quality «QC» in his book "Quality is free". In 1986, AFNOR published a standard, "NF X50-126", which presents a guide for evaluating the costs resulting from non-quality. This standard divides the QC into 4 main categories: the costs of internal and external anomalies as well as the costs of detection and prevention.

The main purpose of this article is to provide an overview of the research carried out on quality cost management systems in Morocco in order to enrich the Moroccan database. This bibliographic review will present the work done on quality cost management systems in the Moroccan market after a review of the COQ models that were a reference base for them.

2. Quality Cost Models :

Various authors have developed several QC models. The modeling of these systems has evolved very rapidly. The following models are just an overview of a very dynamic set of QC:

- Juran's model:

As mentioned above, JURAN Joseph was the first to discuss the costs of quality in his book "Quality Control Handbook" by classifying its costs into two categories: The avoidable costs and the unavoidable ones. [8] JURAN has defined the economical optimal quality level as the highest quality level that a company can achieve with the lowest quality costs. [8] This model is no longer valid, as it does not take into account the current circumstances of the job market.

- The PAF model:

In 1956, Feigenbaum and Juran developed the PAF model: Prevention, Appraisal and Faillure. The first one is any investment made to verify, prevent and reduce anomalies. The second concerns investments made to verify the conformity of the products to the quality requirements. The last one, include all the costs caused to remedy the problems incurred by internal failures and external ones.

- The process cost model:

The process cost model was developed by Ross in 1977. This model is moderately similar to the PAF model [3]. The reason why many authors consider it as an alternative model of the last model. The present model is divided into two categories: Compliance costs "CC" and non-compliance costs "NCC".

- The revised Juran's model:

In 1983, Juran has revised the first published model, by classifying quality costs into four categories: prevention costs, quality measurement costs, internal failure costs as well as external failure costs [3]. In this model, JURAN has redefined the economical optimal quality level as the zero defects.

- The Godfrey and W.R. Pasework model:

This model appeared in 1988 where it incorporated the concept of the external environment. This model classified the quality costs into three main categories: The cost of failure control, the cost of failure and the cost of lost sales. [3]

- Hermel's model:

Hermel's model appeared in 1989. This model is divided into two categories: Prevention and detection costs; which in turn are divided into two categories: Unproductive costs and Productive costs. Then we find the reducible costs. [2]

- Harrington's model:

This model appeared in 1990 with Harrington, who is an English philosopher. His model focuses on two main categories: Direct costs (controllable costs, resulting costs and equipment costs), then Indirect costs (costs borne by the customer, costs due to customer dissatisfaction and costs due to loss renom). [2]

- Carr's model :

This model, which emerged in 1992, did not originate with manufacturing companies, but rather with service companies. It is divided into three categories: Compliance costs, non-compliance costs in addition to lost opportunity costs. [3]

- The opportunity cost model:

Currently, the opportunity cost is becoming more of a management science concept. Where it is defined as the benefits that an investor could have received from an alternative investment project. In fact, in 1998, Sandoval-Chavez and Beruvides divided these costs into three components: the bad exploitation of the installed capacity, the inadequacy of the material used and the bad service. [3]

Apart from the COQ models already mentioned, there is the ABC (Activity Based Costing) model, which is considered an alternative to the COQ models [4]. Developed by Cooper and Kaplan in 1988, its long-term goal is to eliminate non-value added activities and improve processes, activities and quality so that no defects are produced.

The current observation [4] [5] [6] shows that the PAF model remains the most used.

3. The QC at the national level :

In Morocco, studies on this topic are not as advanced as elsewhere. According to the research that we have done for the elaboration of this bibliographical review, we can say that only two works have been carried out on the Quality Cost. This section will be divided into two sub-sections, which each one will define the relevance of those works.

3.1. Work N° 1:

The first work is a doctoral thesis entitled "Design of a measurement tool and reduction of non-quality costs: Application to the management of industrial processes", which was carried out in 2006 in collaboration between the national school of arts and job – Paris Center within the laboratory of product's conception and innovation with the OCP- Jorf Lasfar. This thesis is a work duly owned by Dr. Abouzahir Omar, provided under the direction of Professor Robert DUCHAMP and GAUTIER Remy as co-director of this thesis.

This work gave a presentation of the OCP group where the case study was done as well as a passage on the main product of this group "Phosphate" was provided. In addition, the author has emphasized the efforts made by the group in the development of a quality approach since the 80s. This, before exposing the problematic of the organization, which is the following: Despite all the efforts and investments made by the OCP group in to obtain quality, the OCP is still unable to determine the economic effect of quality. In other words, how the OCP group can create a clear and tangible link between the budgets allocated to quality initiatives and the reduction of NQCs (Non Quality Costs), something that is hardly assured by the classic accounting system [2]. Then, the author spread out a bibliographical study: the evolution of the concept of quality, definition of the QC and its components (control's cost/prevention's cost/internal and external failure-s costs)

as well as the presentation of the different names of this cost, the changes that the concept has undergone over time, its different models, stakes and its order of magnitude at French industrial firms.

A. Omar formulated the problematic of his research as follows: The QC must be taken into account as a steering tool in the chain of processes and must be spread from upstream to downstream management processes, those of business and support processes. In addition, this tool must be able to calculate the efficiency of each of its processes [2]. This is precisely in order to reduce the costs of non-quality, internal and external failures, by integrating improvement actions whose efficiency must be taken into account concretely. For this research, two assumption [2] were proposed, centred on the need to orient the QC tool towards the processes:

- Assumption N°1: Carry out a scan of the processes on the map to judge which ones are relevant to the use of QC;
- Assumption N°2: Carry out a scan of the processes on the map to judge which processes are relevant for the organization to apply a QC approach.

The author has also cited two approaches [2] to continuous improvement and the evaluation of the costs of non-conformity. The latter two are as follows:

- Non-compliance cost assessment approach N°1: This is an approach proposed by Hermel in 1993. It goes from the determination of the consequences of each defect, collection of activity and financial data to a financial evaluation. And to close the present approach by an action plan to optimize these costs;
- Non-conformity cost assessment approach N° 2: This is an approach developed by an industrial group. Indeed, this approach announces that before the organization goes on to the creation and training of the QC steering groups, it is necessary to make the employees aware of the concept and its challenges. Then, define the structure of the QC, its indicators, validate them through a search for information, then develop the indicator sheets to synthesize them into a summary dashboard. Afterwards, the organization must conduct an analysis of the results, develop an action plan and follow up on this dashboard.

For the case study at OCP group, O. Abouzahir chose the second approach, which he made some modifications. Since the author advocates that the foundation of his approach be based on the process approach, he focused the second approach on the priority processes rather than the priority problems. This resulted a new approach following the steps below: [2]

- The choice of priority processes at the process mapping ;
- Calculation of non-quality costs;
- Determination of their root causes and their analysis;
- Implementation of improvement actions;
- Measurement of the effectiveness of these actions. In case of non-efficiency, the organization would be obliged to go back to the root cause analysis stage or to the choice of priority processes.

Once the approach is well established, the doctor moved on to concretize it within the group, where he chose as scope the macro-process of phosphoric acid production. This macro-process is initiated by the grinding of phosphate, which would be attacked by sulfuric acid and phosphoric acid back and submitted to filtration before its concentration to be able to store and ship it.

At this point, the researcher moved to conduct a statistical study of the unavailability of each of the processes mentioned above. Consequently, it was shown that the process of concentration generates 2014 hours of unavailability with a rate of 72%, followed by that of the reaction and filtration with a percentage of 25%, storage with only 3% and lastly the grinding which presents 0% [2]. Therefore, he considered that at the level of the "Concentration" part, actions must be carried out in privilege.

This process itself has been divided into sub-processes: Washing, filling, heating and starting up as well as putting into production, closed by stopping and emptying. For these ones were assigned indicators with their issues, but they were not all used. The author has opted for the most relevant indicators of those listed, justifying this with criteria motivating his choice.

The next step in this experimentation is identifying the cost of non-quality. This was done in chronological order of the following steps [2]:

- Based on the indicators considered relevant, a level of expected performance was set for each sub-process;
- Evaluation of the actual performance of each one;
- Calculation of the difference between the actual and expected performance level, which resulted in a "Non-Quality Gap";

- The non-quality gap was converted into a shortfall in production per ton and quantified as an estimated non-quality cost in DH;
- Application of an ABC analysis that classified which sub-processes generate the most non-quality cost. The thing that could help the researcher decided where to concentrate the efforts;
- Based on the previous step, production and washing sub-processes are the ones that need more efforts. For these two, an analysis of the failures recorded in the history and determination of the root causes were ensured;
- Implementation of improvement actions by a multidisciplinary team. For example, the extension of the washing period and the improvement of the availability of some equipment and many other actions;
- In order to measure the effectiveness of what was put in place, the team calculated the indicators for the following months. The evolution of these KPIs was proof of the effectiveness of the actions taken, which obviously led to a reduction in non-quality costs.

Based on the case study conducted at the OCP group, ABOUZAHIR has proposed a tool for measuring and reducing non-quality costs for the management of industrial processes. This approach has been declined into ten steps as bellows:

- ❖ Identification of processes and determination of the priority process ;
- ❖ Assignment of issue indicators for each sub-process ;
- ❖ Substitution of the process into sub-processes ;
- ❖ Determination of relevant indicators for the sub-process ;
- ❖ Evaluation of non-quality costs by sub-process ;
- ❖ Identification of priority sub-processes by prioritizing those costs (ABC analysis) ;
- ❖ Analysing the root causes of those failures with a multidisciplinary team ;
- ❖ Definition of areas for improvement and development of an action plan ;
- ❖ Implementation of the action plan by a the team ;
- ❖ Measuring the effectiveness of the action plan by monitoring the progress of the indicators summarized in a dashboard. Systematic meetings must be held under the control of a steering committee.

In order to better visualize this approach, we have proposed to schematize it on a flowchart (figure 1):

STEP	COMMENT
Identification of processes and determination of the priority process	By referring to the process map and the criteria set by the company, the Project leader with his team must determine the priority process.
Substitution of the process into sub-processes	Describing the functioning of this process by splitting it into activities.
Assignment of issue indicators for each sub-process	The actors must list all the indicators for each sub-process in an exhaustive way.
Determination of relevant indicators	Choosing the indicators with positive impact on the sub-processes.

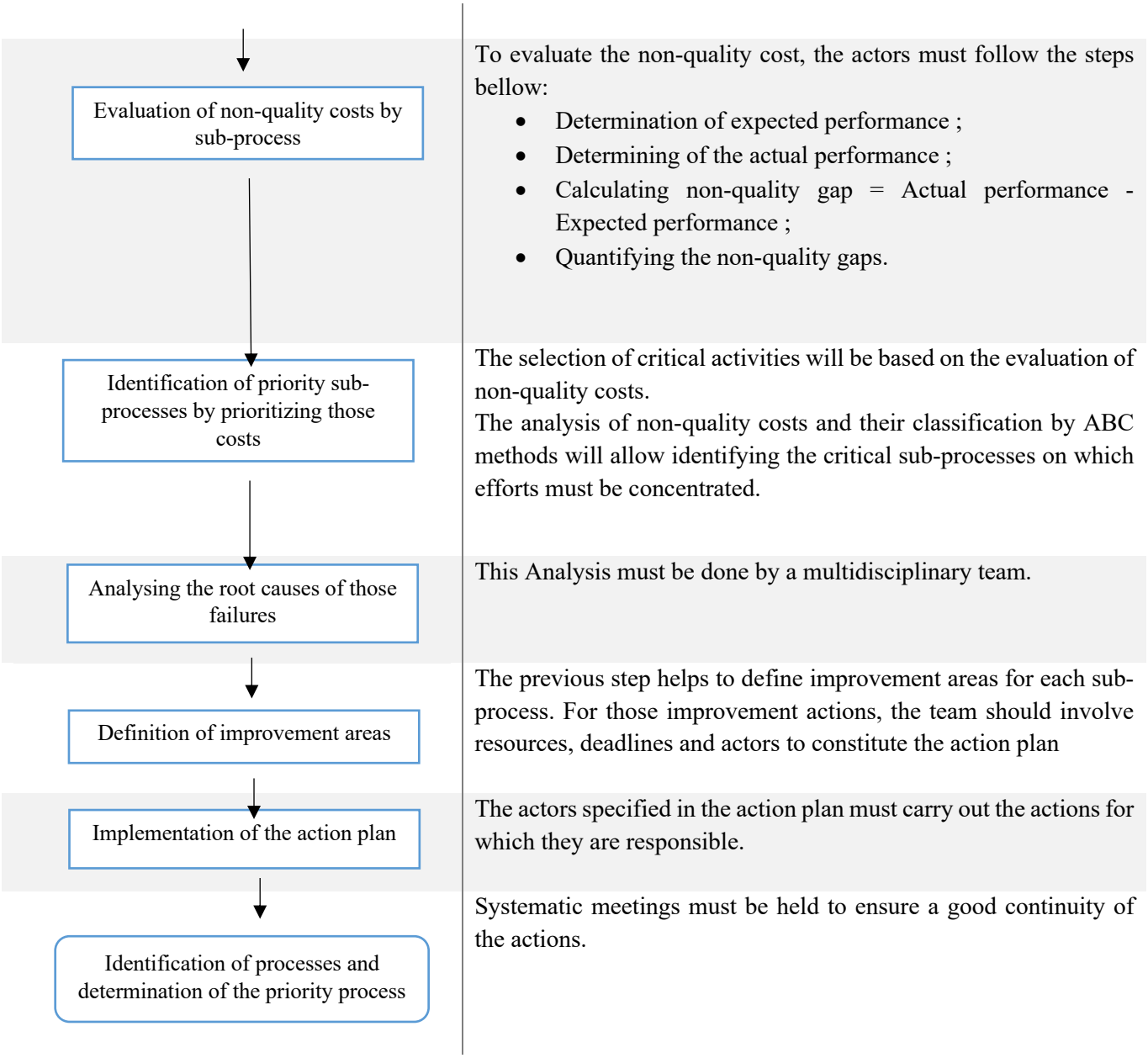

Figure 1: Flowchart of reducing non-quality costs

3.2. Work N° 2:

This work is a doctoral thesis entitled "Study of quality cost systems in Moroccan industrial companies" which was carried out in 2016 at the University Hassan First, Faculty of Science and Technology of Settat- Department of Applied Chemistry and Environment. This work involved the LaFarge Holcim group for experimentation. This thesis is a work duly own of Dr. AYACH Lamiaa, carried out under the supervision of Professor ANOUAR Abdellah and BOUZZIRI Miloud as Co-Director of thesis.

Firstly, the problematic of this work is: In the current economic and competitive context, the sustainability of a company has become a bit delicate, especially since they are in the obligation to offer a good quality product with a

low price [3]. The thing that makes the management of the costs of quality primordial for them as long as this cost presents a considerable margin of the cost of the product. Therefore, this research has been carried out to shed light on the practices of manufacturing companies in this area, to determine the obstacles holding back these organizations to implement quality cost management systems and obviously to enrich the national and international database on the status of industrial companies.

Secondly, a bibliographical study on quality, its history, tools and issues was presented. Before moving on to define the QC, by presenting the costs of quality investment and non-quality costs, its history, different taxonomies, the reference frameworks published in this sense, the challenges of this tool as well as its main models. As well as, a table summarizing the authors, survey methods, countries, sample size, response rate and results of empirical studies on QC.

Thirdly, a passage was elaborated about the LaFarge Holcim group, in which the experimentation was done as well as on its product "Cement". In fact, despite all the advantages that the Quality Cost Management System (QCMS) shows, this cement factory did not have it, judging that the actions of improvements implemented decrease the quality costs [3]. For this reason, the author conducted a case study in this group following the methodology cited below [3]:

- **Step 1:** Selection of priority process(es). So, According to the Lafarge Holcim, a priority process is the one that has an impact on the entire supply chain. For those, the cooking process which has a rate of 87% of the cost of the finished product has been selected as a priority process for Lafarge Holcim.
- **Step 2:** Study and decomposition of the priority process. The so-called cooking process is composed of three sub-processes: Preheating, oven and cooling.
- **Step 3:** Establishment of a list of the components of the cooking process COQ. The elements that have a significant impact on the process were listed according to a PAF model. For example, among the cost elements of the prevention category, we find the quality trainings and the budget allocated to this. For the detection category, the elements control and test of the equipment are costs related to the quality verification. Then, we find the category internal failures: overconsumption of heat and electricity ... and external failures.
- **Step 4:** As mentioned above, the components of the QC were identified on the basis of a PAF model, and the costs related to prevention, evaluation and external failures were quantified with the collaboration of the finance and quality department. This was based on a database of accounting, financial and administrative records as well as technical reports. While for the internal failures were quantified following the approach below:
    - Assign for each indicator a target to achieve, or update them, if necessary by statistical analysis;
    - Measure the performance of the process by determining the formulas of calculation of the non-quality;
    - Evaluate the quality gap by calculating the difference between the performance achieved by the process and the target already set;
    - Quantify this difference in KDH and in percentage.
- Step 5: Once the data for each category became quantifiable, L. AYACH moved on to analyze the distribution in the figure below.

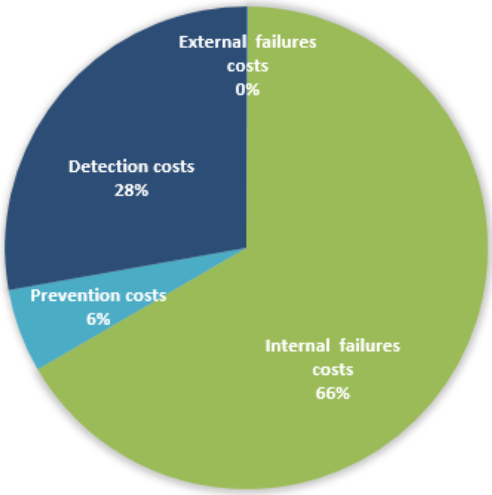

Figure 2: Distribution of quality costs at LaFarge Holcim

As shown, internal failure costs are almost double the other costs when the external failure costs are only 0.1%, a rate that can be considered negligible [3]. Next, the researcher conducted a PARETO analysis of the QC components of the present process where it was revealed that breakdowns, equipment inspection, testing, and decommissioning were the elements responsible for over 80% of the costs [3]. What made these components the elements to be treated first.

It was also necessary to carry out an ISHIKIWA analysis in order to determine the root causes of these elements, but before that L. AYACH had animated a training on the techniques of analysis for the collaborators of the LaFarge Holcim group. Then she proposed an action plan to optimize the QC for the present group in order to keep its durability and its competitive place in the market. Also, a procedure of implementation of the QCMS was elaborated [3] and communicated to them to facilitate this task.

The author also carried out a sampling plan based on data from the Moroccan Office of Industrial and Commercial Protection (OMPIC): In 2018 were 65505 active manufacturing companies in Morocco [3]. From these, a sample size was calculated equal to 382 companies, but as it was expected that not all of these companies would give a feedback on the questionnaire to be designed by the

researcher and that a positive feedback can only come from 40% of these companies, the researcher decided to communicate her questionnaire electronically to 955 manufacturing companies. [3]

Once the sample is defined, L. AYACH moved on to design the questionnaire, which was composed in two sections. The first part, aims to collect data about the organization such as its activity, its size ... as well as to know the perception of the respondent on the importance of the QC and how it is calculated. If the answer were positive, the respondent would be referred to a sub-section about their practices in this sense, otherwise, they would be referred to a sub-section about the obstacles encountered in implementing the QC [3]. Most of these questions were closed-ended and the questionnaire was tested on 12 respondents to get their feedback, using IBM SPSS Statistics 22 software. [3]

In fact, only 23.4% of 1000 manufacturing companies that gave a return on the questionnaire, a number of 234 companies [3]. The thing that led to the increase of the estimation error to a rate of 6.39. The organizations answering this questionnaire belonged to 13 different sectors, of which the dominant ones are: the automotive and machinery sector, followed by the agri-food sector and then the chemical industry [3].

These companies were divided into national and international ones with different life spans, different sizes and different perimeter's intervention (offshore and onshore).

Indeed, 35.5% of the companies gave a positive feedback, while 64.5% did not [3]. The thing considered disappointing by the researcher. To compensate for this, 76.9% of the companies considered that it would be beneficial for them to evaluate the quality costs, 18.4% were hesitant about this point and 4.7% were indifferent about it [3]. This shows their awareness of the importance of QCMS but do not adopt it, generally stating as an obstacle the difficulty of its implementation the insufficient knowledge of the principles of QC while other managers judged that their KPIs are enough [3].

For those who admitted calculating the QC, it was shown that 49.4% calculate it in almost all processes, 26.5% evaluate it in the production process and some others as well as 24.1% evaluate the QC only in the production process [3]. These data are generally reported monthly. Thus, 63.9% of these companies use the process model for their QCMS. This seems very logical, as long as they are certified ISO 9001 V15, they implicitly follow a process approach, which makes the process model more feasible for them. Although these companies take into account several components of the QC, the social, environmental and non-quality components are still not included in their QCMS [3].

Based on all the data cited, the researcher was able to perform a factor analysis, the findings of which are as follows [3]:

- 72.3% of the companies that evaluate their QC are offshore. This is explained by the increased demand of the international market;
- The size of the organization is a data with positive influence on the management of quality costs;
- The age of the organization is a data with neutral influence on the management of the quality costs;
- Companies with a high maturity of their quality management system "QMS" (according to the Crosby scale), generally tend to quantify their QC and sometimes even on all the processes ;
- The sector of activity, life span, number of employees, origin of the company and the maturity of the QMS affect the level of implementation of the QCMS.

The author's research did not stop there, but extended to the study of barriers to the implementation of the SMCQ. These obstacles are as follows [3]:

- Insufficient knowledge of the concept of quality costs and confusion of this term with others;
- Lack of interest and commitment of top management to monitoring QCMS;
- Resistance from employees;
- Complicated quantification of the costs of non-conformance: external and internal failures.

It would be more rewarding if research on operational performance and cost management as well as on improving the competitiveness of Moroccan manufacturing companies were done by Moroccan researcher. In addition to the realization of experimentation within service companies.

This work has shown the importance of quantifying quality costs, which facilitates the flow of communication with managers via a more tangible perspective. However, the proposed model proposed remains very generic and needs to be personalized for each sector.

4. Conclusion :

In Morocco, studies on QCMS are not as advanced as at the international level. Indeed, the research available in Morocco on these systems covers only big manufacturing companies, but no study has been conducted on small and medium-sized industrial companies (SMEs), even though

they represent a considerable percentage of about 73,7% of enterprises in Morocco.

As QCMS research is not widespread at the national level, it is necessary to multiply efforts to strengthen the Moroccan database on QCMS, which will allow organizations to know their improvement milestones, to banish non-value-added activities and thus control investment costs while meeting customer expectations.

This work constitutes a continuity of the research realized in this field. Its main objective is to study the degree of implementation of QCMS in the moroccan market and push researchers to conduct case studies in Moroccan service companies in order to produce guidelines that facilitate the implementation of those systems in those kind of companies.

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