13

Knowledge Management Through the TQM in the Metrology Area

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1. Introduction

Knowledge Management (KM) is continually used in various economic and social sectors as scientific, technological, educational, industrial and organizational. Its understanding and use help us to ensure the generation, exchange and application of knowledge under many specific contexts, which contribute to the learning and the cognitive development of all its stakeholders.

Particularly, it is a way to manage the knowledge is represented by Total Quality Management (TQM) within organizations. TQM has allowed companies and institutions to identify and establish their processes, to define and document their operations and to standardize their procedures to ensure customer satisfaction. It has been possible thanks to the transformation and arrangement from tacit to explicit knowledge that is generated within the organization by all stakeholders in the organization. In addition to that, it promotes the communication with the costumer, the realization of measurements, their analysis, and the continuous improvement and innovation of processes and products.

In this sense, measurements and their control represent a way to verify the compliance with the requirements and their possible deviations that arise during the implementation process. However, they also provide a mechanism for continuing improvement and innovation as they allow us to establish actions to improve the effectiveness of the system itself based on this information. Thus, a fundamental science for the proper development of measurements, specifically in the scientific and technical areas, is represented by the metrology that helps us to guarantee the quality of measurements and therefore, customer satisfaction.

The main objective of this work is to provide explanatory elements through an empirical study that enables us to understand how TQM through metrology is a valuable tool for KM within technical environments for promoting standardization, learning and continuous improvement, which even in some cases, these have been linked to several innovative products or processes. Specifically, we approach the case of the contribution that TQM has had from testing and calibration laboratories.

2. Knowledge management and TQM

There is a consensus on the importance knowledge and innovations have as a competitive difference so as to encourage the success of a company (Johannessen *et al*, 1999). According

to Lundvall (2006) the knowledge economy is found to be based on two premises: the intensive use of knowledge and the speed with which it becomes obsolete. Based on the previous, individuals and organizations are forced to develop new never-ending learning abilities that allow them to face such challenges.

Helander *et al* (2010) point out that learning is a valuable asset and a vital factor for production and it is therefore, defined as a mix of experience, values and information, which under a specific context, constitute a reference framework so as to evaluate and incorporate new experiences and information that can be expressed and content in data bases, documents, organizational routines, processes, practices and norms (Davenport & Prusak, 2000). Similarly, Dalkir (2005) defines knowledge as a fundamental way of knowledge often supported by experience, values and opinions.

In that sense, Polanyi (1966) classifies knowledge into two categories, tacit knowledge and explicit knowledge. The first one makes reference to personal knowledge, which has the characteristics of being hard to articulate, communicate or reproduce and, it is often related to specific situations. Explicit knowledge instead, can be transmitted or communicated through formal or systematic language. Nowadays, there has been a change from knowledge production based on the old scientific paradigm characterized by the predominance of theory, experimentation, disciplinarity and autonomy of scientists and institutions (mode 1), to a more active generation of it by means of transdisciplinarity, specificity, accountability and their social distribution (mode 2)(Nowotny *et al*, 2003).

In the contributions done by Polanyi, Nonaka & Takeuchi (1995), we find that they describe in their knowledge creation model the following four ways of conversion: 1.- From tacit to tacit (socialization), understood as harmonized knowledge; 2.- From tacit to explicit (exteriorization), represented by conceptual knowledge; 3.- From explicit to explicit (combination), symbolized as systematic knowledge; and 4.- From explicit to tacit (internalization), carried out through operational knowledge.

This knowledge dynamic proposed by the previously mentioned authors has become one of the basic principles in the understanding and correct operation of the KM. In that way, Knowledge Management is considered as a discipline that has the goal to generate, use and share the knowledge existing in spaces and organizations so as to fulfill the individuals' needs and the organizations and communities' development (Barragán, 2009).

Among the main benefits from implementing the KM, the following can be highlighted: it generates synergies among all the organization members, it accelerates the market's innovation and development, and it improves the quality of processes and reduces costs and risks involved in the organization's processes (Mohd *et al*, 2010). In that way, innovation is an element that helps us improve yielding, solve problems, add value to processes and products and, create competitive advantages within the organizations[1]. Therefore, KM and human capital represent essential elements in developing business, understanding them as sources of innovation and renovation (Gloet & Terziovski, 2004).

Kaynak (2003) points out how TQM represents an integral management philosophy that contributes to the continuous improvement in all organization's functions. On the other hand, Kalpič & Bernus (2006) discuss the existence of elements such as 1.- The organization that learns; 2.- Re-engineering of processes in business; 3.- Shaping businesses processes; 4.- Quality administration; and 5.- Movements in businesses'

[1] Edquist (2001) explains how innovations in an organization can be generated in technology and organizational processes; as well as in products (goods and services).

intelligence that represent the base through which, the KM allows building organizations based in knowledge. In that sense, Osayawe & McAndrew (2005) show how the TQM promotes creating an environment that favors innovation, creativity and taking risks for the satisfaction of clients' needs by solving problems through the incorporation of managers, employees and clients, who make use of quality control within the organization. In such a way, within the KM environment we can find the TQM is characterized for being an operative area giving support to the KM processes and the creation of organizational knowledge, while greatly influencing the management thinking and practice inside public and private sectors (Johannsen, 2000).

On the other hand, Mukherjee *et al* (1998) declare that TQM processes affect the way people create new knowledge and also determine efficiency within the organization. In the study on the evaluation of quality improvement projects carried out by these authors, they observed two things: the first one makes reference to the role conceptual and operative learning play in the achievement of goals, the development of new technology knowledge and the change in personnel's attention; the second thing observed is that such process of combining both learning types makes coding and diffusion of this knowledge easier. Likewise, Colurcio (2009) argues how the TQM helps on the creation and exchange of knowledge by means of establishing quality principles and methodologies, as these allow generating the necessary conditions for the development of a modern and successful company.

3. Quality multidimensionality

One of the terms we approach in this research refers to quality multidimensionality. In this sense, Prajogo & Sohal (2004) point out that it is divided into two parts: mechanic and organic. The first one is focused to the total quality control in aspects such as processes, requirements, productivity, and efficiency, among many others. Meanwhile, the organic or dynamic part is more oriented towards the development of elements that encourage the necessary conditions to carry out innovations. For example, in their research work, Prajogo & Sohal (2001) have provided evidence about the existence of a strong link between the TQM and innovation. For that purpose, they have described several cases where many companies, through the use of a wide variety of quality tools, have achieved to encourage managing the innovation from implementing TQM practices such as quality culture, learning organization, customer-driven organization and continuous improvement. Among these cases, very important companies can be highlighted, such as: D2D, Rover Group, IBM (UK) Ltd, 3M, Ford, AT&T, Cadillac, Hewlett Packard, Rank Xerox, Exxon Chemical, and Kodak Ltd.

Retaking the previous argument and also based on the theoretical review of literature on the subject, we propose the design of a Knowledge Management model through the use of TQM practices. Under a quality multidimensionality focus and, with an orientation towards testing and calibration laboratories we try to better understand the way in which KM is carried out in the quality and metrology area. Such Knowledge Management model represents a proposal to encourage the KM through the use of implicit elements in the TQM, in the mechanic part as well as the organic one.

For the construction of the model, a wide bibliographic and journalistic research oriented to identifying and analyzing elements used in the TQM practice was carried out. Finding a great amount of them was achieved as it can be seen in table 1.

No.	Author (s)	Year	Elements
1	Havely, A.	2003	The author exposes the possible improvement benefits testing and calibration laboratories could obtain from being accredited by the ISO 17025 norm, among which there can be highlighted : 1.- Improvement of professionalism and abilities, planning, implementation, measurement processes, equipment documentation and maintenance; 2.- Organizational learning through preventive measures and information sources, internal and external; 3.- Inter-laboratory testing; and 4.- Improvement of client satisfaction by means of identifying his needs.
2	Benoliel, J.M.	1999	In his work, he establishes that despite the implementation process of a quality assurance in a laboratory is long and expensive, it has benefits such as: 1.- Improvement of internal organization through processes optimization (procedures formalization and application); 2.- Detection and correction of mistakes; 3.- Demonstration of work abilities; and 4.- Image improvement and handling clients' complaints. Besides developing points that contribute to the implementation of a quality system and organizational improvement such as planning, management responsibility, training, documentation, quality manual, procedures (administrative and technical), development of proof methods, validation of analytic methods and auditing.
			In his study, the author describes how laboratories must fulfill with requirements for certification matters, for technical and management reasons, such as : 1.- Ethic requirements; 2.- Organizational and management procedures; 3.- Clear standards for subcontract in terms of outsourcing (tests) ; 4.- Assurance of quality when acquiring supplies and services ; 5.- Focus on the client, which can make contact and feedback with client better; 6.- Control of unsatisfying work ; 7.- Relevant technical and quality information registry; 8.- Regular internal auditing ; 9.- Periodic review from management; 10.- Qualified and trained personnel; 11.- Facilities

3	Cortez, L.	1999	to assure testing performance; 12.- Calibration testing and methods adequately selected, studied and validated; 13.- To have with the necessary equipment appropriately selected, operated, with periodic, calibrated and verified maintenance; 14.- Guarantee of traceability in measurements; 15.- Well defined sampling procedures; 16.- Well established sampling methods and sample handling; 17.- Quality assurance of testing and calibrations through a quality control system; and 18.- Findings report in a clear, objective and exact way.
4	Cronin, L.B.	1997	He states that the National Accreditation of Measurement and Sampling (NAMAS) points out that the accreditation requirements laboratories must know are oriented to: 1.- Organization, 2.- Auditing and quality revision; 3.- Equipment, methods and procedures; 4.- Handling of testing samples and, attention to complaints and anomalies; 5.- Uncertainty of measurements and handling of traceability; 6.- Quality system; 7.- Personnel; 8.- Environmental conditions; 9.- Registry; 10.- Subcontracts and acquisitions; and 11.- Calibration reports and certificates.
5	Lin, C. & Wu, C.	2005	In their work, they carry out an analysis on how the ISO 9000 norm contributes to knowledge management. In that sense, the authors express that according to the results obtained from interviews carried out with managers, they agree that quality information (document management, messages communication, administrative assistance and quality improvement) and infrastructure (information technology, organization, corporate culture and human resources) represent useful elements to facilitate the Knowledge Management.
			The arguments in this study are in favor of the integration of quality management practices with processes oriented to the creation of knowledge. In their proposal, Linderman *et al* relate client satisfaction, continuous improvement and the vision of the system to the four categories of the knowledge creation

6	Linderman, K. *et al*.	2004	process of Nonaka y Takeuchi. Where some aspects can be highlighted, such as: 1.- Client satisfaction (contact with client, attention mechanisms, complaint management, client analysis, feedback, client's voice, satisfaction and continuous monitoring); 2.- Continuous improvement (equipments, development groups, ideas creation, data analysis, processes control and statistical analysis); and 3.- System's vision (multifunctional orientation, systemic perspective, matrix organization, multifunctional teams, holistic vision and strategic alignment).
7	Molina, M.M. ; Lloréns-Montes, J. & Ruiz-Moreno, A.	2007	Within this research, the relationship between quality management practices and knowledge transference is explained. The authors point out that quality management practices such as cooperation from suppliers, team work, autonomy, process control and cooperation from clients, promote knowledge transference.
8	Ooi, K.B.	2009	Ooi describes how the bond between the TQM principles and organizational knowledge management is related to leadership, strategic planning, focus on client, process management, human resources management, information and its analysis; which through acquisition, dissemination and application of knowledge help to understand its behavior.

Table 1. Review of some examples on the benefits and requirements for the implementation of the TQM's elements.

Once this information was extracted, broken down and analyzed from their respective bibliographic and journalistic sources in order to simplify, the elements found were divided and summarized into two groups (mechanic and organic) and assigned to different categories elaborated for each one of them. In the case of the TQM's mechanic part, the elements were concentrated in the following four areas: 1.- Documentation; 2.- Processes; 3.- Testing and methods; and 4.- Infrastructure (see Table 2).

In the case of the organic or dynamic part of the TQM, the categories were the following: 1.- Continuous improvement; 2.- Focus on client; 3.- Cooperation; and 4.- Information and analysis (see Table 3).

Once the appropriate categories and elements are defined for each one, the model proposed integrates the eight categories and the different elements derived from them. The fundamental idea lies on the fact that it is possible to carry out the KM from the TQM, under the quality multidimensionality concept. In the first part of the model it can be appreciated how it is possible to achieve different requirements of standardizing processes through the TQM's mechanic part, due to the implementation of elements included in the four proposed categories. Combination and internalization of knowledge favor this type of activities as they represent a more systematic and operational knowledge manner (see Figure 1).

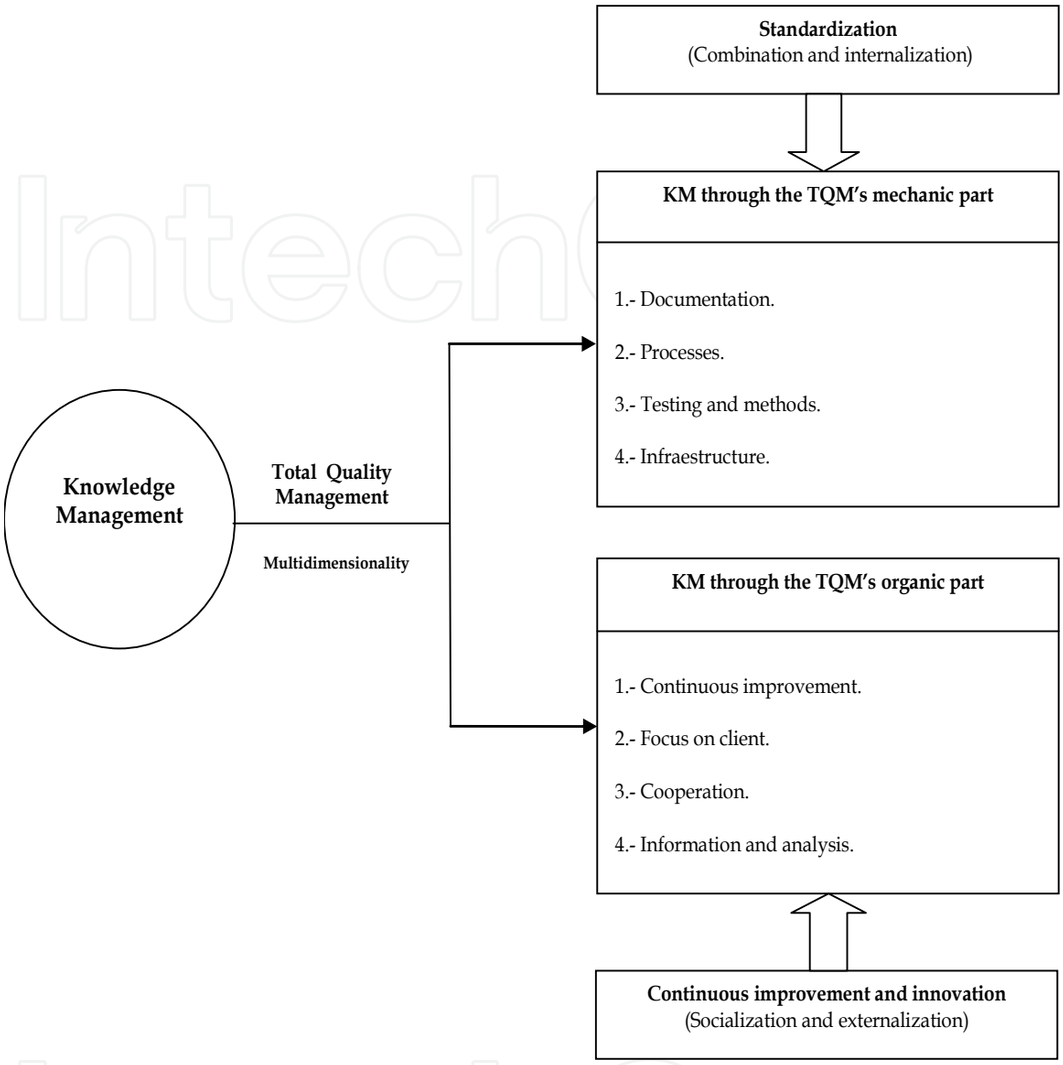
No.	Category	Elements
1	**Documentation**	1.- Planning; 2.- Quality manual; 3.- Ethic and legal requirements; 4.- Registry; and 5.- Results report in a clear and exact form.
2	**Processes**	1.- Organization; 2.- Measuring; 3.- Improvement of professionalism; 4.-Optimization; 5.- Formalization of processes; 6.- Technical ability and training; 7.- Definition of organizational, technical and administrative procedures; 8.- Auditing; 9.- Guidelines for subcontracted employment; 10.- Quality assurance in the acquisition of supplies; 11.- Communication management; y 12.- Human resources management.
3	**Testing and methods**	1.- Inter-laboratory testing; 2.- Development of testing methods; 3.- Validation of analytical methods; 4.- Correctly established testing and calibration methods; 5.- Guarantee of the traceability and uncertainty estimation of measurements; and 6.- Well defined methods of sampling and handling of samples.
4	**Infrastructure**	1.- Equipments maintenance; 2.- To have the necessary equipment, carefully selected and validated; and 3.- Adequate and controlled environmental conditions.

Table 2. Main KM elements identified through TQM's mechanic part.

No.	Category	Elements
1	**Continuous improvement**	1.- Organizational learning; 2.- Preventive actions; 3.- Detection and correction of mistakes; 4.- Processes control; and 5.- Leadership.
2	**Focus on client**	1.- Client satisfaction, 2.- Identification of needs; 3.- More contact with him; 4.- Feedback; 5.- Attention mechanisms; 6.- Service to complaints; 7.- Customer service; and 8.- Voice of client.
3	**Cooperation**	1.- Work teams; 2.- Development groups; 3.- Creation of ideas; 4.- Cooperation from providers and clients; 5.- Team work; and 6.-Autonomy.
4	**Information and analysis**	1.- Analysis of information sources; 2.- Continuous monitoring; and 3.- Data analysis.

Table 3. Main KM elements identified through the TQM's organic part.

In the second part of the model, we can observe how the organic or dynamic part, as well as the set categories, are oriented to encourage continuous improvement and in some cases, innovation. This could be explained by the creation of knowledge obtained from the socialization and externalization of it. They are principles that are based on the interaction of groups or people and on the reflection and discussion of tacit knowledge for the creation of conceptual knowledge. The model will be validated and supported through the research of bibliographic and journalistic literature; as well as verifying the categories and elements proposed from a case study, specifically in the context of the metrology area.



Source: Own creation based on Prajogo & Sohal (2004) and Nonaka & Takeuchi (1995).

Fig. 1. KM model based on the TQM.

4. Metrology in quality

Metrology is defined as the science of measuring and its application (JCGM, 2008). Its use helps to guarantee the quality of measuring and therefore, to improve the several processes where it takes part. Dybkaer (1994) explains that quality in a service laboratory must be shown from two viewpoints. The first one is directed to: a) Identifying the user's needs; b) Selecting measuring procedures; c) Establishing a measuring system of reference to guarantee measuring traceability; d) Having reference materials; and e) Developing competency testing. The second one makes reference to including Good Laboratory Practices and the ISO 9000 certification as competition factors. Cortez (1999) speaks about the importance of setting a distinction between the certification and the accreditation for a

laboratory, as the first one makes reference to the evaluation on the quality system's requirements, while the second one not only covers such aspect, but it also evaluates the laboratory's technical competency. In that way, the certification processes as well as the ones of accreditation are applied in testing and calibration laboratories, certification of quality and environmental systems, products certification, personnel and inspection.

The role service laboratories play is mainly focused on contributing in the activities at analytic laboratories, as it is important for them to have valid methods to demonstrate their grade and competency (Taverniers *et al*, 2004). In the certification part, specifically in ISO 9000, this norm provides us with a structure of quality systems for its design, development, production, setup and services, which are related to the TQM's principles (Sun, 2000). In the accreditation part, the main demands when talking about the 17025 norm are focused towards validation of methods, estimate of uncertainty, determining traceability, calibration, reference materials and standards and, assuring quality in testing and results from calibration (Fischbach, 2001).

Although the greatest initiative to implement the quality assurance has come from the industry sector, Groboth (1999) affirms its introduction has been necessary in other service areas; for example, in testing laboratories. This is the reason why once these laboratories go for the accreditation, as in the case of ISO 17025, they can obtain different benefits such as assuring the laboratory's performance, minimizing the risk of obtaining not very reliable results, a reduction on extra testing, an additional financial load and delays on the process; as well as international acceptance and increase on the laboratory's efficiency and efficacy that help trust and satisfaction of clients to increase (Szewieczeka *et al*, 2009).

5. Research methodology

From reviewing the theoretical frame, the research methodology proposal for verification and analysis of the model will be the case study. It has been described by Yin (1981) and Eisenhardt (1989) as a methodology that allows the understanding of dynamics in particular environments. The case studies dealt with can be multiple or simple, with different levels of analysis and variety in methods. Besides, they can be combined among them, as in the case of interviews, files, questionnaires, and observation to obtain quantitative and qualitative evidence. An advantage of this methodology is that it does not require control over the events analyzed and it is focused on the study of contemporary phenomena (Yin, 2003). In that sense, the instrument used to gather information from the case study was to structure a questionnaire, which will be given to the selected calibration laboratory members, along with *in situ* observation. Such tool was previously validated by three university professors through the methodology proposed by Haladyna (2004) to evaluate and in some cases, to modify the pertinence, clarity, design and induction of questions. Therefore, achieving a questionnaire of 14 questions divided into the three following sections: a) Laboratory's general description; b) KM through the TQM's mechanic part; and c) KM through the TQM's organic part, giving the option to integrate other elements not included in the questionnaire, which the interviewee thought to be relevant for the operation of sections b and c.

6. Analysis of the case study

The case study is located in the Metrology Laboratory (calibration) of the Faculty of Chemistry at the National Autonomous University of Mexico, attaché to the Department of Physics and

Theoretical Chemistry. The laboratory started working over 10 years ago, rendering calibration services to analytic laboratories in the UNAM, companies and external laboratories (private); as well as to students who are required to do a social service, thesis or professional and research stays. Nowadays, it has accreditation from the Mexican Accreditation Entity (EMA) in the areas of temperature, mass and volume according to the NMX-EC-17025-IMNC-2006 norm and, the certification on human resources formation process with a metrological orientation according to the NMX-CC-ISO-9001-IMNC-2008 norm.

In order to carry out the study, a questionnaire was applied to the members of the Metrology Laboratory. In the first part, a general description of the laboratory was tackled for contextualization. Among the elements of interest in this section, we can highlight the mission, vision and laboratory's policy of quality, which are mainly aligned to the satisfaction of the metrological needs of their clients, development of scientific projects, creation of professionals and researchers and, integrating the laboratory as part of the traceability chain of measures within the country (see Table 4).

No.	Area	Description
1	**Mission**	*To support the different productive sectors in the satisfaction of their metrological needs through the development of scientific and/or technological projects, to strengthen formation of their professionals, researchers and professors; as well as to give testing laboratory service and to take part in the traceability chain of the country as an accredited calibration laboratory. All of our activities are linked to the needs in the society, as they generate and renew knowledge in the area and favorably have an impact on the development of Mexico.*
2	**Vision**	*To increase the leadership of the Metrology Unit (UM) in the national and international domains through holding on to accreditations, consolidating metrological areas where the laboratory is accredited, increasing the calibration intervals of calibrating magnitudes in each area and testing methods; besides updating and diffusing metrology knowledge in the Faculty of Chemistry and advising the industry on the metrological applications.*
3	**Policy of quality**	*To generate academic activities focused on the contribution to the formation of professionals, researchers and university professors who are helpful in the society with honesty and academic excellence, with foundation on the University Legislation and in the NMX-CC-9001-IMNC-2008. To provide testing and calibration services according to the service norms and following the NMX-EC-17025-IMNC-2008 guidelines, which fulfill and exceed the requirements from internal and external users. We compromise ourselves to give a quality sustained follow-up, in compliance with Mexican norms, to assure the personnel related to the testing and calibration activities have the technical capacity; as well as within the creation of human resources, and that they become familiar with quality documentation and implementation of policies and procedures at their workplace. We also compromise ourselves to a constant improvement.*

Table 4. Mission, vision and policy of quality of the Metrology Laboratory of the Faculty of Chemistry at the UNAM.

No.	Category	Insertion of elements
1	**Documentation**	***1.- Planning:*** through the design of social service projects, support on getting the university degree and extension of metrological culture.
		2.- Quality manual: demanded as part of the laboratory operations.
		3.- Ethical and legal requirements: the manual of quality is based on ethic and legal requirements. For example, there is a confidentiality agreement for all the activities carried out at the UM.
		4.- Registry: through filling out the work blog and the blogs related to the whole Quality System of the UM.
		5.- Result report of results in a clear and exact form: calibration reports are filled in according to the SNC (National Calibration System).
2	**Processes**	***1.- Organization:*** the activities carried out are planned, structured and organized in a collective manner for the optimization of functions.
		2.- Measuring: there are efficiency and efficacy measurements in each process.
		3.- Improvement of professionalism: through training and timely fulfillment of tasks assigned.
		4.- Technical ability and training: the continuous and updated training is looked for, collegial work is also carried out.
		5.- Definition of organizational, technical and administrative procedures: all the activities are carried out according to the SOP (Standard Operation Procedure) by technical and administrative personnel.
		6.- Auditing: the system includes internal and external audits to contribute to the continuous improvement.
		7.- Communication management: there is an internal meeting program.
		8.- Human resources management: there are well defined profiles and functions for each activity.
3	**Testing and methods**	***1.- Inter-laboratory testing:*** people take part in them to confirm the technical capacity.
		2.- Validation of analytical methods: as part of the measuring quality assurance program, validation of methods must be carried out when they are modified somehow.
		3.- Correctly established testing and calibration methods: the methods are established based on the guidelines laboratories from the National Calibration System (SNC) work.
		4.- Guarantee of traceability and uncertainty estimation of measurements: there are measuring patterns outlined in the National Metrology Center (CENAM), according to the established in the SNC and it carried out the estimation of uncertainty in measurements.
		5.- Well-defined methods of sampling and handling of samples: it has the manuals and procedures.
4	**Infrastructure**	***1.- Equipments maintenance:*** there is a calibration program of measuring patterns.
		2.- To have the necessary equipment, carefully selected and validated: When getting new equipment, it is selected according to the method's specific needs and the pertaining validation is carried out.
		3.- Adequate and controlled environmental conditions: there are working areas that are environmentally adequate for each one of the metrological areas.

Table 5. Verification of elements proposed in the mechanic part of the KM-TQM Model.

The second part of the questionnaire is dedicated to verifying and explaining the elements proposed for the mechanic part of the KM-TQM Model. The points identified within the functioning of the laboratory included most of them, because of the fulfillment of requisites demanded in the accreditation under the ISO 17025 norm and its certification in ISO 9000 norm. Therefore, it was possible to observe the fulfillment of most of the elements contained in the model for each one of the specified categories, which has favored standardization of processes at the laboratory (see Table 5).

No.	Category	Insertion of elements
1	**Continuous improvement**	***1.- Organizational learning:*** it is carried out through team work and internal meetings.
		2.- Preventive actions: it is carried out with continuous supervision of technical and administrative work.
		3.- Detection and correction of mistakes: it is executed through continuous supervision and internal and external auditing.
		4.- Process control: with the quality assurance for measurements through statistical control.
		5.- Leadership: it is given in the proposal and development of projects.
2	**Focus on client**	***1.- Client satisfaction:*** an initial interview when hiring a service and a final application of a survey are given to the client.
		2.- Identification of needs: it is carried out during the interview with the client and in the service application, the scope and length of it are agreed.
		3.- Feedback: when delivering the calibration report, doubts are solved or suggestions are given.
		4.- Attention mechanisms: in person, by telephone and through an email.
		5.- Service to complaints: through the user's voice.
		6.- Voice of client: for all the calibration services and to the training process on human resources.
3	**Cooperation**	***1.- Work teams:*** a collegial work is carried out with other academic groups.
		2.- Team work: work meetings within the UM.
		3.-Autonomy: full compromise and responsibility of each person responsible of an area.
4	**Information and analysis**	***1.- Analysis of information sources:*** periodic review of guidelines given by the EMA and the CENAM.
		2.- Continuous monitoring: Given in the established processes.

Table 6. Verification of elements proposed in the organic part of the KM-TQM Model.

In the third part of the questionnaire, the proposed elements were also verified and explained for the organic part of the KM-TQM Model. The items identified in this section were also abundant; although, the amount was less than in the mechanic part of the model. The previous shows an important step forward of this section. However, it shows the need to look in depth in the development of activities that favor the KM through the elements proposed so as to favor the continuous improvement and innovation (see Table 6).

7. Conclusions

This research represents an exploratory study on the potential the Total Quality Management has in the development and operation of the Knowledge Management within technical environments, in order to optimize standardization processes, promote learning, continuous improvement and innovation.

Among the main findings, we can highlight the large presence of elements proposed in the mechanic part of the model within the case study, due to the laboratory's fulfillment of demanded items for its certification and accreditation in the ISO 9000 and ISO 17025 norms respectively. This has favored the standardization of its processes and it has encouraged the creation of more systematic and operational knowledge. In the other hand, although in the organic part of the model, the elements identified were less, an important effort can be observed which is oriented to the continuous improvement based on preventive actions and a focus on the client that even in some cases, has lead the laboratory to create small incremental innovations within its administrative processes. In other situations, these have developed within its technical processes due to the collegial work with other academic groups and personnel of the laboratory itself.

From the study carried out, a clear relationship can be distinguished between development and operation of the KM, and the improvement on performance and organizational competitiveness from TQM's elements. However, the future research lines must be focused on a more detailed study of proposed groups, their categories and the elements contained in each one of them; besides carrying out a quantitative study that allows extrapolating these results in a larger number of cases.

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Due to the development of mobile and Web 2.0 technology, knowledge transfer, storage and retrieval have become much more rapid. In recent years, there have been more and more new and interesting findings in the research field of knowledge management. This book aims to introduce readers to the recent research topics, it is titled "New Research on Knowledge Management Applications and Lesson Learned" and includes 14 chapters. This book focuses on introducing the applications of KM technologies and methods to various fields. It shares the practical experiences and limitations of those applications. It is expected that this book provides relevant information about new research trends in comprehensive and novel knowledge management studies, and that it serves as an important resource for researchers, teachers and students, and for the development of practices in the knowledge management field.

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