PETROPHYSICS WITH QUALITY: THE TRANSFORMATION PROCESS OF A RESEARCH AND DEVELOPMENT LABORATORY TOWARDS QUALITY

Beatriz Santiago, Pedro Romero*, Olivar Lima de Lima
UFBA, Brazil
* Now with Baker Hughes

Abstract

In the context of this work, the transformation process towards quality of the petrophysics laboratory of the Center of Research in Geology and Geophysics (CPGG) of the Federal University of Bahia (UFBA), located in Salvador, Bahia (BA), Brazil, is presented.

The quality system implemented in this laboratory was based on the norm ISO/IEC/EN 17025 (General Requirements for the Competence of Testing and Calibration Laboratories), which constituted a fundamental tool for the implementation. However, during the implementation process, some problems were encountered. This was going to be reflected in an excessive investment of time and money. It was possible to identify the causes that generate additional costs and delay the implementation process of the quality system ISO/IEC/EN 17025 in the petrophysics laboratory. This was done by using two of the basic quality control tools: the Cause-Effect diagram (Ishikawa or Bone fish) and the Pareto diagram. With the Cause-Effect diagram, the common and special causes of variation (six in total) were detected. As a result of the analysis with the Pareto diagram the relationships between problems and causes were found.

Introduction

Immediately after the "Japanese miracle", the development of quality systems in companies of the western world was transformed into a high-priority task of the management. However, in the scientific technical sector, the advance towards quality occurred with greater slowness. Nevertheless, as of 1990, norm ISO/IEC Guide 25 (well-known at the moment as ISO/IEC 17025) spread to evaluate and credit processes and methods of work in research and calibration laboratories. This program of accreditation also was applied, with greater or smaller success, in development and research laboratories of universities and/or research centers. In most of the cases, the success of the implantation was measured in terms of the time employed and the costs inverted in the process. The reason of the success in any process always is subject to the appearance of common and/or special causes of variation; these interrupt the original timeframes and add costs.

In this work, the transformation towards quality of the laboratory of petrophysics of CPGG, of the Federal University of Bahia (UFBA), is described.

Quality and Quality Systems

The interest in quality at world-wide levels reached its peak in the 90's when diverse theories, definitions, methodologies and techniques for implementing quality systems in companies, industries and R&D laboratories were disclosed. The focus was to obtain the Total Quality[1] certification in processes, products and services, with the primary target to satisfy the client.

Diverse definitions of quality exist, however, in this work the following ones are emphasized:

A product or service has quality if it helps somebody and it enjoys a good and sharp market.
William Edwards Deming

Property, attribute or condition of things or persons that distinguish them from others and determines their nature. Superiority, excellence of someone or something.
Aurélio Buarque de Holanda Ferreira [1]

Quality is defined by the totality of characteristics of a product, process or service that affect its capacity to satisfy regulated or implicit necessities.
International Organization of Standards (ISO) [2]

Quality means to plan, generate ideas and make truly significant measurements... to examine processes, understand the variation and to improve those processes.
Marianne Murdock [3]

A quality system consists of documented procedures and plans, which describe the organization, its authorities, their responsibilities and functions of the personnel in that organization. It can not be established in the organization only with aims to obtain the certification, because in the long run the obtained results will be negative from all points of view (loss of money, distrust of employees that can reject any other process of improvement, invested time, etc.). On the contrary, creating a favorable climate is responsibility of the management and must be of acceptance within the employees of the organization to introduce the changes and/or modifications that the implantation of the quality system implies. An easy and expeditious way in doing this is using quality norms. The ISO norms are the most recognized ones.

It is internationally accepted that an R&D or analysis laboratory must have as one of its main objectives the production of high quality data, by means of analytical measurements that are exact, reliable and suitable for the proposed prognosis [4]. It is not by chance then that for these cases, the establishment of a quality assurance system is recommended as the initial stage in the process towards Total Quality, since in these laboratories not only the quality of the measurements must be guaranteed, but also the quality of the results generated by means of analysis and interpretations of those measurements.

---

[1] The term Total Quality was created with the purpose of including all the methods, schemes and procedures that any company or organization must fulfill to obtain the best results in the performance of its functions

As stated before, for R&D laboratories, ISO disclosed norm ISO/IEC Guide 25 in the ‘90s, which as the result of ample experience in implantation of quality assurance systems and in conjunction with norm IN 45001 led to the publication of ISO/IEC 17025. The laboratories that fulfill this norm, also operate in agreement with norm ISO 9001, that certificates the development of new methods and the development of tests, combining standardized and non standardized test and calibration methods. As well, it operates in agreement with norm ISO 9002 that certificates standardized test and calibration methods.

Therefore, norm ISO/IEC 17025 is the reference used in laboratories world-wide to be recognized as competent.

Variation theory

Variation has been studied by statistics and scientists for decades. But, recently the interest of studying this subject rose between managers and administrators of companies of all nature; including understanding its existence and effects on daily processes. This understanding allows them to recognize, appropriately interpret, and react to changes in data, numbers and measurements and can also be used to measure and understand the performance of people. The knowledge of the Variation’s Theory is one of the most powerful tools that a company can develop in the search of quality [5].

There exist diverse tools to identify the special and common causes of variation in an improvement process. The most frequently used ones, as support to quality programs, are the Cause-Effect and Pareto diagrams, histograms, data collection, data stratification and control graphs. In addition there exist flow graphs, which allow the representation of the present or ideal flow of any process in a way to identify its deviations. For the results of this work the Cause-Effect and Pareto diagrams were combined.

The cause-Effect diagram also known as diagram of Ishikawa, because it was developed in 1953 by Dr. Kaoru Ishikawa when working with a group of engineers in Kawasaki Steel Works; or Fish Spine diagram, due to its form. This diagram, shown in figure 1, allows the identification of the primary causes and secondary causes of any problem and the relations between them. It facilitates the analysis and evaluation of the contribution of each cause to the main problem. The main causes can be grouped under four categories: methods, manual labor, materials and equipment.

The diagram of Pareto (Fig. 1) is a tool that facilitates decision-making towards the causes that must "be attacked" primarily to obtain greater effectiveness in the resolution of problems. It supports the well-known rule of the 80/20: most of the problems and their inherent costs come from a relatively small number of causes. Since there are always more problems than resources, and the problems tend to be complex, it is important to concentrate in those few whose resolution will have the greater impact over the improvement process [6].

Pilot Laboratory: CPGG Petrophysics Lab

The Laboratory of Petrophysics (Rocks’ Physics), assigned to CPGG, was founded in 1997 by Prof. Dr. Olivar Antônio Lima of Lima and Dr. Ben Clennell. The investigation lines of the laboratory are:

a) Nuclear Magnetic Resonance for the characterization of rock reservoirs and its fluids (water and petroleum).

b) Electrical Conductivity and Polarization of rock reservoirs for different saturations of water and petroleum.

c) Density and Permeability for characterization of rock reservoirs.

During the evolution of this work, Professor Dr.-Eng. Pedro Romero, was the person in charge of the laboratory.

At the beginning of the implantation of the quality system, the planning of the activities that were to be executed was done. The vision, mission, values and the quality policy of the lab were also issued.

Due to the lack of human and financial resources, the project began in an empirical way, and as was expected, the specific time for the culmination of each activity could not be determined accurately.

Several of the planned activities were executed at the same time: the inventories of samples, equipment and their respective operational manuals. For some equipment, simplified operational procedures were written with the objective to facilitate the learning/training process and the use of such equipment. The quotations and orders of new necessary equipment were made. Orders of glass materials and several miscellaneous for the operation of the laboratory were made. Also, new lines of research were proposed for the laboratory.

Nevertheless, significant delays in the reception of the materials for laboratory were detected; as well as the existing difficulty in the development of the experimental activities, because of the deficiency of qualified technical personnel, was perceived.

As a result of such problems, the decision to investigate the causes of such problems was taken, in order to eliminate them, control them and/or to diminish them.

For the identification of the causes of the problems (technically known as common and/or special causes of variation of the process of implantation of the quality system), a brainstorming session with Dr. Pedro Romero, and MSc. María Quintairos (Reme), was held. A diagram of Ishikawa as the one shown in Fig. 1 was constructed (see Fig. 3). An interview (Fig. 3) was also passed to the users of the laboratory requesting them to classify the causes exposed in the diagram in order of importance (or relevance) and to give a brief explanation of the selection of the first cause as the most important. It was also asked if they would add or eliminate any cause(s), which and why; and if they had some suggestions to improve this diagram. Finally, the diagram of Pareto (Fig. 2) with the analysis of the answers of the interview was constructed. As it is noted in this diagram, 72% of the problems in the lab were originated by 50% of the causes.

The results of both diagrams (Ishikawa and Pareto) were used to identify and prioritize the causes of the slow advance in the implantation of the quality system ISO/IEC 17025. These causes, presented/displayed in order of importance, were:

1. <u>Lack of financial resources</u>, for supporting the quality assurance or continuous improvement program. Obtaining these resources is subject to the opening of national and/or regional research contests from Brazilian government institutions, such as, CAPES, CNPq or FAPESB; and research projects with other universities, companies or research institutions.

2. <u>Lack of qualified permanent personnel in the lab</u>, to assure the development and continuity of the technical-scientific activities; as well as, the implantation of the quality system.

3. <u>Complex logistic for requisition of materials</u>, being an extremely bureaucratic and slow process. In addition, the nonexistence of registration of suppliers and contact people, that facilitated the obtaining of the necessary materials for daily activities, was detected.

4. Nonexistence of registration/files of use (historical), calibration and maintenance of the equipment. In the laboratory, there was lack of many of the manuals provided by the manufacturers of some equipment, and, in certain cases, they either did not exist operational procedures for the handling of the equipment and its respective software.

5. Nonexistence of controls to monitor the entrance and exit of equipment, materials, tools and samples of the laboratory. There were no inventories, making it difficult to control the goods of the lab.

6. Little preservation, identification and storage of the existing samples (core plugs). In addition, there did not exist procedures of preservation and/or storage in the laboratory, nor registration of contact people for the provision of these cores and crude samples.

The following plans of action were implemented to diminish, control and/or eliminate the causes exposed in the previous section:

1. Financial resources: Professor Olivar Antônio Lima de Lima obtained resources for the laboratory, through projects.

A technical induction was given to two students Reme and Newton de Oliveira (doctorate student), who at the moment worked in the laboratory, to maintain the continuity of the research activities.

A reserach project with the University Río Grande do Sul was approved. This project is co-financed by Petrobras. The resources are destined for the contract of a laboratory technician (which could eventually in the future, be hired as permanent personnel). Additionally, Reme and Newton became proactively involved in the activities related to the implantation of the quality system writing and using operational procedures and safety norms for working in the laboratory and suggesting improvements for the relocation of the equipment.

2. Materials: A meeting was held with the administrative person, Reinaldo, responsible of buying and receiving materials for the laboratory, in order to understand the requisition process of necessary materials for daily activities, and to know the reasons of the delays in the reception of old orders. The objective was to reduce the lead time or time elapsed between the emission of an order and the arrival of the respective materials. It must be noted that, even though the procedure for the requisition of materials could not be modified, due to its institutional nature, the delay average time foe reception of materials improved in 50%, being reduced from 30 days to 15 days. In addition, Reinaldo became proactively involved in the tracking of each order and in the improvement of the requisition process, promoting communications between suppliers and the laboratory personnel. These significant changes took place after explaining to Reinaldo the importance of his activities in the implantation of the quality system.

3. Equipment: Notebooks were assigned to each of the main equipment of the laboratory (RMN, picnometer, permeability to water, permeability to air and electrical conductivity), and a norm was established that stated that whoever (students, professors or technical personnel) used the equipment was obligated to maintain registration of the measurements and experiments executed in the lab. The manufacturers of the equipment that lacked operational manuals were contacted and these were requested. The operational procedures of each equipment were verified and softwares were written by the personnel who work in the laboratory. Suggestions for better practices were included. Additionally,

some calibrations and preventive and corrective maintenances for some components of the equipment were made. For example, the maintenance performed to one of the displacement pumps for fluid injection of the permeability equipment.

Controls formats were generated for the entrance and exit of equipment, tools, materials and samples from the laboratory. Also a format for lending equipment was generated to authorize exits. In these formats the signature of the person in charged of the laboratory or, in case of absence, of CPGG's director and the general manager of quality is demanded.

3. <u>Samples</u>: Boxes were designed and custom-made to store the core plugs existing in the laboratory. An inventory was made and these samples were classified by field, well and/or reservoir, according to the case.

Meetings were held with the petrophysical staff of Petrobras in order to begin new research projects related to measurements of core plug samples with NMR technology. The person in charge of providing crude samples from the Polytechnical Institute of Engineering was contacted.

These action plans have not only allowed the continuity of the research activities and the implantation of the quality system, but have also promoted and fomented the relations (communication) between suppliers, external personnel (companies, research institutes and other departments of UFBA) and internal personnel (technical, administrative and management) of the laboratory.

The process of implanting the quality system in the petrophysics laboratory, even though has presented/displayed difficulties – not all successfully surpassed, has been very well accepted by all the personnel involved and those interested in executing research activities in the laboratory. This, is the most important factor to convert the implantation itself in a process of continuous improvement. In summary, the transformation of the Petrophysics Laboratory of CPGG in UFBA, into the first world-class laboratory in Brazil has just begun!

Conclusions

In order to obtain quality it is not necessary to follow a prescription or manual; simple, decisions at managerial level must take place. The first crucial decision is to assume the determination to change the organizational culture towards the quality.

To implant a quality system in a R&D laboratory is not a trivial task. Frequently problems arise, specially at the beginning of the process, that can originate the de-motivation of the people involved and the consequent desistence to the program. In the petrophysics laboratory difficulties and problems also arose (variation causes) that threatened the continuity of activities of the implantation program.

It was demonstrated that variation exists in all improvement processes, and that it is indispensable to acknowledge its existence and its influence over the system, so to take actions that can reduce it. In order to determine the causes of variation and/or problems, statistical control tools exist. Among them, the diagrams of Ishikawa and Pareto allow to outline and to prioritize all the possible causes that originate some problems. In the petrophysics laboratory the six main causes of the little advance in the implantation program were identified and they were prioritized. The lack of financial resources was located in the first place, the lack of permanent qualified personnel in the second place and the lack of materials in the third place. These three causes generated 72% of the problems in the laboratory at the beginning of the implantation program.

Action plans were implemented to reduce, control and/or to eliminate the main causes of variation, and to maintain the continuity of the activities programmed for the implantation of the quality system ISO/IEC 17025 in the laboratory.

Of fundamental importance was the pro-activity of all the involved people in one or another way with the laboratory.

Quality is responsibility of EVERYBODY!

Acknowledgements

In UFBA we would like to thank Reme, Newton and Reinaldo for always being proactively involved in the project and for believing in Quality.

Beatriz gives thanks to all the professors, administrative staff and classmates in the Faculdade de Tecnologia Empresarial (FTE) for all their support and motivation from the first day and throughout the MBA in Business Management. Specially, she thanks professor Dr. Rosembergue and professor Dr. Isaias.

References

[1] Ferreira, Aurélio Buarque de Holanda. 2004. **"Miniaurélio: o minidicionário da língua portuguesa"**, 6. ed. rev. amp., Curitiba: Posigraf, Brasil, p.591.

[2] **http://lauca.usach.cl/ima/ngras.htm**: Gras, Nury. **"Control y Garantía de Calidad en Laboratorios Analíticos".** Review 19/05/2004.

[3] Murdock, Marianne. **"Hablando de Calidad: Lo que Calidad Es y ... lo que No Es".** *American Society for Quality Control, ASQC, Health Care Division.* Compilación por Rogelio Carrillo Penso, Gotas de Conocimiento®, Caracas, Venezuela.

[4] http://lauca.usach.cl/ima/ngras.htm: Gras, Nury. **"Principios básicos de Calidad en los laboratorios de análisis"** Review 21/05/2004.

[5] Joiner, Brian L; Gaudard, Marie A. 1990. **"Variación, Gerencia y el Dr. W. Edwards Deming"**, Quality Progress Diciembre 1990, Joiner Associates Inc. Madison, WI. Compilación por Rogelio Carrillo Penso, Gotas de Conocimiento®, Caracas, Venezuela, p. 2.

[6] Inda Cunningham, Arturo Enrique. 2000. **"El Mapa: Una guía para el mejoramiento de la calidad en la pequeña y mediana empresa, basada en el método de W. Edwards Deming",** Manual del Proyecto de Sistemas de Gestión de Calidad patrocinado por la Oficina de Ciencia y Tecnología de la Organización de Estados Americanos (OEA) y la Agencia Alemana de Cooperación Técnica (GTZ – Deutsche Gessellschaft für Technische Zusammenarbeit, GmbH), México, p. 65.

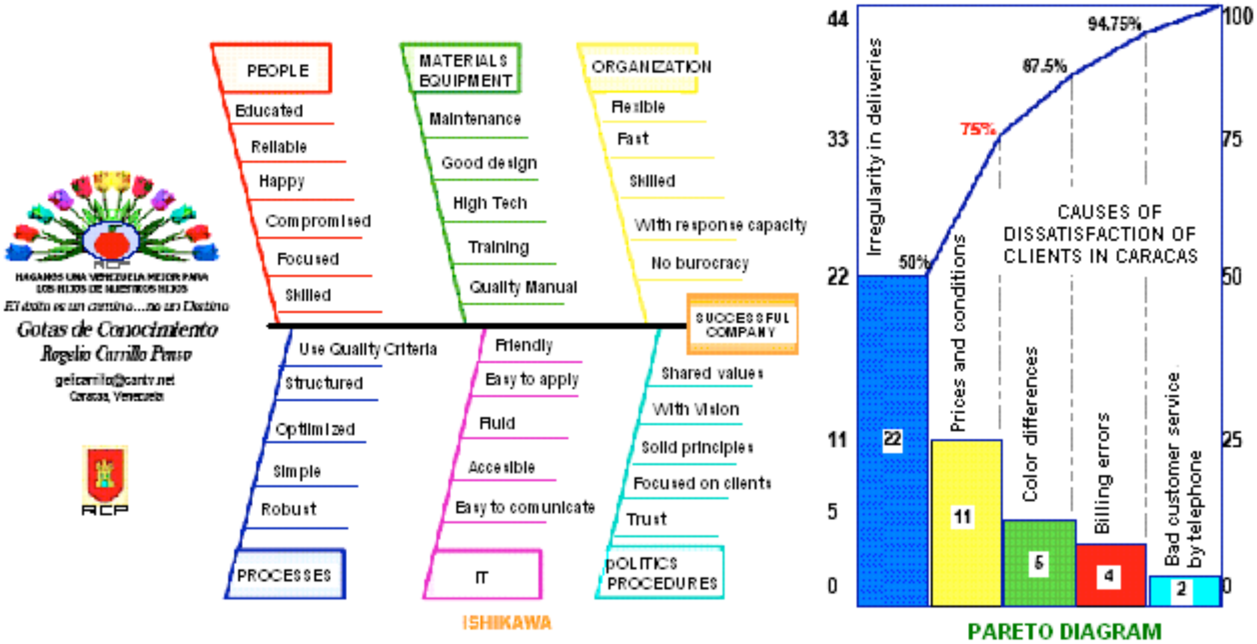


Fig. 1. Ishikawa and Pareto diagrams

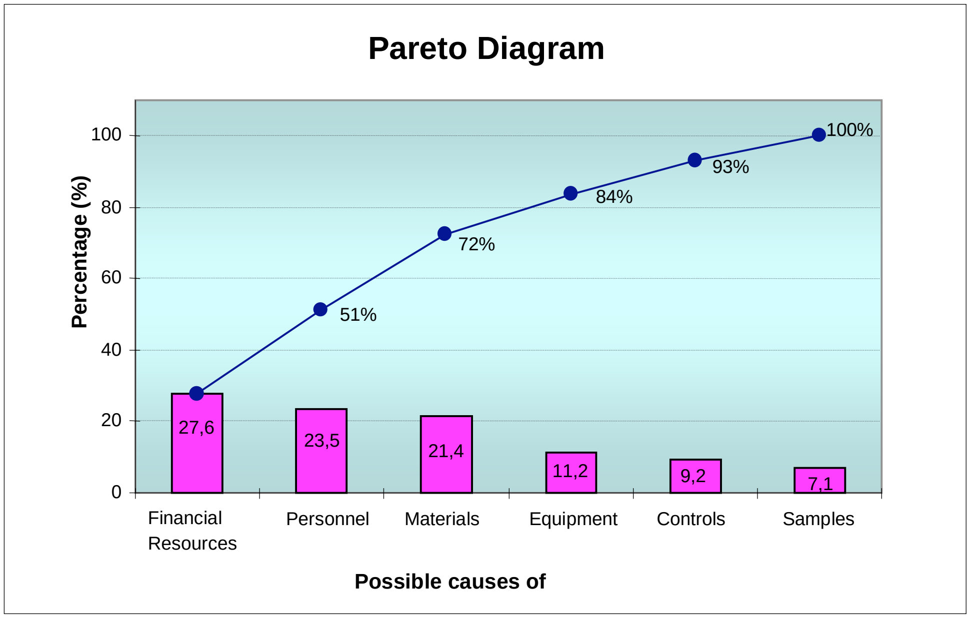
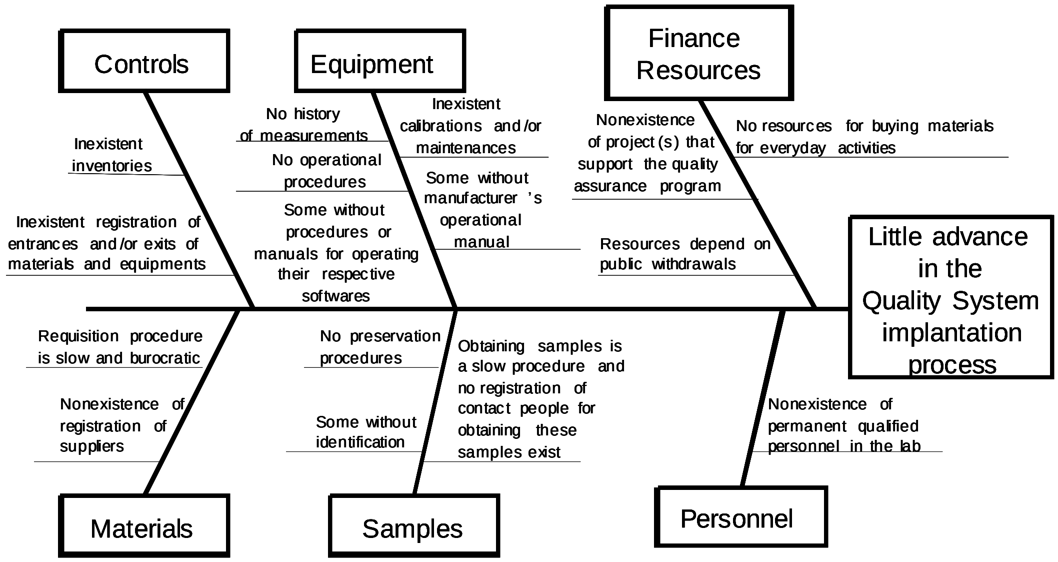


Fig. 2. Pareto diagram with the possible causes of variation detected during the implantation program

UFBA	Petrophysics Laboratory Quality System ISO-IEC 17025	CPGG
	Interview Ishikawa Diagram	

Name:________________________________

Please, observe the Ishikawa diagram (shown below) with the *possible causes of the little advance* in the implantation program of the quality system ISO-IEC 17025 in the Petrophysics Laboratory, and classify them in order of importance.



Ishikawa Diagram

1. Classification by order of importance (1 – 6)
2. Answer the following questions:

a) Explain briefly the reasons for your selection

b) Would you add any other cause to the diagram? Which? Why?

c) Would you eliminate any cause from the diagram? Which? Why?

d) Do you have any suggestion for improving the diagram? Which?

Thank you very much for your help!

Fig. 3. Interview