Implementation of Quality Management System ISO 9001 in A Telecom Network Operation Centre – A Case Study

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Abstract

The objective of this paper is to present the implementation and results of the Quality Management System (QMS) based on ISO 9001:2015 in the Failure Support Process reported to the Network Operation Centre (NOC) in a telecommunications company. The methodology used was Action Research proposed by Borroto and Aneiros (2002) and Latorre (2005); whose phases are aligned with the Deming cycle and ISO standard requirements. Two cycles were carried out: implementing and obtaining the certification of the system. QMS involved stakeholders and it made the staff partake critical reflection in the process and the results. Once the company obtained the NMX-CC-9001-IMNC-2015 / ISO 9001:2015 certificate, it was able to accredit new contracts from the government sector. Other benefits obtained were: defining indicators, agreements reached with providers to improve time response, risk response planning definition, increased staff motivation, escalations decreased, established corrective actions for non-conforming outputs, and improved internal and external communication. The study evidenced resistance to change from some staff members at the early steps of the implementation and the lack of communication between internal areas. This study can be useful for those companies interested in implementing a QMS.

Keywords
Action Research, ISO 9001:2015, Implementation, Telecommunications and Quality Management System.

1. Introduction

Conventional wisdom suggests that quality is an important component for the survival of an organization (Saraf, 2019). Quality influences companies to compete and demonstrate that they meet customer´s requirements. The companies demonstrate this through the implementation of Quality Management Systems (QMS), the revision and adaptation to national and international standards, and the search for certifications such as ISO 9001. The implementation of a QMS based on the requirements of ISO 9001 must be a strategic decision oriented to face the challenges of the global economy (Alzate-Ibañez, 2017). Adopting the quality philosophy is not easy; it requires a cultural transformation not only in people but also in the entire organization (Vanova et al., 2017).

ABC Company operates in a competitive environment since new operators have appeared on the telecommunications market. Some other competitors have been merged to provide services to a higher percentage of

the population; for example, ATT bought Iusacell-Unefon and Nextel companies in 2015 (Castañares, 2018). The ABC Company expanded its market to provide services not only to operators but also to clients from the business and government sectors. The government sector requested to have ISO 9001 certification to participate in biddings for new contracts.

Some authors have analyzed and proposed different methodologies to implement a QMS based on ISO 9001. For example, the best Project Management Practices could be applied (Ingason, 2015). It is based on the Deming cycle too and it states the commitment and direct participation of management, employees' participation and engagement, good preparation and goal setting to be successful. Cabero et al. (2018), used steps similar to those proposed in this work to implement a QMS in a pediatric hospital.

In Mexico, the works that evaluate the results of ISO implementation are few. Nava and Rivas (2008), reported in their investigation "Performance in implementation of ISO 9001:2000 in Mexico certified organizations", that ISO implementation improved the performance of the organization. In this sense, this research paper validates the benefits of having the system implemented and certified.

Some factors that motivate companies to implement ISO 9001 are: participation in biddings, customer requirements, reduction of customer complaints and operating costs, among others (Juanzon and Muhi, 2017). In consequence, the benefits obtained by ISO certified companies are: productivity improvement (Gómez et al., 2013; Martinez et al., 2018), relations with suppliers improvement, production of products and services with the quality requested by customers (Gimeno et al., 2015), process variability reduction, costs and waste reduction, profitability improvement and customer satisfaction increase (Carmona-Calvo et al., 2016), sales increase and accreditation of a significant number of new contracts, which would not have been achieved without certification (Chen et al., 2016).

Some issues or limitations could happen during the implementation. If during the early stages, the organizations do not realize that the staff participation takes time; it means that if training is not included in planning, they are bound to be disappointed and attain their ISO 9001 certification later than they expected, and a higher cost (Knežević et al., 2017).

Considering the aforementioned facts, this document presents a detailed proposal for the QMS implementation. Two cycles were considered: the first cycle covers the implementation steps of the QMS and the second cycle covers the steps to obtain the certificate.

1.1 ABC Company
The name and any details of the company are anonymized due to security reasons, in this paper we will refer to as ABC Company. ABC Company is located in Mexico. It belongs to the TIC sector and it is a medium-size company. The main products and services provided are related to connectivity, security solutions, business communications, mobility and cloud, among others. Customers are categorized into the following groups: Operators, Government and Business.

ABC Company has more than 10 thousand kilometers of optical fiber and six border interconnection points between Mexico and the USA. The network allows offering and delivering services in time and quality under international standards on the following platforms: long distance, voice services, Internet services, and optical fiber.

1.2 Objective
The objective of this paper is to present the implementation and results of the Quality Management System (QMS) based on ISO 9001:2015 in the Failure Support Process reported to the Network Operation Centre (NOC) in a telecommunications company. To achieve this objective, the following steps are defined:
- Define the cycles to implement a QMS based on ISO 9001:2015 and get the certificate NMX-CC-9001-IMNC-2015 / ISO 9001:2015 through utilization of Action Research.
- Identify all the processes, work instructions and formats for the QMS according to ISO 9001:2015 requirements.
- Present the results of the QMS implementation.

2. Literature Review

In the development of quality management in business organizations and organizational practice, the influence of three fundamental approaches to carry it out is identified (Tamayo et al., 2011): quality gurus who refer to main contributions they made to quality; models and awards of excellence that expose the approach towards integral and strategic management; and ISO 9001, which is based on the requirements of this standard. This article considers the approach of ISO 9001.

ISO 9001:2015 is an international standard that focuses on the process-based approach and risk-based thinking. The management principles are seven: customer focus, leadership, people commitment, process approach, improvement, evidence-based decision-making and relationship management. Point 4.4.1 of the standard describes what the organization must achieve, among others: determining the expected inputs and outputs, the sequence and interaction, the criteria and methods to ensure the effective operation and control from these processes (International Organization for Standardization, 2015a).

Petnji *et al.* (2014), found that ISO 9001 certification is more likely to encourage satisfied customers to remain loyal to the company than those in which there is no certification. Furthermore, companies that are ISO certified perform better financially than companies that are not (Khalid et al., 2014). Since customer needs vary over time, organizations should review quality requirements periodically to ensure a good fit to market demand (Aguilera-Luque, 2017). In 2017, the number of companies that have implemented an ISO 9001 quality management standard remains stable in the world (International Organization for Standardization, 2015b); however, Mexico obtained less than 1% of the total certificates issued, although there was a growth of 2.18% compared to 2016. Related to the information technology sector, the number of certificates decreased by 4.54% compared to 2016 (Charlet, 2018).

The implementation of the ISO 9001 standard is carried out as an improvement strategy to meet quality objectives, obtain process traceability, generate greater productivity (Carmona-Calvo et al., 2016), increase value and avoid rework, reduce the impact of risks, identify opportunities, and apply knowledge management (Ciravegna et al., 2019). In this way, the company is able to compete and satisfy its customers, in addition to guaranteeing its products and services (Cabero et al., 2018). The implementation of a QMS demonstrates its effectiveness through better organization of records and formality for the services it offers; it also brings significant benefits for the competitiveness and success of organizations (Fonseca and Domingues, 2018). The effectiveness of the QMS consists of three dimensions: prevention of nonconformities, continuous improvement and focus on customer satisfaction; and five critical factors for its effectiveness: external environmental pressure, quality system attributes, internal motivation, company attributes, and employee attributes; where the last three have a significant impact on the effectiveness of the QMS (Psomas and Antony, 2015). Meanwhile, Del Castillo-Peces et al. (2018) found that the type of internal or external motivation to implement the norm, as well as the age of compliance, are significant variables for the achievement of the positive results that can be derived from it. The barriers to implementing the standard are mostly organizational, where resistance to change is the main one, followed by lack of communication, poor commitment from senior management and insufficient training (Bounabri et al., 2018).

In recent years an important phenomenon has also been observed, companies have ceased to be certified in ISO 9001. The empirical study carried out in Spain on the reasons for decertification of ISO 9001 in 2012 and 2013 (Simon and Kafel, 2018), identified internal and external factors as the main reasons. Internal factors are: financial problems, low perception of the added value granted by certification, and some organizational changes (such as internal restructuring). External factors are mainly related to the decisions made by customers.

To achieve the expected results in accordance with the Quality Policy and the strategic direction of the organization, the standard suggests using the Deming cycle with a global approach based on risk, oriented to take advantage of opportunities and prevent unwanted results. The risk register provides information on threats and opportunities that could have an impact on execution or that have already occurred during the execution of activities (Project Management Institute, 2017). In this investigation, the risk analysis and the response to them are described in the Quality Plan.

3. Methods

The methodology applied was the Action Research proposed by Borroto and Aneiros (2002) and Latorre (2005), which corresponds to the qualitative type due to its practical nature (Lewin, 1946; Susman and Evered, 1978). It has

a methodical and interactive approach (Altrichter et al., 2002) and it provides the ability to intervene and improve the system where it is applied as lessons are learned (Kohli and Kettinger, 2004). Latorre (2005) proposed a cycle composed of four phases: action plan, action, observation of the action, and reflection. The process improvement is a second cycle that takes the output of the previous one to make changes. Figure 1 represents the two cycles considered in this work. The first one shows the steps to implement the QMS and the second one shows the steps to obtain the certification. Cycle 1 includes an additional step called "initial reflection or diagnosis".
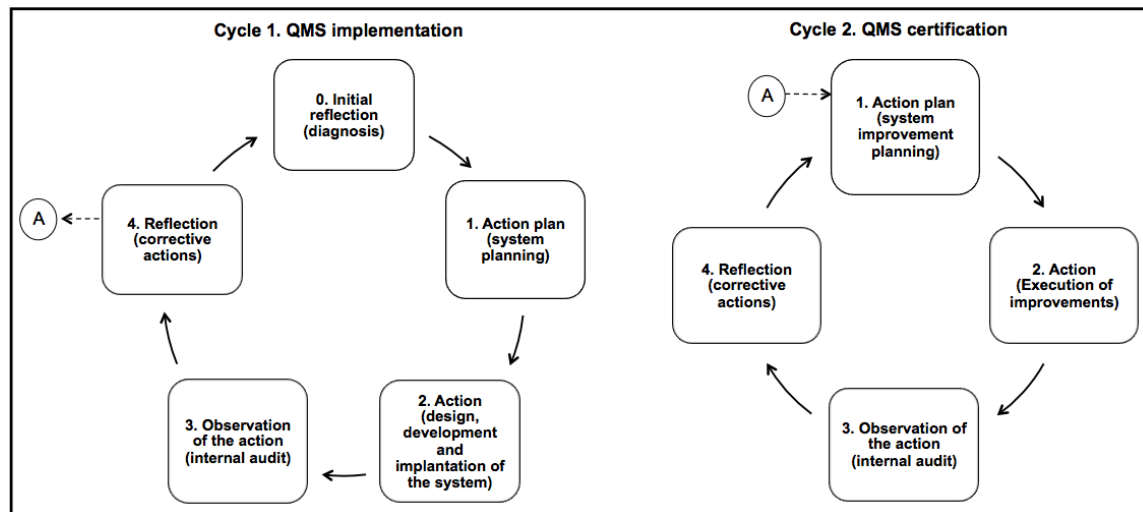

Figure 1. Cycles of the Quality Management System for the ABC Company

3.1 Data Collection

For the QMS' implementation and certification, the data was obtained in different moments. During the initial reflection, a closed questionnaire of 37 questions was applied to determine compliance with the requirements of the standard ISO 9001:2015 and it was complemented with open questions to clarify doubts. In the planning phase, observation was applied to know the NOC's activities, open questions, one-to-one, and group interviews were also carried out to define processes, work instructions and formats. During the internal audits, questionnaires with open questions and observation were applied. Finally, brainstorming was used to define actions to attend the issues. More information was collected from ticket system (logs), monthly reports, and internal and external audits results.

3.2 Data Analysis

The results obtained in the diagnostic questionnaire were used to define the responsibilities and commitments of the Quality Committee, in addition to the roles and responsibilities. With the information obtained in the one-to-one and group sessions, the schedule was defined; the documents were made, in addition to updating the ticket system.

The information was collected from the Ticket System in Excel format to generate the corresponding histograms. KPIs were defined (see Table 1) to measure ticket assignment time, service restoration time, internal and external technical support response time, and ticket closing time. In addition, the responses to the questionnaire were processed to measure customer satisfaction. For cases where the proposed KPIs were not met, the RCA and subsequently the Pareto chart were used to attack the main causes of non-compliance.

To carry out the first internal audit, three-month records were collected with the above information. The results of the audit were analyzed to determine if the QMS staff was following the documents and if they were aware of the system. The results were classified as Non-conformities, compliance and opportunities for improvement.

With the results of the internal audit, a new cycle was started in order to improve the QMS prior to the execution of the certification audit. This method allows achieving continuous improvement in accordance with the requirements of the ISO 9001 standard. The research work was carried out during the period from October 2017 to May 2018, at the ABC Company.

3.3 Cycles description
3.3.1 Cycle 1: QMS implementation.

Phase 0: Initial reflection (diagnosis). This phase begins with an interview with the Engineering and Operations Director and the NOC manager, where the Failure Support Process reported to the NOC was considered as the scope of the implementation. Figure 2 represents this process that comprises five activities that are carried out sequentially, its also shows its input, output, and the expected result of every activity. Every customer's service has a unique identifier.
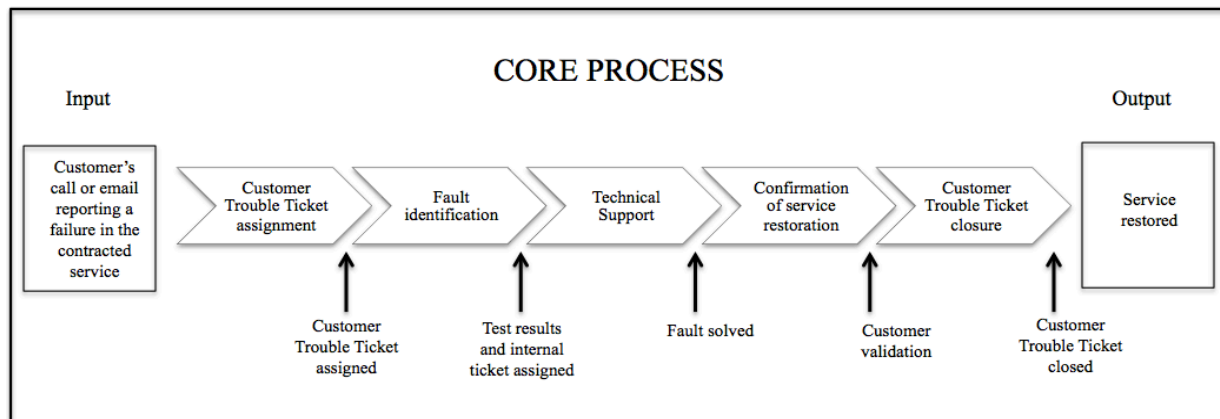

Figure 2. Failure Support Process reported to the Network Operation Centre

When NOC staff receives an e-mail or a call from customer, a report number is assigned in the Ticket' System, it indicates the severity of the fault and the number assigned is used to follow up the case throughout the whole process. After that, the NOC' staff carries out some tests according to the work instruction of the corresponding platform and provides an answer. The KPI established to identify the failure is 25 minutes. If necessary, they involve internal or external technical support in their solution. Where possible, a workaround is applied to restore the service. The target time to restore services depends on the affected platform and the severity of the failure; it is documented in the Quality Plan. If possible, NOC staff makes some tests; otherwise they call the customer to confirm service restoration. The output of the process is the restoration of the service as defined for the QMS. Finally, if the fault is solved, the NOC staff requests authorization to close the ticket.

In order to know the elements to be developed in the implementation plan, as it is the first time that the company has implemented a QMS, a set of 37 questions was applied, indicating the requirements established by the ISO 9001 standard. The result showed 21.62% of compliance. Based on the results, the participants of the system and the Quality Committee were determined; roles and authorities were defined, as well as the documents (procedures, instructions and formats) to be developed.

Phase 1: Action plan (system planning). This phase includes the generation of the activity plan for the system implementation. The plan specifies the time required for each activity to be carried out, the person responsible for it, in addition to the expected result. The time plan was estimated to last 7 months from the beginning until obtaining the certification for this project.

Phase 2: Action (design, development and implementation of the system). It includes the training of personnel involved in the QMS and the preparation of the Quality Manual, the generation of documents and records. Two key points made by senior management at this point are quality policy and quality objectives definition. The documents generated for the system were: a Quality Plan, 10 procedures, 10 instructions and 18 formats, according to the Control Procedure document. The documents are updated and communicated accordingly. All the documents are focused on supporting the quality policy and objectives. The way in which the processes, requirements and documentation of the QMS interact is shown in Figure 3. It also describes the inputs, output and responsible of every process and requirement.

During this stage, NOC staff must review that the Customer Trouble Ticket contains the information indicated in the work instructions and it is validated that the documents related to the corresponding platform were followed (voice, internet, optical fibre, or internet). The same is applied to the rest of the processes. In cases where inconsistencies are detected or process improvements are found, they are carried out in accordance with the provisions of the Document Control Process.
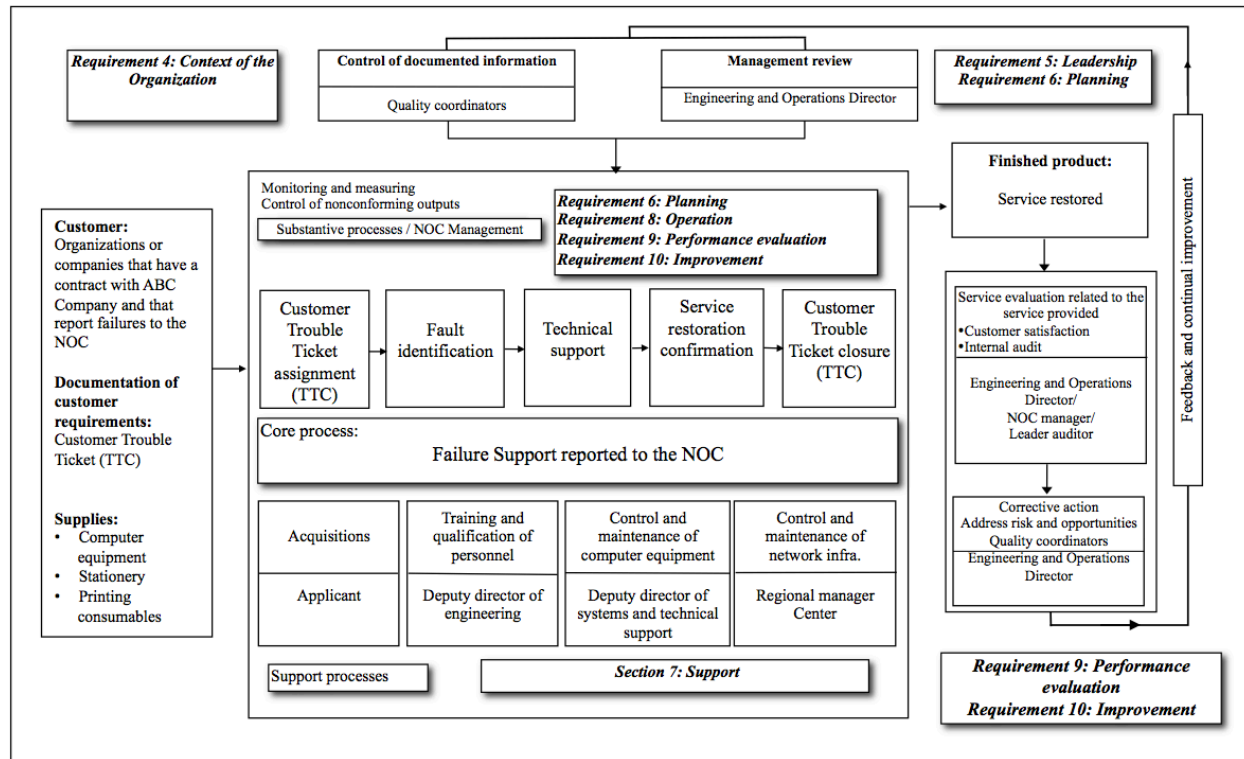

Figure 3. Interaction of processes, requirements and documentation of the QMS of the ABC Company

The KPIs of the core process are measured and reported according to the information established in the Quality Plan. Deviations to the process involved in the QMS are reported in the Management Review Meeting.

The Quality Plan establishes resources (human, materials and infrastructure), activity verification (method, measurement frequency and responsible), risk plan (risk and action plan), document to be used in each of the activities of the main process and the output of the activity.

Phase 3: Observation of the action (internal audits). An audit is a systematic, independent and documented process to obtain objective evidence and evaluate them objectively in order to determine the degree to which the audit criteria are met (International Organization for Standardization, 2015b). The audit also seeks to identify the good and best practices implemented, nonconformities, gaps and defects and, offer proactive and positive assistance to improve process implementation in order to help the team to increase their productivity (Project Management Institute, 2017). The audit was carried out according to the audit plan, indicating the nonconformities and the corresponding observations in the audit report.

Phase 4: Reflection (corrective actions). In this phase, the results obtained in the internal audit are analyzed, synthesized, interpreted and explained. Corresponding corrective actions are generated in accordance with the corrective action procedure to ensure that the nonconformity or observation found does not occur again. Other inputs to generate corrective action are: customer complaints, non-compliant outputs, management review, and results of customer satisfaction measurement.

3.3.2 Cycle 2: QMS certification
In this case, the corrective actions, from the previous cycle, are reviewed to generate a new action plan and carry out an improvement in the QMS. This cycle includes the following phases:

Phase 1: Action plan (system improvement planning). Those responsible for monitoring the corrective actions, hold meetings with people involved in the non-conformity to identify the root cause of the issues. Brainstorm and Rout Cause Analysis are used for this activity. The defined actions to solve the issues are documented in the corrective action format indicating deadlines and responsible parties.

Phase 2: Action (execution of improvements). Once the activities are completed, the corrective actions are closed and the internal auditor is informed in order to obtain their approval. After that, the corrective action is closed.

Phase 3: Observation of the action (external audit). It describes the activities related to the certifying bodies and the certification of the QMS. According to the Entidad Mexicana de Acreditación (2019), there are 27 accredited bodies to carry out the certification of Quality Management Systems in the technological information sector in Mexico. External audits consist of documentary review, pre-audit and, certification audit.

Phase 4: Reflection (corrective actions). In this phase, the results obtained in the external audit are analyzed, synthesized, interpreted and explained. With the data obtained, the corresponding corrective actions are generated to meet the observed deviations and carry out a new improvement to the system. If the actions are resolved within the time established with the certifying body, the company obtains the corresponding certificate.

4. Results
The QMS implementation through action research was successful. It was noticed that action research contributes to the professional development (Eilks and Markic, 2011; Laudonia *et al.*, 2018; Klima Ronen, 2020) of all the staff involved in the system.

Scope and time plan definition were important to establish responsibilities. According to the Action Research, two cycles were defined, one to implement the QMS and the second one to get the certificate. A key to accomplish the implementation according to the time plan was monitoring activities in a timely manner. As a result, a total of 10 procedures, 10 work instructions, 18 formats and a Quality Plan for the QMS were defined and documented.

Trouble tickets and activity log are recorded in a database. The information recorded is obtained in excel format for the following points: fault identification, technical support, service restoration, ticket closure, and results of the customer satisfaction survey. Subsequently, the data is analyzed to generate the reports according to the information established in the Quality Plan. The database is also used to identify the non-compliant outputs and to send customer satisfaction surveys. QMS implementation improvements and results could be summarized in Figure 4. It shows the KPIs established to measure the five activities of the main process and the corrective actions taken. The figure is described below.

Customer Trouble Ticket assignment. In this step, it is important to fill the trouble ticket template without errors, otherwise it will be sent to the wrong area or the staff could use wrong work instruction. To avoid mistakes, severity criteria for the failures reported were defined and a training plan was scheduled. The work instructions to fill the trouble ticket templates were updated. The ticket´s system was updated accordingly. Process definition and work instructions helped to standardize the ways of working.

Fault identification. A period of 25 minutes was established to make initial tests. For February and March 2018, the KPI was not met (see Table 1). The analysis showed two issues: on the one hand work instructions were not followed properly or fault required more testing time; on the other hand, staff was not following the main process, some of them made tests and after that opened the customer trouble ticket. As a result, some negative values were shown in the report measurement. Corrective actions were taken to improve the KPI. In this step, a better diagnosis was made and the number of cases sent to technical support was reduced.

Technical support. In this point, internal o external technical support was involved. KPIs were oriented to identify the main causes of network failures: regions (network is divided into four regions), equipment (microwaves, routers, voice equipment, fiber among others), external providers from equipment and services like Telmex, ATT, Infinera,

etc. It also helped to define if spare parts were needed and where or if it was possible to apply a work around. Once the main causes were identified, it was possible to take actions to reduce failures (this included updating the risk action plan). In this part of the process, there was also evidence of a lack of communication between regions and NOC staff and the lack of updating the single database assigned to the internal support. The corrective actions taken consisted of extending the internal support work hours that helped to reduce the recovery time for failed services and updating the ABC network maintenance plan to reduce network issues. In general, KPI measurements are within the objectives, except for those major failures like a fiver cut due to natural disasters. Table 1 shows (in bold), the months where the KPI was not met.
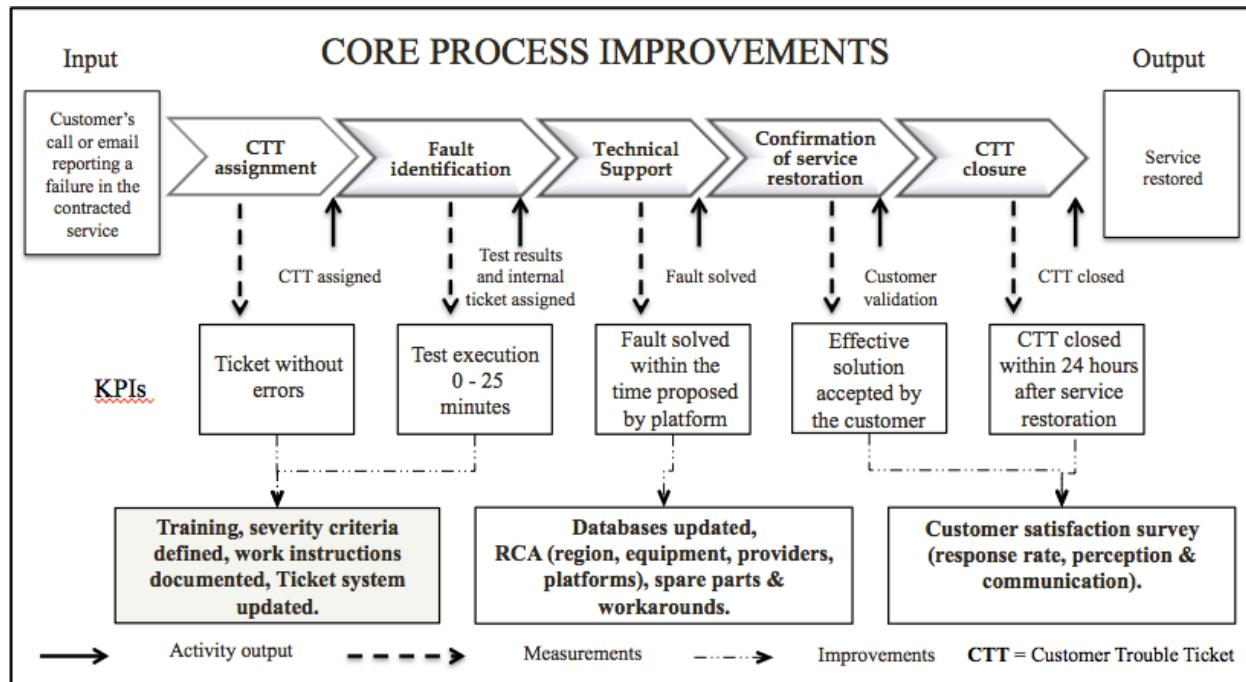

Figure 4. QMS implementation improvements

Confirmation of service restoration. The KPI was intended to validate the effectiveness of the solution so that the problem did not recur. Communication between the customer and the NOC staff improved so that feedback was carried out proactively.

Finally, the **Customer Trouble Ticket closure**. KPI was not met (see Table 1). As a consequence, the sending of satisfaction surveys was delayed. The root cause analysis showed two main problems: the lack of follow-up of the process and the lack of customer consent.

The number of satisfaction surveys received was very low compared with those sent. As part of the corrective actions, the process was modified, an English format was generated, telephone follow-up was mandatory, personal meetings with clients were scheduled to inform them about the QMS. This point is important since customer satisfaction is key to increasing revenue (Carmona-Calvo et al., 2016). The customer satisfaction survey gets information on: communication, customer perception of fault tracking, service restoration time, and fault service provided by ABC company.

Table 1 shows the results from January to July 2018 for the established objectives. During the implementation period, it is possible to see the adaptation to the new ways of working (January to April), after that period most of the activities were normalized. More work has to be done for the ticket closure to reach the objective. In order to improve the KPIs, Root Cause Analysis and Pareto principle were used to identify and eliminate the main non-conformities.

Table 1. Results of the objectives from January to July 2018

(a) KPI definition			Implementation period				QMS certified		
Failure Support Process	Platform	KPI	Month (Data is in %)						
			J	F	M	A	M	J	J
(b) Fault identification		0 – 25 minutes in 80% of cases	**84.9**	75.4	68.3	**91.9**	89.6	92.95	94.3
(c) Restoration Time	Optical fiber	According to the severity and time definition in Quality Plan in 80 % of the cases	75.0	75.0	**100.0**	**100.0**	100.0	88.4	100.0
	Internet		**81.3**	**83.4**	**100.0**	**100.0**	90.3	100.0	87.0
	Private Line		72.8	63.0	62.5	**88.9**	88.4	78.4	**100.0**
	Long Distance		56.3	64.0	**96.7**	**92.8**	85.7	81.8	88.2
(d) Ticket closure		Within 24 hours after service restoration in 80% of the cases	52.6	46.5	63.9	55.4	32.6	26.5	35.2

Bold: KPI achieved

The activity log and lessons learned helped to generate knowledge and reduce the risks in the attention of activities due to staff turnover, lack of knowledge or training period for new members involved in the core process. In general, the personnel involved in the QMS had an excellent disposition to participate in the system. It was clear that management positions commitment was the key to implement the QMS in the planned time, which is in line with the results obtained by Ingason (2014). Once the QMS was implemented and all ISO standard requirements were met the certificate was obtained. Non-conforming outputs were analysed and solved in accordance with the corresponding processes.

5. Conclusion
The implementation of the QMS based on ISO 9001:2015 to the Failure Support Process reported to the Network Operation Centre (NOC) introduced important benefits such as obtaining the certificate. It allowed the company to participate in biddings and accredit new government contracts (Secretaría Función Pública, Instituto Mexicano del Seguro Social, and Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado).

The proposal presented in this document offers the possibility of improving timely detection and attention to failures. Defining process and work instructions helped to increase the staff knowledge, reduce the impact of services and reduce mistakes, which is in line with the results explained by Zimon et al. (2016). Other important achievements were the creation of the internal escalation plans and training plans for NOC members. This agrees with the study carried out by Martinez et al. (2018), where the implementation of the QMS allowed the correct management of the infrastructure to develop the activities, and with Petnji et al. (2014), who took into account that if there are failures in the services, the strategy must be aimed at improving customer satisfaction, which in turn will help increase their loyalty.

Finally, this document shows the benefits of the QMS through Action Research; it focuses on a practical aspect in order to change it. In that sense, most of the staff realizes that their work is professionally relevant and important, so they get involved and commit to the system. Action Research states the commitment and direct participation of management, employees' participation and their engagement, and good preparation and goal setting to be successful (Ingason, 2015). The implementation and certification were carried out according to the time plan.

On the other hand, ISO 9001:2015 also demands an action to address risks and opportunities, so that more work is on prevention than on correction. ISO9001:2015 represents a major opportunity to forge an integrated system of performance management, through the creation of significant ties between quality management and continuous

improvement, on the one hand, and corporate risk management on the other hand (Sitnikov et al., 2017). The certification audit showed that the activities carried out by the ABC Company, in terms of fault management, are homogeneous; however, it is important to keep the work pace constant.

5. 1 Limitations of the investigation

Regarding the background, the main limitation were the few data, in magazines or theses published, on implementations of a QMS in telecommunications companies in Latin America and Mexico. Another limitation was the low response rate to know the customer satisfaction; in the first months, customers did not respond to the survey. Finally, the resistance of some staff members to follow the processes and work instructions was a limitation. It was one of the root causes of target failure along with the workload presented by the NOC.

5.2 Recommendations for future research

A study of the implementation of the QMS under the ISO 9001 standard and its impact on costs or productivity in the telecommunications area is recommended, in this case, it is necessary to know the cost of the man-hour and the number of cases or activities that one engineer can attend in the course of a shift, remembering that in the NOC follow-up calls, support request, test conferences and reception of new services are made. Another study that can be carried out is to know the feeling and vision of telecommunications companies in the resources that participate in the QMS since the present work did not contemplate any activity to measure the work environment.

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