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The application of quality methodologies in reducing failures. IN OPTICAL NETWORKS: A CASE STUDY ON OPERATIONAL EFFICIENCY AND STANDARDIZATION

THE APPLICATION OF QUALITY MANAGEMENT METHODOLOGIES IN REDUCING FAILURES IN OPTICAL NETWORKS: A CASE STUDY ON OPERATIONAL EFFICIENCY AND STANDARDIZATION

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SUMMARY

In this scientific article, my objective is to analyze the impact of applying established quality management methodologies, specifically the Ishikawa Diagram, the 5 Whys technique, and the 5S methodology, on the optimization of maintenance processes in telecommunications.
I start from the premise that the stability of GPON *(Gigabit Passive Optical Network)* and HFC *(Hybrid Fiber Coaxial)* networks depends not only on technological robustness, but also on the efficiency of field and management procedures. Through a case study based on my experience in continuous improvement projects (TESP and PAQ) at a large Brazilian operator, I demonstrate how structured root cause analysis allowed for a reduction in the volume of Service Orders (SOs) in Santa Catarina. I use a deductive methodology with an empirical-analytical approach, based on a literature review and the analysis of operational results. I conclude that the standardization of tools and critical failure analysis are essential vectors for reducing operational costs (OPEX) and increasing end-customer satisfaction.

KEYWORDS: Telecommunications. Quality Management. GPON. Ishikawa. 5S. Operational Efficiency.

ABSTRACT

This paper aims to analyze the impact of applying established quality management methodologies—specifically the Ishikawa Diagram, the 5 Whys technique, and the 5S methodology—on the optimization of telecommunications maintenance processes. The study proceeds from the premise that the stability of Gigabit Passive Optical Networks (GPON) and Hybrid Fiber Coaxial (HFC) networks depends not only on technological robustness but also on the efficiency of field and management procedures. Through a case study based on continuous improvement projects (TESP and PAQ) at a major Brazilian operator, this research demonstrates how structured root cause investigation facilitated a reduction in the volume of Service Orders (OS) in the state of Santa Catarina. A deductive methodology with an empirical-analytical approach is employed, grounded in a literature review and the analysis of operational results. It is

concluded that tool standardization and critical failure analysis are essential drivers for reducing operational expenditure (OPEX) and enhancing end-customer satisfaction.

KEYWORDS: Telecommunications. Quality Management. GPON. Ishikawa. 5S. Operational Efficiency.

1. INTRODUCTION *I observe that the telecommunications sector in Brazil has undergone profound transformations in the last two decades, driven by the exponential demand for data and the need for high-speed, low-latency connections. In this scenario, optical networks, especially GPON technology, have become the gold standard for internet access. However, I note that the physical implementation of these networks and their daily maintenance impose significant logistical and technical challenges.*

With a background spanning from my training in Electrical Engineering to Systems Analysis and experience in Data Centers, I observe that technology alone does not guarantee service excellence; rigorous process management is necessary. The complexity of modern networks demands that operators maintain strict control over their assets and the quality of service provided. Recurring failures generate rework, increase operational costs, and damage the company's image. It is in this context that I see the use of total quality management tools finding fertile ground in the telecommunications services sector.

This work focuses on the analysis of two strategic projects I experienced: TESP (Elite Troop for Problem Solving) and PAQ (Quality Improvement Program). The research problem guiding my article is: how can the systematic application of investigative and organizational methods mitigate the excessive volume of corrective maintenance in fiber optic networks? My central hypothesis is that the precise identification of the root cause of problems and the standardization of the field technician's work environment are determining factors for network stability.

I justify the relevance of this study by the constant need for efficiency in the sector. I bring to light my practical experience, accumulated from working as a field technician in residential and corporate installations to managing critical infrastructures in Data Centers. This holistic vision of mine, which unites the operational end with the strategic core of the network, allows for an in-depth analysis of failures and their solutions.

To develop the reasoning, I structure the article into six content items. Initially, I address the operation and challenges of GPON networks and discuss the theoretical basis of the tools of
quality. In the third and fourth sections, I detail the practical application of these tools in the TESP and PAQ projects. Subsequently, I analyze the results from the perspective of technical efficiency and discuss the cultural challenges of implementing these methodologies. I base my methodology on the review

This is a bibliographic review of classic authors in quality management combined with technical literature, with a time frame up to 2021. I hope to demonstrate that network engineering and process engineering are inseparable for the success of modern telecommunications.

2. GPON Network Infrastructure and the Challenges of Maintenance

GPON technology has revolutionized the market by enabling the traffic of large volumes of data through a passive infrastructure. With my specific certifications in Huawei and GPON technologies, I emphasize that, although robust, this architecture is sensitive to physical interference and installation errors. Unlike metallic or HFC networks, where I also have extensive experience, fiber optics requires millimeter precision. I know that excessive bending or poorly executed connectorization can cause signal attenuation, resulting in slowness or service interruption.

In a scenario of accelerated expansion, quality control of these facilities becomes a Herculean challenge. The high volume of maintenance work orders is one of the main indicators of inefficiency. Often, the technician travels to the client only to find that the problem was in a degraded external infrastructure or a poorly done previous installation.
This cycle generates high costs and frustrates the subscriber.

Corrective maintenance, the main focus of this study, occurs in response to a perceived failure. The major challenge I faced in operations in Santa Catarina was transforming this reactive maintenance into an opportunity for definitive network remediation. My experience in the Transmission and Headend sector reveals that a significant portion of failures originate internally: non-standardized procedures and a lack of adequate tools. It is at this point that technology gives way to work methodology. Therefore, to reduce the volume of work orders, it is not enough to simply invest in cutting-edge equipment, such as the latest generation routers and OLTs I currently work with. It is imperative to invest in the intelligence of field operations and in accurate diagnostics.

3. QUALITY TOOLS: ISHIKAWA AND THE 5 WHYS

Total Quality Management provides analytical tools for solving complex problems. The Ishikawa Diagram allows for a graphical visualization of the causes of a problem, grouping them into the categories of the 6Ms. In the context of telecommunications, I consider the undesirable "effect" to be the high rate of callbacks. I distribute the "causes" across the spines of the diagram: in "Manpower," I list the lack of training; in "Material," the quality of the connectors; in "Method," the fusion procedures. With my analytical profile shaped since my technical training, I understand that visualizing the problem in this way prevents management from making decisions based on guesswork.

Additionally, I use the "5 Whys" technique for further investigation, asking successive questions until I find the root cause. Often, the apparent cause is just a symptom.

The combined application of these methodologies brings scientific rigor to problem-solving. In complex technical environments, such as the data centers and transmission networks where I work, superficial failure analysis can lead to losses amounting to millions of dollars. I understand, as does Vicente Falconi, that there is no sustainable improvement without method. It is necessary to create a culture where error is investigated as a learning opportunity.

In the TESP project, the use of these tools was a necessity for operational survival. My team used the Ishikawa diagram to prioritize the causes with the greatest impact, applying the Pareto Principle. I conclude that mastering these analytical tools is as important for technology professionals as mastering network protocols.

4. The TESP Project and Root Cause Investigation in Santa Catarina

The main objective of my participation in the TESP Project was to address the high volume of maintenance work orders in the cities of Santa Catarina served by the GPON network. The region presented failure rates that demanded surgical intervention.

Applying the Ishikawa Diagram allowed my multidisciplinary team to isolate the faults.
We identified that a considerable portion of the problems stemmed from the "last mile" and internal facilities. We realized that factors such as "Method" and "Material" were predominant.
Using the 5 Whys method, we investigated recurring problems and uncovered root causes ranging from incorrect tool use to inadequate protection against sea air. Without this methodology, the standard solution would simply be to replace the wiring, without preventing recurrence.

Based on the data, I developed a structured Action Plan. The actions included technical retraining and preventive replacement of materials. With my previous experience in technical support and installations, I was able to contribute valuable insights into the day-to-day realities of the technicians. TESP demonstrated to me that data analysis is fundamental for decision-making. The transition to *data-driven* management allowed for a more efficient allocation of resources, optimizing response time.

The results achieved served as a model for other locations. The reduction in the volume of service orders freed up the workforce to focus on expanding the customer base. The project validated my thesis that complex problems have solutions based on disciplined processes. My leadership and ability to integrate knowledge were crucial in translating analytical data into practical actions.

5. The PAQ Project and the 5S Methodology in Field Organization

In parallel, I noticed that the organization of the work environment was a critical factor. The PAQ Project focused on improving the technicians' toolkit through the 5S methodology. Having

Having worked as a maintenance technician, I knew firsthand how disorganization impacts productivity and leads to damage to precision tools.

I applied the principle of Utilization (Seiri) by separating the necessary from the superfluous, removing scrap from the vehicles. I applied the principle of Order (Seiton) in structuring the toolboxes, ensuring that each tool had a defined place. Standardization (Seiketsu) ensured that all technicians used the same standard.

I realized that the impact goes beyond aesthetics; an organized technician inspires confidence in the client. Maintaining the instruments ensures the accuracy of the measurements. Discipline (Shitsuke) was the final challenge, maintained through verification routines. My participation in technical groups and my role as a knowledge multiplier were fundamental in engaging the teams.
I conclude that 5S is the foundation upon which technical efficiency is built; without organization, technology becomes underutilized.

6. RESULTS: OPERATIONAL EFFICIENCY AND COST REDUCTION

The convergence of the projects' actions resulted in tangible indicators. The reduction in the volume of work orders in Santa Catarina was the most significant indicator, meaning that the problem was correctly resolved on the first visit. Financially, I observed fuel savings and a reduction in material consumption.

Standardization has facilitated the training of new employees, reducing the learning curve.
With my academic background in Systems Analysis and Development, I understand the value of documentation and systematization of knowledge. Another result was the increased availability of the network, vital for essential services such as remote work.

The experience I gained in these projects contributed to my professional development, preparing me for greater challenges in the Data Center environment. I took the "do it right the first time" mentality and the search for the root cause of the external network to the heart of the IT infrastructure. The analysis of the results suggests to me that quality methodologies work independently of the technology. I observe that innovation lies in the innovation of work processes and the ability to apply a structured method.

7. CONTEMPORARY CHALLENGES: CULTURE AND TECHNOLOGY

I see that the implementation of methodologies faces cultural barriers, with technicians resisting analytical methods. I understand that the role of technical leadership is to demonstrate that these tools aim to facilitate the work. The evolution to Wi-Fi 6 and 5G will require even more precision, and I have been working to disseminate this knowledge by giving internal lectures.

Process automation, my area of interest and expertise, is emerging as the next frontier. I believe that integrating monitoring with quality management will allow for predictive diagnoses. However, I emphasize that automating a chaotic process only generates chaos more quickly.

In a data center, where I currently work, physical organization is vital for security. The 5S principles I applied to the technician's toolkit are the same ones that ensure the operability of thousands of servers. Continuous training is key; my resume, full of recent certifications in MPLS, SD-WAN, and BGP, demonstrates that I must be a lifelong learner. In short, the contemporary challenge is balancing high technology with high human interaction and management.

8. CONCLUSION

The case study I presented, based on my professional experience in the TESP and PAQ projects, confirms my hypothesis that quality management methodologies are extremely effective in the telecommunications sector. The use of the Ishikawa Diagram and the 5 Whys allowed me to transform raw data into accurate diagnoses, reducing waste in the GPON network.

It became clear to me that technology depends on excellence in human execution. The PAQ Project addressed this vulnerable point, guaranteeing decent working conditions. My career path, evolving from electrical technician to Data Center specialist, illustrates the importance of interdisciplinarity and a systemic vision.

I conclude that operational efficiency is not a matter of chance, but of method. The lessons I learned from TESP and PAQ are universal and serve as a reference for any manager. Finally, I recommend that operators continue investing in the intelligence of their processes and in the analytical training of their employees, because ensuring the stability of the connection is our noble mission.

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