IBIMA Publishing
IBIMA Business Review
http://ibimapublishing.com/articles/IBIMABR/2017/197381/
Vol. 2017 (2017), Article ID 197381, 12 pages
DOI: 10.5171/2017.197381

Research Article

Towards a Platform for a Supplier Quality Management System

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Received date: 6 October 2015; Accepted date: 8 February 2017; Published date: 26 September 2017

Academic Editor: Paolo Renna

Abstract

Today any OEM automotive industry that wants a status of a world-class organization has to follow a proper supplier quality management based on the worldwide recognized international standards. With this, the customer within a supply chain should have the sureness that the company has supplier capabilities in place to provide a service that consistently meets its needs and expectations. Although some of this Supplier Quality Management Systems (SQMS) are deeply integrated and used inside of an organization, sometimes they are implemented using inappropriate or limited tools, making the work of employees harder and acting often as entropy sources in those systems. Having the right tools to handle Inspections as well as Nonconformance, Complaint, Corrective Action and Concession processes is key to successfully track the supplier performance. This paper presents a platform to support a SQMS, that fits the technical specification ISO/TS 16949 requirements.

Keywords: Supplier Quality, Total Quality Management, ISO/TS 16949.

Introduction

The automotive production of modern days had come a long way since it was first developed and the quality became more important in this industry, with the start of the mass production era. The use of relevant tools according to the organization's needs became strategic and essential for the industry in today's competitive environment. Using the proper tools and optimizing processes, industries can improve their performance and thereby increase customer satisfaction and enhance supply chain. The entire automotive industry pursues the adoption of standards, specifications, procedures and other practices in order to improve the final quality of its products. However, they still have difficulties in finding the right tools to their production environment and often these processes are

Cite this Article as: João Paulo Sousa , Carlos Rompante Cunha, Elisabete Paulo Morais and João Pedro Gomes (2017)," Towards a Platform for a Supplier Quality Management System", IBIMA Business Review, Vol. 2017 (2017), Article ID 197381, DOI: 10.5171/2017.197381

carried out with less appropriate tools to ensure the good practices required.

An organization spends substantial time and money purchasing raw materials and managing suppliers. Therefore, supplier quality, meaning quality parts, on time delivery, on right quantity, can substantially affect the overall quality and cost of a product. We believe that quality management procedures and tools are instruments that help to increase and improve the efficiency throughout the complete supplier chain.

A company cannot produce a quality product if the components of which it is made are faulty. One of the keys to obtain high quality products is to work with the suppliers to achieve the same quality level that has been attained within the organization and this is why supplier quality management is mandatory in the complete chain of automotive industry, and it is one of the requirements of the technical specification ISO/TS 16949 (ISO, 2013). To apply this method successfully, the proper tools play a decisive role. This paper presents a prototype for a supplier quality management system of model defined in Sousa, Cunha, Morais, & Gomes (2015), which was a based case study of a Portuguese company in the auto industry that supplies parts to the major automobile manufacturers. The prototype follows the ISTO/TS 16949 standard, implementing the functioning of their processes.

With this prototype, we expect to improve the evaluation and selection of the supplier network and increase the efficiency of approval process of new suppliers. Handling the inspections and non-conformance will help the tracking and management of raw material quality, ensuring that all the non-conformance will be addressed and that appropriate actions will be requested.

Background

The quality term exists since always and is a subjective concept that is related to the perception of each individual and is related to several factors such as culture, needs and expectations. In the past, the quality of a product only meant to comply with the customer's requirements. Since the industrial revolution, the quality has developed until the present day mainly through four eras (Dahlgaard, Kristensen, & Kanji, 2002): age of inspection, focused on the product; age of statistical quality control, focused on the process; age of quality assurance, focused on the system; and age of Total Quality Management (TQM - Total Quality Management), focused on the business (Bovas Abraham, 1998):

age of inspection: by monitoring the parts, only focused in the separation of "Good" and "Bad" parts;

age of statistical quality control: applied statistical techniques for process control in order to identify and minimize or remove special causes of variation that could affect the product. Emerged the management style where the defect causes are identified and actions in them are taken.

quality assurance era: the cost of rework and consumer displeasure are considered. A preventive management started with positive implications in terms of quality and consequently resulting in the reduction of waste.

age of TQM: it is a natural evolution of the previous three stages, integrating them, being however wider as it applies to quality in all areas of a business, including sales, finance, purchasing, among others and not only the productive ones.

Total Quality Management Definition

The term TQM was stated to be used in the mid 80s and became a recognized part of the

quality related language in the late 80s (Martínez-Lorente, Dewhurst, & Dale, 1998). Total quality management (TQM) is a process that was applied successfully in industries in the US in the 1980s. By using the process, large companies, such as Texas Instruments, Xerox, IBM and Motorola, were able to improve their business positions by overcoming threats from global competition and other changes in the business environment (Lozier & Teeter, 1996). The TQM is a comprehensive and structured approach to organizational management focusing on the maintenance and continuous improvement of products, people, services and processes with the goal to meet or exceed customer expectations (Flynn, Schroeder, & Sakakibara, 1994; Goetsch & Davis, 1997; Shiba, Walden, & Graham, 1993).

TQM is a philosophy with customer focus and results orientation with the involvement of all. It is a systematic approach to quality management across the business, which is based on the use of tools and techniques of continuous improvement in all organizational processes. It is in this environment that global automotive industry fits, which requires a high level of product quality, productivity and competitiveness, having as engine the continuous improvement (Asif, Awan, Khan, & Ahmad, 2013; Lanza, 1997; Li, Markowski, Xu, & Markowski, 2008).

To achieve these goals, the vehicle manufacturers insist that their suppliers need to be certified to the quality management standard known as ISO/TS 16949 (Sroufea & Curkovicb, 2007). This standard was developed by the industry, the IATF (International Automotive Task Force), to stimulate the improvement of the supply chain (Radley M. Smith, Roderick A. Munro, 2004). The purpose of ISO/TS 16949 is the development of a quality management system that generates continuous improvement through avoidance of defects, reduction of deviation and waste minimization, on the entire supply chain of the automotive industry (Foster Jr., 2008; Hoyle, 2005). By applying this quality system standard, automotive manufacturers could offer superior products and good services to customers. It is in this context that supplier quality management has become mandatory, in an industry that needs to ensure the same quality level in all steps of the complete supply chain.

Architecture an Implementation SQMS

In Sousa et al. (2015), were presented and described the procedures that are part of the SQM currently in operation in an Original Equipment Manufacturer (OEM) for automotive industry in the north of Portugal and the way they are implemented. In this section, it will be presented the proposed model and architecture that will support this model.

Class Diagram

Fig 1 shows the class diagram in Unified Modelling Language to describe the classes and their relationships. This diagram was the start point to define the prototype class structure.

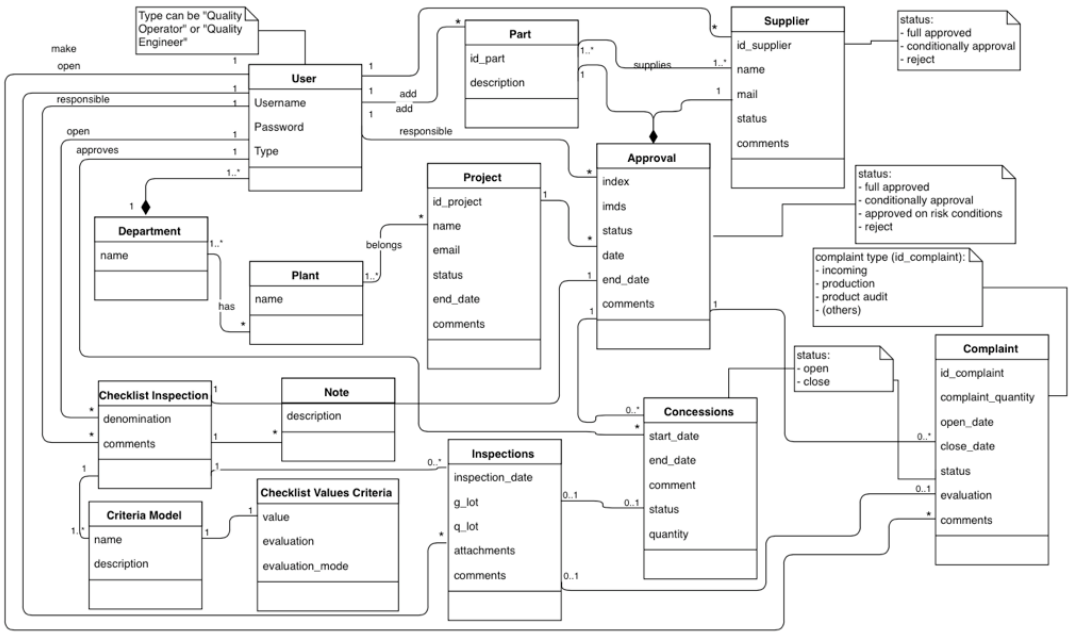

Fig 1. Class diagram of the SQMS prototype

Fig 2 shows the relational model diagram of the database of the SQMS prototype. The database is composed of 28 tables to hold all the system data. Following, it will be described some of the most relevant information of the main tables of the database. The table Approval holds all the parts approvals identified univocally by the part id, supplier id and index. All the parts need to be approved to be part of the system. The table HistoricalApproval records all changes that happen in the status during the part approval process, and who made these changes. The table ProjectPlan indicates which are the projects that belong to each plant of the company. A project may be associated with more than one plant. The table InspectionChecklist saves the inspection checklists of the parts, each part has only one inspection checklist. The table CriteriaModel relates the checklist criteria with the inspection checklist and the table ChecklistValuesCriteria contains the collected values during an inspection. The table Inspection relates the inspection made with the parts, one part can be inspected several times. The Complaints table records all claims made during an inspection or approval. An inspection or approval may raise to several complaints.

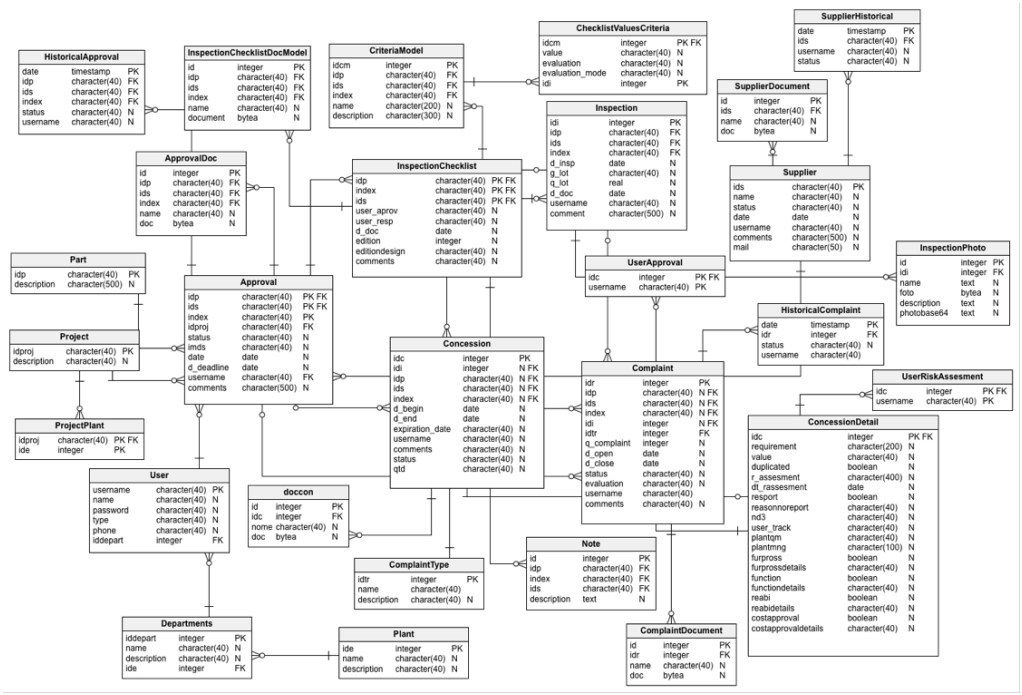

Fig 2. Database entity relationship model diagram

Architecture of SQMS

To implement the model defined in Sousa et al. (2015), we implemented a platform set by two parts (Fig 3): a web platform and a mobile app. This architecture is supported mainly by a Tomcat Application Server, a PostgresSQL database to storage the data and the already existing Directory Server to authenticate the users. The SQMS was built using the Google Web Toolkit (Google, 2014), Android SDK, and Java language.

To provide the mobility required to do some tasks out of the office area, we also implemented a mobile app to run on a tablet. This app will be used by the quality operators to consult inspection checklists and launch inspections data directly on the system. It also allows to add photos, video or audio to the inspection guides to generate the claims reports to the supplier.

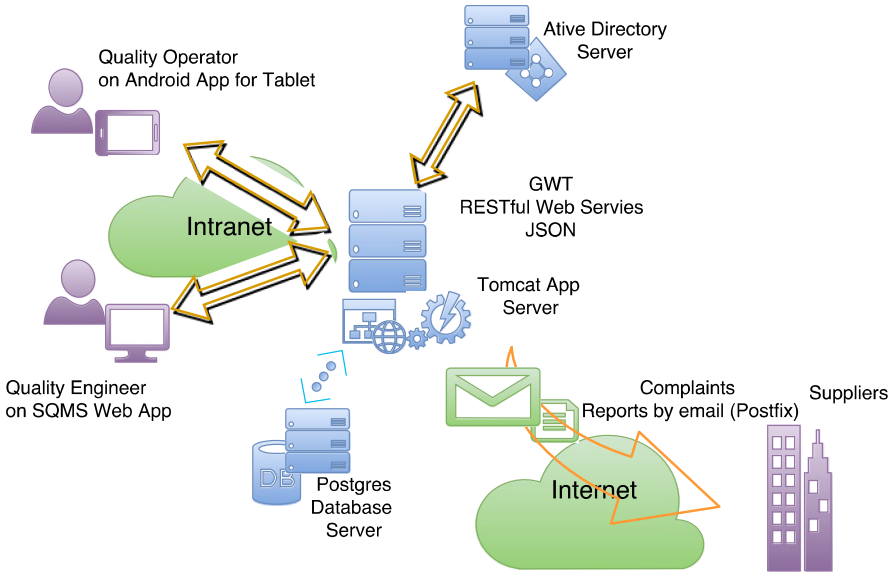

Fig 3. High Level Architecture to support the SQMS model

Web Application

One of the SQMS prototype parts developed was a Web platform. The choice to implement a web based architecture brings several advantages already described in Sousa et al. (2015). In order to help the system to be more usable to all users it also supports internationalization to adapt to the different languages because the organization has plants in different countries. The SQMS prototype is in advanced stage, and this section will present some of the most important options of it.

Fig 4 shows the main window after the user has logged in. The left side of the page has a vertical menu with the main options divided in three main sections:

- Searches: which allows the user to quickly search by parts approval, inspections, claims, concessions, parts, and projects. This feature was requested by the quality team to easily find some of the items by the part id.
- Data Management which is divided in the following options: Approvals, Inspections, Complaints, Concessions, Suppliers, Parts and Projects. All these options allow the data management of each of them.
- Administration which offers the following options: Users, Logs, Plants, Departments and Complaints Type, related with the platform administration.

On the right side of the main page lies the desktop area based on Tab Layout Panel that will be opened by the selected option. When the employee logs on the application, they will see a panel that cannot be closed, with all the alerts about pending claims, expired concessions or open approvals. If the user finds that the procedure concerning one of these alerts can be updated, he has the chance to do it directly in this

panel. Such as in the case: if the 8D format report is received from the supplier, and it was approved by the quality engineers, the user can update immediately the claim to the closed state.

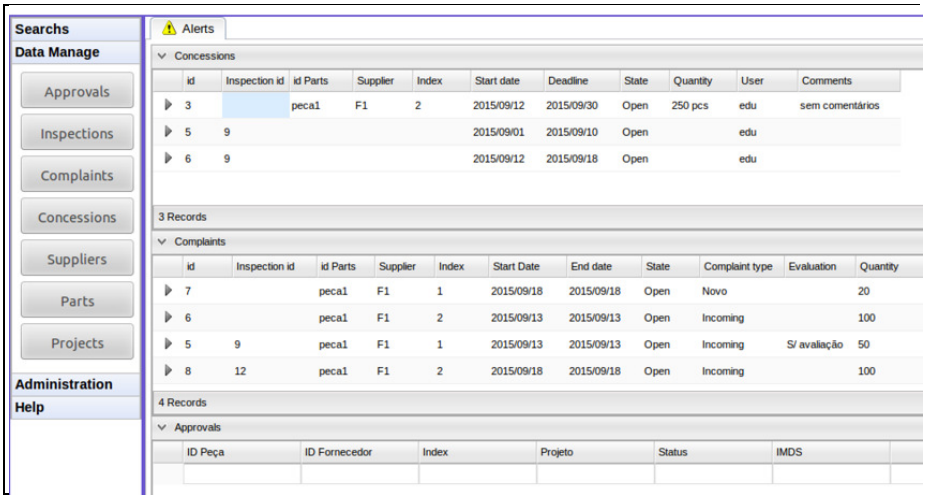

Fig 4. SQMS Alert panel

Fig 5 shows the concession panel where it is possible to view or edit all the concession, or to add a new concession. A new concession is created in case of deviations from product or process characteristics and is always limited in quantity or time that parts in that status can be used. For each concession an action plan is needed to detect and eliminate the root cause of deviation, so several new documents can be uploaded related to that concession.

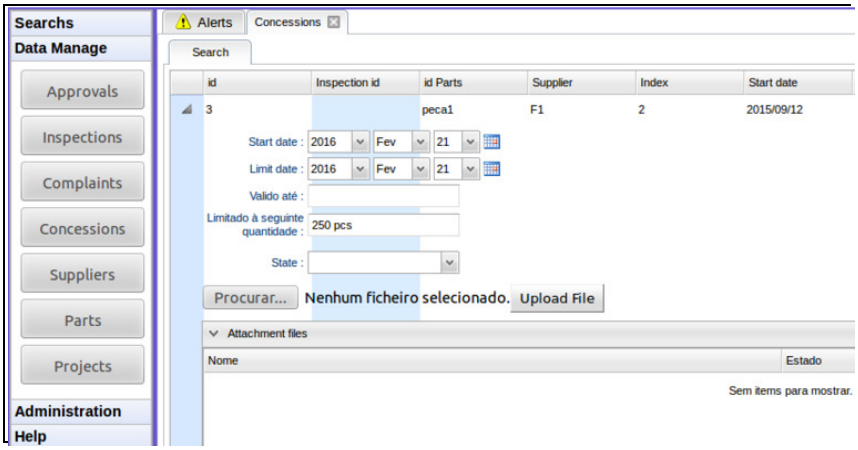

Fig 5. SQMS Concessions panel

Fig 6 shows Inspection Panel where it is possible to view all, edit or add a new inspection. This feature is also provided by SQMS mobile App, that allows to make inspections in the production line or incoming warehouse. The inspections are done with the support of checklist form that contains the items to evaluate and its inspection criteria and record through the SQMS mobile App form. Usually photos are attached and notes are taken to better describe the non-conform part, if found. If a new checklist model is needed to make new inspection part, its possible to make a new checklist model that will be available to the quality operators after the approval of the quality manager.

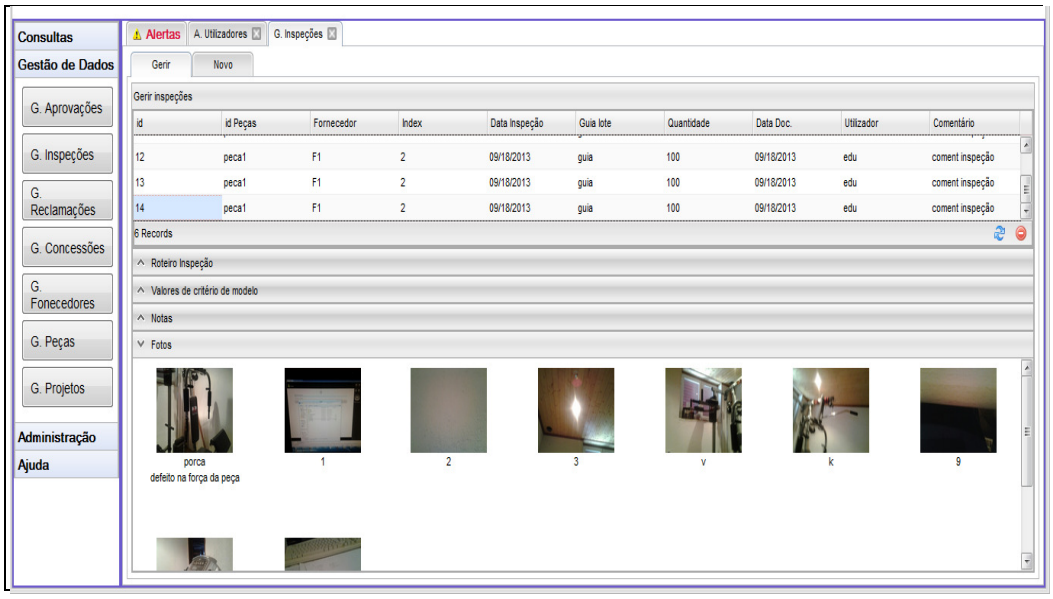

Fig 6. SQMS Inspections panel

Fig 7 illustrates the panel view, edit, delete or add a new supplier to the system. Because the approval of a new supplier has been done by a defined procedure and an established checklist to evaluate the general capabilities of the supplier; this new supplier option allows to attach some documents like contracts, NDA (Non-Disclosure Agreements), audit results, among others.

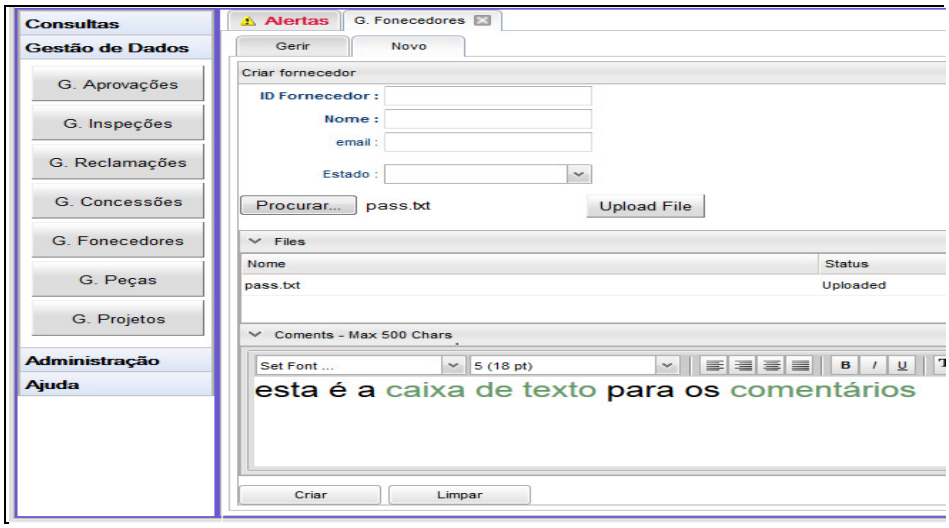

Fig 7. SQMS Supplier panel

Fig 8 shows the complaint panel that displays all the open complaints, allowing to create, edit or delete a complaint. Several reports describing the failure can be attached and a report is created to the supplier. When an answer from the supplier is received, it is analyzed by the quality engineer. If accepted, then the first parts received after actions implemented need to be inspected and positively evaluated that the complaint can be closed. The closed complaints do not appear in the panel and are only accessible in the historical panel.

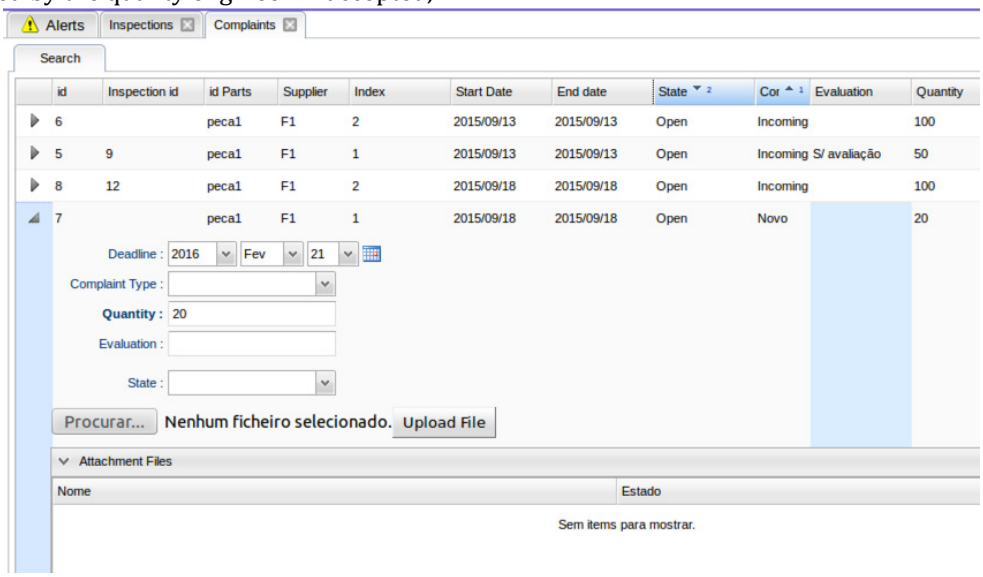

Fig 8. SQMS Complaints panel

Fig 9 shows the historic of all operations done in the system. Each record shows the id operation, date and the user which made the operation.

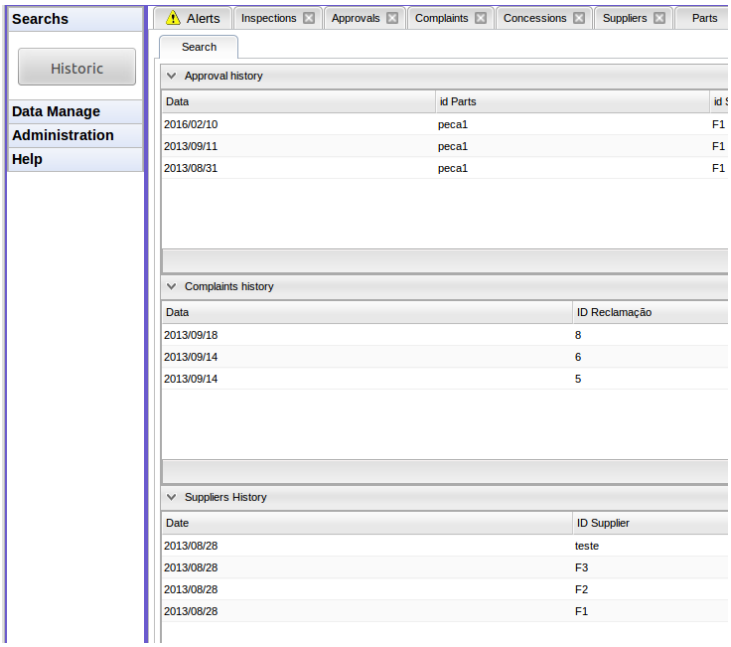

Fig 9. SQMS Historic panel

Mobile App

A mobile App to be used on a tablet was developed to allow the quality operator access and manage data of the SQMS platform. Some of the most import features are to consult the checklist that contains the items to evaluate and its inspection criteria. The quality operators can also use this app when they are in the production line or incoming warehouse making inspections and recording these inspection data using a form and saving them into the system database (Fig 10 – left screen). If a non-conform part is found, the deviation needs to be analyzed and according to the severity of the defect the parts will be blocked and claimed to the supplier or a concession will be issued. During the inspection process, old inspections or open complaint related to that part can be checked to assist the quality operator (Fig 10 – right screen). This feature solves a common problem that has been reported, that in different plants of the same group, were found defects in common parts and this was handled independently, consuming time and resources.

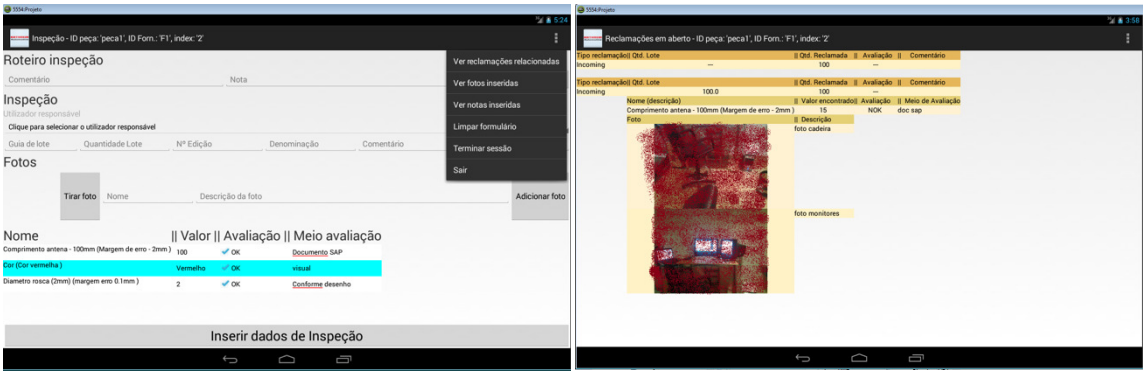

Fig 10. SQMS Mobile App

Discussion and Future Work

With a more global supply chain, it turns more difficult to answer and act on time, when a problem appears. The use of lead technologies as specific software and mobile devices, helps to strengthen the supply chain, making it possible for operator within plant to consult or input richer data (text, audio, photos, videos) from anywhere, using any mobile device. These data stored on a database can be quickly viewed and analyzed by the management, allowing to take decisions more quickly and in a correct way.

With the SQMS system, we expect to improve the internal processes to control the quality of the parts and suppliers. It is also expected to ensure that all quality employees within plant (operators, quality engineers and management quality) follow the quality processes adopted by the company.

In this paper, we have presented the SQMS prototype which supports a Supplier Quality Management System of a particular OEM Car Manufacturer. The major contribution of this work is the implementation of a platform that automates the several parts of the supplier quality processes in the scenario of a multinational company with several plants across the world.

A prototype was developed to validate the proposed model and architecture. With this prototype, we intend to collect data in a scenario of manufacturing environment, to evaluate the real impact that this system can have in the overall efficiency of the supplier quality management process of this OEM automotive industry.

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