POLITECNICO DI TORINO

DEPARTMENT OF MANAGEMENT AND PRODUCTION ENGINEERING

Final thesis to obtain the Master of Science degree in Management and Engineering.

A systematic analysis of Total Customer Quality Management. What more can be implemented to organize efficiently the integration of quality management between production and supply to the customer procurement engineering?

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Abstract

Customer quality management is in some ways, a tie between engineering role with sales, supply, analysing the customer claims, representing companies engineering view on a product to final clients, a position in that encompasses all products (or future products) bought by a customer.

Customer could be an industry group - such as automotive - a segment or even just one major account. Customer quality is outward focused and integrates end user account with internal procurement engineering. Product quality is internally focused.

The role of customer quality is to work directly with the customer's quality groups - Supplier quality, component engineering, procurement engineering or site quality assurance - to do whatever is required to satisfy them. That could be to support new business, it could be sustaining quality of existing products. It could be to trouble shoot problems. Some of it then regular maintenance of documents and supporting audits by the customer.

Dependent on the situation, the customer quality maybe a field quality role where it acts as an interface to quality engineers within the different business units where it is easier to have a specialized customer quality interface. A Customer quality organization and Product quality organization maybe better for geographic coverage to concentrate on a particular client with a specific product requirement.

Customer Quality Management manages the processing of customer complaints, returns, field service and product improvement requests, quickly resolving product quality issues reported by customer. To also improve efficiency, responsiveness and customer satisfaction while ensuring customer reported quality issues are properly documented and effectively resolved.

Mostly CQE will also be doing the Laisoning job between Customer & plant through supporting sales department.

Actually, my thesis deeply highlights the role of Customer Quality Engineer within the development of a product and supplying a product to the final customer. Daily activities of CQE are working with companies internal engineers to get key information about all products, then integrating with procurement engineers of customer’s side by providing assistance in exploiting the product in a right way.

While carrying out all this activities, CQE uses several instruments to deploy quality management, and one of them Scrum Methodology. Quality management in Scrum enables customers to become aware of any problems in the project early and helps them recognize if a project is going to work for them or not. In Scrum, quality is about customer satisfaction and a working product, not necessarily meeting arbitrary metrics. This distinction becomes very important from the customer's point of view because they are the ones investing time and money in the project. Quality management in Scrum is facilitated through three interrelated activities, Quality planning, Quality control and Quality assurance.

Of course, management of customer claims and their analysis cannot be traced without database of previous and current claims, even further particular tests and specific analysis of production and supplying are very tightly connected with building of data mining.

Consequently, above mentioned instruments facilitate terms for product development and implementing Lean approach for creating standards of production, a product technical characteristics. In fact, these characteristics draw the room for quality where product functioning out of specification means non conformity and claimed in terms of quality issue. By the way non conformity during the exploitation means, this issue is coming from field of customer where the end user is already consuming the product.

Indeed, there is a case where the product might be as a non conforming even right after production line or as 0 km issue in automotive industry, the industry in which my thesis partly researches and finds a solution of quality engineering of parts. Quality engineering cooperates with customer quality by directly supervising the production, even though there are many technical standards and lean approach on production, there is still a range of tolerance within which the product is accepted. So far, it means there is so slight but subsequent potential diversity in size, specification, life time, conformity, so it means for monitoring of conformity even the risk based approach and product safety must be developed.

Content

Introduction

This chapter is an introduction to the report and master thesis. It describes, in sequential order, the background, the purpose, the problem definition, the delimitations and the company where the study has been done.

Background

Today's competition is quite tough and the quality of the products on the market needs to satisfy some kind of need expressed by potential customers. There are many definitions of quality which can be discussed but eventually it comes to subdivide the quality management to several little specific team work and the Customer Quality Engineering is one of those positions to be defined in the scope of this project selling products to be sustainable in business. Different products can be of different quality but it is essential to produce quality products when dealing with vehicles, which is the case for Westport Fuel Systems Italia SRL. Companies who want to produce products of high quality, high safety and want approval often needs some kind of quality management system since there are regulations and laws that demand special quality control for certain products. To be approved as manufacturer of vehicles secondary mechanical parts and having reliable customers it necessary to be able to guarantee every product is safe and properly gets integrated with primary parts. Conformity in the production process is vital. A producing company shall have control over its processes to be approved as a manufacturer. The quality management system should reflect the high uniform quality output of the organization's products. The developed quality management system should give support to the daily work at the company to be a high performing organization. Another possible outcome of the project is to develop the organization's structure to the better by visualizing activities for improvements and learn from that. Furthermore, WSF Italia is also a supplier not only manufacturer, in its business model it is merged unit of 3 big factories and WSF Brescia is a final assembly working are where the final added value to the products are added. With this horizontal integration, the quality must be investigated or the control is organized not only as a manufacturer but also as a supplier. In fact, it means the communication to deal with the feedback about non-conformity coming from the suppliers must be implemented efficiently enough. When this project started, WSF already have been having a tightly established quality control system, subdividing the system to three units: Supplier quality control, production line quality control, customer quality control, all run by highly qualified engineers. In this point, WSF in order to have an efficient

customer care to keep its strategic customers and partners, the company arranged the task to prepare for an implementation of a customer quality management system as a master thesis project at the Polytechnical University of Turin (Politecnico di Torino).

Purpose

The purpose of the master thesis is developing an understanding of how to implement a quality management system in an established company that rules the Russian market with its dominant market share of 80%. The thesis's aim is to create a solid implementation of Total Customer Quality Management that can guide and support the people in the organization towards better learning and development of the business. The warranty claim's will be investigated individually, and according to the KPI results the frequency of the component failures will have a priority level and simultaneously reported to the internal production line and testing laboratories to build an efficient assembly flow, final testing methods, cooperation with the sub-suppliers. Geographically tighten with the customer, collecting the data and providing it to the internal technicians with a technical language WSF use internally.

Problem definition

There are difficulties which are required to overcome when initiating this kind of project. There are needs and other aspects which require to be considered to successfully navigate through the development and implementation phase. A great part of the work has been to understand which these difficulties are and how to avoid or handle them. The research questions below have been central for the thesis's scope and they are used to shape the questions for the interviews. Starting with the main question:

- How to implement a customer quality management with key customers?

There are certainly different ways to approach the implementation of a quality management system. The main intention is to determine the existing problems in the scope of several next questions.

- Are there any specific matters to be considered to be important for monitoring the quality of the products supplied to the customer. To perform the implementation in a successful manner it would be supportive to know the warranty terms and the affect

on operating cost to enhance customer quality management's contribution to the business model.

- What is generally needed to consider when developing and implementing a quality system? Since there are different quality system standards, would anyone be better for this project, why the next question is stated.
- Is the integration of customer quality with production quality and supplier quality organized efficiently and the contact between them implemented in a flexible way?

The matter to have an influence on cost cutting activities is the most important goal to reach inside this project. WSF Brescia has been facing to several non-conformity issues for the last couple of months in which the real root cause was unclear, for example with the sensors of the rails supplied to the Russian market, C332A type of reducers have been returning from the field with an unknown reason. Furthermore, the role of Customer Quality position is not defined precisely inside the company and the CQE has not a direct shift to intervene the ongoing processes while CQE always needs to contact with the responsible staff to ask an authorization to join the collaboration. This means the CQE must looks for the availability of others and this causes inconvenient waiting time during the process.

Delimitations

The main limits are contacting time with the subcontractors and intervention to the monitoring of outsourced components. The components produced internally are easily analysed to find the root cause and contamination action, while the outsourced parts must be claimed to the subcontractors or the companies in the alliance. Of course, the quality standards appropriate the procedure of supplying from one company to another one, and also the internal production process is also run with specific standards in each plant. Nevertheless, still there is an uncertainty in component conformity level due to the resources exploited during the final inspections. The master thesis aim to answer the questions defined in the problem analysis. Other side tracks can be seen as supportive research for the main problem. A quality manual should be a living document which is updated and maintained over time. The warranty claims on outsourced components are very unclear, and the problem cases are observed by mailing and waiting for the technical response of series of responsible stuff of each individual company. WSF Italia SRL has a lot of strategic important customers and the big share belong to the Russian market. So, the most significant obstacle to monitor and finding the proof that

we are exactly responsible for the issue, is distance and availability of WSF stuff to go and check physically in a short periodic time. The production shall be outsourced, that is known. Therefore will the production process be left out from the scoop. There are also other processes which are not considered yet in the development since the recommendations are to focus on a few processes.

Westport Fuel Systems Italia SRL

The master thesis has been collaboration between Politecnico di Torino and a company named Westport Fuel Systems Italia SRL. WSF Italia SRL is an established company and has a leading market share in Russian Auto vehicle Market, operates in CNG and GPL fuel equipment industry, and was founded in Canada, Westport, in 1995. The main objective is to develop and market their products which primary focus on the Russian market but intend to target the European and Asian market as well. At Westport Fuel Systems, we are driving innovation to power a cleaner tomorrow. They are inventors, engineers, manufacturers and suppliers of advanced clean-burning fuel systems and components that can change the way the world moves. Their technology delivers performance, fuel efficiency and environmental benefits to address the challenges of global climate change and urban air quality. Headquartered in Vancouver, Canada, the company serves our customers in more than 70 countries with leading global transportation brands. Powerful trends in greenhouse gas ("GHG") emission reduction regulations have created a compelling opportunity for gaseous-fuel product solutions powered by natural gas, propane, renewable natural gas, and hydrogen. With our strategic partners, we are turning our business plan into reality. We share a common objective: to create clean transportation solutions that meet existing and future emissions regulations and targets for GHG reduction. We have more than 50 years of experience in delivering innovative alternative fuel products. Our proprietary technologies deliver the performance, fuel efficiency and environmental benefits to address the challenges of global climate change and urban air quality. And our vast intellectual property portfolio gives us a competitive advantage to think ahead and drive innovation. From components to fully integrated systems, we offer a wide range of products and services for alternative fuel solutions powered by natural gas, propane, renewable natural gas, and hydrogen. Our breadth of reach spans from passenger vehicles to heavy-duty trucks, light-duty auto vehicles, and our ability to license our intellectual property portfolio. Through the Westport Fuel Systems family of brands

and a leading distribution network, we serve our customers in more than 70 countries, including the world's largest and fastest growing markets.

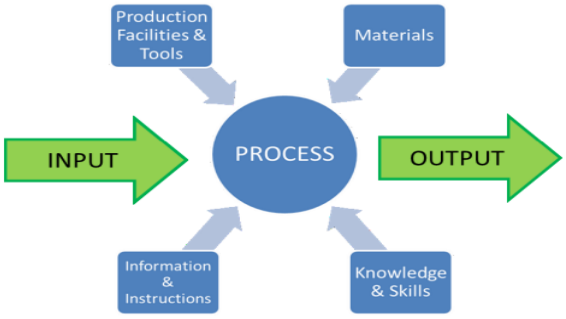

Figure 1. The process modelling

To get the type approval, it is necessary the company can show how they in a structured manner developed the vehicle and have conformance to the approved vehicle type for every single vehicle manufactured. A well-structured quality management system supports the product development, product design process, procurement and production of the product.

Method

The method chapter describes how the project was performed; presenting a plan, literature studies, interview method and workshops. The project was held to the main plan to approach the problem. As time proceeded, iterations have been made to adapt new findings and insights. The last section is reflection which gives input to the recommendations and further work. Figure 1 below shall illustrate the thesis work procedure.

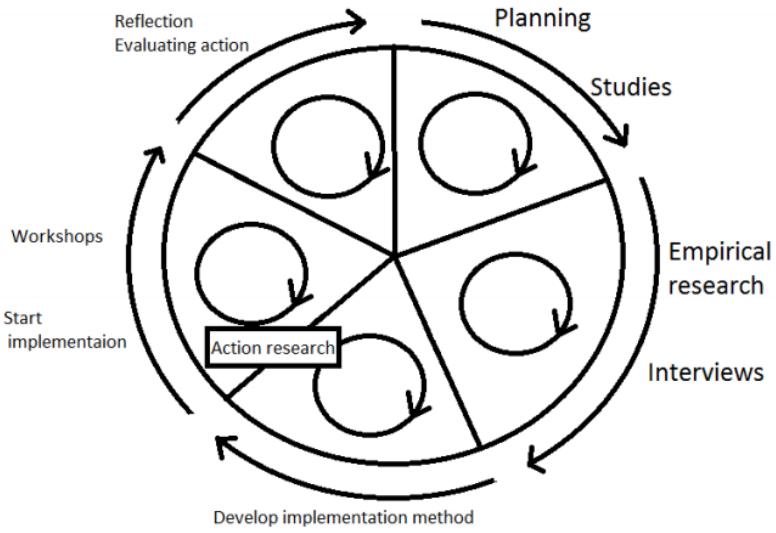

Figure 2. The methodology cycle to make a research and implementation.

Figure 2 Illustration of the method's activities in a circular arrangement, starting at the top. Each circle inside each section illustrate an iterative action

Action research at the company

Action research is a good approach for problem solving when the research questions relate to understanding a series of actions. By taking action and directly experience the research environment can the problematic situation be resolved from one's own, known, point of view. Action research creates understanding of changes of processes and stimulates for improvements and learning. Participation in forums like workshops creates interaction between the participants i.e. the employees. Knowledge and reflections are shared which stimulate the learning process. Each workshop session is an opportunity to learn and gain insights, for all participants. The different participants focus on different things due to different interest and the participants contribute with different aspects which contribute to the system view. The results of the workshops in the action research have created a foundation for the coming work. The

knowledge developed in part 1 is the foundation for moving into the next step, part 2. The learned and developed understanding has resulted in recommendations which can be illustrated as a catalyst or support for taking next step into part 2. Figure 3 illustrate the situation

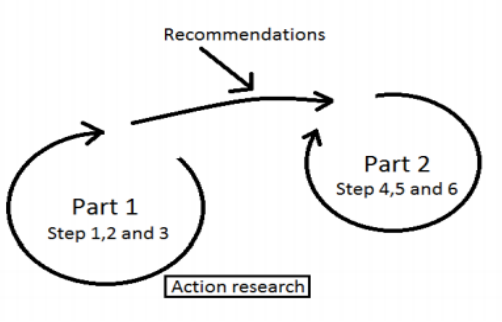

Figure 3. An overall implementation plan with part 1 and 2

The steps in part 1 are described in the action research chapter and the steps in part 2 are included in the recommendation chapter.

A part of the action research was also to start up the draft for the quality manual. It is based on the organizations capabilities and shall be a support in the company's further implementation of a quality management system. It holds documents of what is done today and suggestions of what should be done. The quality manual should be seen a proposal of one way to work.

Planning

Planning was naturally one of the first steps in the project as well as it is a continuous process during the whole project. In the beginning was a rough plan made with some early to-do-tasks taken from brainstorming session and input from the management at WSF Brescia and the supervisor. It was important to get early an overview of the topic and to set up the problem definition for the project. Since an implementation work can be very extensive it is also important to set up and define the delimitations for the amount of work and to plan a completion of the project. The delimitations are described in the introduction chapter. The different activities were overlapping each other. The included steps were; planning and literature studies, interviews, development and start the implementation. That was a quite rough plan. Each part was more detailed when it was in action. There is a lot of material available about quality management and standards like the ISO 9000 series which have been useful for a basic understanding of the concept of quality management system. It shall be

pointed out the focus has been on the own management system. It is often most risky to look at the standards requirements to fill the gap too early. That is why the requirements for any standard not have been highly prioritized in the thesis work. Most of the search for literature has been made on the database of the lectures of Politecnico di Torino and in company library. The first interview with product developments responsible staff Giulia Bianchi in the field management systems gave basic understanding and an introduction to the management role. Much of the instructor's ideas and opinions have followed the thinking as the project progressed and influenced the planning. The project got influences due to their approach which has been useful. Scanning for partner companies in similar situation as WSF Brescia who can give input to the project was also a part of this phase. The search was primary focusing on connection of these partner companies with special employees who concentrate on product exchange and its quality matter. The purpose of getting in contact with other companies was of cause to be able to benchmark how this kind of project can be performed and get inspiration. The idea was to get answers to the questions stated in the problem definition. Then, obviously the stage of the planning will shift to the implementation the core point of the project that will be a geographically specialized Customer Quality Engineer.

Interviews – an empirical research

The approach for making interviews has been dependent on who has been interviewed. All interviews have been semi-structured with focus on a couple of questions derived from the problem definition. There are two categories; quality stuff and R&D laboratory technicians, the roles will be explained later briefly. It has been very similar questions in all interviews but with minor modifications depending on the interviewed person. Some questions to the colleagues would not have been as relevant at company visits and vice versa. Instead could the question be changed to be relevant in another perspective e.g. the colleague was asked when companies tend to contact them and then was the companies asked if they hired any consultant for advice. The first interviews were more organized than the later ones which sometimes got into a discussion characteristic where both parts expressed their view of the questions in focus. The positive aspects are that the interviewer who wants to learn and be taught can ventilate his or her ideas and interpretation whereas the conversation gets more interesting for both parts. It is also good to ensure the meaning is understood. On the other hand is there a risk of missing information if the words are put in the mouth of the

interviewee. The interviews had a qualitative rather than quantitative approach since they needed to give an understanding with input from different experts. All interviews were quite short but very well prepared, between 30 minutes and one hour, seeking for subjective answers and had no multiple choices questions. The interviews contain information which will not be presented in the main report due to it is not necessary information for the project. The project is very much based on the problem detecting and the information given from the interviews. The result from the interviews is in line with and verifies the literature studies and theory. The interviewed professional consultants had overall a quite similar view of how the challenge could be approached. In general they all advocated the process view and gave the advice to keep the documentation user friendly which means keep down the amount of text and keep all documents at an easy and understandable level. Too often does it become too complicated and then it is very common the only thing the documents become is a bookshelf product of no use. This recommendation has been kept in mind through the entire project. The interviews with the companies' internal engineers who are in charge with the production and make design of the product had a little bit of another characteristic. The companies staff interviewed were all in the production business. One company produces dental implants, another with positioning systems for internal human organs and a third company produces synthetic bone material for implant applications. The production and supply method of WSF Brescia is specialized to the customer specifications. Even the target market is divided for several geography like Europe, India, China and Russian. That is the reason for dividing the customer quality management to two direction, in this project I also try to be concentrated mostly to Russian market, since I speak Russian and I know Russian business sphere's working culture. In fact Russian OEM is considered a strategic partner for WSF Brescia's business model. So, the main scope of the thesis intends to highlight the client issue and QMS with Russian several companies operating in automotive industry.

Develop an implementation method

Since the internship practiced was an opportunity to see how the system works and challenging with workshops, eventually the same approach been used in this project. The steps to work with the customer were planned to be held in a sequence starting with an introduction workshop and followed with active sessions which made a base for the findings and implemented routines. As planned the workshops were related to each other. The idea was

to give understanding in a first workshop and then practice in the following and finally to find a routine to organize an efficient working cycle with the customer issues. The claim analysis made up a journey starting tracking the data and registering the new claims from the customers to a start-up of the implementation, which is called part 1 in the action research. Part 1 is logically followed by part 2. With experience and learning from part 1 should WSF Italia be able to manage part 2 which is planned to be performed by the employees themselves. Part 2 is mainly a recommendation since it explains how WSF Italia could continue the work.

Reflection about method

The method is applicable for this kind of already established environment and the circumstances. The first two sections in the method cycle has of course been a base for the project which are quite fundamental for the research and development of the knowledge. Planning is important for visualizing and it gives an overall picture of what is required. The literature studies and the interviews are vital for the understanding and possibility to develop the implementation method and its activities. One can argue the development phase is the planning of transferring the previously gained knowledge into the company, which is actively executed in the next section. Being active at site has therefore been needed for the thesis to understand the activities in the company. To understand the processes it is very relevant to see and study for yourself where the activities are performed. A less successful method could be analyzing the current state and propose a new solution without involving the concerned employees. It is probably not prosperous in the long run since it gives less chance of engagement and further commitment. Therefore the workshop approach has been good since it engages everybody to valuable group discussions from which the group learn and get insights. When visualizing the company situation, it provides a useful base for discussion and reasoning. It has also been an education of e.g. process mapping which is useful in the coming work. The last section, reflection, is in practice the report writing. It is during this time the overall picture is summarized and thought of as its whole. It is now easier to look back and see the consequences of the acting (or nonacting if you like). It is now the knowledge and experiences really root in me. The intention has been to communicate this reflection approach to the people I worked with during this journey. Writing reports can be very good for the reflection process since one is forced to think about occurred activities.

Overall, I think the reflection part is important and is easily missed. Reflecting while you are in the middle of a process is easily forgotten. Just stopping for a while and think of what is happening in the big picture can be helpful. I could have missed that within the sections which are criticism to me regarding the actualization of the method. So what have I learned as a researcher and student from this project? I have got experience of doing a reality based project in a very special environment. The experience of working in a big company was new for me and might not be offered again. I got understanding in the OEM automotive business problematic with partner companies who installs our products to the vehicles and they are a general industry who designs and WSF Brescia must follow the specifications of the vehicles to develop its own product as well as rooted knowledge in quality management, all by learning by doing. Personally, the experience of having own responsibility for the project has been very meaningful for me. By working on my own I have now got a better understanding of how to drive changes since I practiced it. It was discovered that the engagement and demand from the internal customers is vital for progress in the process development. Resources are needed in form of the concerned employees to design their processes. These people need to be involved in the development. It becomes more difficult to establish new routines if there is lack of commitment of the improvement work and no ownership of the change. Commitment and understanding is increased with participation from the involved people. I have therefore seen myself as some kind of intermediate actor who guided the employees to awareness. Some sessions have my role got the organization characteristic for example when discussing drawings with the team called my me. My job was then to facilitate the discussion to find a structured manner to solve the claims immediately to give a support to sales department. Being at the office, in the environment and researching on site has been beneficial. It has enable to see behaviours and problems the environment creates, it has been motivating and provided the social 8 connections. Being part of a group of people who works towards a common goal is motivating for me. The personal interaction with the employees at WSF Brescia would probably not have been as intensive if the master thesis project had included another person as well. It would not create the same bonds which are important for a good collaboration. What is even more interesting and important is the attendance of a “quality manager” at the site. According to the Quality managers, it had an effect on the employees at the company. My attendance at the office was unconsciously reminding the employees of the importance of working with business development and process improvements. It has led to awareness of process development. I think the base for further development of the business is the awareness and

understanding of the importance of quality management. Without a person dedicated to these issues, awareness and knowledge among the personnel are important in order to not ignore the focused improvement work.

When I reflect on what the company could have done for me I realize even more that I am the kind of person who needs deadlines and pressure from my environment to work more efficiently. That is an insight on my own personality. A more detailed plan could with more sub goals could have been effective to follow up the projects progress and also create pressure in the organization.

Scrum methodology Agile methodology

As in many other sectors, technology is causing massive market disruption in the automotive industry. Nowadays, in-vehicle connectivity, autonomous driving, electric cars, and car-sharing are transforming the sole definition of a vehicle.
While the determining factor for car purchase used to be the driving experience, today, people no longer see cars only as a mode of travel. Consumers view vehicles increasingly as "smartphones on wheels", and the in-vehicle experience is now the major factor influencing purchase decisions. The modern car is expected to be autonomous, electrified, eco-friendly, connected, and offer services like networked parking, over-the-air-updates, and cybersecurity.
Original Equipment Manufacturers (OEMs) face a series of challenges in this new and dynamic market situation. The fast-changing consumer demands are putting automotive companies under increasing pressure to innovate faster.
Automotive companies need to shorten the production cycle to ensure their innovations are still up-to-date when the new model reaches the market. The ability to continuously learn and adapt to changes quickly is becoming critical for automotive companies' survival.

How can Agile help Automotive Companies?

Compared to traditional waterfall-based approaches, the Agile way is highly iterative and encourages delivery in smaller batches. The main focus lies in the frequent delivery of customer value and a quicker response to changing conditions. So, in the new era of car manufacturing, it is no wonder we are witnessing Agile's application in the automotive industry more and more often.

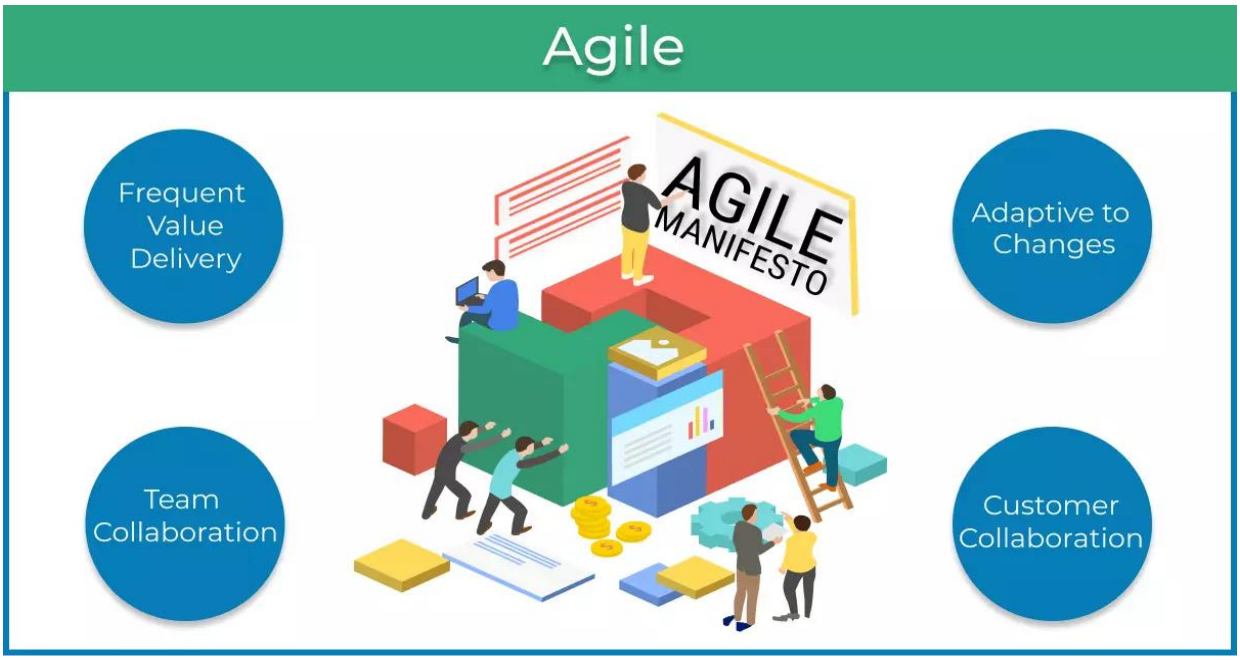

Figure 4. Agile Quality Content

Better Products Through Customer Collaboration and Faster Feedback Loops

Our main customers are already stated that they are OEM and some aftermarket manufacturers. Customers are expecting more from the products than ever before. From efficiency to performance to connectivity - automotive companies must make sure they are understanding correctly what potential buyers find valuable and what drives their purchase decision.

To put Agile in the picture - some of the main principles of the approach put forward customer collaboration and faster feedback loops. Agile companies continuously engage with their customers to gather feedback early in the process and to recognize changing market forces as they emerge. The CQE is an intermediate resource who transmits the feedback from customer point view to the internal engineering team, the agility here even implemented on collaboration with an internal R&D laboratory team to find the root causes of the non conformity and work on it to prevent from happening again in terms of warranty.

Further on, they use prototypes and MVPs to validate assumptions about how the product can meet customer needs.

An excellent example to illustrate the importance of customer collaboration during product development is this quote from Anne Sandberg, Head of Continuous Improvement & Change at Product Creation, Volvo Cars:

Collecting such learning during the product development cycle allows faster product improvements and results in increased product quality and managing the warranty claims and following the budget to prevent from lost due to non conformity that might be not the fault of the company.

Decrease Time to Market and Handle Complexity Through Cross-Functional Teams

A cross-functional team is a group of people with different functional expertise, collaborating towards a common goal. What we typically see in traditional work structures is the separate siloes competing for resources. There are also a lot of hand-offs, miscommunication, and eventually delays.

Contrary to that, introducing a cross-functional team structure stimulates collaboration between the team members with different expertise, reduces the number of hand-offs, and enhances communication. Further on, the diverse groups are also more flexible, enabling them to share knowledge and solve problems faster. Focused on how to best use the available resources together, cross-functional teams automatically decrease the time to market of their products.

An example from the practices shows that reorganizing employees into product-focused, Agile teams can accelerate development cycles by 40% and improve engineering and capital efficiency by 25%.

Another benefit of cross-functional teams is better coordination across functional areas. With vehicles becoming a complex mix between AI, mechanics, software, and cutting-edge design, having different functional areas collaborating with each is an effective way to manage complexity. Bringing diverse expertise together also opens the doors for innovation and better utilization of already developed functionalities, ensuring further competitive advantages.

What are the roles of Quality Assurance in Agile?

As mentioned before, QA has a wide variety of new roles and responsibilities in the Agile development and project management. These roles are not assigned to QA members by anyone. Instead, everyone does a bit of everything, in order to contribute to the greater good, i.e., the successful completion of a project in every sense.

Simply put, if you're wondering where do QA members fit in, the answer is in the entire process. In other words, QA members are not just responsible for writing test cases and deploying flexible test methodologies to detect the root causes. In fact, the scope of their role goes far beyond that. Therefore, here are a few examples of QA roles and responsibilities in the Agile project management.

- Analyzing inputs from clients, stakeholders, end-users and everyone else involved in the project.
- Revising user stories, such as requirement generation, out of scope stories, missing stories, etc.
- Consulting on functionality aspects with the developers.
- Viewing the product from both user and client point of view.
- Building automated test cases, regression testing and acceptance criteria.
- Consulting on sprint development, duration, requirement development, especially in Scrum Project management
- Ensuring that functionality features do not impact other features in a negative way.
- Minimize and mitigate risks.

With Agile, the project delivery will include iterations, combined with close and frequent customer collaboration.

Figure 5. Agility Attributes

An effective method for Agile project management in R&D departments is Kanban. Famous for its visual character, Kanban is an evolutionary process focused on incremental changes on the path to agility. The teams visualize their project workflow and work items on Kanban boards to ensure a high level of transparency and alignment. By segmenting the boards to match their specific workflow, teams also unhide bottlenecks and easily discover weak spots

in the work process. Optimizing those allows them to increase their efficiency and operational capacity.

Additionally, Agile project management is highly focused on continuous improvement. By integrating feedback loops, Agile teams can reflect on what they have produced so far and seek ways to improve collaboratively. As a result, they can quickly refine their product.
All this will enable automotive R&D departments to reduce project risk and increase the likelihood of meeting customer's expectations.

What to Watch Out For on The Path to Agility

The automotive industry is a very traditional industry that has been cultivating a sequential product development approach for the past 100 years. To move away from that will be one of the biggest challenges on the path to agility auto vehicle part companies will face.
Next to that, the industry is defined by strict calendar cycles and long supply-chains, that the new methods will have to find a way to respect. However, there are already numerous examples that applying Agile in the automotive industry can do miracles, so it should not be a question of "if" to adopt Agile, but "how".
Before jumping to restructuring and transforming current ways of working, an important step is to evaluate the company's current state. The goal should be to identify business challenges and look for the root causes of inefficient processes. These insights can then be used to set priorities and goals for the Agile transformation. Without alignment around the objectives of the transformation, any results are doomed to look unsatisfying.
Typically, Agile movements tend to be bottom-up directed. However, the support of the company leaders is crucial for scaling Agile across the organization. Without a substantial buy-in from the top management, the new working methods will be either short-lived or will stay isolated in individual departments.
How to manage the transformation is also a crucial strategic decision. Organizations with less Agile experience should go stepwise and "by the book" at first. A few pilots in individual units can achieve quick wins and showcase the approach's benefits, creating excitement around its implementation.
Once a certain level of maturity is reached, embarking on a full Agile transformation becomes much easier.
Given the fact that there are multiple understanding of quality and quality systems , different strategies for quality tools emerged as well. When it comes to classifying the quality tools

available today, there are several approaches to the topic, a fundamental one covering “The Seven Basic Tools of Quality” also known as 7 QC Tools. The 7 QC Tools developed in Japan in the 1950’s by Kaoru Ishikawa when the country was undergoing some major revolution in the field of quality and it was inspired by seven well known weapons of Benkei. The tools are often referred to as The Seven Basic Tools of Quality because they can be implemented by any person with basic training in statistics and can be applied to solve complex quality related problems. They include: The Pareto Chart, Histogram, Process Flow Diagram, Control Charts, Scatter Diagram, Check Sheets and Cause and Effect Diagram . Carpinetti argued that the most important techniques are: Quality Function Deployment (QFD), Failure Mode and Effect Analysis (FMEA), Six Sigma, 5S, Design of Experiments (DoE) and Statistical Process Control (SPC). After 1977, The Union of Japanese Scientists and Engineers (JUSE) appreciated the following tools and techniques to be the most essential for quality improvement: The Affinity Diagram, The Relations Diagram, The Matrix Diagram, Tree Diagram, Arrow Diagram, Decisions Diagram and The Factorial Analysis of Data. There are those who debate on classifying quality tools according to the type of inputs they require into: qualitative tools such as: Flow charts, Cause and effect diagrams, Multi- voting, Affinity diagram, Process action teams, Brainstorming, Election grids, Task lists etc. and quantitative tools such as Shewart cycle, Control charts, Scatter diagrams, Pareto charts, Sampling, Run charts, Histograms. Another perspective of classifying the quality tools focuses on the reactive, proactive approach, dividing the quality tools in: Reactive tools - Graphics, Histograms, Checklists, Pareto diagram, Brainstorming, Election Grids, Solutions matrix, and Proactive tools - Relations, Affinity, Tree, Matrix, Alternative, Arrow diagrams, Principal components analysis. When it comes to the evolution of the Agile approach, it can be said that it underwent some significant changes and stages in its development. Studies such as those of Abrahamsson, Highsmith and Cohen focus on the aspect of Agile developing as a reactive response to the outdated traditional project management methods. Unfortunately, this approach considers Agile to have appeared only in the last couple of years but the agile ideas have been around for longer than that. In their paper, Larman and Basili noted the usage of iterative and incremental approaches since the 1970’s. In his paper, Beck suggested that the Waterfall model was first developed to help asses and define user needs by noting the user requirements. The Waterfall model tried to fix the problem of changing requirements by establishing well defined requirements and not allowing any changes to be made to it, but as practitioners observed, the requirements just couldn’t be well defined in one swoop. Incremental and iterative techniques evolved as a response to the rigidity of the user

requirements, and tried to improve upon the Waterfall model by keeping the main aspects of it but introducing the notion of overlapping increments to help reduce the development time. Now, the requirements are also noted before the development stage begins, but they are broken into chunks of standalone functionality known as increments. The development of each such increment can be overlapped with the others, creating a "multitasking" effect and saving time. And while the MATEC Web of Conferences 121, 05003 (2017) DOI: 10.1051/matecconf/20171210 MSE 2017 5003 2 incremental development aimed to reduce the allocated development time, there are models that provide better handling capabilities for changing requirements and risk management. In the table below, we have outlined the main aspects and differences between the traditional approach towards project management and quality and the agile approach to these aspects.

Key aspect of traditional project management approaches and agile development

Traditional project management tools	**Agile project management tools**
Rigid. Team members must adapt	Flexible. Can adapt to team members
Abstract	Visual and intuitive
Works best with large teams	Works best with small and medium teams
Reporting is an element of major importance	Constant feedback is important
Works best with teams that share a work Space	Can adapt to remote teams
Interest in the final result	Interest in each sprint release
Well established quarterly/semester/annual Meetings	Daily meetings
Schedules a series of events	Schedules releases and product versioning
Works with critical path calculations	Works with burn down charts
Formal management structure	Informal management structure
Dependencies between tasks can be dealt with on the go	Dependencies between tasks must be dealt with as soon as possible as they directly affect product releases

Quality within	
Traditional Quality Management	**Agile development**
Focused on delivering project objectives	Focused on constant improvement of delivered products
Adapts to established requirements	Adapts to customer changing demands
Comprehensive documentations is mandatory	Working software is more important than documentation
Progress is monitored through reports and periodical meetings	Progress is monitored through daily meetings and results
Defines working products criteria	Works with user stories
Reactive response to change	Proactive response to change
Sustainable development	Sustainable development
Complex solutions	Simplicity is essential
Considers that best decisions are made by professionals	Allows teams to self-organize and gives freedom to team members in choosing architecture, requirements and design
Gives power to team leader	Gives power to team members

Theory

In this chapter, the theory behind the project work presented. It is based on the studied theory, with much influence from the advices and recommendations from the interviews with a group of experienced personal of the company. The theory consists of studies of quality management including important factors for a successful development and implementation of quality management systems.

The cornerstones for Total Quality Management

According to the theory of total quality management (TQM), there are core values which are essential to successfully make up a foundation for the quality work as well as for managing changes in organizations. The most important aspect is the committed leadership to the quality issues. It cannot be emphasized how important committed leadership is to create culture for successful and sustainable quality improvements. Managers should create commitment and engagement from the people at all levels in the company by being credible, clear and good at communicating. The management should show interest in and support activities regarding quality. The top management should by acting be a role. On top of that fundamental base are the important values; focus on the customers, base decisions on fact, focus on processes, improve continuously and let everybody be committed. It is important that the organizations culture is formulated by these six values and that they can interrelate to each other. It is also important the management is well aware of and have the right mindset about quality management. It is an ongoing process in itself which shall be improved over time, not a one-time project. Consequently, the team in charge with the customer should not forget that there are some very delicate cases which is not covered by the standards of the technical response to the claims, but needs some unofficial way to solve. This could be either directly talking with the customer procurement engineers to discuss the situation, kindly ask to provide some measurements and reports to use for the further analysis, but of course by giving a reasonable motive to spend that effort by the partner engineers.

The figure 6 below illustrates the relationship between the important values, the cornerstones.

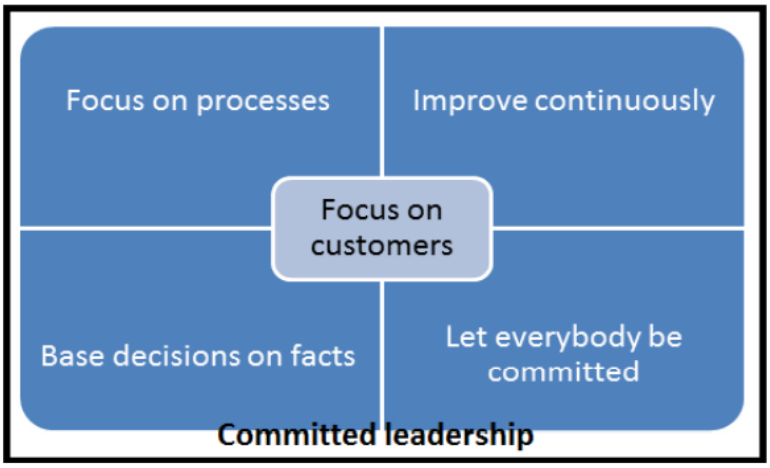

Figure 6. The principles of customer focus

Focus on customers means that their needs and expectations are important input to your business and to be able to process that input into something valuable for the customer. Basically, the task is to find out these needs and expectations of the customer and then systematically fulfil these needs when developing and manufacturing the product. From the economic point of view, the high level of collaboration with the customers is a matter to add more value to the product portfolio and giving assurance of supply quality to the customer procurement engineers. This is nowadays often expressed in customized products in various product areas. Customers can be divided into several groups geographical and supplied product type, business model type. If the focus is mainly on the external ones it is easy to forget the internal customers, the employees. With a process view shall the upstream actor satisfy its specified customer with high quality products so the (specific) customer can focus on fulfil their own task. The employee has need which is required to be satisfied in order to do a good job. Providing the employees with better opportunities to do a good job and make them feel proud of their work will create a breeding ground for satisfied external customers in the long run. Base your decisions on facts. To get reliability towards others it is decisive to be able to show the work which is supporting your decisions. Do relevant research, gather information from relevant stakeholders and use the information to do the right improvements. Since time to market needs to be shorter and the lifecycles of new products are generally shortened it is vital to present a product with conformance to the requirements as early as possible. Basing the decisions on analysis of facts and not on guts feeling shall therefore increase the chance to be successful. A process is an organized repeatable action whose objective is to create value for a customer, all specific customers,

namely OEM, HDI, aftermarket. A process transforms certain inputs, such as information and material into some kind of output like a service or goods. The purpose of the process is to get as high quality result as possible out from the resources, the input. It is important to understand your processes, knowing the supplier of resources and have clear signals about what is needed in the processes, to minimize resources and to satisfy customers.

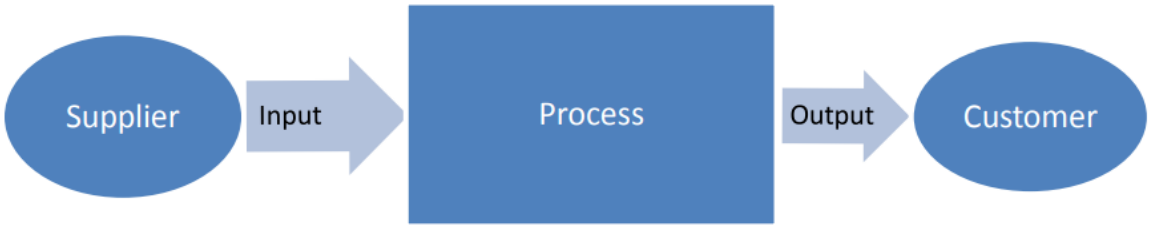

Figure 6. Illustration of process definition

Process: "Sequence of interdependent and linked procedures which, at every stage, consume one or more resources (employee, time, energy, machines, money) to convert inputs (data, material, parts, etc.) into outputs. These outputs then serve as inputs for the next stage until a known goal or end result is reached." The process view is the best approach when working with a management system. Understanding the concept of processes can give a good platform to take off from. Start to define the business' main structure and be open minded to change it if it does not correspond to the company's situation. The company creates its own logic of processes which each one have their specific output. It is however important to have the right focus. It is easy to bring the requirements (for certification) too much attention and not look to the needs of a management system.

Processes are often categorized into three different types. These are main processes (also known as operative processes or core processes), support processes and management processes.

- Main processes, has the main task to fulfil the needs of the external customers and to improve (add value to) the products provided by the organization. Examples are product development and sales

- Support processes have been fulfilled by the customer quality engineer to keep in touch with the customer representatives. These processes shall provide resources and support to the main processes. Examples are maintenance versus tracking the non-conformity cases and information processes on warranty claims.

- Management processes whose purpose is to make decisions on the targets and strategies of the organization, implement improvements in other organizational processes. Management processes have, as well as support processes to all stakeholders involved in this business model. Examples of processes can be strategic planning and auditing.

Improvement continuously is an important element in a successful quality strategy. Stop improving means there is no positive changes which soon lead to being less successful. In TQM is the PDCA cycle (plan-do-check-act) a central concept for the improvement work, as well as in the ISO9000 standard. The basic rule for continuous improvement is that it is always possible to improve processes, products or services in a way the input resources is reduced, quality of output is increased or cost is lowered. The challenge is to find the right way to change to improve. Another vital aspect is the mind-set that everything can be improved; get a better match of customers' needs with fewer resources. Consequently, the role customer quality is not only giving support to the internal activities and collaborating with customer engineers but also participating in technical decisions that are important for sales department. This could be seen in cost cutting activities to business unit development.

The Japanese call it "Kaizen", which means 'good changes' which equals improvement work. All interviewed persons describe how they do their improvement work in workshops. A couple of persons involved in the process meet under organized circumstances and discuss possible actions to improve the process or business. This is the situation which is formulated immediately when the claim comes with an urgent status and a specific caution. The customer quality engineer in that case organizes a team meeting with the responsible internal engineers and external suppliers to discuss the issue and finding a root cause. In accordance the root cause, automatically the containment action comes to be implemented, all these steps relatively with the definition will be written in 8D technical report. Of course, here the matter of availability of responsibiles can arise, so, the solution of an organization is discussed below.

Together people can be stimulated to bring forward new ideas and get feedback on those from co-workers. Often is there a purpose to share; visions, mental models, knowledge (information) between each other. The outcome can then be a more effective organization with understanding for each other's work and better system thinking. Workshop can be defined as: training class or seminar in which the participants work individually and/or in groups to solve actual work related tasks to gain hands-on experience.

Westport Fuel Systems Italia S.r.l.

8D REPORT

tbd	YY-XX

ACCEPTED ☐ REFUSED ☐

Customer	Customer Contact	Concern Title	Open Date	Status Date
			(DD-MM-YYYY)	(DD-MM-YYYY)
Customer Claim Code/Nr.			Safety Related ? ☐	

Product Type	Part Name	Drawing Level

WFS Italia pn	Customer pn	Batch nr/ Production Date

1 Team

Role	Name	Department
Champion		
Team member		
Team member		
Team member		

2 Problem Description (Voice Of Customer)

3 Containment Action(s)	Responsible	% Effect	Implementation Date
			(DD-MM-YYYY)

4 Root Cause(s)	% Contribution
4A. OCCURENCE (Why did it occur?)	

4B. NO DETECTION (Why wasn't it detected?)

5 Chosen Permanent Corrective Action(s)	**Responsible**		**% Effect**	**Date**
				(DD-MM-YYYY)
6 Implemented Permanent Corrective Action(s)	**Responsible**		**Efficiency Verification**	**Date**
				(DD-MM-YYYY)
7 Action(s) to Prevent Recurrence				**Implementation Date**
				(DD-MM-YYYY)

Documentation updated	Doc. name/code	Responsible	Remarks
DFMEA			
PFMEA			
Control Plan			
Procedures / Instructions			
Standards / Specifications			
Other			

8 Review & Approval (Team)	**Close Date**	**Reported By**	**Department**	**Phone No**
	(DD-MM-YYYY)			

Let everybody be committed is about creating an environment which gives motivation and encourage employees to active participation in decision making and improvement work. Participation and commitment are achieved through delegation of responsibility and authority. Employees, who are given a chance to do a good job, feel professional pride and get feedback for well performed work will be committed to their job. This leads to improved quality of work .

A part of creating motivation for change is about showing interest in the employee. By asking the employee questions about their job, the conversation can dissolve the defensive attitude that might exist. By enlightening how to realize positive aspects of making the improvement and what is needed to avoid, the drawbacks, gives credibility to the improvement project. “There are many aspects; commitment, setting goals, measure and follow up, communication, engagement, usage of a clear method, continuous risk analysis. But the most important is the change analysis. What is positive, negative and what actions we take. It is vital to be restrictive with spreading the negative aspects, doing that can be devastating”

Related to commitment is the process ownership. The process owner is responsible for a particular process i.e. manufacturing. The ownership includes responsibility for improvement work of the process and all resources in the process, including the economic resources. The process owner should create rules, direction and framework for the operation.

Process management methodology

The importance of adapting to the process view has led to the creation of the process management philosophy and thereby also some methodologies consisting of different steps, although process management can be deployed in different ways. One methodology is presented below. Basically it is made up of four steps (Bergman, Bo; 2010)

1. Organize for improvement. Start with appointing process owners and a process improvement team. It is not necessary to appoint for every single process in the beginning since it has been shown that the focus should be on a few processes.
2. Understand the process. It is needed to understand the process before it can be improved. Define customers, suppliers, input and output (wanted result) to get knowledge about the process. Be systematic when describing the present process. Co-operation with customers and suppliers is a good way to understand their needs and the interaction in the value chain. It is a good idea to map the process in a flow

chart. In a flowchart are the different activities identified and the connection them between can be visualized. The learning and insights that are generated when mapping a process is valuable in itself. The shared visualization of the process (flow chart) make out a good foundation for improvement work since it is a good mutual reference.

3. Observe the process. Earlier behaviour of the process is used as basis for improvement. To find facts that show on an earlier behaviour it is a must to measure the process in different ways. Resource consumption, reliability and customer satisfaction (quality of output) can all be areas for improvement and should therefore be measured. Find improvement opportunities based on the data gathered.
4. Improve the process continuously. Adopting a holistic view of the organization is a central factor in process management. Therefore the improvements shall focus on;
    - quality (the capability to satisfy customers' needs and expectations),
    - efficiency (how well the processes are utilizing the resources in the organization to produce results)
    - adaptability (how well the process can be adapted to changed conditions)

Figure 7. Total Quality Management

Processes are often unnecessary complex due to all changes made over time. Try to simplify and be open-minded. (Bergman, Bo; 2010)

Process mapping

Process mapping is a central tool in the TQM. With a structural analysis of a flow of material or information can it be distinguished how work is actually done from how work should be done in three steps. Visualization of what really occurs in the flow creates a map

which shows the interconnection of the roles with each other. This mind mapping is useful to understand the flow from upstream to downstream and gives a scheme which is crucial in case of an urgent call. By very small means can another level of performance be achieved called "should be". It refers to what the organization should be able to perform without any extra means. Using the current investments software, people, equipment and processes is it possible to reach another level of performance by for example rearranging the material or information flow.

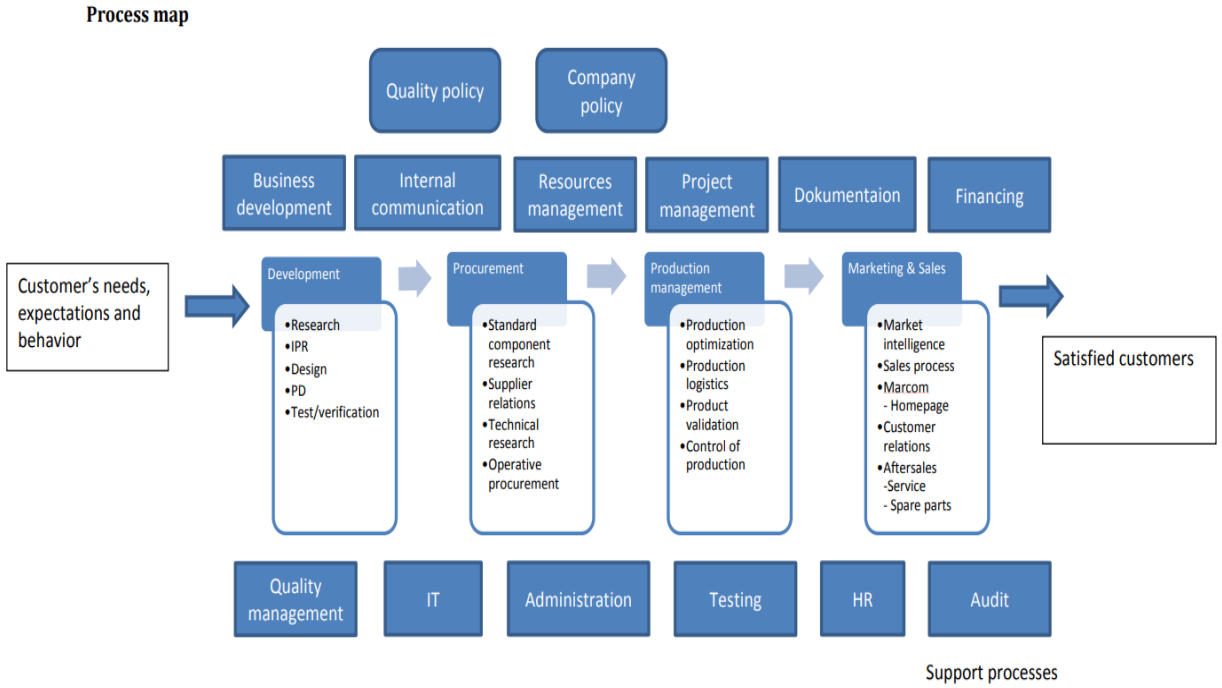

Figure 8. Process map

There is a third step called "could be" which refers to the level of performance an organization can reach by investing extra resources. "Benchmarking" is a major driver of change at this level since it is a lower risk strategy which gives both direction and an indication of goal level. Another approach is "business process reengineering", which however is a strategy with higher risk (prof Agostino Villa, Politecnico di Torino)

Once again, there are different approaches to make a process map. Flow charts can illustrate the different activities in the process. Block diagrams do also include where in the organization the activity is performed which means the operator or performer is included in the horizontal lanes, sometimes referred to as swimming lanes. A banking example illustrated in figure 5 shows how the credit checker is initiating the process, then perform step 1 and step 2. Step 2 generates a document. The supervisor takes over for step 3 and then ends the process.

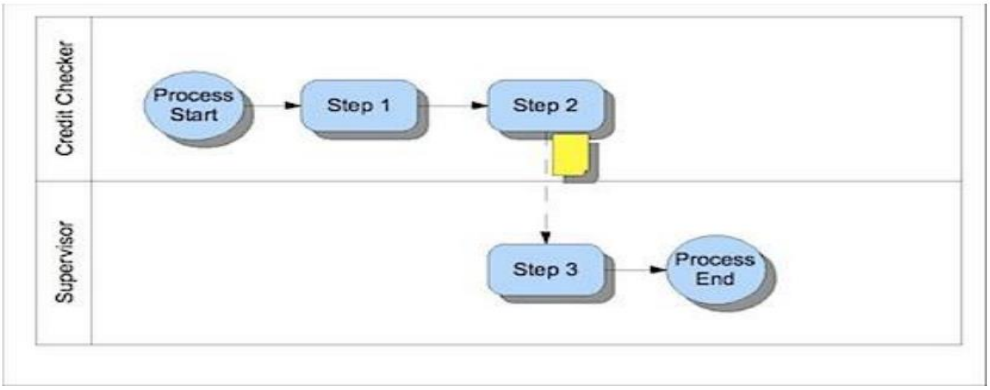

Figure 9. Process flow

Let us say it is the "circuit mapping" level of performance in the banking example in figure 5. Analyzing the process can result in opportunities for improvements. E.g. the document produced in step 2 is delivered by ordinary mail to the supervisor. Maybe if the sites were located closer to each other or another way of transporting the information can be identified could result in a shorter lead time for the process.

The concept of learning organization

Continuous learning is firmly connected to learning. To get continuous improvement as a natural feature in organizations, it is vital to create a learning organization. One definition is: "A learning organization is an organization skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights" (Bergman, Bo; Klefsjö, Bengt 2010)

The Collaborative Habit: Life Lessons for Working Together - Twyla Tharp describes how an organization shall be able to affect its surrounding in a beneficial manner, not only be affected by the surrounding. Senge describe five important elements which all need to be considered for a learning organization. These elements are; personal mastery, mental models, team learning, shared vision and system thinking.

- Personal mastery. Personal mastery is about personal development through learning and personal growth. It is the organization's responsibility to give the opportunity to its employees. The opportunity to fulfill oneself as a person. The organization is dependent on the individuals' willpower to learn but it is in the organizations interest to develop the individuals. Personal mastery is generally a matter of skills and knowledge, referring

to the ability to widen ones intellectual horizon, gather energy, develop ones patience and adopt a matter of-fact view of life.

- Mental models. Individuals interpret the surroundings in different ways. Based on our knowledge, suppositions and experiences we have different mental models. What is important is then to understand one's own mental model as well as each other's (and also the customer's). It can simplify the communication and reduce the mental gap between individuals.
- Team learning. Team learning is a skill and learning together is an ability which needs to be assimilated in good way. Sharing knowledge in the organization is important to make the information reach the operative efforts made for improving processes, products and in the end give the customers a better total experience. A high performing team can learn and develop together.
- Shared visions. A shared communicated vision shall create a feeling of belonging and desire to reach objectives. It is important the vision is not forced upon from above. A collective vision which the employees shall adapt to is not ideal.
- Visions create stimuli to new thinking and acting. With a shared vision, there is an understanding and acceptance in the group of how to complement one other.
- System thinking. In a system can an event or decision in one part of the system have impact on another part of the system. There are many interactions in a system which needs to be perceived in advance. Otherwise can system parts be sub-optimized followed by overall losses.

People can get a very strong feeling of collective purpose when they are a part of a well-functioning group. The feeling of belonging to something greater than themselves gives incentives to create and perform. Learning organization and emphasize success factors are being skilled in the following areas:

- systematic problem solving o experimentation with new approaches
- learning from their own experience and history
- learning from experiences and best practices of others
- transferring knowledge throughout the organization

Figure 10.

Intergration with customer procurement engineers and ISO 9000

When the quality is credence attribute the market for quality collapses, no matter what price consumers are willing to pay, and no matter what quality producers are willing to provide. For every customer quality is important attribute, customer are willing to pay for quality product, means if they are satisfied for particular product. So for credence attributes the solution is certification. Certification is a process whereby an unobservable quality of product is made known to the customer through some guarantee system. For example the environmental quality of goods means that product follows the natural environment throughout their life cycle and it score more related to environmental quality. In the automotive industry most of the standards have designed keeping in mind customer need and suppliers. It contains many different requirements and criteria which make pressure on suppliers. The main issues raised by them were:

- Proliferation of similar standards;
- Different requirements for documentation
- Various independent audits
- Lack of standardized terminology
- More terms for the same concept
- The same term with different meanings
- Different classification scheme

Previously, each company has established what are the expectations from the supplier‟s quality system and appropriate documentation for evaluation. Common approaches have been established then, harmonized, which took into account several issues considered key issues, which were well developed and verified for the three companies. They are:

- Quality System Requirements (QS 9000)
- Background Statistical Process Control (SPC)
- Analysis of failure modes and effects (FMEA - FMEA)
- Plan in advance of product quality and Quality Plan (APQP)
- Approval Process for production of parts (PPAP)
- Manual measurement system analysis (MSA)
- Quality System Assessment (QSA)

For developing the application of new standard the arrangement for mutual recognition principle is needed so IATF (International Automotive Task Force) was formed. These are producers of raw materials, components, parts and other services directly to original equipment manufacturers (OEMs). (Quality Engineering course, Prof Maisano)

Quality management system standards, ISO 9000 Series

A quality management system is a system by which an organization aims to reduce and eliminate nonconformance to specifications, standards and customer expectations in the most cost effective and efficient manner- (Luthra 2011)

Standard certifications are applicable to all internal and external suppliers of products or production material or service provider to the original equipment manufacturer (OEM). The standards reflect the automobile sectors interpretation. The eight clauses such as scope, application, terms and definitions, QMS, Management responsibility, resource management, product realization and monitoring and measurement. ISO/TS 16949:2002 highlight the importance of crossfunctional activities as can be seen from the requirement :

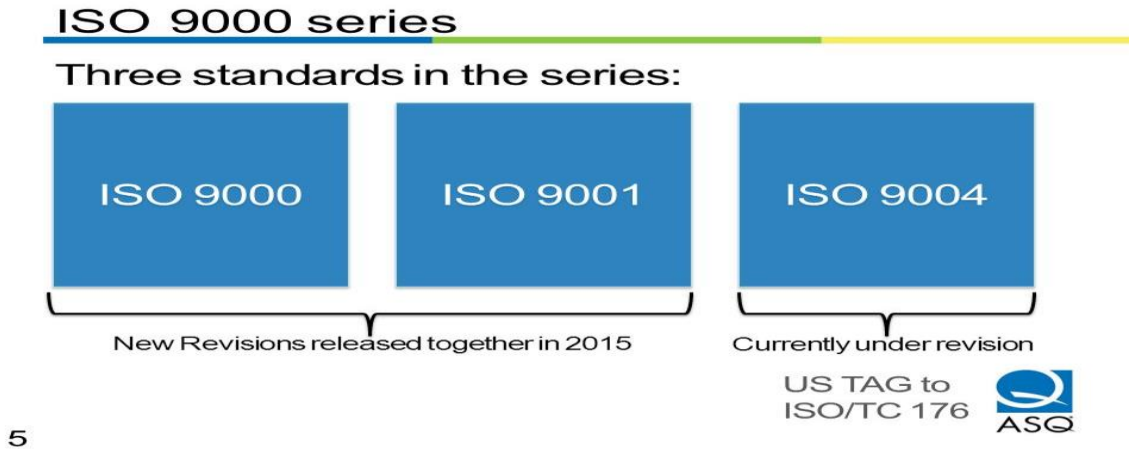

Figure 11. ISO series

- A process-oriented quality system
- Control plan for processes producing bulk materials
- Analysis of field failures
- Continual improvement
- Emphasizing defect prevention, reduction of variation & waste in the supply chain
- Customer satisfaction requirements
- Preventive action process
- Improved employee training requirements
- Communication with suppliers and customers to assure quality
- Improve employee quality responsibility
- Employee competence
- Awareness and training
- Design and development
- Production and service provisions
- Control of monitoring and measuring devices

Organizations should implement QMS system that can provide substantial benefits while maintaining consistent compliance with legislative and regulatory requirements. Economics being a key factor, the entire cost of implementation can be recovered in less than three years as evinced by the length of time that ISO 9000 and QS-9000 have been in place. (Quality Management course)

The requirements for the quality system

There are requirements of what the quality management system shall consider in order to be certified according to the standard. Those requirements are specified in ISO 9001 and are the part of the series which cover processes but does not include any requirements on the products of the organization. It is the customers who have requirements on the product. Table 1 present the required areas and a short explanation of each. The four main areas are management responsibility, resource management, product realization and the fourth is management, analysis and improvement.

Table 1 Requirements of ISO9001:2015 standard

Area requirement	Explanation
Managements responsibility	

management commitment	Demands on commitment to the QMS's improvement and development. Also demands on communication to the organization
customer focus	Needs and expectations of the customers are identified and must be met for customer satisfaction
quality policy	Establish a quality policy and objectives
planning	Plan the resources needed to meet the established goals.
management review	The routine for the internal audit to make sure it is appropriate and meet its purpose
responsibility, authority and communication	Covers the requirements of administration of the quality management system
Resource management	
provision of resources	Declaration of mobilization and needed resources
human resources	The total needs of competence, i.e. education, training, skills and expertise. Ensure it is met
infrastructure	Management of infrastructure i.e. buildings, equipment and services needed for the business to be successful
work environment	Management of the mental and physical environment
Product realization	
planning of product realization	Documentation of product development
customer-related processes	Find and review customers' and organizations' product requirements. Get feedback from customer
design and development	Plan and control the product development. Establish procedures for review, validation and verification. Systematic processes of design and development.
purchasing	Control to ensure conformity of supplied products. Evaluation of suppliers ability to deliver expected quality
production and service provision	Controlled use of instructions, equipment and procedures. Establish controlled and documented traceability. Process control
control of monitoring and measuring equipment	Specify measurements, monitoring equipment needed to ensure product conformance. Includes measuring capability of instruments.
Measurement, analysis and improvement	

general	Specify, plan and implement the measuring and supervision activities required to ensure fulfillment of standard and improvements, and how to do it.
monitoring and measurement	Monitor measured customer satisfaction, processes and products.
control of non-conforming products	Documented procedure for identifying and screening non-conforming products before market.
analysis of data	Collect and analyze data to decide current state of customer satisfaction, process and product characteristics and suppliers.
improvement	Strategy for continuous improvement Eliminate causes of variation and deviation.

https://en.wikipedia.org/wiki/ISO_9000

Motivation:

Quality is the key process of any activity. Quality provides competitive edge through higher productivity and lower cost of Production. ISO 9000 has become one of the most sought after International standards the certification under which is considered as passport for quality. The ultimate aim should be to achieve customer satisfaction through continual Improvement of quality of products and services. This implies the importance of an exhaustive and systematic Quality Certification process which can be applied for Automobile Industry. The Quality Certification processes consist of identification the need of Quality, evaluation, and its impact on TQM and development. An enterprise should measure Quality Certifications because:

- You can't manage what you don't measure.
- If you measure Quality, how it will improve.
- You can uncover and remove hidden waste and cost drivers in the supply chain.
- You can facilitate Quality performance improvement.
- You can increase competitiveness by shrinking Product cycle times.
- You can make informed business decisions that impact the enterprise

https://en.wikipedia.org/wiki/ISO_9000

The Quality Certifications Includes:

Some important models are:

1) ISO 9000 and 9001 2) ISO /TS 16949 3) PDCA cycle 4) Deming Prize 5) TQM

The Quality Evaluation Criteria:

- Customer Focus
- Leadership
- Total quality performance, systems, and philosophy
- Involvement of People
- Process approach.
- System approach to Management
- Continual Improvement
- Benchmarking
- Factual approach to Decision Making
- Mutually beneficial Supplier Relationship
- Product development.
- Financial capability and stability
- Productivity.
- Process and technological capability

Quality Certifications Methodology:

For evaluation of the organization, there is no best way exists but the overall objective of quality certification process is to reduce risk and maximize value to the product/process. The framework of Quality Certification process includes Five Clauses:

1. Quality Management System
2. Management Responsibility
3. Resource Management
4. Product Realization
5. Measurement , Analysis & Improvement

The principal requirements of the standard are illustrated below:

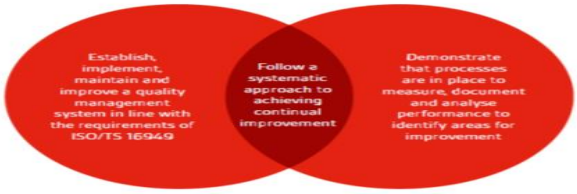

Figure 12. Principal requirement of the standard

Understanding the principles of continual improvement:

The Plan-Do-Check-Act (PDCA) cycle is the operating principle of all ISO management system standards, including ISO/TS 16949. Organization's effectiveness can be improved by using this cycle. Focusing on a specific task, the PDCA cycle is helpful in achieving continuous improvement within the organization. The four phases in the Plan-Do-Check-Act Cycle involve:

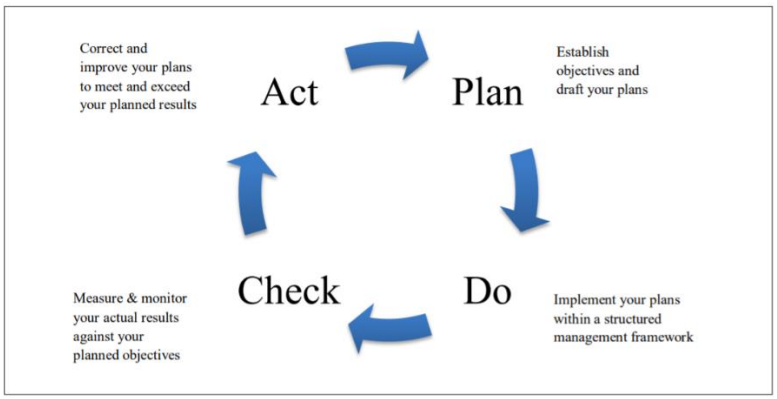

Figure 13. PDCA cycle

Conformity of Production (COP)

Conformity of Production is a means of evidencing the ability to produce a series of products that exactly match the specification, performance and marking requirements outlined in the type approval documentation. Whether you are a manufacturer, or the agent applying for approvals on behalf of a manufacturer, and whatever vehicle it is, suitable COP arrangements must be made (VCA, Vehicle type approval and ISO certification through VCA worldwide 2011). There are authorities (like VCA in GB or RDW in Netherlands) which certify companies to be approved as vehicle manufactures. These authorities make an audit at the manufacturers business site and

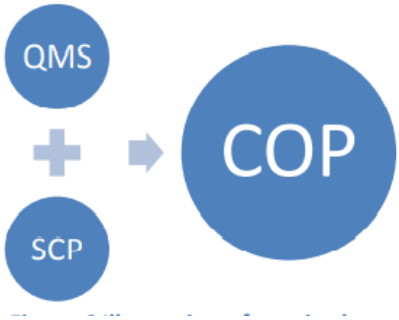

Figure 13. Conformity study

investigate whether the applying organization fulfil the requirements. There are two main routes for demonstrating COP compliance. The first method is through a recognized QMS such as the ISO 9001:2015 series or ISO/TS16949. Beside a recognized quality system, specific control plans (SCP) are also required. As the requirement for a recognized QMS is not mandatory, the second method for demonstrating COP compliance is for manufacturer's who do not have a recognized quality system. In these cases a quality manual and detailed control plans are required. See figure 6.

The quality manual and control plans should then be detailed enough to ensure a high degree of confidence that compliance with the relevant directive or regulations can be continually met. In conjunction with the quality manual and control plans a site visit may be required to ensure that the procedures supporting the application are in place and are sufficiently robust (VCA, Guide to Conformity of Production 2011).

For manufacturers who do not have a recognized quality system (ISO/TS) a copy of the quality manual or the documentation that the manufacturer uses to ensure product consistency should be submitted along with detailed control plans. Here follows a brief summary of what the authority expects from the quality system. The quality documentation should include but not be limited to following areas:

- List of approved suppliers
- Incoming goods
- Non-conforming goods
- Staff training
- Calibration of equipment
- Change control
- Final inspection

- Visit at site

  See the Appendix A

The control plan is a list of process controls, actions and procedures, which make sure that the completed product will conform to the approved type. The control plan has to be more than a work instruction for assembly of the product; it should in detail describe how conformity to the approved type is ensured rather than simply describe the assembly procedure. The control plan should take into consideration at least the following areas; control description, test method (visual, electrical or mechanical), pass/fail criteria, frequency of test, responsible department, report method, responsibility for follow up (VCA, Guide to Conformity of Production 2011).

Quality manual

A quality manual contains the documents that control and specifies the processes in the organization. It shall describe how the company works with its quality management system. Once in a while, e.g. once a year the organization does an audit of the system. The purpose is to ensure the quality management system is effective for the organization and up to date. It shall help the organization meet its stakeholders' expectations and demands. The audits give opportunity to find areas for improvement. The quality manual is a "living document" which means it needs to be updated when for example a process is improved or a routine is phased out.

The documents in the quality manual have a certain format. Besides document name, area of content and reference number, revision number, author, validation date and approval date are included. This applies to all chapters in the quality manual.

It is vital the quality manual becomes a help which support the daily work. The manual shall only hold relevant information for the organization. The manual should be able to be used as an introduction guide for new employees.

Documentation

This part of the theory deals with the difficulties with documentation. The studied material gives supporting advices when documenting procedures. The documents can easily become too informative and leave out the user friendliness that is necessary or otherwise will the documents not be used. The purpose is to have some supporting guidelines when documenting

the processes in the organization. In a small company the verbal intercommunication is often quite good relative larger companies with more employees. Instructions can be communicated verbally to a large extent but sometimes when talking is not possible, procedure descriptions or guidelines can be helpful to perform a task. Here follows a list of aspects to consider when writing documents;

- Make sure the document or procedure is written adequately for the people who shall read it. Beware of the end user since people have varying degrees of expertise, background and learning styles.
- It shall be easy to read and understand. Keep down the number of words, use familiar words and short sentences. If the text is too wordy, too formal or too long, it can lead to misunderstanding or disregarding.
- Use somewhat informal or personal writing style if possible.
- Use gender-neutral words and cultural biases should be avoided
- Examples are often good for explanation
- Avoid cross-references. Do only use them to avoid large amounts of text.
- Avoid jargon and acronyms, can be misunderstood.
- Use bold or italic for highlighting. But use sparingly for best effect.
- Sequenced procedures should be numbered.
- Try to write in same terminology throughout the document to avoid confusing the reader.
- Procedures shall be properly organized with a logical sequence and starting with an overview, heading, purpose, stakeholders etc.
- A new user shall effectively perform the procedure. Make sure the writing is detailed enough.
- Manuals, paper-based or e-documents, should have a title page, table of contents, glossary and index

Summarizing what a good, well written document should be like;

- ✓ Be a series of logical steps, optimizing productivity and output quality.
- ✓ Defines who does what, when, where, how and why.
- ✓ Does not leave room for any sub-optimal interpretation.
- ✓ Minimizes the risk to the company by suitable controls (Berger 2008)

Importance of Quality Certifications:

Poor supplier quality leads to reduce company's revenue, impact on market share, cost of product, brand image and reputation. According to AMR survey almost 67% of the cost of poor quality can be due to supplier failure. So organization must attain reduction in cost of poor quality by implementing a quality management system. What are the benefits of certification to TS 16949?

- Global recognition as a reputable supplier - certification is recognized and accepted throughout the automotive supply chain as an industry benchmark
- Customer satisfaction - through delivery of products that consistently meet customer requirements
- Reduced cost of compliance with customer specifications - through implementation of a single management system and reduced audit requirements
- Reduced operating costs - through continual improvement of processes and resulting operational efficiencies
- Improved stakeholder relationships - including staff, customers and suppliers
- Legal compliance - by understanding how statutory and regulatory requirements impact the organization and its customers
- Improved risk management - through greater consistency and traceability of products and services
- Proven business credentials - through independent verification against recognized standards
- Ability to win more business - particularly where procurement specifications require certification as a condition to supply.

How can ISO/TS 16949 help your business?

By adopting ISO/TS 16949 certification, organization acquired most of the benefits as below:

- The automotive industry is the most efficient and productive sectors within the global economy as a result of quality management techniques. Whether you operate internationally or expand locally, certification to the standard provides firm evidence that your management system meets the exact requirements of the automotive sector.

ISO/TS 16949 standard is proven to help deliver tangible commercial improvements such as:

- Enhanced corporate reputation: By demonstrating compliance with industry and legal requirements.
- Improved customer satisfaction: Through delivery of products that consistently meet customer requirements.
- Ability to win more business: Via easier access to global markets and new business and investment prospects.
- Improved operational processes and greater efficiency through implementation of a single management system and reduced audit requirements.
- Improved risk management: Through greater consistency and traceability of products and services.

Conclusion:

- In general, quality is the most important criterion in the organizations studied. In addition, delivery is a critical supplier's performance measure in the Automobile Industry, since in case of a delivery failure, this could result in a late end product to the final customer and this delay could be lethal for the client. Furthermore, in the manufacturing business this issue is noticed since these organizations can also be ISO 9000 certified.
- The study concluded that the standard of ISO 9000 series was working as a base to regulate the Group's affairs and not to improve its productivity directly as this large business by itself set the minimum levels of quality management standards.
- The study suggests that the standard to be efficient and effective is more helpful for small businesses rather than large ones and other standards with higher levels of quality management requirements may be appropriate for large businesses.

Empirical research and implementation of the project

Research on internal quality management

TQM as defined before is divided into three groups: Supply Quality, Production Quality, Customer Quality. All these roles have a direct connection with the R&D laboratory technicians since the product created in the base of company business is either designed by the team researchers or tested in case of suspection to have defect or non-conformity. The researches of all these interrelations in 5 months time span gave the same obstacle while sending the activity request. The availability of the laboratory technicians was to complex to catch and carry out the test in time and as a Customer Quality to respond to the Procurement Engineers of the client companies. Obviously, the lag in the planning of the laboratory tests in overall has an affect on the cost efficiency in trading. I have attended more than 10 laboratory activities starting from leakage test (relatively easier one) to disassembling the parts and checking the internal spare parts to identify the root causes of several issues happened to the products in warranty. Eventually, I started realizing that it could be useful even for a CQE to intervene independently to these activities by getting the fiduciary permission by the responsibles of the laboratory technicians. The CQE can organize the daily routine to give enough time to collaborate with the laboratory to learn from them utilizations of the equipment and this can give time efficiency in case if the technicians are overloaded.

In addition, in most of the cases the CQE has to answer very specifically to the technical questions of the customers, indeed I have faced so many times the questions of non-conformity to what it is possible to give an answer only by having tried already the tests independently. An independent test that is allowed by the less degree of bureaucracy can provide very crucial technical experience to be exploited in the dialogue with the customer's side engineers. The researches on technical preparation of the team in charge with a certain market is crucial, meanwhile it is a unique solution to achieve a cost cutting efficiency in trading.

For instance, to give a clear explanation on this matter, WSF Brescia has a very complex problem with Continental sensors spare part kit that is utilized with the reducers CNG/LPG by GAZ and Italgas companies. The sensors seem to work in the first 50.000 km but then they start massively giving non-conformity but still in warranty. WSF Brescia is trying to solve the problem by investigating the root cause that drives an unclear defect, because WSF Brescia is responsible to refund the credit notes for the list of non-conforming parts monthly.

According to the data monitored the lost of budget is really high even 3 times higher than all parts manufactured inside WSF, so it is very important to take serious methods to solve this problem. Indeed, again the research explains that the reason why a CQE could not solve this problem is lack of enough technical experience of the CQE. Of course, in a long time period a team responsible for Russian market struggled with GAZ and even an intermediate company like Italgas to carry out tests in the service centres of Italgas with a Continental sensor but the inefficient management of this project was useless, since a CQE has never seen these types sensors and could not understand the full image of utilization condition of this sensor. Otherwise, a CQE might strictly inquire the test to be carried out and not postpone the process since WSF is loosing an operating cost.

However, the role of CQE can but concluded to be not only engineering duties to be implemented during the dialogue with customers but also must take serious steps to intervene cost cutting matters. Eventually, the role of CQE will be adding value to the service and organizing an efficient management in business unit by attentively monitor the operation cost.

Lean approach (SPDCA & standard)

Figure 14. SPDCA diagram.

Scan: In this phase the objective is to study the current state of the claim taken as reference. It is the moment in which through the vision and the study of the issue arisen, this is mapped in order to so as to identify the flow information flow, the operational flow (of material) and the workflow of it. For example, in the case of a receiving a claim, all operations and sub-operations related to a cycle are identified. A cycle, the CQE will go to work following the flow of the instruction. Here the process is structured in two phases: first, all information and provisional VOC are identified and of the process, going to quantify them, if possible, analyze one by one the different.

Secondly, the various causes of non conformity are analyzed one by one in order to discover the root causes of their presence.

At the end of this phase, a series of possible solutions are proposed to the customer company, which assesses their feasibility.

Plan: After having studied the claim in detail and analyzed all the possible root causes, we move on to the to the planning phase of the containment actions to be implemented. In the first place, it is necessary to take a future actions that must be created that highlights all the changes and improvements.

Secondly, The mind plan must be created that all the changes and improvements of this approach will work with the targets in the basis of the certifications of the standard.

This is an important part of the process, but it is not the only one.

This is an important step in the process of "doing". In the end, an action plan must be defined as this is the best way to make sure that the containment action is carried out in an efficient manner and totally in the accordance of the all technical requirements.

Do: This phase is the step in which what has been planned is implemented. It is important to secure that each countermeasure follows its own PDCA cycle, so as to arrive at a compliant solution through monitoring of its implementation. Compliant through monitoring of its implementation, verifying its

effectiveness and, where necessary, making improvements.

Check: After having carried out all the activities of the previous phase, in order to highlight the results achieved, a graphical representation of the KPIs, used for the assessment, is structured.

Periodic monitoring of the project. This has the purpose of verifying the changes. This aims to verify the changes made to the initial process, highlighting the deviations achieved.

Act: In the last phase of the SPDCA approach, a stabilization of the changes to be made to the process implemented.

If the improvements are effective, it is possible to reach a new standard that allows the creation of a new basis for continuous improvement.

In the basis of this approach, we have already implemented a number of improvements of the production flow, shifting to "one piece flow" model of assembly line can be one of the best example.

Researches on Quality monitoring, KPI

The automotive industry is second to none for world class quality controls across their entire supply chain. To maintain this standard, suppliers must adhere to rigid development requirements tracking, proven manufacturing systems and must be open to periodic process audits. This can often mean requiring defect levels that are below 1 dpm (defect per million) at the component level. In order to achieve these levels of outgoing quality, each intermediary step in the manufacturing processes should have quantifiable results that can be monitored and controlled. Statistical process controls are often needed to highlight any departure from normal operations.

Gone is the manufacturing era where a daily batch of widgets could be run for a full shift, and the output sampled for quality. After a review, a technician might tweak some machine knobs at the end of the day to ensure compliance. Today's pace of the global manufacturing environment requires adherence to quality and manufacturing consistency on an ongoing basis. Monitoring the automotive manufacturing metrics to ensure that quality can be achieved is paramount.

With batch setups and teardown for discrete customized manufacturing runs, repeatability of process is critical to manufacturing the same product today that was made yesterday. Variance minimization can be achieved by tracking the key performance indicators (KPI) and system

requirements. Indeed, here the CQE must work with the internal quality team, participate in a daily activities of the production line and see the control system by himself very often. Monitoring machines and processes for adherence to conformity can identify any initial deviance from normal control limits. Knowing the quality control system helps to reply effectively to the claims coming with the wrong assembly issues. Mechanical conformity tolerance can be tested with visual acumen. Product conformity can be tracked for performance expectations. Statistical analysis will highlight the impact and time critical nature for remediation of the issue.

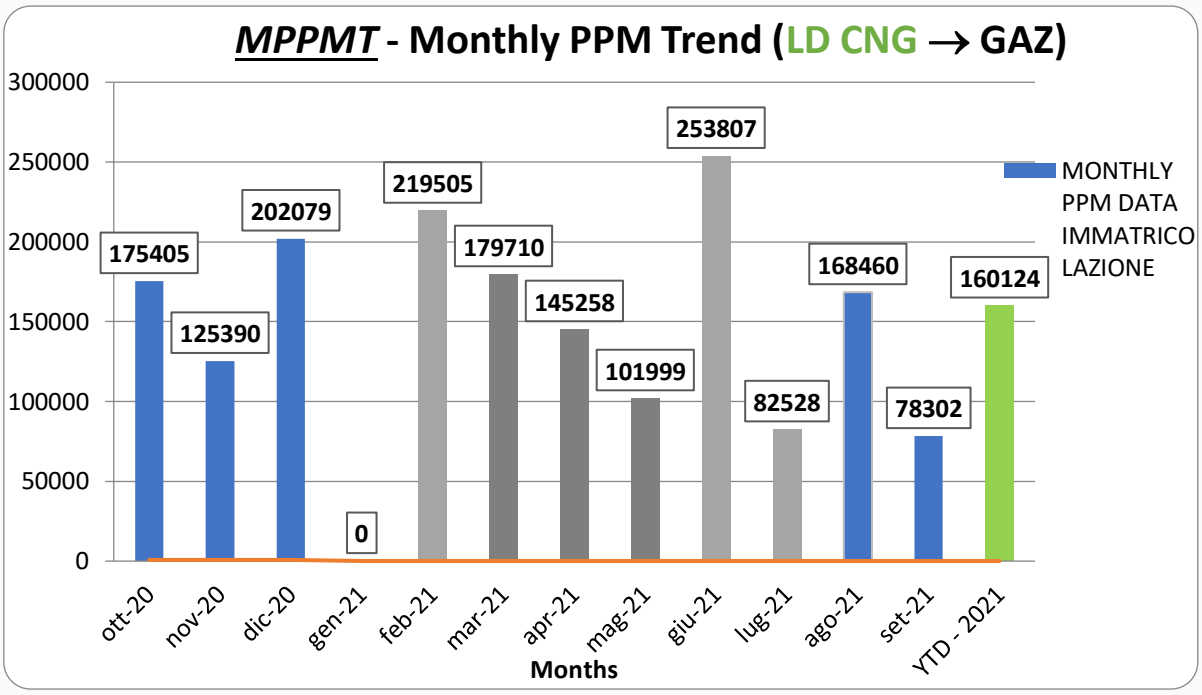

Table 2. Total KPI graph of YaMZ

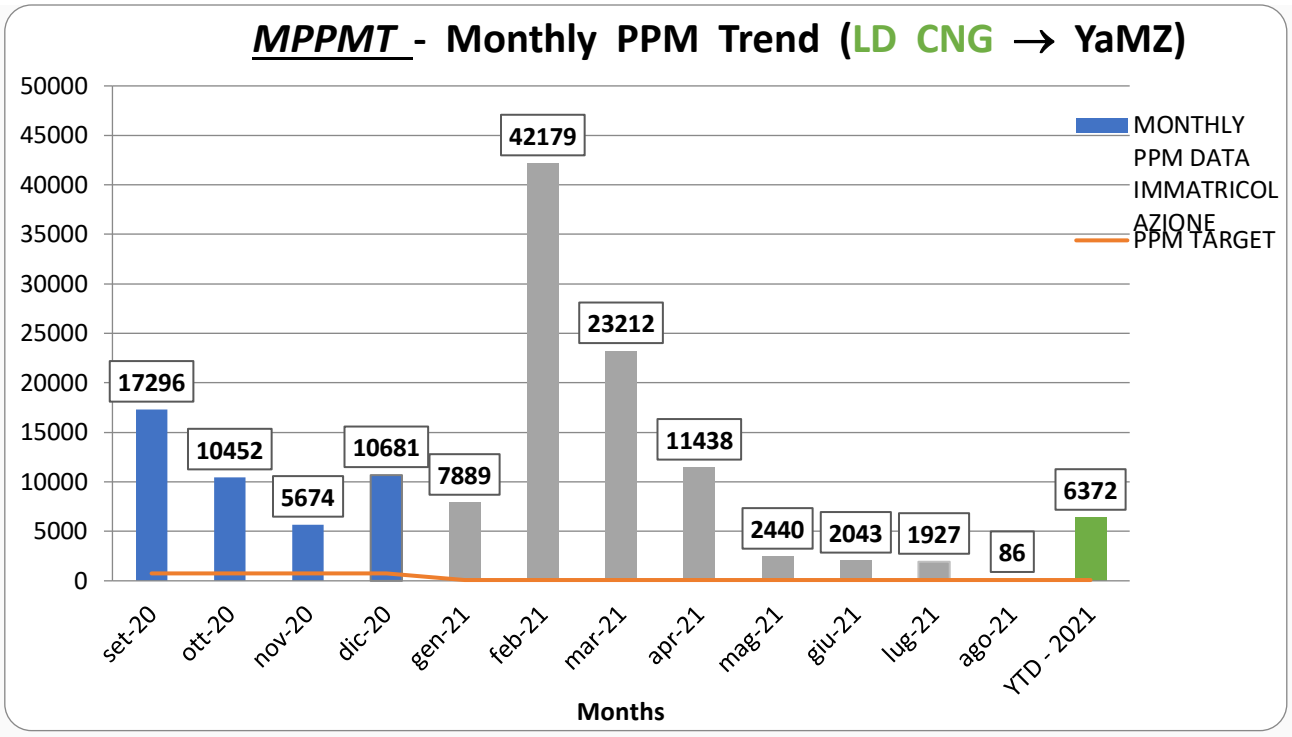

Table 3. Last 12 months KPI of YaMZ

The graphs are done to analyse the KPI of the last 12 months of the non conformity warranty cases of YaMZ. Date of intervention and date of installation of the product on the vehicle is analyzed and only the first intervention with a particular type product is registered to build a KPI. The PPM is set by the production quality team and it used to be 750 per month until December of 2020 then it became 80 unit per month.

Quality planning

Historical quality issues can be used to investigate root causes of defects and implement corrective actions. Periodic customer claims may have been manually searched for parts to identify quality issues. However, this information can now be extracted from data that is harnessed from machines within a factory. Efforts to discover defects and reveal the causes can now be performed with graphs that intelligently model warranty data analytics. The KPI can be targeted to monitor those areas of the production process that are the most critical to the outgoing product quality.

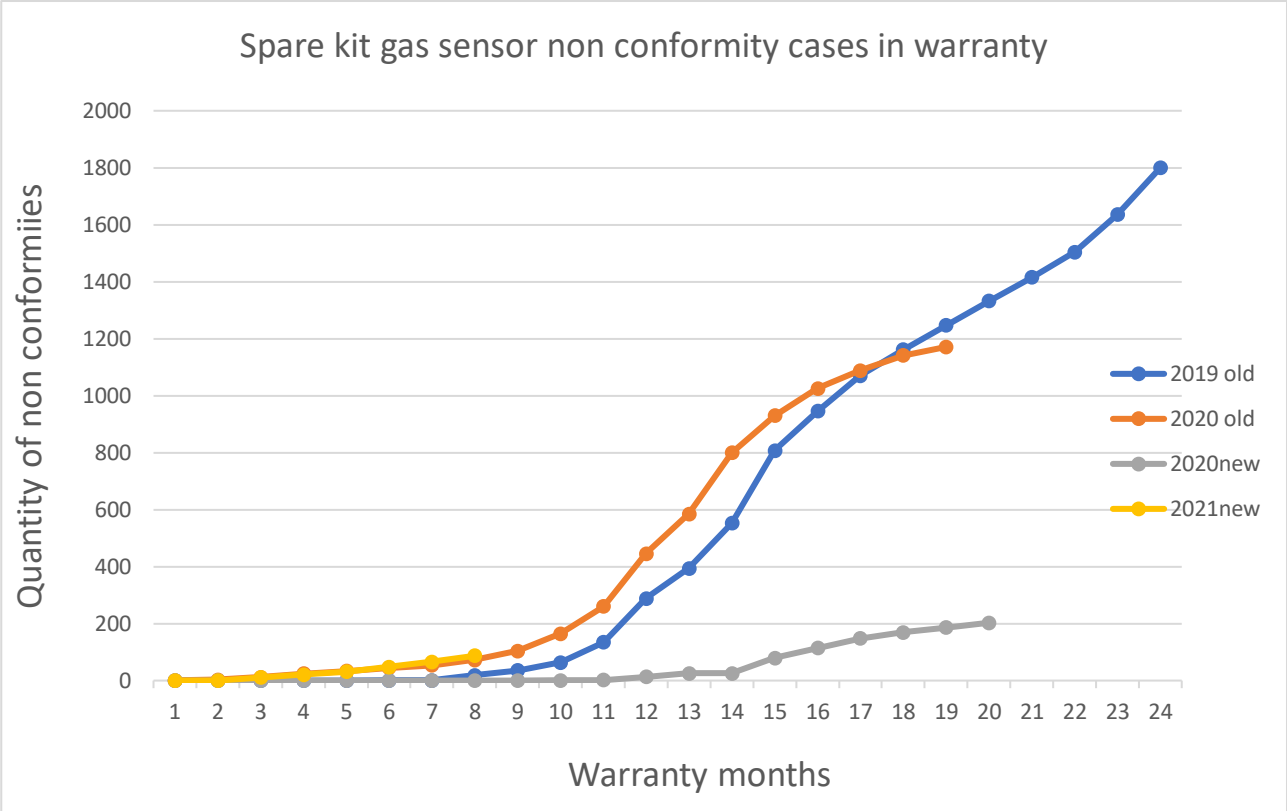

Table 4. Warranty months analysis

Here in this graph, the sensor non conformity cases are taken to do analyse the warranty trends. The reason why exactly the sensor was chosen to be investigated in this thesis is its tightly alignment with all quality teams. The CQE receives the list of all non conforming parts and filter them by the type and modification code. So, the sensors are separated and shown in the graph from which month the mass of the conformity starts and the curve to understand whether the problem is taken under control or not. As we highlighted before, immediately after receiving the claim according to the quantity and urgency, the claims take priority and the root causes are identified and the containment actions are implemented immediately. However, the efficiency of those containment actions to prevent from reoccurrence the defect and in terms of time of problem solving is seen on the KPI warranty graph. The sensor (spare kit) is supplied by external suppliers, so in case of its massive conformity it involve customer, production, supply quality teams under the control of project engineers and global quality. Of course, if the part is manufactured internally by WFS, the claim and its further solutions are carried out between customer and production quality teams and the KPI is under the responsibility of the teams involved. Furthermore, the above mentioned process map, production flow is very important to coordinate the claims for CQE.

Month	2019	2019 # Trucks	2019 ACC Average	2020	2020 # Trucks	2020 ACC Average
1	0	12700	0	1	14894	1
2	0	12700	0	2	14894	3
3	0	12700	0	9	14894	12
4	0	12700	0	12	14894	24
5	0	12700	0	9	14894	33
6	1	12700	1	12	14894	45
7	0	12700	1	9	14894	54
8	18	12700	19	19	14894	73
9	17	12700	36	31	14894	104
10	28	12700	64	61	14894	165
11	70	12700	134	95	14894	260
12	155	12700	289	186	14894	446
13	105	12700	394	139	14894	585
14	159	12700	553	215	14894	800
15	255	12700	808	130	14894	930
16	138	12700	946	96	14894	1026
17	125	12700	1071	62	14894	1088
18	90	12700	1161	53	14894	1141
19	86	12700	1247	30	14894	1171
20	85	12700	1332	0	14894	
21	84	12700	1416	0	14894	0
22	88	12700	1504	0	14894	0
23	132	12700	1636	0	14894	0
24	164	12700	1800	0	14894	0

Table 4 and 5. Warranty months analysis distribution

2020	2020 # Trucks	2020 ACC Average	2021	2021 # Trucks	2021 ACC Average
0	14894	0	0	12185	0
0	14894	0	0	12185	0
0	14894	0	11	12185	11
0	14894	0	10	12185	21
0	14894	0	10	12185	31
0	14894	0	17	12185	48
0	14894	0	18	12185	66
0	14894	0	21	12185	87
0	14894	0		12185	
1	14894	1		12185	
1	14894	2		12185	
11	14894	13		12185	
12	14894	25		12185	
0	14894	25		12185	
55	14894	80		12185	
34	14894	114		12185	
34	14894	148		12185	
21	14894	169		12185	
17	14894	186		12185	
17	14894	203		12185	
	14894			12185	
	14894			12185	
	14894			12185	
	14894			12185	

Quality Control

By controlling production in real-time, any quality issues that arise can immediately be identified. Through implementing predictive maintenance and repairs in advance of problems, most of the breakage can be mitigated in advance. Defect discovery should be identified as soon as possible and from the smallest quantity possible. When observing the manufacturing quality, iterative feedback loops for corrective action can be tight and timely.

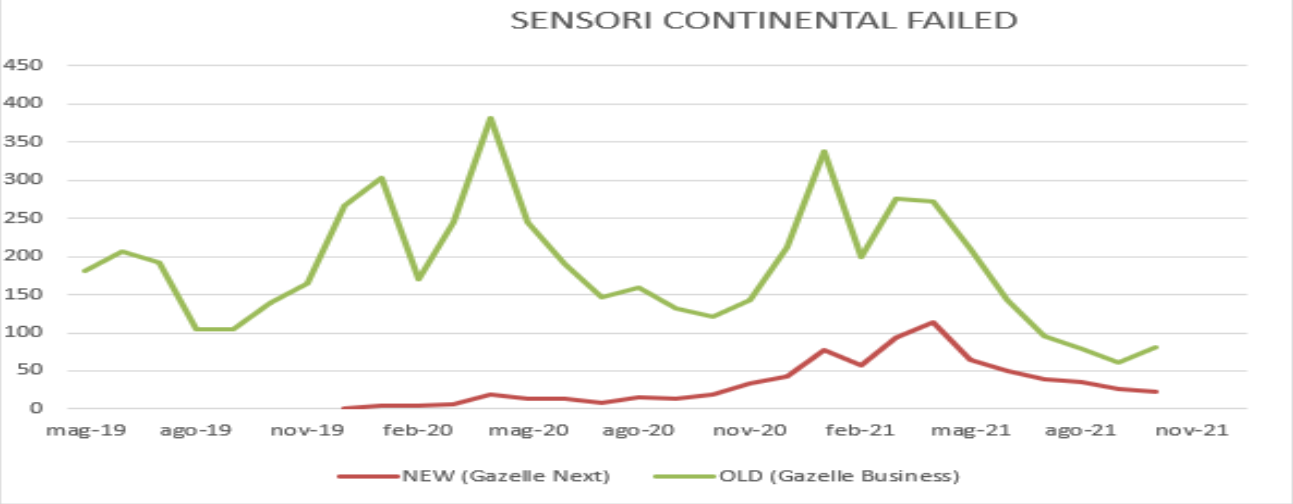

Table 6. The trend of claims with sensors.

Quality Assurance

Effective tracking of problem reports and customer complaints helps resolve the quality queries in a timely fashion. By closing the loop from customer issues to identifying problems before they leave the factory floor, overall quality response can be improved, and end-customer quality satisfaction will increase. Machine performance parameters can be tracked to identify out-of-bounds conditions when they occur. Alerts can be sent for management decisions to take corrective actions and quarantine any suspected material for further investigation.

Machine Metrics offer insight into KPI metrics and Process optimization. The health of equipment can be tracked with machine monitoring in real-time. Solutions to manufacturing challenges can be realized through the data provided by the equipment instead of halting a line and having personnel investigate to find the point issue. By monitoring production KPI

across the enterprise, quality issues can be identified, corrected and improved before a customer discovers them.

Customer procurement engineers

Creating the procedure to analyze the claims

Having procedures in place will help you manage a claims in 3 stages:

1. Find out why your customer is unhappy.
2. Do everything you reasonably can to make your customer happy.
3. Review the incident to consider potential improvements to service or complaints handling.

Particularly, WSF Brescia receives monthly list of the defective parts from GAZ, Italgas, YaMZ, ATC (auto VAZ Russia), but these are all from Russian market while another customer quality team receives the claims from the other markets as well. The claims are divided into two parts as it was said above like defective parts from the field (utilized already) and 0 km parts identified defective during the test on the production line by OEM customers. Then, there daily or randomly claims coming from Italgas, the reducer model C332A is under long term investigation process and WSF Brescia jointly with Italgas are trying to find the right way of utilization this model with the trucks.

Communicating claims procedures

The company must be sure that the staff are aware of, and skilled in, our business's claims policy and procedures. It's vital that they understand their role in resolving and recording complaint incidents, and nominating complaint contacts.

CQE should also take steps to communicate the claims policy and procedures to customers (e.g. through the website and business communications).

The procedures to get the claims are carried out either by email with excel datasheet or using the two sided dialogue web portal. Usually, the 0 km issues must be taken from the

web portal and the notification gives an alert that the list of the defective parts is modified, so CQE can know about it. The claims of monthly list of non-conformity and daily random alerts are received only by email or telephone calls. However, all these cases must be registered internally in the shared Excel file to have an opportunity to track forward.

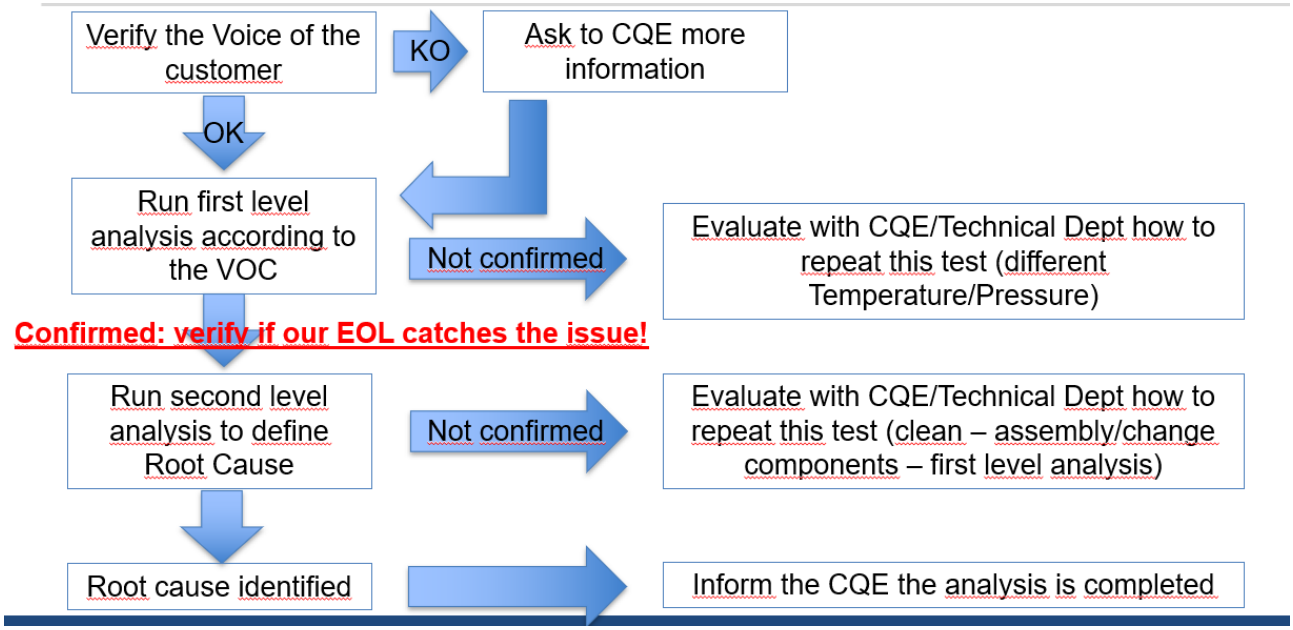

Figure 15. The loop of accepting claims

Reviewing claims and handling policy

Your claims handling policy will ensure you are keeping good records of claim incidents.

Schedule time periodically to review your business claims and check for patterns in the type, nature and handling of claims.

This review will allow you to identify issues such as:

- the number and type of claims
- customer service weaknesses
- your staff's claims-handling skills
- customer claims behaviour and your management approaches.

This method helps to record not only a number claims by soring them to several types, but also to check the frequency of that type of non-conformity. This is very important for CQE to know to intervene to the management teal of production quality. In WSF Brescia, there is a morning meeting held online via Microsoft Teams to discuss the quality matters and assign the specific tasks to individuals. Afterwards the team of technicians and quality engineers carry out another "White Board Meeting" in front of the laboratory of incoming point, where the engineers exchange the experience, discuss the outstanding claims, production monitoring and giving an order of priority to tasks to work with claims. This method is constructed on Kaizen "change for the better and continuous improvement".

Resolving claims

While many claims are easily resolved, some can be very challenging. Resolving claims with dissatisfied customers requires good technical check processes, courteous communication and strong conflict resolution skills.

So, many claim can be solved or technically responded if it is a standard case and there is a clear guideline to apply, but strongly depends on the type of the product. For instance, the reducers of C332A is mostly exploited by the companies of Italgas and if there is a leakage or high pressure than the tolerance, it is clear to give response by asking modification of the reducer with a new spring kit. But, although it is considered as a corrective action, it is has not shown the proof that this is a completely right solution. The proof and further relatively appropriate technical solution might be obtained after some time since the installation method and exploitation instruction are not definitely known by WSF Brescia and only the customer procurement engineers have an access to this information. Eventually, this confusing matter drives a CQE to collaborate with design technicians internally and build very tight connection with quality engineers from the customer's side. CQE must discuss all defective cases one by one and ask the pressure and temperature measurements of the vehicle with already heated engine and provide this information to R&D lab. This process flow is so important to that extend which means the company starts loosing budget by paying warranty refund back and it lasts until the CQE takes all under control. Furthermore, the claims arrived daily or randomly must be register in the shared excel file of WSF Brescia, it is for tracking the lifetime of a particular product and must be registered with a serial number of the product. Even according to the contract with the customers, all claims are accepted and reworked only

with the presence of serial number of the product and according to the situation sometimes the transportation documents are also required if the issue is not only about one unit of a product but the whole lot supplied is under suspection.

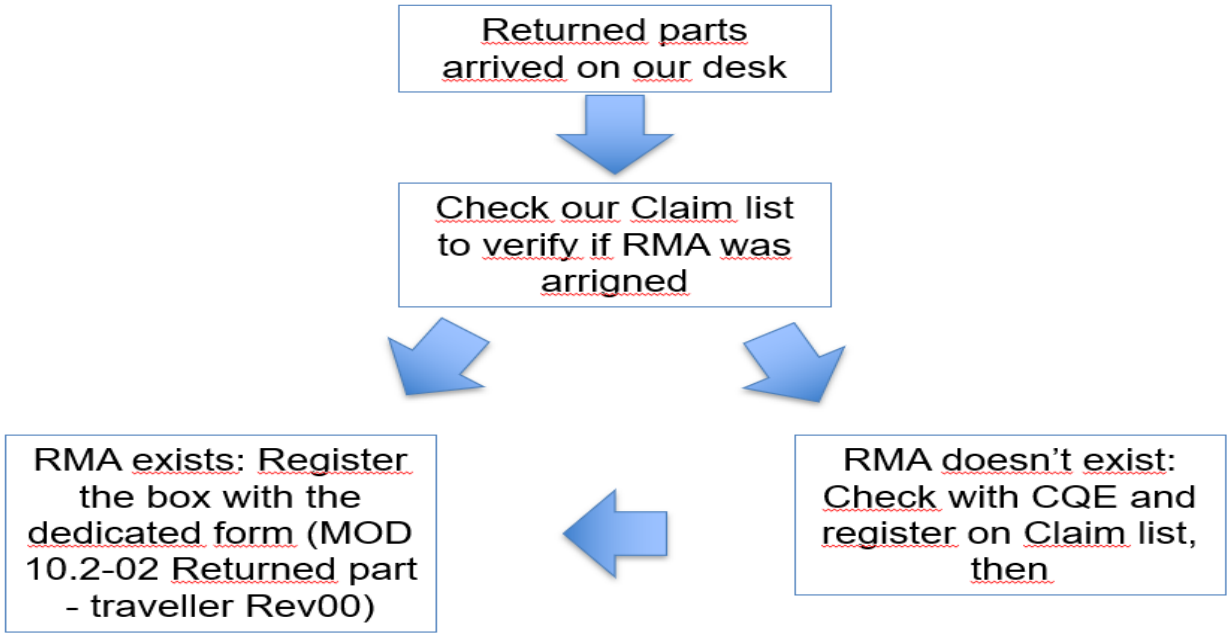

Figure 16. RMA checking

Managing unresolved claims

If CQE is unable to resolve a complaint after taking all reasonable steps, you may find a third party dispute resolution service helpful. Indeed, very hopefully the claim solutions do not reach that point.

There are some cases of unresolved claims, they usually can differ according to the status and information provided. Sometime, the claims arrive to WSF Brescia and the CQE immediately make 8D report with a team gathered by CQE and send it to the customer procurement engineers. This is always the first essential step to do but starting from this point the customer might either forget to reply back or the data relating to the claim get lost. The CQE remains blocked with this claim, but the contract declares that in case of silence during the communication on a particular claim from customer's side, the claim is automatically refused and gets registered as closed for the favour of WSF Brescia. This happens so often, for example in April, I received very urgent call on a claim, that was

about the non-conformity the emergency PRD of the valve which is installed on a gas tank. This very urgent but very rare case 1/1000000 and so many factors could be a root cause, the phenomenon was so distinct and both production line of WSF Brescia and utilization and testing point of a customer can be equally responsible. In fact, I sent 8D to Gaz and asked them to send us the part back but even after 3 months we had not received the part and the claim was closed automatically.

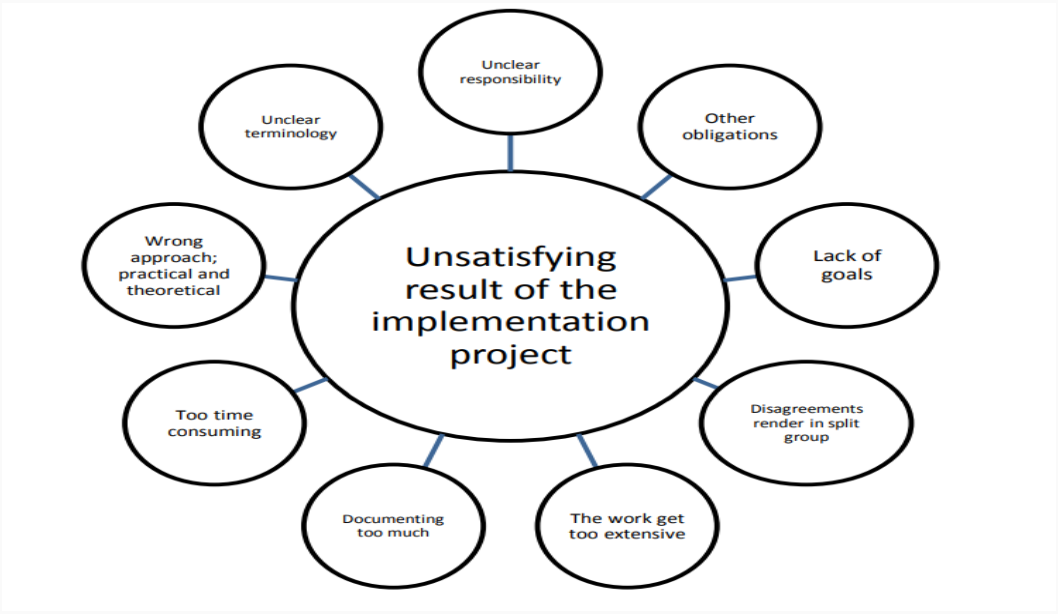

Figure 15. Unsatisfying result of the implementation

Customer satisfaction

WFS Italia S.r.l. Customer Satisfaction Scorecard Summary

	Activities			CUSTOMER SATISFACTION			
Customer	Workload	Description	Key Resources	Customer portal	Status Aug-2021	Status Sept-2021	Challenges
YaMZ	High	Boosting up supplier customer relationship	Tetdoeva Worth	NOT APPLICABLE	3	/	Coils issue ongoing, difficulty to obtain information by final OEM customer (possible issue due to change of configuration by customer compared to the specification). Oxygen sensor claim ongoing,
GAZ	High	Warranty activity improvement; design change improvement	Tetdoeva, Cecchini	NOT APPLICABLE	3	/	Proposal for solution with Sensata sensor ongoing. Continental field claim still high, root cause partially defined, due to application. Joint analysis planned for October 2021. Reductor with new filter (cod 901421)
Autovaz	High	Lada Largus planned again with ECU	Tetdoeva, Cecchini	NOT APPLICABLE	4	/	Current pending claims are from the previous months; now the situations improved.

Table 7. Customer Satisfaction Scorecard

The customer satisfaction scorecard is periodically updated with the workload that means the priority level of the customers. The key resources are indicated who are responsible as a Key Account Manager and Project Engineers and daily the CQE also involved directly to all challenges. The challenges are key target points to reach during the partnership and to keep the added value to the partnership. The customer portal here means the online portal where the information with the companies are shared but here with the Russian market the individual portals do not exist, so the CQE exchanges the data only in an email form in a written official way.

Rating	Title	Examples
1	1- upset, escalating	Customer sending repetitive emails, and asking for management, calling many follow-up meetings
2	2- not happy	Customer sending repetitive email "reminders"
3	3- neutral	Ongoing work with customer and reasonable response time
4	4- positive attitude towards us	We see positive feedback in their communication; relationship is less formal;
5	5- very happy	
blank	blank - no activity	

Figure 16. Estimation of the Customer Satisfaction

CONCLUSION, RESULTS & DISCUSSION

The hypothesis on the title of this Master's Thesis is considered concluded: The Quality Management System of WSF Brescia really is an asset for adding value to the product and service of the company trying to keep its leadership in Russian markets.

How did we arrive to this conclusion? The Thesis and supporting research demonstrate clearly how the construction of a customer quality management and clever use of it as a part of the marketing initiative helps in gaining a tight connection with current markets as well as secures the friendship and effective partnership with the customers in an ever changing business climate. A quality management system compiled together with the quality awareness and innovative modification of the product portfolio of the company will start to generate results. Furthermore, documented processes will help enormously in the transfer of tacit knowledge.

The standardization of the process to control the claims can make the work easier and the duties shall be clear for both sides, this is important in conflict of interests.

It has been an amazing journey in which many theories and principles were reflected upon the flexible but practical and cost-efficient approach of the case company. The third chapter presented the theoretical research approach and objectives for the development and implementation of ISO 9000 series to quality management system for the team in charge of all quality management (supply, production, customer) at company by defining the regulatory role of the documentations. The theories presented are based on literature studies by the professors of Politecnico di Torino, Agostino Villa, Domenico Maisano, the professor Bo Bergman from Chalmers University of Technology. The authors and their work were later referred to where applicable throughout the Thesis to assist in building a proper theoretical quality framework for this case study. The sequential and process management theories are adopted from the lectures of Agostino Villa, the university subject that highlighted the production process was Analysis and Management of Production Systems. In the first and fourth chapter the case company WSF ITALIA was introduced in detail by describing the background as well as the market situation, focusing on the most important business units connected with Russian OEM automotive market. A somewhat lengthy study to the recent situation with the Russian customers showed that there are some issues to be solved with the procurement engineers in terms of refunding the warranty payment back but the root cause is not identified to terminate this so often happening payment. It is also shown how

it is almost impossible to predict the future of the field, if but only a few years forward – this is shown also in the actual status of the maritime business. Another focal point was at the recent efforts to penetrate new and potential but highly complicated shipbuilding market area such as the Russian OEM automotive market. The chapter also explained the business philosophy of the case company with a few practical examples of claims management and the issues to be taken under control in order to prevent loosing the budget, even a comparison to one of the world's largest car manufacturers, reveals some of the marketing efforts done in the recent times and explored the ways of surviving in a tumultuous market environment. The fourth chapter was dedicated for describing the building of the Researches and Manual from a preliminary idea to implementation. Empirical research consisted of interviews and familiarisation with the company´s practices and operations, all in addition to literature research, to create a manual for any CQE who is considered to work with Russian customers. A fairly long portrayal of the reasons why CQE needed this is an essential part of the research. As far as applicable to the case company, ISO 9001:2015 quality management principles and requirements were explained in practice by showing the creation of process descriptions and the evolution of those into a quality manual, neither existing previously in the case company – every document and chart were exclusively made for CQE manual. The chapter also presented and discussed the documentations of the ISO 9000- series of – all of them were also compared to the brand new Quality Manual of the case company. To finish the chapter, the development project is put onto a timeline, which spanned almost 6 months, however it provided for a chance to follow the implementation from start to finish, and to observe the tracking the claim history and creating an efficient database that is flexible to convert to statistical analysis and gives support to Project Manager. As last but not as the least, this final chapter was comprised of a rationalized conclusion for this survival story, presenting the achieved results and discussing some important follow-up matters.

Quality Management System & Quality Manual

The most tangible result of the research was the "Customer Quality Manual" which encompasses and documents the duties and responsibilities of Customer Quality Engineer's position. It is to be implemented by the WSF Brescia into current position and sales process as soon as it will be finished. Some parts of the manual were included already in the company process regulations and mentions of it were added in the documentary material. The

structure of the System and the Manual are fully compatible with the ISO 9001:2015 requirements. As the manual contains detailed and confidential information of the company, the manual is not released as part of this Thesis. The development of a quality management system is however not a single event – it is a continuous process of improvement. Plans and needs change direction when the company gains experiences or the business environment becomes upset by a global, unexpected factor. Therefore it is essential and recommendable, that the company management follows and evaluates the quality management system periodically, by external audits for example. The results of an audit are not solely negative, nor should the given "improvement recommendations" be considered as criticism – when applied thoughtfully, they may even result to new innovations. A necessary tool for the application of such recommendations are the process descriptions, which should be kept updated periodically. A company that stresses quality promotes a culture whose attitude, functions and processes will produce value by fulfilling the expectations of the customer.

Conformity Study of ISO 9001

During the research process, a new version of the ISO 9001-series was launched and it prompted an additional study into the details. Based on the comparison presented, the case company's decision was to continue the research and implementation work as previously planned. The reasoning is quite simple; Firstly, there is no need to rush into the 2015 edition, as the older version is completely valid for certification up to 2018. Secondly, if the new version would have been applied, the viewpoints on the implemented Quality Manual should have been mostly restructured and rewritten, as the approach is slightly different. Thirdly, the 2008 version has been available for a decade and by now has millions of users all over the globe – in other words, it has been proven time and time again, in circumstances too many to mention. Why would it just seize to be applicable? The quality management of the case company considered the "Customer Quality Engineer" as a clear representation of the functions of the company and its quality management system to work daily with the procurement customer engineers.

In Summary

Automotive is yet another industry that is completely changing under the influence of technological innovation. Customers increasingly see their vehicles as smartphones on wheels and continuously demand new features and upgrades. The new dynamic in the car market also calls for a new way of working.

Applying Agile methods helps automotive manufacturers stay on top of their market and:

- Build products based on market demands through more frequent customer collaboration alongside the project's life cycle.
- Increase product quality through faster feedback loops and an iterative product development approach
- Handle complexity through cross-collaboration teams
- Decrease time to market by reducing hand-offs, boosting collaboration and increasing the overall operational capacity of the teams

Appendix A

Explanation from the certifying organization VCA

Approved suppliers - how the company selects suppliers to provide quality goods or services and how they ensure they use only those suppliers

Incoming goods - how the company ensures that the goods it receives conform to the required specifications/order

Non-conforming goods - how does the company ensure that any incoming goods or manufactured goods that do not conform to specification are not used in production or distributed to the end user

Staff training - how does the company ensure that its staff are properly trained and how it records that training

Calibration of equipment - how the company ensures that any equipment used for manufacture or for test are maintained in calibration

Change control - how the company ensures that any changes in design or assembly processes which may affect the validity of the approval is notified to the relevant departments and or the relevant approval authority

Final inspection - how the company ensures that the final product conforms to its specifications has appropriate labeling and instructions for use.

Thesis acronyms

WSF Italia SRL – Westport Fuel Systems LLC

WSF Brescia – Westport Fuel Systems factory in Brescia

CQE – Customer Quality Engineer

VOC – Voice Of Customer

CNG – Compressed Natural Gas

GPL – Gas to Liquid

GHG – Green House Gas

OEM – Original Equipment Manufacturer

QMS – Quality Management System

MVP – Minimum Variable Product

R&D – Research and Development

TQM – Total Quality Management

PDCA – Plan Do Check Act

GAZ, YaMZ, ATC, Italgas – Russian OEM and aftermarket manufacturers

KPI – Key Performance Index

8D – Technical response document

PRD – Pressure Release Device

RMA – Returned Material Authorization

References

Quality Engineering and Management course materials course, lecture materials and guidance of Prof Domenico Augusto Francesco Maisano.

Analysis and Management of the Production Systems, lecture materials and guidance of Prof Agostino Villa.

Bergman, Bo, and Bengt Klefsjö. Quality - from Customer Needs to Customer Satisfaction. Lund: Studentlitteratur, 2010.

Westport Fuel Systems Brescia https://globalzone.internal.westport.com/na/Quality/emer-quality/SitePages/Home.aspx

A review on Quality certification in Automobile Industry – L.Gaikwad 2015, Manojkumar Kadam , S.N.Teli , L.M. Gaikwad

Business dictionary. n.d. http://www.businessdictionary.com/definition/process.html (accessed June 11, 2011).

Ente Italiano di Normazione https://www.iso.org/iso-9001-quality-management.html

ISO (2015). Quality Management Principles. ISBN 978-92-67-10650-2. (http://www.iso.org/iso/pub100080.pdf)

VCA. 2011. http://www.vca.gov.uk/vca/index.asp (accessed August 16, 2011).

Certification https://www.vehicle-certification-agency.gov.uk/conformity-of-production/

Kanban methodology https://kanbanize.com/agile/industries/agile-automotive

IATF https://www.iatfglobaloversight.org/