Professional MBA

Automotive Industry

Improvement of customer-supplier-relationship based on empirical studies and using characteristics of the Advanced Product Quality Planning

A Master´s Thesis submitted for the degree of

"Master of Business Administration"

supervised by

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Eiersdorf, 01.06.2013

Preface

I would like to express my deep appreciation to my life partner Mrs. MMag. Ingrid Weißnegger, she supported and motivated me in any part of the master thesis. Originally the title of the thesis was different but because of the outcome of the survey it was necessary to make some modifications. My adviser on the TU Vienna is Dipl.-Ing. Dr. Palm, I also thank him very much for his support during the whole time of writing.

Affidavit

I, **CHRISTOPHER OPETNIK**, hereby declare,

1. that I am the sole author of the present Master Thesis, **"Improvement of customer-supplier-relationship based on empirical studies and using characteristics of the Advanced Product Quality Planning,"** 92 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master Thesis as an examination paper in any form in Austria or abroad.

Vienna, 01.06.2013

Signature

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List of abbreviations

APQP	Advanced Product Quality Planning
QFD	Quality Function Deployment
PDCA	Plan-Do-Check-Act
SCM	Supply Chain Management
TQM	Total Quality Management
PSW	Product Submission Warrant
AIAG	Automotive Industry Action Group
SPC	Statistical Process Control
CIP	Continuous Improvement Process
D-FMEA	Design Failure Mode and Effect Analysis
P-FMEA	Process Failure Mode and Effect Analysis
MSA	Measurement Analysis
PPAP	Product Part Approval Process
DMAIC	Define Measure Act Improve Control
SOP	Start of Production
US	United States
OEM	Original Equipment Manufacturer
ISO	International Standard Organization
DIN	Deutsche Industrie Norm
TS	Technical Specification
CMS	Complaint Management System
IMDS	International Material Data System
EDI	Electronic Data Interchange
VDA	Verband der Automobilindustrie
QM	Quality Management
OHSAS	Occupational Health and Safety Assessment Series

Abstract

From today's point of view most system suppliers currently have problems in their supply chain regarding communication, standards, different understanding, different norms and certifications with their suppliers. In the product development phase, these collaboration problems in the supply chain lead to a series of emergency measures, a delayed or even a cancelled start of production at the customer plant. This leads to unnecessary costs or in worst case to a massive penalty followed by customer visits and downgrade of the delivery performance index. The company MAHLE wanted to improve the communication between the suppliers and MAHLE by the development of a new supplier specification.

A literature review concerning the customer-supplier-relationship was done and the methodology of the Advanced Product Quality Planning was introduced. Three excellent supplier specifications have been benchmarked and accentuated exemplarily. After a survey with selected suppliers the outcome was, that the communication could be improved and that the interviewees get too less or imperfect information. A better understanding is necessary; therefore a proposal for a maximal supplier specification and a possible way to improve the interaction between the customer and the supplier has been developed.

1 Introduction

If customers come back to the origin of their product for further orders, MAHLE did everything right, but if the product itself comes back, mostly MAHLE did something wrong. To avoid this, MAHLE has to intensify its focus on the field of supplier collaboration to gain more positive effects.

1.1 Motivation

The motivation to deal with the problems in the field of customer-supplier-specification in my master thesis is rooted on the one hand in my employment at MAHLE and on the hand in my personal strength to analyze and improve current proceedings, especially in terms of saving time and money. Over the time and during my job I found out that it is mandatory for an efficient production process and production outcome that the quality of MAHLE's suppliers is in perfect condition. In order to verify, whether this is my own perception based on my work experience, or if it is also confirmed by scientific literature, I started a benchmark of supplier specifications, based on literature research to the most important topics in these specifications, especially the Advanced Product Quality Planning (APQP). The benchmark consists out of a comparison of the specifications of three well known suppliers in the automotive industry; it will show which elements occur in which supplier specification and what elements are the most common out of all compared documents. Based on these results I am going to describe three elements which occurred at all suppliers in detail.

1.2 Research focus and problem

The research topic of my master thesis is generally based in the automotive industry, especially in the field of customer-supplier-relationship.

The actual practical problem in the customer-supplier-relationship is that the communication is very inefficient. Documents and information get lost in the supply chain, this leads to misunderstandings concerning the interpretation of specifications and arrangements and furthermore these facts lead to a high effort of time and money which could be avoided.

The research problem derives from the fact that there is no concrete information how to organize and arrange supplier specifications to make the interaction between customers and suppliers more efficient – neither in literature nor in everyday practice.

Out of this reason that it was not possible to find any guideline how a supplier specification should be written, my aim was to focus on the APQP process and work according to these standards to get a better and more efficient communication between the customer and the supplier. This means that the APQP guideline, which is published by the Automotive Industry Action Group (AIAG), should be the basic tool for a written specification to avoid problems in the supply chain regarding quality, logistics and project management issues.

1.3 Research question

Based on the research problem and the relating research focus, I have developed following research questions:

- How are the supplier specifications currently designed and what are the most common elements in the supplier specifications?
- Does the supplier get all needed information from the customer? What would be the ideal information interaction between a customer and a supplier?
- What are the main points to be declared for clear understanding and an efficient collaboration?
- What could be the strategy to strengthen the customer supplier interaction and to optimize the current process?

1.4 Outline of the Master Thesis

The target of the Master Thesis is to define a process for an improved interaction between customer and supplier in the automotive industry. After literature research and benchmark analysis of the supplier specifications of several suppliers, a new process for a friction-free collaboration between supplier and customer shall be developed.

1.5 Main objective

After literature review and benchmark analysis concerning supplier specifications of different suppliers and ascertainment of the satisfaction of the suppliers of MAHLE, the main objective is to improve the quality level of collaboration between potential suppliers and MAHLE for a positive Start of Production (SOP) without additional costs for trouble shooting during the production process.

1.6 Sub-objectives

APQP is a method for the improvement of quality. APQP starts before the beginning of the production process and prepares and optimizes the production process before it has even started. Furthermore APQP impacts also the communication between the customer and the potential supplier from the first contact until the SOP, therefore the application of APQP in the product development process is a sub-objective of this thesis.

1.7 Structure of the Thesis

Starting with a general overview of the automotive industry in Central Europe, I will continue with literature research. After a description of the Advanced Product Quality Planning I am going to compare the specifications of different suppliers, followed by an overview of the results of my survey with the suppliers. The outcome of the survey shows the main points which have to be considered to improve the customer-supplier-relationship. Based on these results a possible way to improve the collaboration was submitted.

Figure 1: Structure of the thesis (Source: Author)

2 Literature Review

Based on the title of the master thesis it is obvious that the main literature is out of the quality management, especially literature about APQP processes and about current supplier specifications from actual suppliers in the automotive industry was used. Concerning the part of the master thesis which describes the current APQP guideline the main reference was the guideline itself which is published by the AIAG.

Summing up, a good way for the design of thesis was to work with well-known authors from the past on the one hand together with current innovative literature which especially refers to the APQP-method.

2.1 Automotive industry

At the time of writing, the automotive industry is the biggest industry on globe. With its rapidly changing periods it is one of the most difficult industries to understand. More than 8 million people are working for about 50 manufactures, which are producing more than 60 million vehicles in the year 2003. 80% out of these 60 million cars are produced by only 12 manufactures. The future scenario for the next decade says that only 6 manufacturers are producing the yearly volume on cars which is needed in the world. (Hoyle 2005:1)

From today's point of view, the continuance of automotive industry is not threatened – nearly everyone needs a car to come from one place to another, transport goods, meet friends or just to show his personal success and position in society. Summarized, nowadays definitely most of the people cannot live without a car any more. In

the last decades there was a rapid change in the thinking of the consumers. This means for example, that many people are focusing on fuel efficiency or on safety – the priority of several characteristics changed. (Hoyle 2005:1)

With this status quo the automotive industry has many open points which need a suitable solution urgently. (Hoyle 2005:2) Companies buy more components and services from their suppliers and sub suppliers than they used to do in the past. Customers are relying on their suppliers to improve their own quality, develop new and innovative processes and nevertheless they also have to be faster in research and development than their competitors are. (Liker et. al.2006:25)

Based on these facts it can be summarized, that the communication and the flow of information between the customer and the supplier gets more and more important. (Liker et. al. 2006:25)

"What is important is not the system but the creativity of human beings who select and interpret the information."

(Taiichi Ohno, Former Executive Vice president, Toyota Motor Company)

2.2 Automobile Product Development

Like shown in Figure 2, it is necessary to start as early as possible with efficient and well managed processes along the whole supply chain to reduce costs and be in time with all steps of production. This means that the monetary effect of a modification during the phase of the product or service definition is a thousand times higher than a modification which is implemented not before the process improvement. If the optimization of the product is done at the beginning, which means during the product and

service definition, there is normally no need of an optimization of the process afterwards. This procedure will save time and money and is a good strategy for reducing costs and saving time.

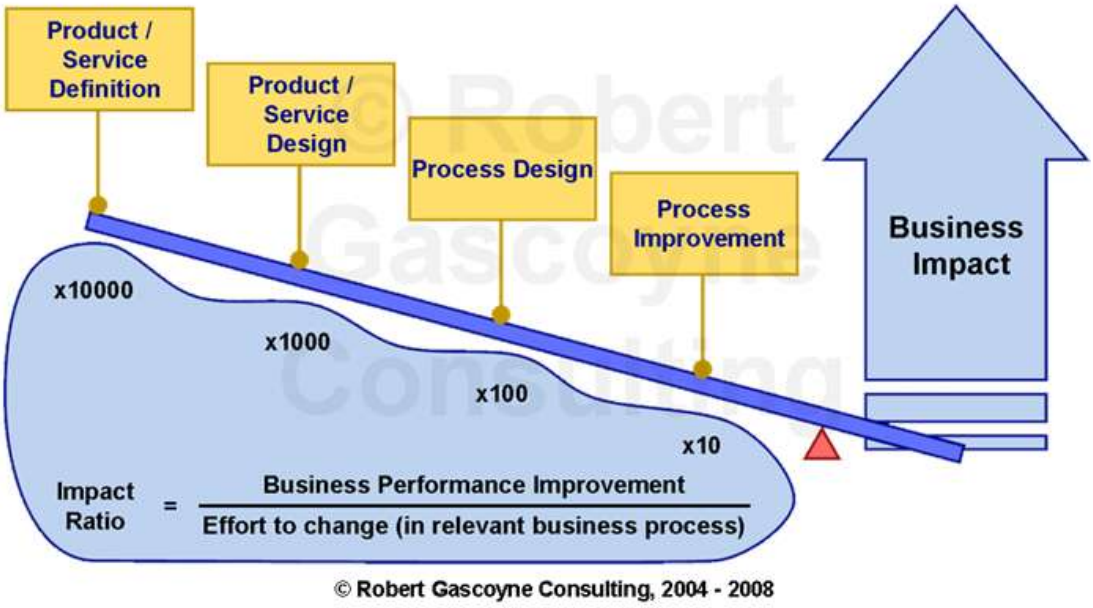

Figure 2: Impact and effect of product definition in the value chain (Source: Gascoyne 2008)

2.2.1 History of the Product Development Process

In the automotive industry the time of restructuring began with the Japanese standards, therefore many of the western companies tried to catch up to be on the same level in the production and product development. Beginning in the early 1990s most companies in the automotive industry started restructuring in the product development process. A dramatic reduction f time for new processes and new products was the outcome; suddenly the process development got a crucial challenge for companies. (Stalk & Hout, 1990: 1) In the second half of the nineties, a lot of Tier 1 suppliers had already changed their processes, which were apparently proving success. (Jürgens 2000: 1)

2.2.2 Product Development Performance

The international comparison shows the product development performance, lead time, product development, productivity and total product quality (TQM) from Japanese car makers and US respectively European car makers. In the supplier business, these trends can also be seen. Like shown in Figure 3 and Figure 4, the Japanese have a significant advantage in lead time and productivity of product development compared to US and European market. (Jürgens 2000: 24)

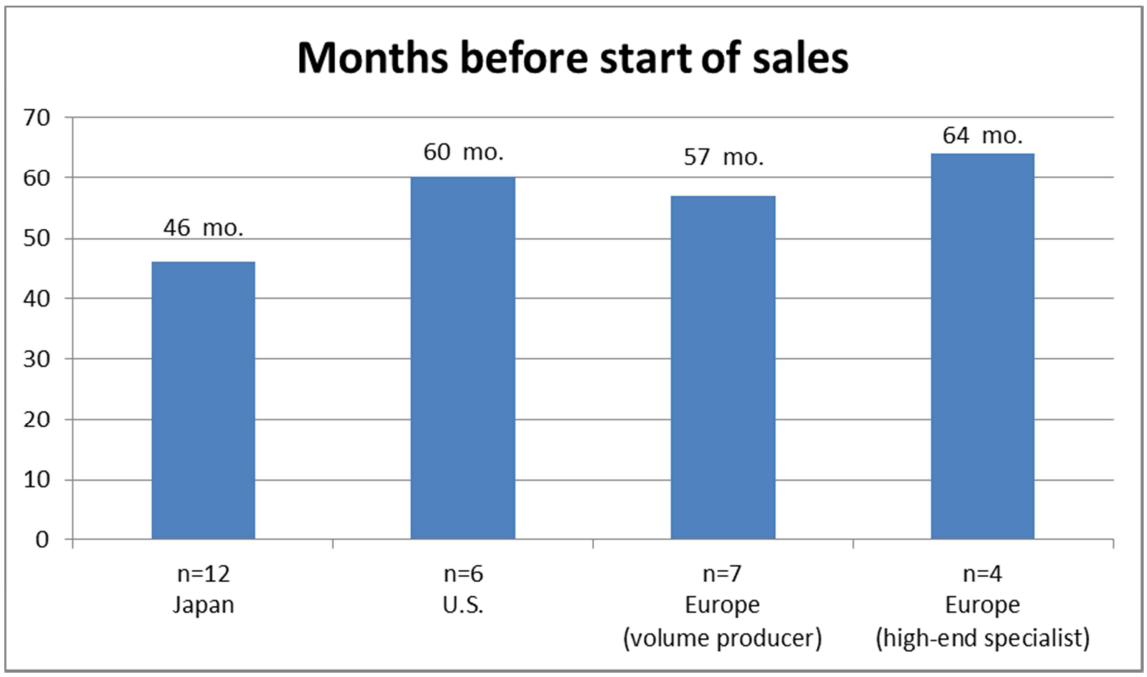

Figure 3: Adjusted lead time by regional strategic groups (Source: Jürgens (2000): 24)

The Asian car makers need from concept study to start of sales about 1.7 million person hours on average. Compared to these facts, US car makers need more than 3 million person hours. In addition, the Asian are also a year faster in completing a whole project than the western producers. This means that the Asian car producers are much more efficient than the western producers. Summing up, the Asian car industry gains a massive advantage because they focus like shown in Figure 3 more on the product design, which leads to a well-designed product and an optimized production process. (Jürgens 2000:24)

The main goal of the future product development to reduce lead time is, that engineers and managers have to shorten, reduce or simplify their activities at all stages, overlap critical paths and to definitely reduce the iterations for solving problems. Considering these recommendations without reducing the quality of the product and focusing on the time before the start of production is mandatory. (Jürgens 2000:38)

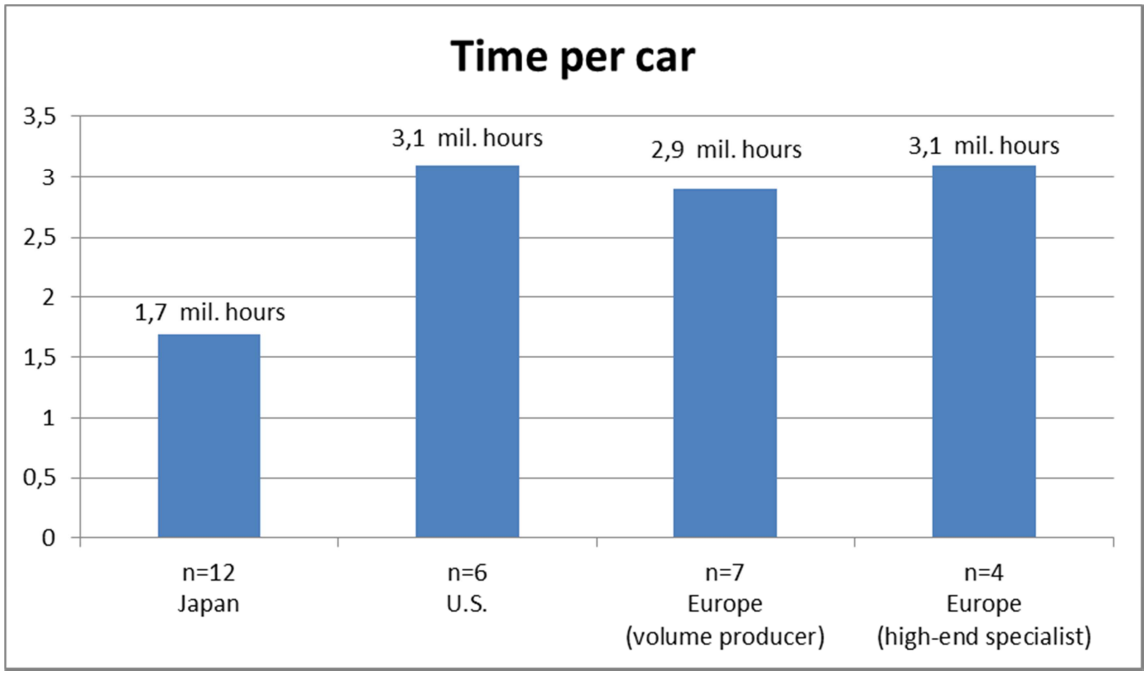

Figure 4: Adjusted engineering hours by regional- strategic groups (Source: Jürgens 2000: 25)

2.3 Customer-supplier-relationship

A variety of stages is included in a typical supply chain which consists out of a raw-material supplier, followed by manufacturer and distributor, retailer and at least the customer. There are dynamic processes within a supply chain – there is a constant flow of information, product and funds between the different stages. (Chopra et al. 2013: 14)

The customer on top of the supply chain is the one who decides if the quality of the product is satisfactory or not. He is the only stakeholder who brings in revenue and therefore it is necessary to fulfill the requirements and the customer's needs. The requirements are initialized by the customer but nevertheless it is important for the quality of the product to manage every stage of the supply chain well. (Hoyle 2005: 9) In this thesis especially the management of the customer-supplier-relationship as a part of supply chain management is analyzed in detail.

2.3.1 Organization of supplier relationship considering customer expectations

Everybody, especially customers of the automotive industries, has wishes, requirements and expectations which have to be fulfilled. Expectations never follow certain standards, they are always individual and depending on each human being and expectations are implied requirements. Each participant of the market takes his own expectations for granted and expects the maximum of cooperation and flexibility of its customers and suppliers – expectations which are fulfilled only seldom. This leads sooner or later to problems and make clear requirements and standards mandatory. (Hoyle 2005:4ff)

To follow a certain, repeatable path saves time – it is economical and furthermore the fastest way to get things done and problems solved. These criteria's are essential for business – following certain standards is essential for efficient processes and projects. (Hoyle 2005:4)

It is very important for every organization to focus on its customers, but also not to forget its suppliers. The relationship between a customer and a supplier developed to a much more intensive connection in the last years, also because of fewer partners. Nevertheless there is a benefit for both parties – they are bound stronger to each other and benefit from this in future. (Hoyle 2005:20)

Current literature describes, that it is necessary for organizations to evaluate their own production with the view to analyze if it still makes sense to produce their products on their own or if outsourcing of the whole or at least parts of production would increase the efficiency. Also because of more and more outsourcing, almost every organization has to work on the improvement of the relationship with its suppliers. Therefore different experts agree that it makes sense to work with the same or at least with a similar system as the Japanese rivals already do since quite a long time. This system requires building up a close-knit network of vendors which can continuously learn from each other and also improve their quality. (Liker et. al. 2006:26)

Nevertheless, the automotive industry gets an information overflow day by day. The problem is that this information does not lead the suppliers to an overall understanding. People like Deming or Juran wrote about quality management in the 1950s. Their output was a set of principles which was not only readable for specialists. (Hoyle 2005:4) Especially the principles of Deming are useful to improve quality based on learning. The main aim of these principles developed by Deming was continuous improvement of the production process based on a cycle with four steps; these are going to be described in detail on page 43. (Stamatis 2001: 17f)

2.3.2 The Supplier Partnering Hierarchy

To fulfill the expectations and requirements of the customers, on the one hand the own production has to be well managed in terms of efficiency and quality but on the other hand also the collaboration with the suppliers has to be on a high level to ensure the quality of the delivered products. (Zink 2004: 43ff) To ensure a defect-free manufacturing at the customer's plant, suppliers have to be reliable and quickly deliver their materials. To reach this goal, personal relationship is mandatory. (Fredendall 2001: 147) The common trend is to intensify the relationship with suppliers which lead to a decrease of the number of suppliers – this is called "Single Sourcing". (Zink 2004: 48) Therefore it is necessary to attach importance to an efficient and intensive long term-relationship with the suppliers.

One way to organize and evolve the customer-supplier-relationship is shown by the Supplier Partnering Hierarchy which has its origin from Honda and Toyota. It shows how to work very close together with suppliers and represent the six main stages of supplier development. (Liker et al., 2006: 31)

Conduct joint improvement activities. • Exchange best practices with suppliers • Start with kaizen projects at supplier plants • Set up study groups of suppliers
Share the right information intensively but selectively. • Set specific places, times and agendas for meetings. • Share information in a defined and structured way. • Insist on accurate data collection
Develop the technical capabilities of suppliers. • Develop a common company lexicon. • Teach suppliers how to work with problem solving skills. • Hone the innovation thinking of suppliers.
Supervise your suppliers. • Send monthly feedback to your suppliers. • Get part of the management involved in solving problems.
Turn supplier's rivalry into an opportunity for your company. • Source each product from more than one vendor. • Create easy understandable production systems.
Understand the way how suppliers are working. • Respect the suppliers. • Learn about the business of the suppliers. • Go and see how they are working.

Figure 5: Partnering Hierarchy (Source: Liker et al., 2006: 31)

The partnering hierarchy (see Figure 5) shows a pyramid which includes six steps of the development of the customer-supplier-relationship. At first an understanding of how suppliers work is necessary. This can be done by visiting the suppliers and

learning about their business. The second step is to turn rivalry into opportunities by sourcing components from more than one vendor. Monthly feedback and solving problems with the management of the suppliers is the third step of the pyramid. With the next step, the development of the technical capabilities of the suppliers should be supported. This could be done by honoring and developing their innovation and problem solving skills or for example by introducing a common lexicon. With the fifth step of the hierarchy, the information flow should be designed intensively but selectively – this means setting specific times and agendas for meetings and share information in a structured way. On top of the pyramid the corporate improvement of the supplier and the customer is the goal. This could be implemented by exchanging best practices, setting up study groups or even by initiating Kaizen projects at supplier's plants. (Liker et al. 2006: 30f)

Summing up, the Partnering Hierarchy is one way to deal with suppliers, especially to intensify the relationship by different actions. This pyramid includes most of the described topics of this thesis. The topic APQP of the next chapter (see page 16ff) could be one of the joint improvement activities of the sixth step of the pyramid. The benchmark analysis on page 28ff compares different supplier specifications which are useful to inform suppliers in a structured way. This is anchored in the fifth step, where the way to share information is specified. The possible future strategy described at the end of chapter 4 (see page 70ff), which is an outcome of this thesis, considers furthermore different parts of the Partnering Hierarchy Pyramid.

2.4 Advanced Product Quality Planning (APQP) in the automotive industry

The Advanced Product Quality Planning has its origin from the TQM Total Quality Management; it is a quality system for the entire company and everyone within the company. APQP is a continuous project management and quality planning tool for all phases of a product life cycle. (Conti 1993:8) Quality planning in general is obligatory for the competitiveness of the automotive industry. At the time when quality planning is implemented properly in the company structure, it enhances suppliers to produce and develop products, parts and also systems and components that satisfy their customer's needs. To reach this goal, quality planning is obliged to work with requirements and principles based on the APQP standard, which helps to avoid failures in the production process. (Stamatis 2001: 20)

Why using APQP?

The automotive industry knows that many different things along the whole supply chain are not really efficient and could be done in a better way. Facing these problems, APQP is used very often in this industry. Nevertheless, the main question is why these things go wrong. (Stamatis 2001: 25) Advanced quality planning is based on a methodology that yields a quality plan for the definition of a process, product or service which is compatible with customer requirements. APQP offers to both, to the customer and the supplier, a systematic approach to improve the quality of planning, prevent defects and to intensify CIP (Continuous Improvement). (Stamatis 2001: 26)

The Continuous Improvement is also anchored in the Supplier Partnering Hierarchy, which is described in detail on page 13. It is a tool which can also be called Kaizen – this is a Japanese word for improvement – and comprehends continuous improvement in different fields of personal life and business. Therefore it can be classified in

the joint improvement activities of customers and suppliers under the aspect of Kaizen projects. (Hoyle 2005: 681; Liker et al. 2006: 31)

When using APQP?

The implementation and application of APQP is especially necessary if expectations and requirements of customers should be met or even exceeded. This happens in the following points:

- During the development of new products and processes,
- while talking about changes in products and processes,
- if quality problems appear,
- after the relocation of a tool or product to a different production location. (Stamatis 2001: 27)

To work with the APQP process it is a must, that all activities are measurable. The documentation has to describe who has to do the measuring, what is the specification about, where is it necessary to measure and when should the responsible person measure. All ongoing activities have to be tracked, if possible by describing work schedules and objectives. Finally all activities most have the focus on the goal of quality-cost-delivery, using all given information to improve quality. The focus of APQP is to reduce costs while increasing quality and reducing lead time. (Stamatis 2001: 29)

The APQP process is characterized through four techniques:

- Failure Mode and Effects Analysis (FMEA)
- Statistical Process Control (SPC)
- Measurement System Analysis (MSA)
- Product Part Approval Process (PPAP) (Stamatis 2001: xx-xxi)

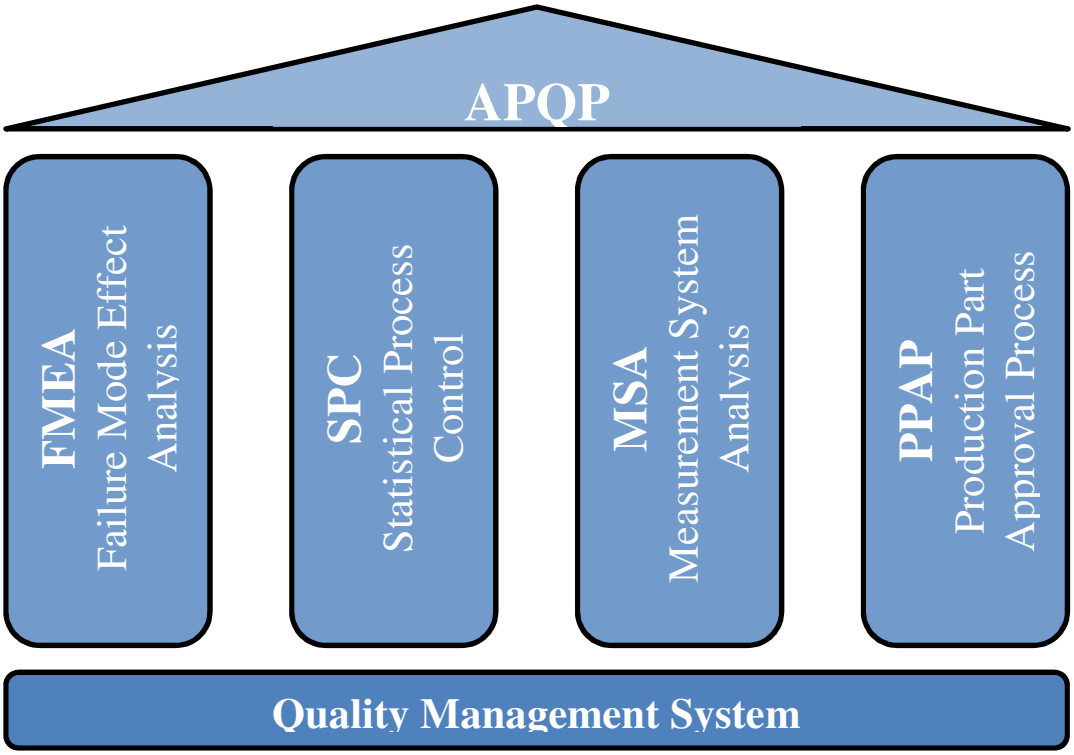

Figure 6: The four main techniques of APQP (Source: Author)

2.4.1 Failure Mode and Effects Analysis (FMEA)

Failure Mode and Effects Analysis is a technique to identify potential failure modes and to eliminate the occurrence of the failure. There are in general two different types of FMEAs:

- The Design FMEA (D-FMEA)
- The Process FMEA (P-FMEA)

Every FMEA is a living document – this means that it is not possible to finish a FMEA; it needs to be updated continually for customer needs and new expectations. The D-FMEA is one of the four pillars in the APQP process. It includes previously selected product and process characteristics. (Book et al. 2008: 18)

A P-FMEA should be developed at the same time as quality planning starts and additionally before serial production starts. In general the P-FMEA is the specification for every machine which is built for the product, because the P-FMEA includes all needed information regarding quality checks. (Book et al. 2008: 27) Different studies in the automotive industry have shown that the complete and full implementation of Failure Mode and Effect Analysis would have prevented many former complaints. An FMEA is meant to be a "before the event" action and not an "after the fact" exercise. Consequential the implementation of a FMEA should be done as early as possible to improve quality. Starting upfront with a FMEA can reduce or eliminate waste and cause preventive or corrective change. It is absolutely mandatory to install a FMEA-moderator who is responsible within the company that communication between the project team and between all types of FMEAs is given. . (Ford Motor Company 2004: 2-4)

The general purpose of a FMEA:

- Saves time and money because of no redevelopment of a product
- Clear documentation of all actions which are taken to reduce the risk
- Part of a “Lessons learned Tool”
- Increases the safety of the process
- Improves the quality of the product and process
- Defines special characteristics
- Increase of customer satisfaction. (Ford Motor Company 2004: 2-5)

2.4.2 Statistical Process Control (SPC)

Statistical Process Control has its origin in the Second World War, where the US Army implemented SPC to have successful tank production with very high quality standards. After the Second World War, at the beginning of the late 40s and early 50s, the Americans supported the Japanese people in the development of their products; the leading of this support was done by Juran and Deming. (Regius 2006:3)

Statistical process control is the immediate quality steering - working with SPC is kind of working with statistical methods to get well done capability in the process. The main tools of SPC are check sheets and calculation check sheets which are used to increase the quality of the process and the product itself. The results of the quality steering are recorded on quality norm cards to get an overview of the correlation between the production process and the product. This means, SPC is not only valid for processes; it is an interaction between the process and the realized product. It is necessary to differentiate exactly between these both groups during the process of steering – it has to be clear at every stage of the check, which group is taken under consideration. (Geiger & Kotte. 2008: 381)

The output characteristics of such a process can be expressed graphically as a probability distribution. In Figure 7 a sensitivity curve which is a loss function is shown, this function has its lower (LSL) and its upper (USL) tolerances. In the figure below it is obvious, that the loss to the customer increases the more the process center deviates from the target.

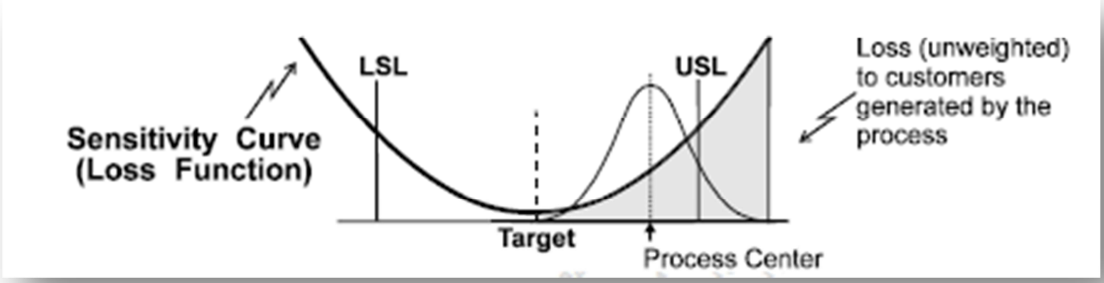

Figure 7: Alignment of Process to Customer Requirements (Source: Statistical Process Control SPC 2nd ed., 2006:168)

To improve the negative trend and to optimize the process, the process center has to be aligned with the customer specification target. The sensitivity curve shows the way of the production process. There are positive effects if the customer variation around the target center value is continually reduced. These process or analysis based on the results of the steering process is called aligning the "Voice of the Process" with the "Voice of the Customer". It can also be designated as a feedback system. (Gryn 2005: 153)

2.4.3 Measurement Systems Analysis (MSA)

In the industry not all processes and product characteristics require a complicate measurement system. Most of the time simple standard tools like calipers or micrometers are adequate and do not require an intensive strategy planning. In some specific cases, especially when the customer identifies risks in the components which have to be measured the APQP committee has to decide about the measurement strategy at the supplier. (Down et al. 2010:24)

To deal perfectly with variations in the process, the APQP team has to have knowledge of:

- What should happen during this process?
- What happens during this process?
- What can go wrong in the process? (Down et al. 2010:13)

The activity of inspection is an evaluation of parameters and results of the processes. It is the act of checking process parameters in assembly or subsystem parts or in complete serial products and end products. The output should be a confirmation if the process is operating in a stable manner with a not too high variation according to the customer target. The only need is to fulfill the customers' needs according to the specifications. There is no discussion about the need of well worked gages, but to provide enough and the right gages a management decision is more or less necessary. (Down et al. 2010:14)

To get a clear understanding, a measurement system is the collection of different instruments, gages, methods, fixtures, environment and operations to quantify a unit of measure, basically the complete process to obtain measurements. (Down et al. 2010:5) For a process in the automotive industry it is very important that the ability to detect some differences in process variables is given. It should be a target that most of the operators have the ability to measure their part according to define measure analyze improve and control (DMAIC) on their own. (Gorman et al. 2002: 1)

In every current business measurement systems play a very important role, nearly all production personal is judged according to some measurement systems. So each measurement system has to satisfy its customer's needs, it doesn't matter if we speak about the automotive industry or not. To satisfy the customer, the following points have to be fulfilled:

- A stable process has to be given at any time of the measured period
- The process has to be accurate - this means, that after each measurement a comparison with the target has to be made
- A linear process of measurement has to be given - this means that the result is not up to the person that executes the measurement
- The process of measurement has to be repeatable, this means that the process of measurement is the same at every time of the year
- The process has to be reproducible – this means if other people are using the measurement system in the same way, they get the same result (Abila 2006)

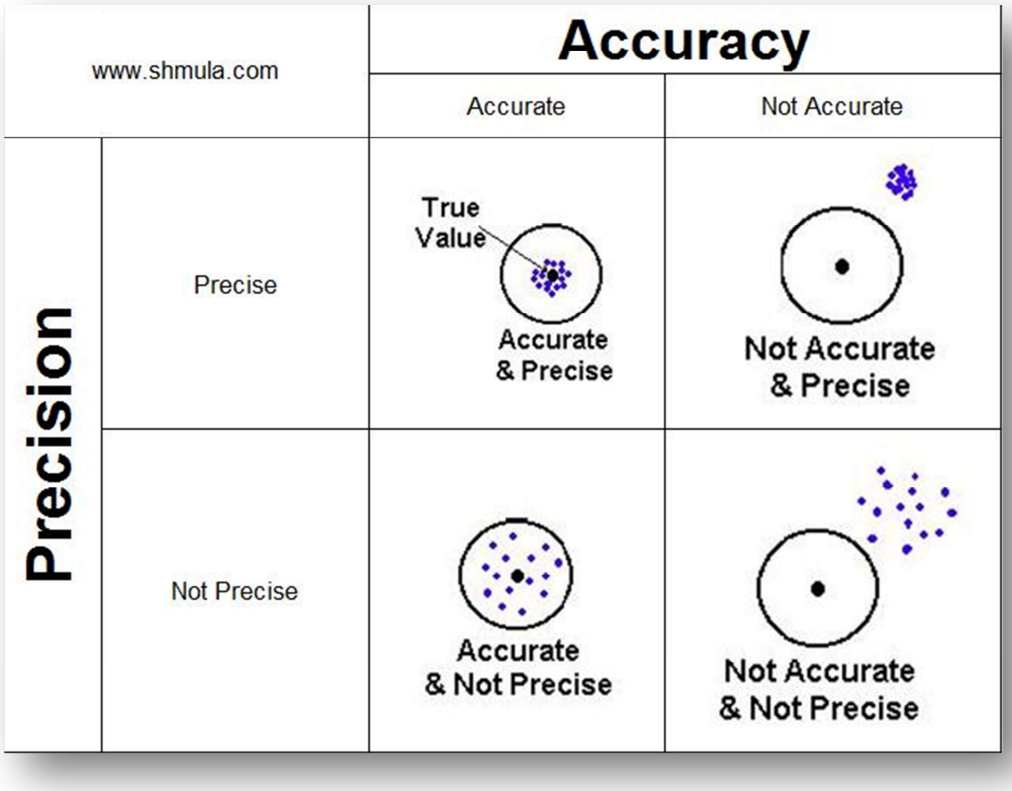

Figure 8: Description of Measurement system analysis (Source: Abila 2006)

The figure above categorizes measurement into four categories:

- The measurement system analysis can be accurate and precise.
- The measurement system analysis cannot be accurate and precise.
- The measurement system analysis can be accurate and not precise.
- The measurement system analysis can be not accurate and not precise. (Abila 2006)

2.4.4 Production Part Approval Process (PPAP)

The PPAP process is the last column of the advanced product quality planning. According to most of the quality systems which are implemented in the automotive industry the PPAP process has its origin at Ford, Daimler and General Motors. It describes the methodology in which all situations out of a release process are taken under consideration. The Production Part Approval process is a standardized system for the release of a product from a supplier and in generally takes place in the automotive industry. The purpose of the PPAP process is to check all the specifications and the design of the supplier - for example if it is possible to produce the part under serial conditions. (Linß 2007:153)

To get all information the automotive industry Action Group describes a PPAP handbook with 19 diverse points:

- Design record
- Documents of technical changes
- Technical release
- D-FMEA
- Material flow analysis
- P-FMEA
- Measurement results
- Records of material and performance tests
- Check of capability studies
- Analysis of Measurement systems
- Documentation of a qualified labor
- Control plan (Linß 2007:153)

The main purpose of PPAP is to verify if all data regarding to customer engineering and specification requirements are understood from supplier side properly, so that the manufacturing process has the potential to produce the final product without any failures and problems in a certain time and with the specified quality. If all these points are fulfilled, the quality management can proceed with the part submission warrant (PSW). The PSW is a kind of sample inspection which takes place in 5 different levels. (Daimler Chrysler et al. 2006:1) The task of the organization is to verify if all information and each measurement and test result has a conformance with the need of the customer. The normal procedure is that a responsible official person, normally a quality auditor, approves the Production Submission Warrant and provides contact information. (Daimler Chrysler et al. 2006:11)

2.5 Summary and need for action, further proceedings

The Automotive Industry is the biggest industry on globe, based on the great demand for automobiles its continuance is not threatened. This industry went through rapid changes in the past, also nowadays reaction on changing customer requirements and priorities are mandatory. More and more components are produced by suppliers and sub-suppliers. This leads to an increase of the communication with the suppliers and also the significant value of this communication rises.

To fulfill the customer's expectations, every stage of the supply chain has to work well. Therefore it is already necessary to optimize and improve the customer-supplier-relationship which is basically needed to be able to deliver products with high quality standards to the consumer. Despite the increase of outsourcing, the number of suppliers is decreasing which means that the relationship between the customer and its suppliers often develops towards a kind of partnership. The development of the relationship of specific suppliers can be selectively supported by using methods like the Supplier Partnering Hierarchy. These six steps show how it is possible to intensify the collaboration and develop it to a long-term, friction-free relationship.

Efficient and well managed production processes, very often according to standards and systems of the Asian market, are the most important task which has to be done already during the product development. The planning and optimization of these processes is often supported by the tools of APQP which has the aim to avoid failures and optimize production processes in advance – this leads to a reduction of costs and an increase of quality, caused by the implementation of the four main techniques: With FMEA it is possible to identify failure modes and eliminate the occurrence of these failures. SPC helps to get well done capabilities in the process by using statistical methods. MSA is an analyzing tool to ensure that the process of measurement is operation in a stable manner. The technique of PPAP describes the methodology for the release of a product in the automotive industry.

Based on the description of each of the mentioned chapters itself and the described context of the topics it can be resumed that in times of the increase of outsourcing an efficient and intensive customer-supplier-relationship is necessary to fulfill customer requirements and ensure quality standards. The basic needs for an efficient collaboration and production are also well managed processes which can be planned by using APQP. The planning has to start already during the product development – the more effective the earlier they are considered.

In the next chapters of this thesis, important issues of this literature review are going to be analyzed regarding their practical application. Furthermore – especially because of the focus of this thesis on the customer-supplier-relationship – it had to be dealt with supplier specifications as they are the basic document for this relationship. In the next chapter the common basis for defining supplier specifications, the APQP manual which is published by the AIAG, is described. To develop an improved supplier specification it was necessary to analyze the supplier specifications of three different suppliers, nominated as excellent suppliers by internal experts, regarding the regulated content and considering the occurrence of the elements which are the basis for the customer-supplier-relationship.

After this benchmark the results of a survey which was done with suppliers of MAHLE is going to be analyzed in detail – especially regarding the availability of information for the suppliers, the collaboration with MAHLE and the application of APQP in the interviewed companies.

Conclusively derived from literature review, benchmark analysis and the results of the survey, possible suggestions for improvement of customer supplier relationship are going to be described.

3 Benchmark of supplier specifications

Implementing a new or redesigned specification or policy is very easy but to work with the document with the suppliers is a challenge. The task of the management is to reflect what the organization already believes and what the organization is implementing in the future regarding standards and documents. Presentation and communication of the specification is about gaining understanding but it is not the key for success. It would be easy just to send the message from one source to another but it is much more complicated. In the hierarchy of suppliers there are different levels of skills – some of them understand the specification easily and some levels need a translation or training by their local manager. (Hoyle 2005:231)

One method to check if all the information in the specification is understandable and easy to follow is an audit program. Auditing is a way of verifying whether the chosen method has been effective or not. (Hoyle 2005:232)

APQP guideline

Like mentioned before, there is no real guideline in how to write a supplier specification, but very often there is an Advanced Product and Quality manual. This manual provides that the Advanced Product Quality Planning is implemented in accordance with the needs and requirements of the customer. To keep in mind, there is no specific instruction on how to reach each specific APQP or control plan entry - this is what every organization itself has to define. Nevertheless the APQP manual is a guideline which makes the development for every single supplier easier. The authors of the general guideline are managers from all over the world who developed it together with the big OEMs like Chrysler, Ford, General Motors and with some suppliers like Delphi and Eaton. (Book et al. 2008: iii)

The APQP manual covers about 100 pages and has its origin in the Automotive Industry Action Group, the so called AIAG. Its main chapters deal with the preparation of programs, the design and development of the product and process, their validation and also with the feedback and corrective action plan as well as with a description of the whole methodology itself.

The following listing gives a detailed overview about the content of the APQP manual published by the AIAG (Book et al. 2008: v-vi):

- Introduction
- Business overview
- Fundamentals of Product Quality Planning
  - Organization of the Team
  - Definition of the Scope
  - What happened during Team to Team
  - Training
  - Customer and Organization Involvement
  - Simultaneous Engineering
  - Control Plans
  - Concern Resolution
  - Product Quality Timing Plan
  - Plans Relative to the Timing Chart
- Plan and Define Program
  - Voice of the Customer
  - Business Plan and Marketing Strategy
  - Product/ Process Benchmark Data
  - Product/ Process Assumptions
  - Product Reliability Studies
  - Customer Inputs
  - Design Goals
  - Reliability and Quality Goals
  - Preliminary Bill of Material
  - Preliminary Process Flow Chart

    - Preliminary Identification of Special Product and Process Characteristics
    - Product Assurance Plan
- Management Support Product Design and Development
    - Design Failure Mode and Effect Analysis (DFMEA)
    - Design Manufacturability and Assembly
    - Design Verification
    - Design Reviews
    - Prototype Build – Control Plan
    - Engineering Drawings
    - Engineering Specifications
    - Material Specifications
    - Drawing an Specification Change
    - New Equipment, Tooling and Facilities Requirements
    - Special Product and Process Characteristics
    - Gages/Testing Equipment Requirements
    - Team Feasibility Commitment and Management Support
- Process Design and Development
    - Packaging Standards and Specifications
    - Product/ Process Quality System Review
    - Process Flow Chart
    - Floor Plan Layout
    - Characteristics Matrix
    - Process failure Mode and Effect Analysis (PFMEA)
    - Pre- Launch Control Plan
    - Process Instructions
    - Measurement Systems Analysis Plan
    - Preliminary Process Capability Study Plan
    - Management Support

- Product and Process Validation
    - Significant Product Run
    - Measurement System Analysis
    - Preliminary Process Capability Study
    - Product Part Approval
    - Product Validation Testing
    - Packaging Evaluation
    - Product Control Plan
    - Quality Planning Sign- Off and Management Support
- Feedback, Assessment and Corrective Action
    - Reduced Variation
    - Improved Customer Satisfaction
    - Improved Delivery and Service
    - Effective Use of Lessons Learned/ best practices
- Control Plan Methodology
    - Control Plan Column Descriptions
    - Process Analysis

The table of content above shows the state of the art guideline in how to handle an APQP process in automotive industry. This APQP process should be the basis for every supplier specification. (Book et al. 2008: iii)

3.1 Analysis of supplier specifications

Worldwide competition and changing customer expectations require an excellent relationship between the manufacturer and its suppliers. High quality standards for both of them are mandatory to meet customer's expectations – this requires continuous improvement of all products and services as well as an optimization of processes and company procedures. For long term success it is necessary, that the manufacturer

can rely on the quality, costs, service and used technology of its supplier. The main target of such supplier specifications is to give the necessary requirements and information to ensure a friction-free product and process development to the supplier to be able to deliver high quality to the customer. (Deutz AG 2011: 1, Krug et al. 2011: 5, Mehring 2012: 2f)

Policies and procedures which are often split to different documents are consolidated in supplier specifications or a supplier manual. Nevertheless supplementary documents are needed to regulate special terms and conditions. It is possible to include the supplier specifications already to the invitation of tenders – this causes the possibility to inform potential suppliers about necessary standards even before they participate in the tender. (Weilguny et al. 2012: 24)

In this chapter the current specifications and strategies of some important suppliers are going to be analyzed. According to the best known suppliers in the automotive industry, which also have subjective perceived specifications on a high level, five big companies have been suggested by the tutor of MAHLE. On the part of the author three out of these five suppliers have been selected after all supplier specifications have been reviewed. The main criterion for the selection of the three analyzed suppliers was the subjective wide scope of the specifications.

At first, the main points of the analyzed supplier specifications have been highlighted, after a generalization of the mentioned parts in these manuals, they are compared to each other.

3.1.1 Thyssen Krupp Presta Camshafts

Thyssen Krupp is a leading manufacturer of assembled camshafts on the world market. The company is decisively determined by the quality of products and the price. Thyssen Krupp camshafts employees approximately 1800 people in 5 locations, with more than 25million produced camshafts every year. (Thyssen Krupp Presta Camshafts 2012: http://www.thyssenkrupp-presta-camshafts.de/language-gb/index.htm, accessed on 29.05.2013)

The objectives of the company contains:

- Competence and expertise in material selection,
- customer oriented logistics represent the strength,
- high quality standards,
- lightweight innovations. (Thyssen Krupp Presta Camshafts 2012: http://www.thyssenkrupp-presta-camshafts.de/language-gb/produkte/produkte.htm, accessed on 29.05.2013)

It is only possible to fulfill the whole philosophy if all employees are motivated and reliable. Thyssen Krupp remarks in their supplier specification that the production of their products is every time flawless, this is what they are also require from their suppliers and throughout the whole supply chain. The company requires also a system how to work efficient with continuous improvement in the supplier's organization. (Krug et al. 2011: 6)

Thyssen Krupp supplier requirements

- General requirements
- Procurement process and supplier management
- Process and product development process
- Production process and product approval
- Series production
- Logistics process (Krug et al. 2011: 8f)

The main mission of the company is to add customer value, combined with new and innovative standards. The employees in the company have a very high significance because they contribute constructive ideas and reach clearly set and agreed targets. In general the specifications are about sustainability in their growth, the company speaks very often about innovative processes compared with business success throughout ongoing product and process optimizations, together with their partners. Summarized the company Thyssen Krupp has its focus on the suppliers, because they know that the only way how to succeed in the business is with a sustainable strategic partnership for the present and also for the future. (Krug et al. 2011: 2ff.)

3.1.2 Magna Europe

The company Magna is one of the most successful supplier and also OEM in the world. Magna works compared to other suppliers completely different. The company especially sets value on social competence. The nine operational principles of Magna are:

- Safe and healthful work environment
- Integrity and respect
- Pride in craftsmanship and total quality
- Recognition and rewards
- Operational availability
- Scrap and waste elimination
- Operational effectiveness
- Communication
- Employee focus (Mehring 2012: 2ff.)

Like mentioned before, five out of nine points regard to people and ethics. Based on this fact, Magna sets a high value on its employees and the topic human beings in general. The philosophy of Magna is to give every employee the opportunity to work

with Magna in a long term relationship. So if employees remain at a company for a long time, they usually have a good and sustainable relationship with all suppliers of their employer. (Mehring 2012: 2ff.)

Magna's supplier requirements

Compared to the other suppliers, Magna's supplier requirements are structured in six main chapters:

- Introduction
- Basic requirements
- Product/process development & part approval
- Serial production
- Material & logistics
- Supplier performance (Mehring 2012: 2ff.)

The specific requirements also apply to ISO/TS 16949 and to ISO 9001and other similar registrations. The specifications are very close to the general APQP manual, but contain also additional particular details concerning communication. The general rules from Magna regarding communication are the following:

- Communicate in a proactive way, that means knowing when to raise the "red flag" by identifying a potential problem,
- communicate to the customer if there are any changes in the material or the process,
- communicate to the customer if there are any changes in the production location,
- communicate to the customer if there are potential failures and problems in the manufacturing process which can cause a quality issue,
- communicate to the customer if there is potential supply or capacity issue.

If there is no clear communication according to following points of Magna these issues will result in internal escalation. If no action is done, the partnership could end up in a non-compliance this will lead to loss of the business. (Mehring 2012: 4)

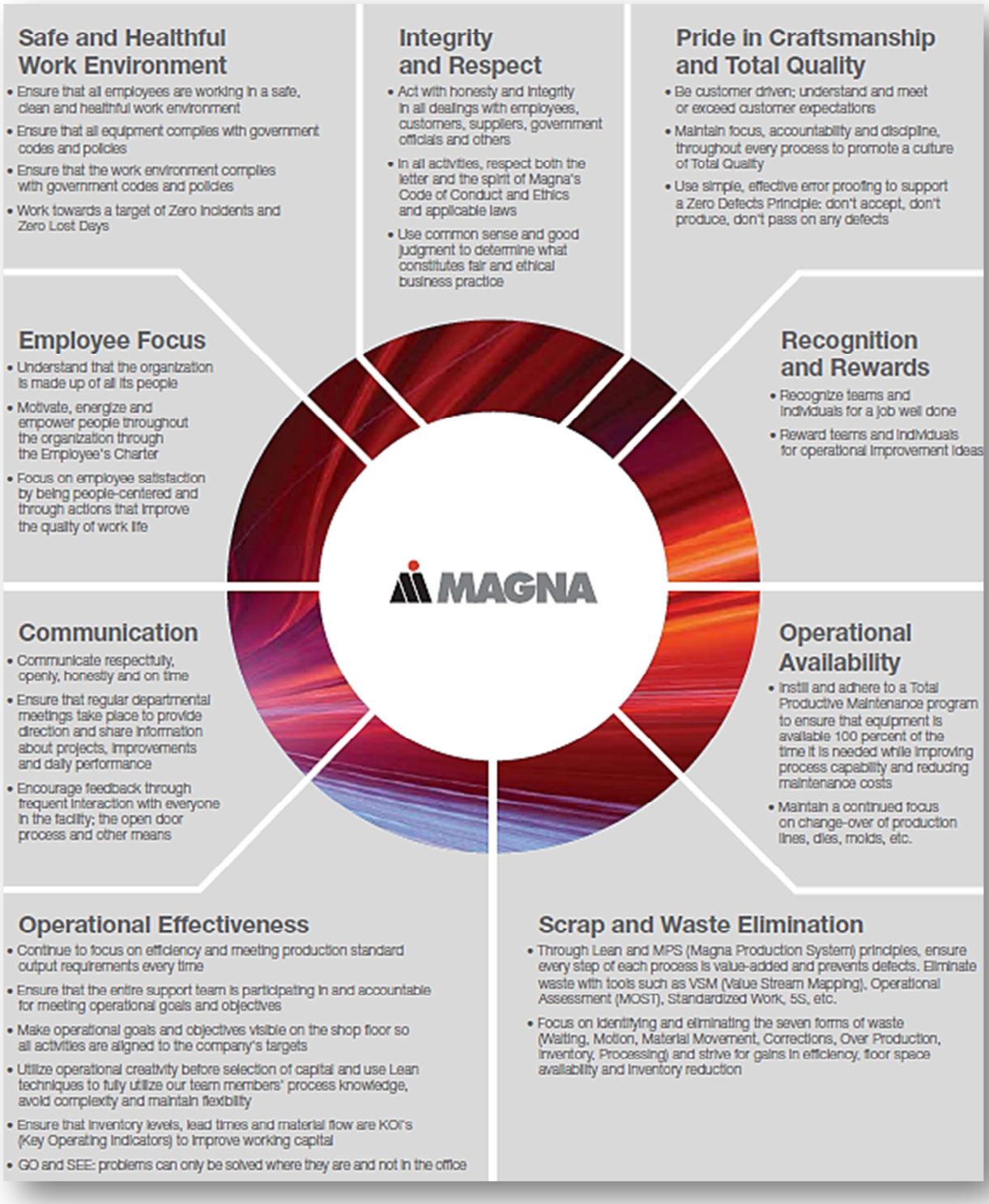

Figure 9: Magna Operational Principles, Annual Report 2012. (Source: Magna International Inc. 2013)

Summarized, the general impression of Magna is that this company sets value on social issues, because in their supplier specification most of the chapters contain policies concerning ethics, global working conditions, environmental issues and protection of workers. Overall, the specifications are oriented at international accredited regulations and routines.

3.1.3 Deutz AG

Deutz was the first engine manufacturer in the world and they want to remain the best also in future. Changes of customer requirements and worldwide competition moved Deutz to a continual improvement of all products, services and business processes. (Diederich 2012: Deutz Management Philosophy. http://www.deutz.com/company/corporate_philosophy.en.html - accessed on: 05.04.2013)

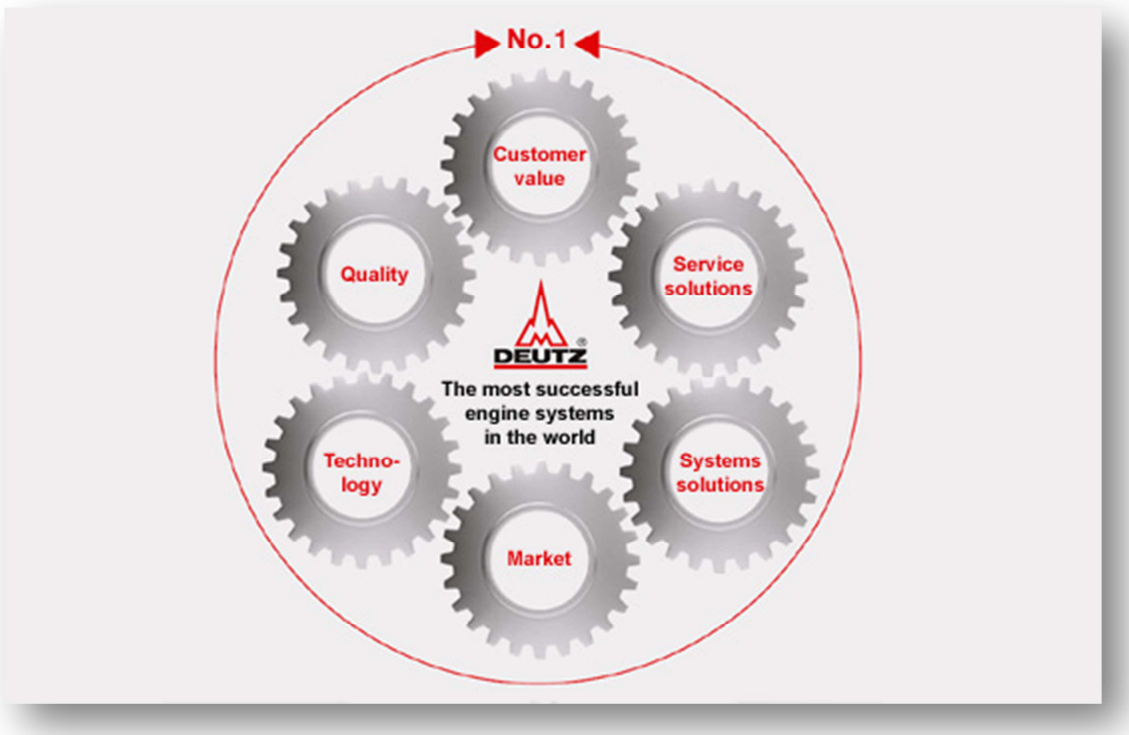

Figure 10: Deutz Management Philosophy. (Source: Diederich 2012)

Having a look on the supplier specification, Deutz is working with 5 main chapters:

- Introduction
- Basic requirements
- Qualification process
- Series monitoring
- Further agreements

(Diederich 2012: Deutz management philosophy. http://www.deutz.com/company/corporate_philosophy.en.html, accessed on: 15.03.2013)

Deutz wants its suppliers to get the needed information not only from its specifications, they also reference to additional sources. For example, Deutz refers to the following documents:

- VDA 6.1 and VDA 6.3
- APQP, MSA, SPC

or generally in:

- ISO / TS 16949
- DIN EN ISO 14001.

(Diederich 2012: Deutz management philosophy. http://www.deutz.com/company/corporate_philosophy.en.html, accessed on: 15.03.2013)

Another requirement is that the supplier has to proof and submit the validation of the certificates of its company by an accredited certification association. (Deutz AG 2011: 2)

Deutz is working with a standard supplier specification handbook with a clear structure, refers to APQP processes and other documents which have been described before.

3.2 Generalized overview of the supplier specifications

In the previous chapter the special features of three excellent supplier specifications have been described and accentuated exemplarily. To get an overview about the content and regulated issues, they are compared to each other afterwards in a matrix in which the different elements have been generalized.

To make the extensive documents of these different suppliers comparable, a generalization of the mentioned phrases was done and the generalized phrases have been filled in a matrix (see Figure 11). These phrases are listed in horizontal level in the matrix below. After this, the specification of each supplier was checked in detail and the occurrence of the generalized phrases was checked and filled in the column of the particular supplier in the matrix. This comparison shows now, how often each of the 31 generalized elements was mentioned in the supplier specifications.

no.	elements	Thyssen Krupp	MAGNA Europe	Deutz AG	Total
1	supplier evaluation – audit	x	x	x	3
2	change request	x	x	x	3
3	complaint management	x	x	x	3
4	quality management system	x	x	x	3
5	customer requirements	x	x	x	3
6	initial sample/evaluation	x	x	x	3
7	packaging / labelling	x	x	x	3
8	traceability	x	x	x	3
9	transport	x	x	x	3
10	business language	x	x		2
11	health, safety and enviroment	x	x		2
12	project planning	x	x		2
13	subcontractor	x	x		2
14	APQP (FMEA, MSA, SPC, PPAP)	x		x	2
15	drawing and characteristics	x	x		2
16	feasibility analysis	x	x		2
17	supplier rating	x	x		2
18	continious improvement	x	x		2
19	electronic date interchange	x	x		2
20	Confidentiality		x		1
21	ethics and working conditions		x		1
22	lessons learned	x			1
23	IMDS (international material data system)		x		1
24	flow chart	x			1
25	control plan	x			1
26	capacity planning	x			1
27	planning of preventive maintenance	x			1
28	request for special release	x			1
29	escalation level		x		1
30	layout inspection	x			1
31	requalification		x		1

Figure 11: Elements of supplier specifications (Source: Author)

In the comparison, nine elements were found in all three specifications. These nine are the main issues of supplier specifications, the mentioned issues are regulated in each of the three compared documents. The issues reach from regulations to packaging/labeling, transport and traceability over initial sample evaluation and quality management to customer requirements. Furthermore the topics supplier evaluation-audit, change request and complaint management have occurred in all three specifications.

The outcome of this analysis is based on and affected by the chosen suppliers. Nevertheless, derived from this analysis these nine elements are obviously the most common and important parts of a supplier specification. Going with the topic of this thesis, the issues packaging/labeling, transport and traceability as well as initial sample evaluation and customer requirements are not taken under consideration. The detailed analysis of quality management system would go beyond the scope of this thesis, although it is in a strong correlation with the main topic. Therefore the three, green highlighted elements in Figure 11, namely supplier evaluation-auditing, change request and complaint management are going to be described in detail in the next chapter. Additionally to each issue a method for optimizing the process was suggested.

3.3 Detailed breakdown of the three main and mostly mentioned elements

Based on the comparison in Figure 11 three out of nine of the most mentioned topics of the compared supplier specification are now described. The aim of this chapter is to give the reader an overall impression about the range and the level of detail of some important topics of the supplier specifications.

After the analysis of the three mentioned points, a possible way for optimizing and improving the particular element is suggested.

3.3.1 Supplier evaluation-auditing

According to ISO 9000 clause 3.9.1 audit means the examination of a result, to verify the accuracy by a non-production person. (Hoyle 2005:679) All suppliers have to conduct internal audits at planned intervals to determine if the current quality proceeding fits to the planned arrangement. The agreed criteria or planned arrangements in this context are the focus and the vision of the management, expressed by the quality objectives, policy and particular requirements for products as expressed by different customers and different regulations expressed by statutes and law. The intervals for audits can be different and start at any time during a year of production – there is no clear workflow when it has to start and how often an audit has to be made.

A change of the quality objectives may happen once in a year. A much faster change happens during the product lifecycle. Therefore the intervals of audit need to be set according to changes in policies and products. Audits in the automotive industry are a very important instrument and represent the measurement component of the quality system. (Hoyle 2005:570)

There are two opportunities which an audit provides:

- Clearness about the current status of products and processes
- The auditor has the possibility to motivate the responsible manager to make changes happen in a short period of time.

The positive outcome of each audit is an improvement of the actual process and product; furthermore the corrective action has to be implemented immediately or at least as soon as possible. The action plan behind each audit is not a punishment; it should be seen as a positive effect to solve problems and work more efficient. Most of the suppliers speak about an enormous amount of time and money that is necessary to make an audit, but it is a very effective tool to improve the quality at each company. It is also possible to trust in the supplier and to assume, that he does regularly audits in his own production. This works as long as the quality of the delivered products is alright, if there are quality issues on the products it is necessary that the

customer himself does a visit at the supplier plant to make an audit and check the reasons for the decrease of quality. (Fredendall et al. 2001: 153)

The main aim of an audit tool is not the identification of faults because there are other techniques for this purpose. The aim of an audit is to verify the functionality of a production process, not the active search for problems or failures in documentations. Nevertheless, if there are such failures or problems, they have to be eliminated as soon as possible. To solve these problems and get rid of these failures, Deming developed a method, called the Deming cycle. (Hoyle 2005:570)

Improvement of processes according to the Deming Cycle

Improving quality should be done continuously. What Deming points out is that a goal without a method for reaching it is useless. Solving problems simply maintains the status quo but for a long term success more than this is necessary. Most improvements come from design or redesign of products and processes or from changes in the organizational system, but not all changes result in an improvement. Therefore, the Deming cycle illustrates an ongoing process which has to be repeated and passed through until the planned status is reached. As long as there are still open issues, the cycle has to start again. (Stamatis 2001: 17)

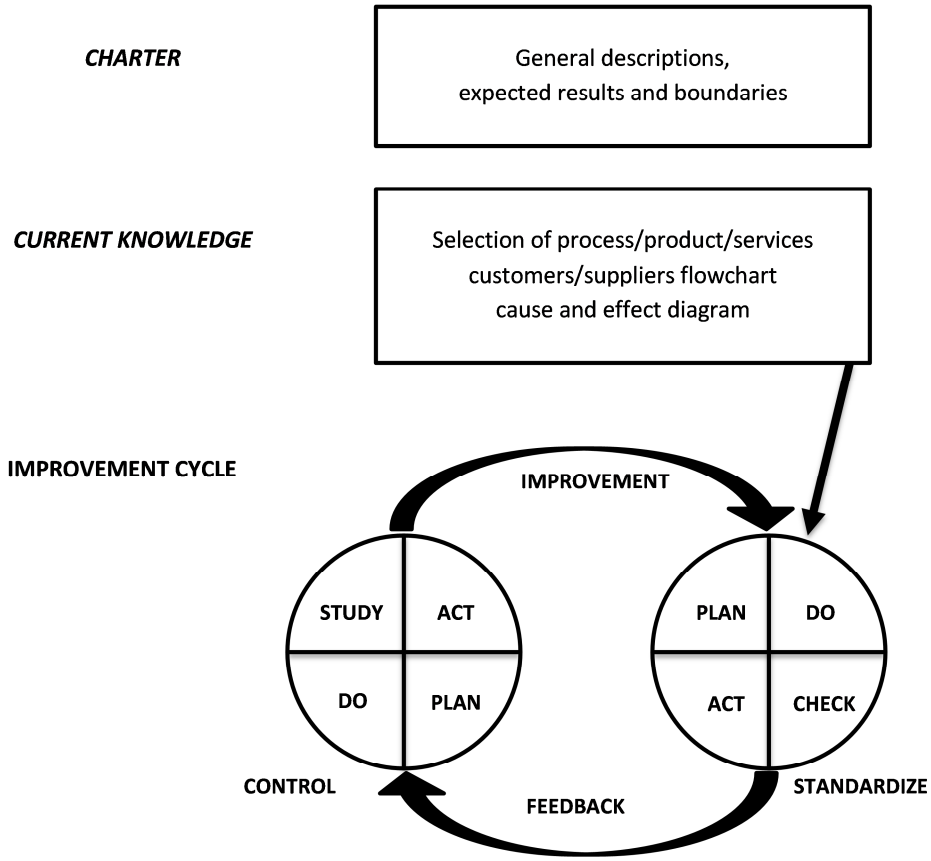

Figure 12: Model to improve quality based on learning, (Source: Stamatis 1998: 18)

The first component in the figure is called charter, it will provide guidance to the team and will support them with some decisions which they will have during a whole project. In the second step, a short introduction about the current knowledge of the team is shown. At this stage of the project the team defines the current knowledge of:

- the most important quality characteristics,
- the relationship between cause and effect,
- customer's needs,
- how the process or the product works.

To improve the whole cycle of quality, a massive amount of time has to be spent on increasing the team's knowledge. With the gained knowledge the team has to develop an improvement. To handle that specific steps and realize the resulting

improvements, a series of improvement cycles is necessary. The different cycles are called PDCA-cycle, or also plan-do-check-act-cycle. (Stamatis 2001: 19)

The PDCA-cycle's steps are going to be analyzed afterwards in detail:

- Step 1: Plan
  Definition of the overall strategy or plan for the organization; this plan can include a vision, a quality improvement, product development plans or operational improvements.

- Step 2: Do
  An action plan is necessary to schedule the project. Also an application of a methodology to modify or change the actual process and product has to be done. In the second step it is possible to make the first trials and test runs with the modified process or product.

- Step 3: Check
  Observing of the result, if needed it is also possible to change the solution. In step 3 it is mandatory to compare the current result with the strategy from step 1, if it is the wrong way, it is the right time to change again.

- Step 4: Act
  Evaluation of the change; learn from the results, again if needed the cycle can be repeated as long as there is a deviation. The proven solution can be extended as appropriate. (Ayers 2006: 168)

3.3.2 Change request

In the automotive industry, it happens very often that during the production process the design or even the functionality of a product based on further developments changes. Therefore, a change request is placed by the customer to the supplier.

To start with any kind of change – at both sides, at the customer and at the supplier's plant – there are a few questions which need to be discussed upfront:

- What process or product is changed?
- Why is it necessary to change?
- What is the positive outcome or the benefit of the change?
- How much does the change cost?
- Are there other solutions and what are the advantages or disadvantages?
- Which is the best solution?
- Is it possible to test if the best solution is effective before the change is done?
- How is it possible to measure the benefits and the positive aspects after the change? (Hoyle 2005:368)

Changes in the automotive industry are most of the time changes of the design which are usually simple modifications of parts of the design. The changes can occur at any stage of the design process, from the time when the specifications are agreed until the final acceptance of the customer. This means, the design or the product is proven by the customer; this procedure is called "Design Freeze". Design Freeze means that after that agreement basically no changes are allowed anymore. Nevertheless, if a change is necessary after the product is already launched in production and it is necessary because of functionality, it is called modification. The wrong handling of changes can cause high costs and generate enormous delays. This means, that the right management of changes is mandatory. (Fredendall et al. 2001: 155)

There are a few points which have to be taken under consideration by managing change requests. To minimize the resistance against changes in an ongoing process it is necessary to work according to the following procedure:

- The change is agreed by all
- The change is supported by leadership and management
- The change follows the company values and culture
- The change decreases the current problems
- The change increases new interests and also experiences
- Reactions to the change are necessary to be discussed by the top management. (Emmett et al. 2009:171)

Every process of change needs a controlling function; therefore change control during the design process is obligatory because collecting the costs and the time is something what has to be forwarded to the responsible person which implements the change. Most of the time a change will cause a delay. As long as positive effects for the production result out of the change, it has to be done immediately. Another point of controlling the design change is to control the limitless creativity of designers in order to keep the design within the fixed budget and timescale. (Fredendall et al. 2001: 155)

Generally, to work with the change management in the automotive industry it is obligatory that every change is based on clear workflow – everybody should have the possibility at any time to have a look at the change process to see the current status. It makes also sense to find out at any time of the product or process lifetime, how the situation was before the process of change; it is very helpful to work with change versions on drawings and documentations. (Hoyle 2005:368)

3.3.3 Complaint management

The complaint management is regulated very detailed in the compared supplier specifications. The description includes information how to handle with faults – this means specifications about the responsible quality manager, how many parts have a failure and how did the failure occur. Different reasons can lead to faults, which also mean that the occurrence of faults can be frequently. On the one hand it is necessary to reduce the occurrence of faults, on the other hand the dealing with complaints due to incorrect quality has to be regulated clearly and managed well organized. Also Deming maintained that the failures in service followed by complaints are inevitable because of the large number of variables involved in service transactions. Therefore the Deming cycle should give enough feedback and experience resulting out of mistakes. These results followed by improvements are the key points for earning success and sustained profitability in the automotive industry. Customer complaints – especially in this branch – are very expensive, nevertheless companies are able to profit a lot and get helpful feedback because every complaint contains the direct voice of the customer. (Gonzalez-Bosch et al. 2001: 1)

To work efficiently with customer complaints and consider customer's needs it is helpful to use the Quality Function Deployment tool.

Quality Function Deployment (QFD)

Quality Function Deployment is a special technique to translate requirements defined by the customers. QFD forces supply chain designers in considering the needs of the customer. Using this principle it is possible to reduce the risk of losing sight of a requirement of a customer. (Ayers 2006: 88)

In general there are two methods to analyze customer wishes and requirements. One of them is the QFD, the other one is the so called "Kano model". (Regius 2006:17)

QFD captures the “voice of the customer” and is used in the supply chain processes commonly. The QFD-house – like shown in the figure below – is also called the “house of quality”. It shows what is known about dealing with customer requirements.

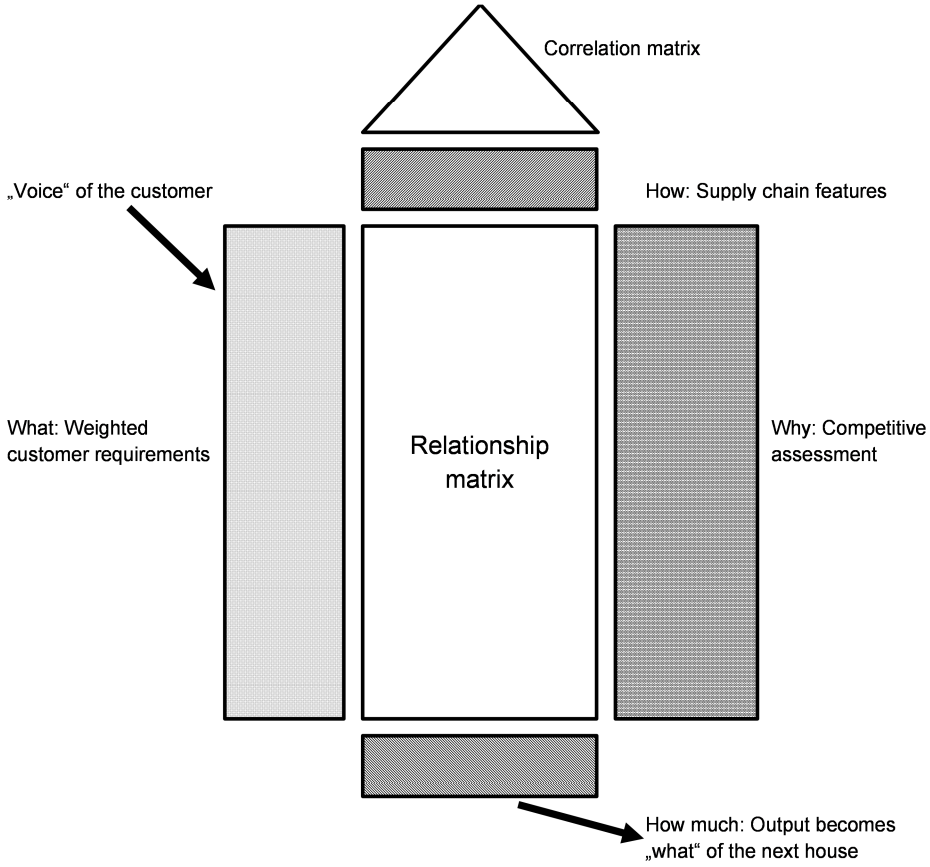

Figure 13: QFD house of quality, (Source: Ayers 2006: 88)

These requirements can be identified by a survey. Examples can be technical support, quality requirements, lead time, pricing and packaging. These are the characteristics to satisfy the customer and are so called the “what” of the house. (Ayers 2006: 88) Like shown in the figure above, the “why” is the so called competitive assessment. It shows the position against other competitors on each customer requirement; it can identify areas and products to turn a functional part into an innovative one. The next word is “how”, which is a list of supply chain features for measuring the current supply chain. The box in the middle is the so called “relationship matrix” which links the customer requirements (the “whats”) with the design features (the “hows”). (Ayers 2006: 89)

In the mentioned “relationship matrix”, the design features are evaluated in terms of their interest to the customer requirements. The outcome of the quality house is the “how much”. This quantifies which needs have to and can be done. The main target is that the team starts a rethink about the design features. (Ayers 2006: 90)

With the QFD-method it is possible to identify the requirements of the customer and check, how they could be implemented technically in the production process. So the outcome is, if the requirements or even complaints are transformed into knowledge about customers, that from this feedback the company can gain experience for the future and provide a valuable amount of information for every enterprise. To work with this capital, companies have to build, design and operate with a continuously growing Complaint Management Systems (CMS). (Gonzalez-Bosch et al. 2001: 1)

Summing up, every quality management tool is helpful and useful to have less customer complaints in the future. Nevertheless, a company can only sustain if the spirit towards total customer satisfaction exists and is realized in the day-to-day operations of the whole company.

3.4 Summary and possible impact

Summing up, as a result of the benchmark nine issues which were mentioned in every analyzed supplier specification could be found. Three out of these issues were relevant for this thesis. They have been described in detail and supplemented by a suggestion for an improvement in this field.

At first, the possible course of action for a supplier evaluation-audit which gives clearness about the current status of products and processes at the supplier’s plant was described. Audits also motivate for changes which happen in a short period of

time and cause usually an improvement regarding quality. Optimization of quality can be done by using the Deming Cycle. This cycle effects an ongoing improvement according to four steps – plan, do, check, act.

The second issue which was conducted in the matrix was the handling of change requests. A change request is placed by the customer to the supplier and effects a modification of the product or the process. The wrong handling of changes can cause high costs and generate enormous delays in the delivery chain. Therefore it is mandatory to follow a certain procedure regarding these requests.

The complaint management was another topic which is regulated in each of the analysed supplier specifications. The occurrence of faults has to be reduced but nevertheless if it comes to failures and furthermore to complaints of the customer, a regulated and clear complaint management procedure is needed. To consider all customer's needs it is helpful to work with the Quality Function Deployment tool. This deployment is a special technique to translate requirements or complaints defined by the customer.

These three points are also essential for MAHLE. Supplier audits are a common tool in this company to gain an overview about the processes of suppliers so that MAHLE is able to support if problems occur. In the past the same mistakes and problems at different products and processes occurred again and again. This means, that a complaint management system is mandatory to reduce failures. Also a well-managed change request system could help in these terms.

Summing up, the benchmark shows that supplier specifications contain on the one hand many different issues, on the other hand essential topics are overlapping. The supplier specifications cover basic points, which would have to be regulated otherwise in a contract. Therefore this document includes standard requirements and terms and is in practice part of the contract between the supplier and the customer. Nevertheless it is obvious, that additional documents depending on the kind of product like logistic agreements or project management regulations are needed.

4 Survey with Suppliers

After the description of the basic theories of this master thesis, the next chapter gives detailed information about the conducted survey with different suppliers of MAHLE.

4.1 Technical and organizational execution

The programming of the survey was done via an online portal called “Monkey Survey”. With this software it is possible to interrogate more than 100 suppliers. Therefore, the questions are entered into an online database. Each interviewed supplier got an e-mail in which he got a detailed description of the content of this master thesis and also an explanation of the benefit for the supplier himself. Additionally, this e-mail included also the link to the survey, this was *https://www.surveymonkey.com/s/MAHLE.*

To make sure, that every interviewee is able to enter the online survey, it had to be checked that it was possible to open the link at least with Microsoft Internet Explorer, Netscape and Opera. Basically with these pre-actions, technical problems could be eliminated before occurring.

Pre-test

After the development of the survey the reliability of the questionnaire had to be checked and the understanding of the design and the technical background of each question had to be proofed. An also very important topic of the test was to check the needed time for all the questions. The idea was to send the survey to 10 specialists so that they can give a feedback to these questionable points.

The result of this pretest was a verification of the experts – they could answer the questions within about one hour, the questions are well formulated and understandable. The technical relevance of the questionnaire was discussed with the supervising tutor of MAHLE and the advisor from university – both of them agreed to the survey.

Start of the interview

By clicking the link in the received e-mail, the interviewees were able to enter the survey. Before they reached the survey, he or she was facing a start page on which it was possible to read about the necessity of this online survey for MAHLE and also about the benefit for the supplier. The interviewee could also find the contact details from the person in charge of the questionnaire so that in case of a problem or a question he or she could e-mail or phone the interviewer directly. It was also very important to convey the people that they can feel safe when they give their honest answers; therefore a sentence was implemented which told the interviewees that the results from the survey are confidential and it is not possible to match the answers with the interviewees if they don't want this.

4.2 Structure and design of the survey

The online survey was divided into three separate parts to make the completion of the form a little bit easier for the suppliers.

Part 1

After the interviewee started the online survey by clicking the link on the start page, he or she was directed to the first part of the survey. The questions from the first part of the survey were about the supplier company itself and the amount of people working in the company to get rough information about the target group. In addition it was necessary for the interviewee to fill out some information about the responsibility of himself or herself and in which department he or she is working for.

Part 2

In the second part of the survey, the aim was to get an output of the satisfaction of the suppliers of MAHLE regarding for example current documents like:

- Specifications (Lastenheft)
- Drawings
- Checklists
- Quality guidelines
- Logistic guidelines
- Basic supplier-delivery-contracts

During this second part, the aim was also to check if the supplier is satisfied with MAHLE itself and also regarding the different departments –for example quality, logistic and project management – and what could be improved if they feel uncomfortable with the current solution.

Part 3

In the third part of the survey the aim was to get some feedback regarding the quality philosophy from MAHLE's suppliers. Therefore the suppliers gave answers concerning their own quality management system, especially if they work with Advanced Product Quality Planning, how they handle Lessons Learned and if they work with

audits. After part 3 the survey was finished and after answering the last question the survey link brought the applicants to a thank-you-page and the inserted data was automatically transferred into an online database.

4.3 Realization of the empirical study

The e-mail with the inquiry for answering the questions of the survey was sent to the 120 most important suppliers of MAHLE, based on the supplier database and chosen by the person in charge of MAHLE. The selection was based on the intensity of collaboration – this means how often and with what order volume MAHLE does business with the suppliers.

Ten days later, a reminder was sent in which a deadline of ten days was communicated. Some suppliers called the person in charge with a few questions which were easy to answer over the phone. Some others communicated, that they are not responsible anymore and that they had forwarded the e-mail to the appropriate contact person. Two potential interviewees were not willing to fill out the questionnaire because they didn't want to interact with MAHLE in this special case because of bad experience with surveys in common.

4.4 Research results

To give a resume, 82 suppliers out of 120 potential interviewees, answered the asked questions. These 68% represent the evaluable part of the whole empirical study. In this chapter, the answers are going to be analyzed and commentated in detail.

What are you responsible for?

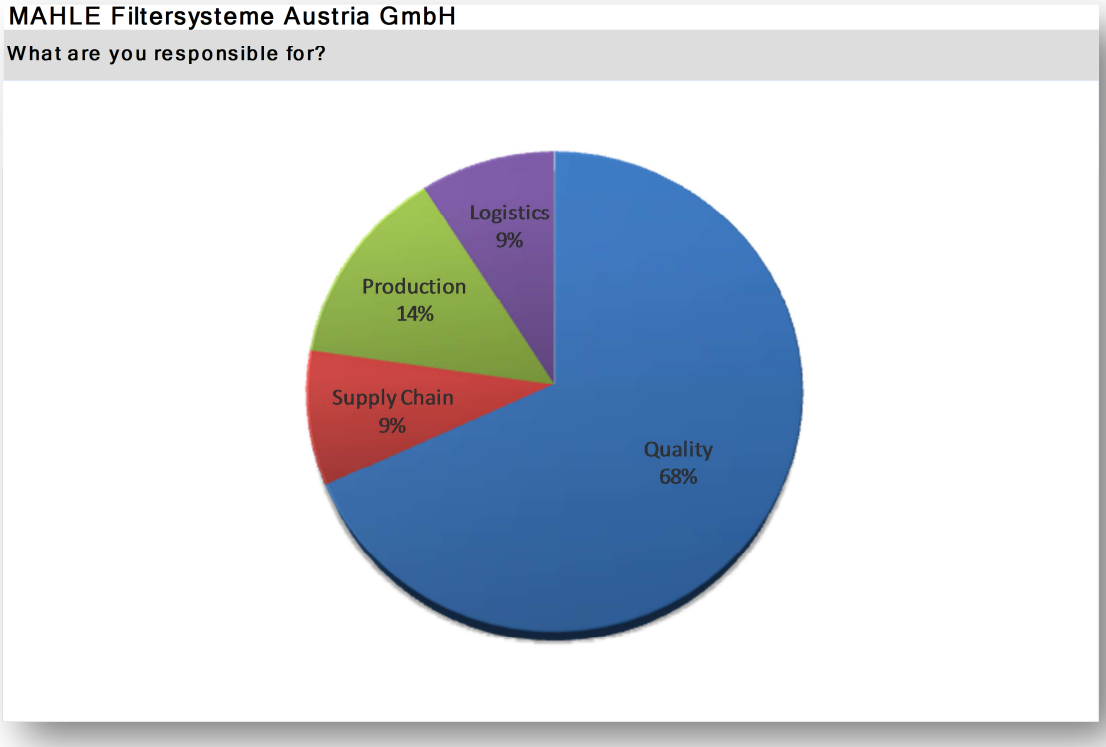

Figure 14: Responsibilities on the job

The reason for the mix of answers regarding job responsibilities of the interviewees is settled in the different responsible departments of the contact persons of MAHLE at the supplier plants and the various sizes of the contacted enterprises. 68% of the contact persons of MAHLE at each supplier are employed in the quality department of the particular supplier, the rest is divided into people who work in the field of supply chain, logistics and production.

What is your company producing?

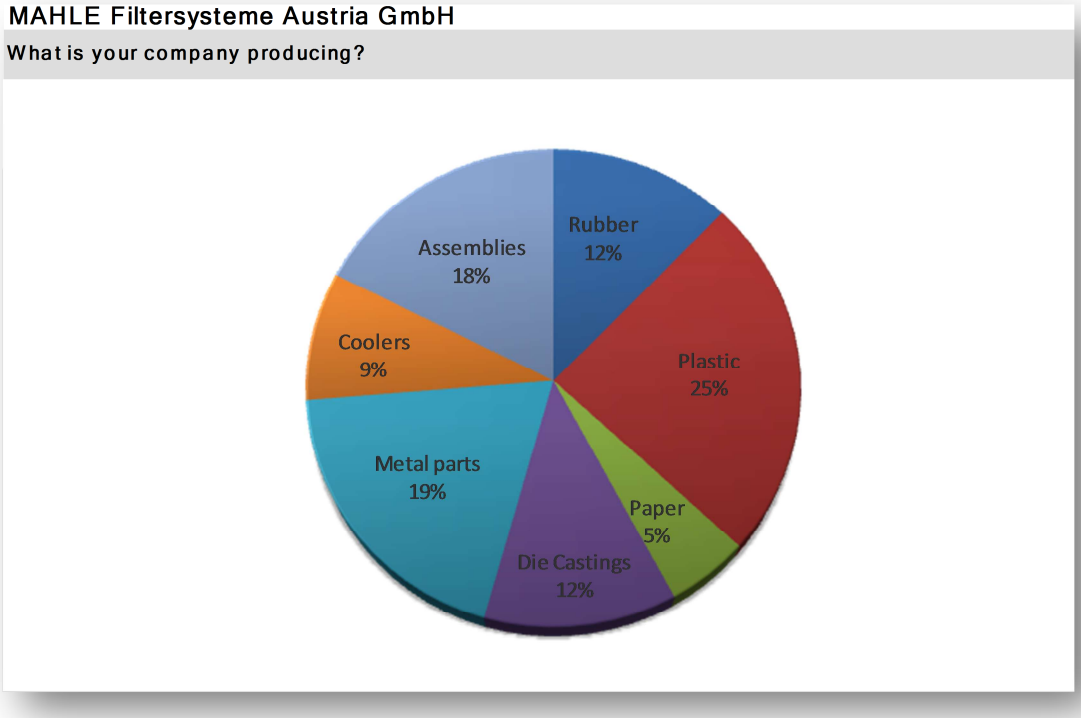

Figure 15: Production of each company

The appropriation of the different branches of the interviewed companies is very balanced. In the supplier database of MAHLE, a selection of suppliers regarding their branches was not done, the interviewed suppliers were chosen by MAHLE; therefore it is understandable why this question had to be included. The result shows, that the part of the branches is in a range from five to 25%. This means, that the highest number of suppliers interviewed is in the field of plastic, metal parts and assemblies, the lowest number is in the field of paper. With these facts, it is nevertheless not possible to suggest, that for example the paper producing suppliers are less important than the plastic parts delivering suppliers because the number of interviewed companies of a branch doesn't fit to the assigned volume of orders of this industry sector.

Where do you produce your products?

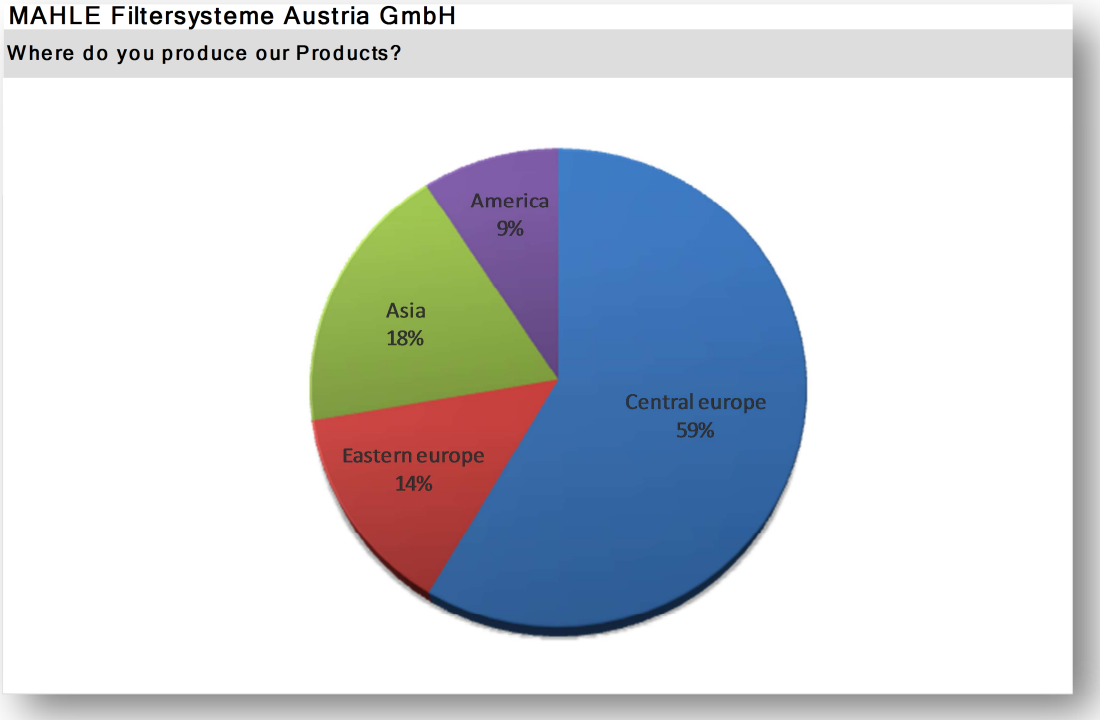

Figure 16: Location of Production

In this figure it is obvious that most of MAHLE's suppliers, exactly 59%, have the main production of the parts produced for MAHLE in Central Europe, but this doesn't mean that they have no production in Asia or America. In general, MAHLE does more and more contracts with suppliers from Eastern Europe and Asia but the main region from which the delivered goods come from remains Central Europe.

With how many people at MAHLE are you in regular contact?

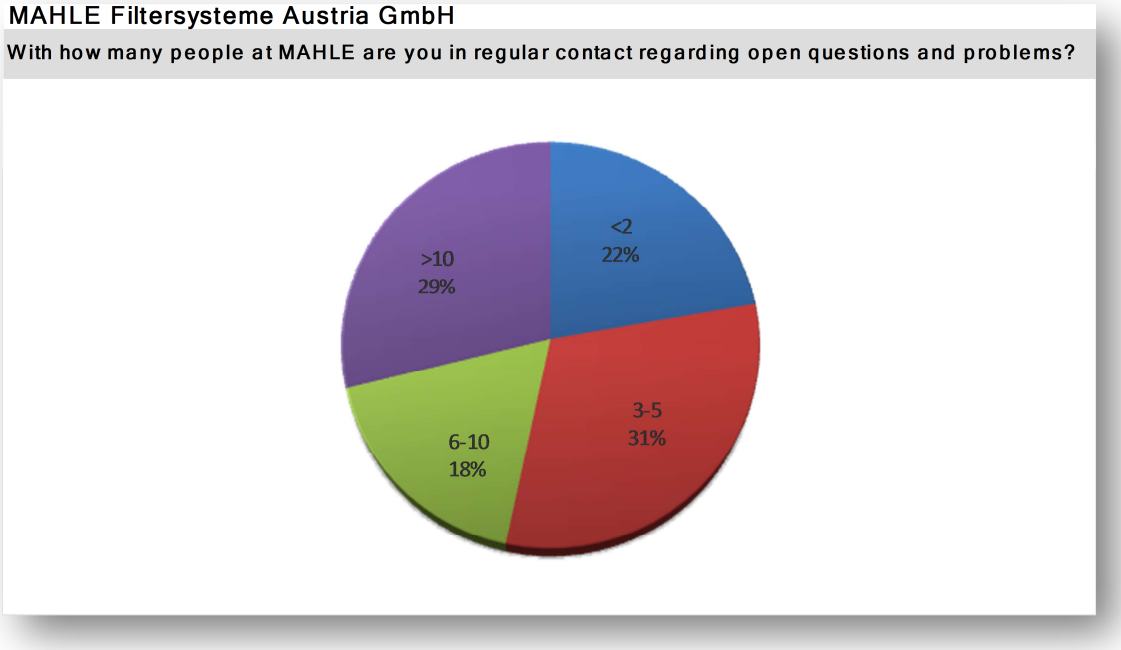

Figure 17: Regular contact between customer and suppliers

The number how often each answer of the four possibilities has been chosen is nearly balanced. 22% of the interviewees are with less than two people of MAHLE in regular contact, about 31% are in contact with 3-5 people, 18% with 6-10 people and about 29% describe that more than 10 people have regularly discussions with MAHLE.

When arranging this questionnaire, it was not obvious, that this question could cause problems regarding the evaluation. The problem with this question is, that some of the suppliers are in regular contact with the headquarter of MAHLE in Germany and additionally also with the production plant in Austria. Therefore it is not possible to draw any conclusions out of these answers. To prevent this problem it would have been necessary to express the aim clearer and differentiate between the two plants.

How many people are working in your company?

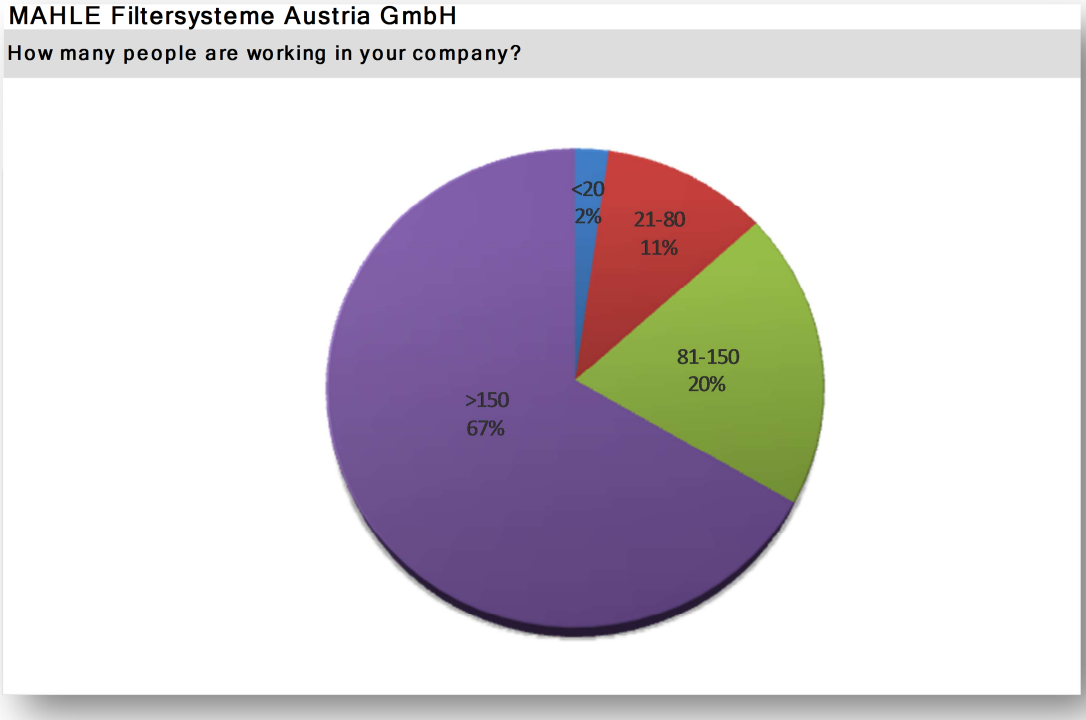

Figure 18: People working at the suppliers company

In Austria small and middle enterprises are the most common size of companies. Only 1,2% of all companies with their headquarter in Austria have more than 150 employees. (Leitl 2013: 1) Nevertheless, 67%, so about two-thirds of the interviewees, work in a company with more than 150 employees which means, that MAHLE does business with a large number of the big companies. The percentage of people working in a company below 80 employed people is less than 15%.

How satisfied are you with the current relationship with MAHLE as a customer?

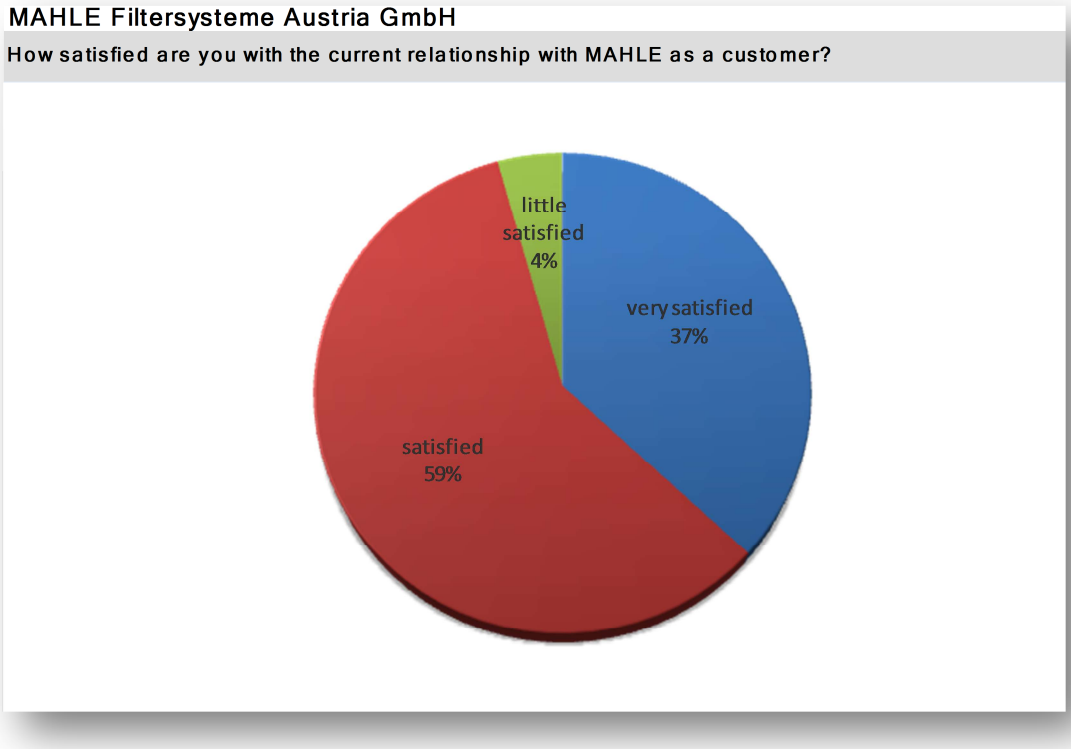

Figure 19: Current Relationship with MAHLE

In the figure above, 96% said that the current status regarding the relationship with MAHLE works quite well. So focusing on the 4%, a few of the interviewed people commented the question and noted, that the development of the relationship is on the right way, but had just started. So to avoid this problem at the beginning of new projects in the future it makes sense to work as soon as possible with the little-satisfied-suppliers to develop and increase the level of communication by improving the method or selective training of the person in charge right from the beginning.

What documents do you get from MAHLE?

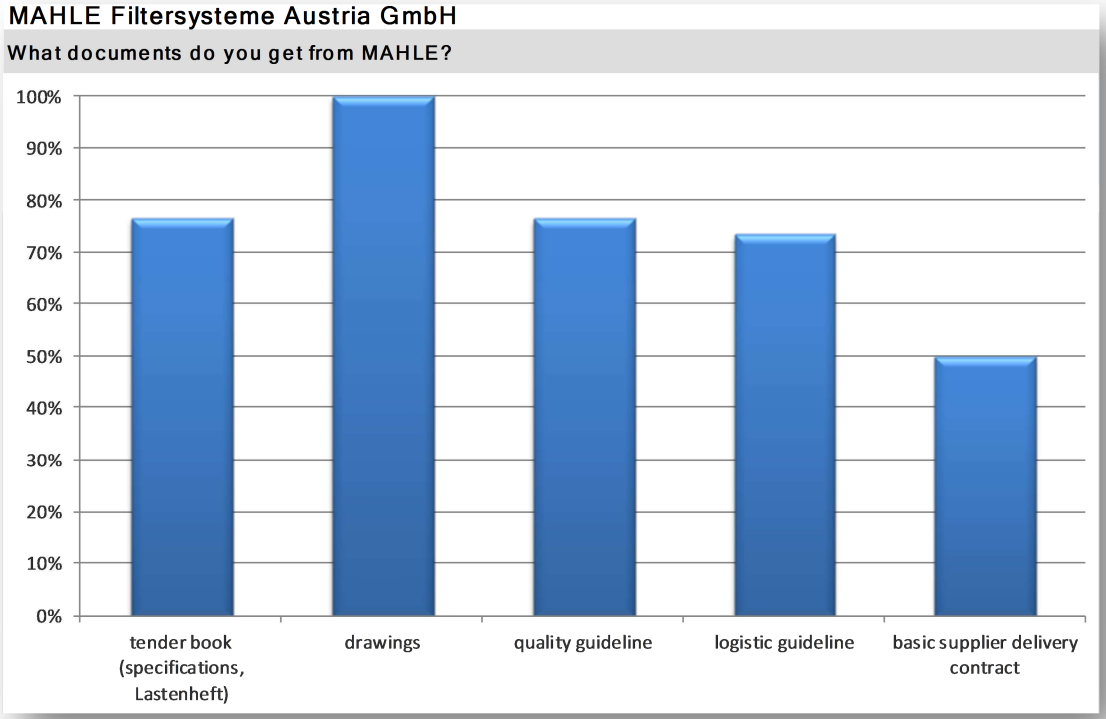

Figure 20: Documents from MAHLE

In the figure above it is shown, which documents the suppliers get. Every supplier gets at least a drawing; about 75% of the interviewee also get a tender book or quality or logistic guidelines additionally. It is necessary to point out, that at this question it was possible to check more than one box. The high figures strengthen my hypothesis that it absolutely makes sense to put all available information online, so that every employee of the supplier who is responsible for parts or the whole product that is produced for MAHLE has access.

Summing up, many documents with specifications are needed, therefore the standardized supplying of all partners with the right information at the right time is a high potential for increasing the efficiency.

Would it be easier for you if you could download all the needed information from the web?

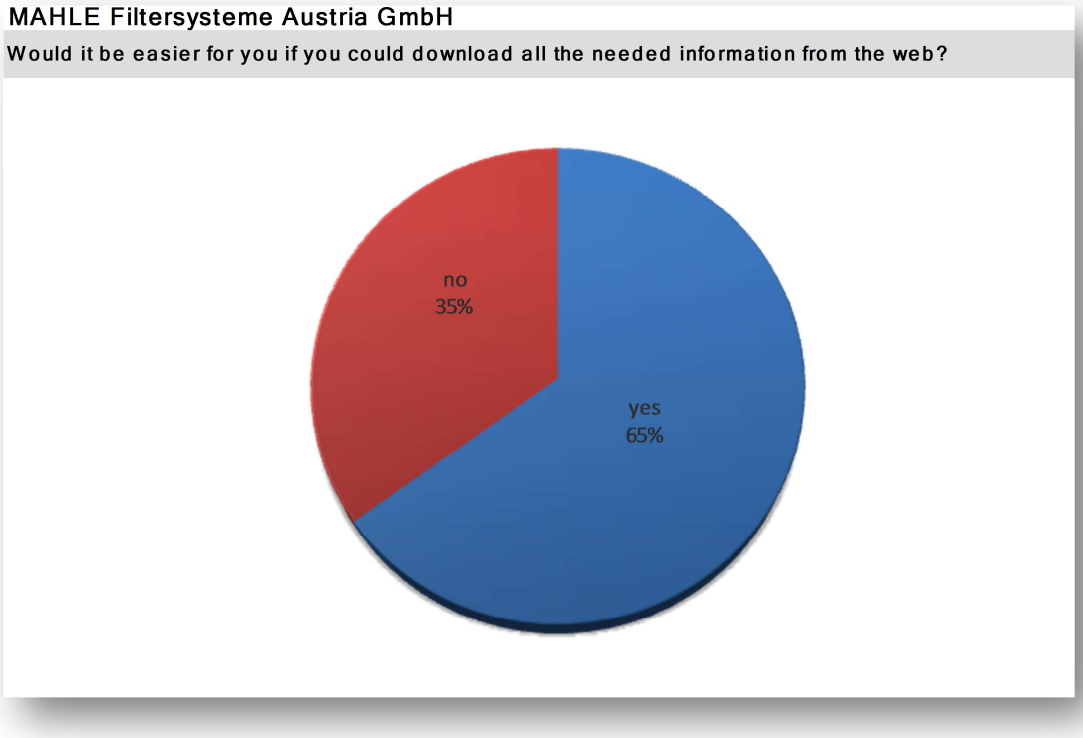

Figure 21: Handling of Documents

Based on the benchmark studies above, the research shows that most companies have their documents available online, so the only thing a supplier has to do is to log on the customer's website and download all information needed. This standardized process leads to an increase of the efficiency – both, the supplier and the customer save time, money and avoid the necessity of troubleshooting. Contrariwise, the communication between the supplier and the customer is reduced to a minimum. If a greater problem occurs, finding a solution gets more difficult because of inexistent regular contact between the persons in charge. Therefore, the sometimes common quarterly meetings are particularly suitable to sustain a good partnership and combine this with online availability of standard-documents to get more efficient.

Do you have enough information regarding the MAHLE quality standard?

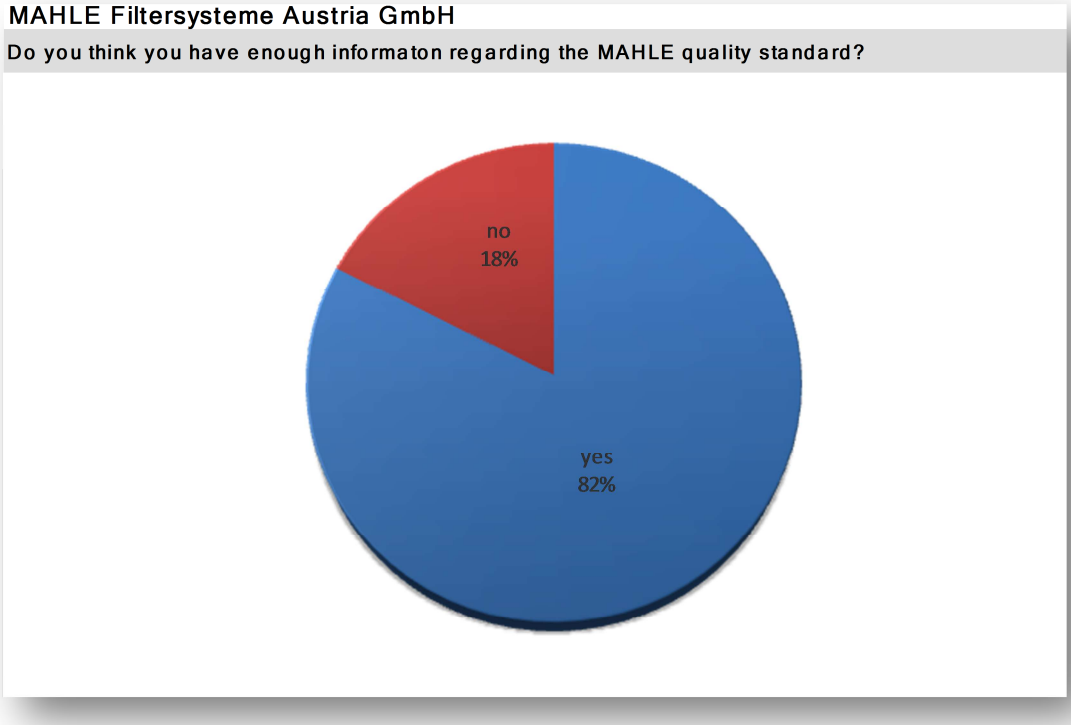

Figure 22: Information regarding quality standard

18% of the interviewed companies said that they do not have enough information regarding quality standards because they do not get enough documents and they do not know what the main focus from the side of MAHLE quality management is. It is not enough to send only drawings to suppliers, there are much more figures and details behind which have to be clarified. The companies also point out, that they get different figures from different people of MAHLE's project team. This absolutely should not happen; the information flow has to go only form one person from MAHLE to another person at the supplier or should be at least discussed in the team. This impact of too many responsible people is shown in figure 16, three-quarter of the companies are discussing open points with more than 3employees of MAHLE and this often ends up in difficult discussions, because of too much different information.

Do you know APQP (Advance Product Quality Planning)?

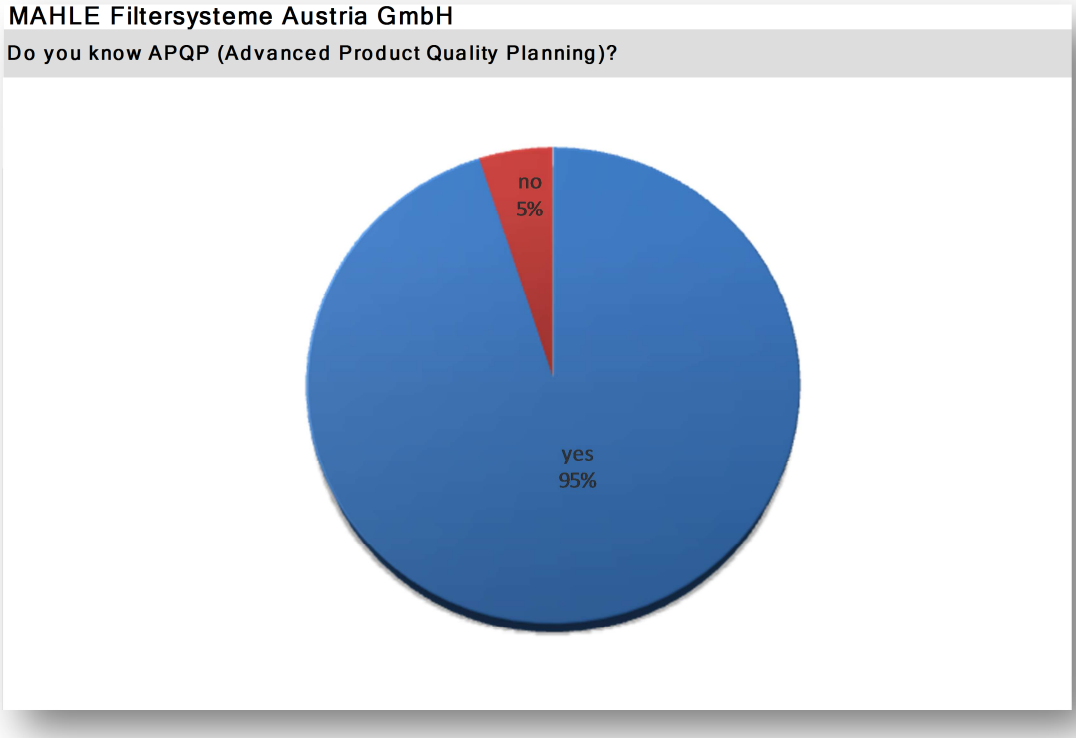

Figure 23: APQP

Most of the companies said, that they know about APQP. APQP stands for Advanced Product Quality Planning and nevertheless this Advanced Planning does not take place at most of the current suppliers. Although only 5% have not heard about this method, based on the comments to this question the quality management system of the most suppliers is not adequate to work along these standards.

Do you have an APQP Team in your company?

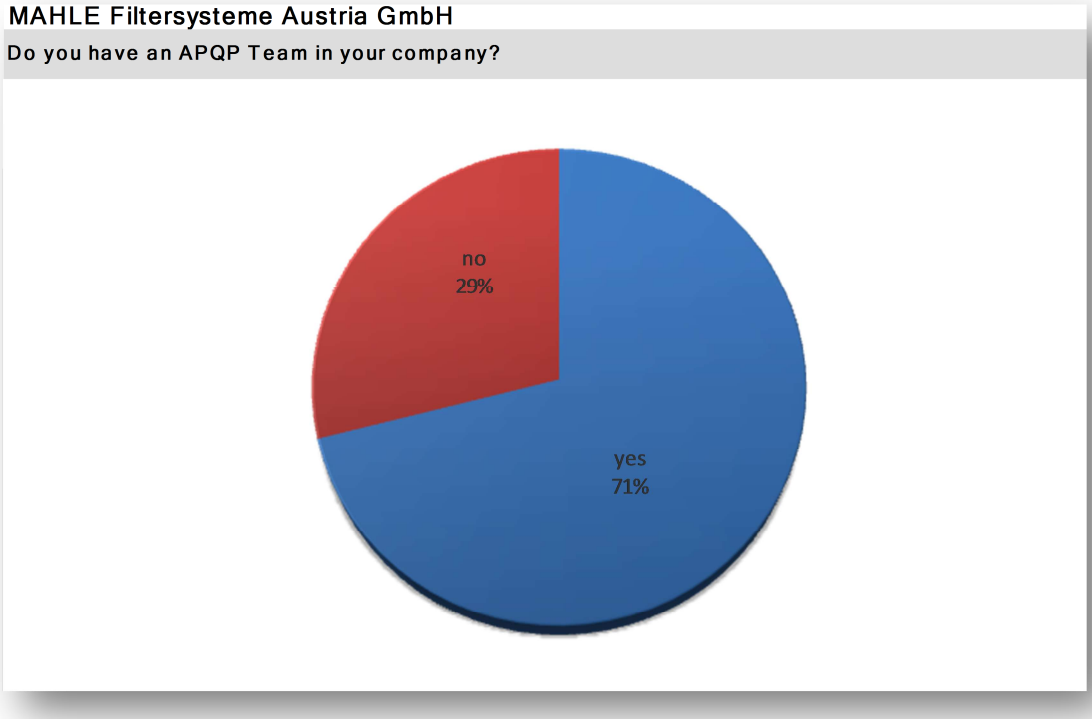

Figure 24: APQP Team

The aim of this question was to step a little bit deeper in the APQP thematic. The output was that almost a third of the companies does not have an APQP team which is the first task when implementing a system like APQP. Like described already, APQP consists of four columns, most companies are working with FMEAs and SPC, but working with a Measurement System Analysis or a PPAP-procedure is not common and would cause massive problems, most of the time because of deficient know-how. In general, all quality instruments need time and specialists. This system requires well-educated employees with a high salary.

So if a company wants to work along the standards of APQP, they have to install at first an APQP team. The team should consist of cross functional members; the task is to assure an effective product quality planning. Cross functional members from different departments, such as engineering, manufacturing, material control, purchasing,

quality, human resources, sales, field service, customers and also representatives of suppliers would be appropriate. The main task of the team is to identify and implement the customer's needs. (Book et al. 2008: 3)

An important question every company has to ask itself should be, if it makes sense to have all the specialists in house or if it is also possible just to buy the needed tools and specialists in times they are needed. So the figure shows that there is a remaining potential of about a third of the interviewees to develop in the field of Advanced Quality Planning.

Are you working with "Lessons Learned" in your company?

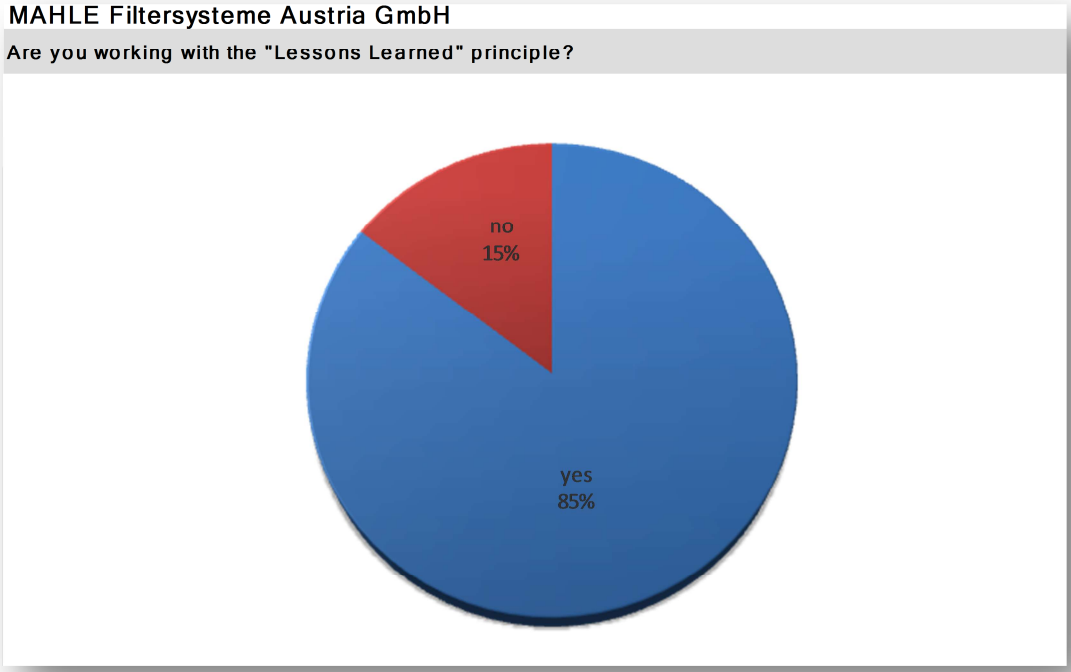

Figure 25: Lessons Learned

15% of the interviewed companies are currently not working with the principle "Lessons Learned". This result does not seem to be remarkable instantly, but if these 15% really do not learn out of their made mistakes, has to be scrutinized. This would mean that if there is currently a failure in the product, the company makes the same failure again and again. To avoid these failures, a system has to be implemented. It is necessary, that problems which have already been solved are written down and are discussed so that they never occur at any product or process anymore. "Lessons Learned" is a commonly used system which means learning from failures to avoid future problems and set improvements for new products and processes. If a company does not have a system which fulfills this principle, it will never fulfill the customer's needs.

Do you make regular audits at your suppliers?

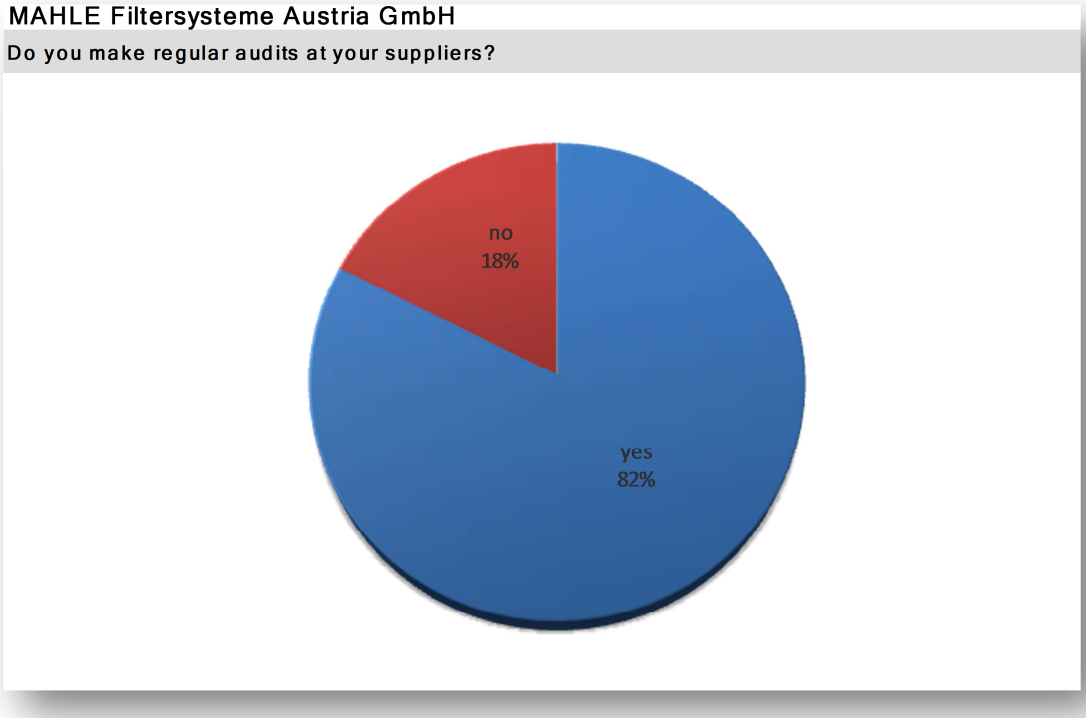

Figure 26: Regular Audits

Auditing suppliers is a day-by-day-business for a quality or supply chain manager. Regular Audits are helpful to gain a current picture of a supplier, a product or a process. Audits usually help both parties – the company who makes the audit to get the current status and also the supplier to have a real feedback on which parts it is necessary to keep an eye on and what has to be done till the customer is satisfied. 15% of the companies do not make regular audits; some of them trust their suppliers and have no current problems. Others are too small to make an audit, but these suppliers mostly have an ISO-certification, so this is enough from their point of view. Nevertheless, most of the companies are auditing their suppliers before they sign a contract with them to get a general overview.

4.5 Summary and actions for improvement

When looking at the answers of the survey, it is possible to summarize the main facts.

The chosen interviewees who answered the questions reflect suppliers of every branch which make business with MAHLE. The production location of nearly 60% of the suppliers where MAHLE gets its products from is located in Central Europe. Two-thirds of these companies employ more than 150 people. About 68% of the persons in charge are employed at the department of quality management at the supplier side. This means, that the contact person from the supplier known at MAHLE comes most of the times from the quality management, this shows the high importance of quality issues in the supplier-customer relationship.

From the supplier side was mentioned, that – although the question was interpretable whether if the production plant in Austria or the headquarter in Germany was meant – many persons are named as contact person for nearly the same requests. Nevertheless 96% of the interviewees are very satisfied or at least satisfied with the current contact situation with MAHLE.

About 80% of the interviewed suppliers said, that they are informed well about the quality standards of MAHLE, although about 65% would like to have the possibility to download the standard documents from a supplier panel.

Summing up the results to the questions concerning APQP it is obvious, that the Advanced Planning does not take place in every company. More than 71% have already installed an APQP-team in their company and even 95% know the advantages of this system. The importance is undisputed and therefore it is necessary to work with that kind of system to fulfill the customer's needs. In many companies parts of the

Advanced Product Quality Planning takes already place, but is not called APQP. For example, 85% of the interviewees work with the Lessons Learned-principles and 82% do regular audits at their production facilities.

Derived from these results, the demand for centralized available information concerning general issues is present. The results from the current proceedings regarding the way and the content of information as well as the person in charge change very often, therefore an improvement is necessary.

5 Improvement of customer-supplier-relationship

The survey shows, that an improvement of the content and the way of information is mandatory to fulfill the expectations of the suppliers. A possible solution based on literature review, the benchmark analysis and the results of the survey could be the development of an extensive supplier specification which is available 24/7.

5.1 Improvement by the use of a “maximal supplier specification”

Derived from the requirements of the interviewed suppliers it seems to be necessary to introduce a supplier specification which is also available for every supplier. Based on the generalized statements from the benchmark of three supplier specifications on page 39 a so called “maximal supplier specification” which contains all mentioned elements of the three analyzed suppliers was developed. This pattern suits furthermore to the APQP guidelines on page 28 which are also a basic document for the development of supplier specifications. Regarding to this list of issues it would be possible for MAHLE, but also for every other company in the automotive industry, to implement a supplier specification which contains the most important general information for every supplier.

The maximal supplier specification could include following elements:

Quality Management System:

The point concerning quality management system includes a detailed record about the QM-systems which should be used. This system is reflected by continuous improvement of products and processes, good communication on all levels and an accu

rate and timely processing of new and changed projects. The standard quality management systems have the aim of achieving the zero-defects objective. (Krug et al. 2011: 10f)

Production part approval process:

To this issue, the standard of the AIAG PPAP submission level 2 or the VDA volume 2 has to be taken under consideration. (Krug et al. 2011: 27, Mehring 2012: 16)

Customer requirements:

The aim of the requirements is to give the supplier an overview with which quality rules and certifications he has to work. The core focus must be on the certification of ISO/TS 16949 but also the environmental norm DIN EN ISO 14001 must be taken under consideration. (Deutz AG 2011: 2)

Supplier evaluation-audit:

The supplier has to do the audit in form of a system a process or a product audit, so the supplier gets as early as possible an agreed date when the audit happens at the supplier's plant. The supplier gets the chance to prepare all needed information and documents. (Krug et al. 2011: 14)

Initial sample:

Basically initial samples are products manufactured and tested under series conditions, the outcome should be an initial sample report where all technical issues are documented. This report is delivered together with the samples and the documentation about the process to the customer. (Krug et al. 2011: 27, Deutz AG 2011:12)

Change request:

The supplier has to inform the customer in advance about all changes of the product or the process. If there are changes in raw material he has to change also the IMDS database. If the supplier makes modifications on tools, he has to make a complete validation according to VDA. The supplier has to provide new sample parts for the customer free of charge. (Mehring 2012: 14)

Complaint management:

The effected production location of the supplier's side must handle the complaints; a 8D report is necessary, which includes immediate measures and short term solutions as well as the current capabilities and characteristics of the product. If the documentation is changed because of a complaint, the document has to be also submitted to the customer. If parts are on stock, the supplier has to take care that the complete stock gets visually checked according to the complaint. (Krug et al. 2011: 31, Deutz AG 2011: 21)

Packaging and Labelling:

The customer has a department which has the focus on packaging instructions so it is mandatory to pack the product according to the customer's specifications. During the income inspection at the customer's plant, faults in packaging and labelling are taken under consideration. (Deutz AG 2011: 27)

Traceability:

Traceability depends on the functionality of the products, with its relevance on safety or homologation. So as an example the traceability from raw materials to the shipment of the final product to the customer's plant has to be documented. (Mehring 2012: 10, Deutz AG 2011:26)

Transport:

The transport conditions are specific and different for each location around the globe; therefore each company should prepare a logistic specification with the needed information for the facilities in detail. (Krug et al. 2011: 35)

Business language:

The task of the supplier is to support the customer during any stage of the project with the clarified upfront project language; basically the language should be English. (Deutz AG 2012: 11, Krug et al. 2011: 11)

Health, safety and environment:

The suppliers must be committed to environmental responsibility and should have different projects and programs to protect the environment according to the standards of ISO 14001. A continuously focus of the supplier should be given to safety to improve the safety situation according to safety management standards such as OHSAS 18001. (Mehring 2012: 4, Krug et al. 2011: 11)

Project planning:

It is the task of the supplier to create project plans; these plans include the fixed milestones which were agreed from both parties. The basic project planning should also include preventive actions during the project; this standard is available in the AIAG guideline for APQP processes. (Mehring 2012: 11)

Subcontractor:

The responsibility of a development of a subcontractor is the task of the supplier; therefore the subcontractor has to meet the same requirements as the supplier is doing it. If the supplier changes the subcontractor, the supplier has to inform customer. (Krug et al. 2011: 12)

APQP:

The advanced product quality planning is a structured method for the process planning during the product development. The APQP method should facilitate the communication between customers and suppliers so that all agreed tasks are fulfilled in time. The supplier has to take care that the management of his company supports that instrument in their factory. (Deutz AG 2011: 30)

Drawings and characteristics:

Important characteristics should be described on the drawing, technical specifications about the product or the part should be listed in addition. All drawings need a change index, to verify the change afterwards. (Krug et al. 2011: 19, Deutz AG 2011: 12ff)

Feasibility analysis:

Before the supplier accepts a contract a feasibility study has to be done, this includes not only the technical study but also logistics, costs and timing to ensure a well-organized process. The feasibility document has to be forwarded to the customer. (Mehring 2012: 11)

Supplier rating:

The customers expect from their suppliers a quality management system based on ISO/TS 16949, which needs to be proven from an independent certification organisation. The basic supplier rating should have the outcome according to the general quality system, product quality and the logistics process. (Krug et al. 2011: 32)

Continuous improvement:

The supplier has to perform on a continuous improvement cycle. There are different ways how to work with continuous improvement, one recommended tool is the PDCA cycle. (Mehring 2012: 18)

Electronic data interchange:

If the suppliers meet the technical requirements of an IT infrastructure then they will receive their delivery calls via EDI. Further information should be described in an attached logistic agreement. (Krug et al. 2011: 35)

Confidentially:

Because of a big amount of information between the customers and the suppliers it is recommended to the suppliers to certificate according to ISO/IEC 27001 Information technology – Security Techniques – Information Security Management Systems. If suppliers are not certified, a plan how to reach that goal is often mandatory. (Mehring 2012: 6)

Ethics and working conditions:

The suppliers should give their workers a clear policy and procedure to ensure absence of corrupt practices. The sub supplier handling and the expectation should be in good faith. The working conditions have following rules: it is not allowed to work with children, no forced or compulsory labour is allowed, workers shall be protected against any form of discrimination. (Mehring 2011: 5)

Lessons learned:

The aim of the lessons learned process is in the systematic of global capturing, what means to collect information with the goal of solving current problems, sharing experience for future products and processes, to prevent failures which happened in the past. (Krug et al. 2011: 19)

International material data system:

Suppliers shall fulfil the International Material Data System requirements. Most of the OEMs are supporting the database, the aim of IMDS is to conduct all the materials which are used in the produced products to manage them in a global database to have all the information for further recycling activities. (Mehring 2012: 7, Tec4U www.imds.de – accessed on 31.05.2013)

Flow Chart:

A Flow Chart has to show the complete production cycle with all processes and steps. The beginning of the flow chart is the incoming of goods from the supplier and the last process is packaging and delivery to the customer. (Klug et al. 2011: 21)

Control plan:

A control plan shows the whole production cycle in detail and it shall be created from the prototype over the pre-launch and the production phase in accordance to ISO/TS 16949. (Krug et al. 2011: 22)

Capacity planning:

The suppliers have to ensure that all machines and equipment are available at any time as well as the procurement of all required operating equipment for the manufacturing of the part. If there are more cavities in equipment, the supplier must ensure that all cavities are capable. (Krug et al. 2011: 23)

Planning of preventive maintenance:

The supplier must ensure that a system for a preventive maintenance is installed; this means that all devices and tools are maintained through a maintenance plan on a

chronology basis. Also a plan has to be provided in which it is visible what to do in case of a broken tool and what could be the emergency strategy of the supplier. (Krug et al. 2011: 25)

Request for special release:

The supplier is responsible that the produced part has the dimensions of the drawing, if there is a deviation in the initial sample report because the supplier is temporarily unable to meet this requirements, he may submit a written request for special release. (Krug et al. 2011: 30)

Escalation level:

The supplier needs a system how to proceed in case of a problem. It would be beneficial if the supplier installs an escalation scenario which provides scenarios for different levels of problems. (Mehring 2012: 8)

Layout inspection:

The supplier agrees that it is possible without a special request, that the customer can have a look on the production line where the supplier produces the customer's product; he is also allowed to check the documentation of the results. (Krug et al. 2011: 31)

Requalification:

The supplier has to submit the yearly requalification documentation to the customer. The frequency has to be defined upfront, and during an audit it is possible to check the requalification documents. (Mehring 2012: 18)

5.2 Improvements of the way of communication

After defining the supplier specifications they need to be published in a way, that they are available for every supplier and potential supplier. It would be possible to send the document via e-mail or even by mail, but the easiest and most efficient way – for the supplier and customer – would be to publish the supplier specification on the web.

With this kind of system it does not happen as easy as today that a supplier does not get the fundamental information regarding logistic or purchasing because of the standardized version of the documents which is available online 24/7. This procedure could be implemented as soon as possible with less costs and efforts.

Nevertheless, the supplier's requirements are not solvable with only one particular solution which suits for every company. The first suggestion could be extended to a web-based platform over which all communication is done.

This tool could be used as an online interface between the customer and a potential supplier. Every potential supplier would get its own password and online-space in which the different standardized documents like drawings, logistic, quality and purchasing guidelines or checklists for supplier audits are callable. The whole communication from the first contact until the placement of an order should be organized traceable over this platform.

For practice, this would mean that standardized documents could be provided with a few clicks on the customer-supplier-panel and individual information and documents could be traceable displayed on this platform. This means, that the contact with more than one person would not be as problematical as before, because every contact would be recorded and the content of the conversation would be visible for the authorized user.

For the supplier the benefit would be, that the standardized documents are available from the first contact and that the whole conversation is documented in this tool.

Different branches, mostly the branches in which the contact with customers is a daily business, already use such systems. Nevertheless such a tool is not common in the automotive industry but would be helpful in times of short and dynamic product life cycles.

6 Conclusion

The aim of this master thesis was the improvement of the customer-supplier-relationship between the company MAHLE and its suppliers because of assumed dissatisfaction of the suppliers in the current proceeding regarding the communication. The outcome of the survey shows the actual problems exactly which concerns the way and the content of information as well as the person in charge – consistency in these fields is missing. The demand for centralized available information concerning general issues is present.

Based on a benchmark analysis of three exemplarily excellent supplier specifications, a possible maximal supplier specification was developed. This pattern fits to the APQP guideline which is also a basic document for the development. With the combination of these documents, general issues could be dealt with – this is the foundation for a friction-free collaboration between suppliers and customers. Regarding to this proposal it would be possible for MAHLE to implement a supplier specification.

It is also necessary to improve the current way of communication – this could be done with the introduced strategy of implementing an online tool. The easy way would be to publish the specifications and additional other common documents on the web. An advanced approach to improve the collaboration would be a web-based platform which could be used as an interface for the whole communication with suppliers and potential suppliers. The development could be oriented at other branches which already use such systems and would have to be planned in detail. It would be helpful to get a detailed overview and a journalized course of business.

To my opinion it was very important to get this – partly – non expected feedback of the suppliers. In daily business it is seldom that feedback is given, most of the times by getting complaints. Continuous improvement is mandatory to be successful in business – negative points always have to be taken under consideration, it doesn't matter if they derive from this survey or out of complaints or other feedback.

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Tables and figures