Optimization of Quality Assurance- and Control Activities within the Supply Process in Plant Engineering and Construction

Master thesis

Arkadiusz Lasisz, BSc

Submitted at the

Department of Economics and Business Management

Montanuniversität Leoben

Leoben, March 2016

Aufgabenstellung

Herrn **Arkadiusz Lasisz** wird das Thema

Optimization of Quality Assurance- and Control Activities within the Supply Process in Plant Engineering and Construction

zur Bearbeitung in einer Masterarbeit gestellt.

Im ersten Abschnitt der Masterarbeit sind die theoretischen Grundlagen zur Bearbeitung der beschriebenen Themenstellung herauszuarbeiten. Hierzu ist vor allem ein Überblick über die Qualitätssicherungs- und Kontrollaktivitäten im Anlagenbau innerhalb des Beschaffungsprozesses als Teil der Beschaffungslogistik zu geben. Insbesondere ist auf Qualitätsprozesse und -merkmale in der Beschaffung einzugehen sowie ein Bezug zum Lieferantenmanagement zu schaffen, für das die Qualitätsabteilung einen wichtigen Input liefert. Des Weiteren ist das Thema Prozessmanagement innerhalb der Aufbau- und Ablauforganisation einer Unternehmung zu behandeln und verschiedene Möglichkeiten von Prozessanpassungen und -änderungen zu beschreiben. Die Themenbearbeitung ist aus der einschlägigen Fachliteratur zu gewinnen.

Der praktische Teil umfasst die Definition der Unternehmenstätigkeit der Firma Sandvik MCMH Leoben. Die Ist-Analyse von Planungs- und Abnahmeprozessen innerhalb der Qualitätsabteilung sowie die Identifikation von Schwachstellen und Optimierungsmöglichkeiten stellen den Schwerpunkt der Arbeit dar. Des Weiteren sind Abnahmestandards festzulegen und Dokumentation, Bewertung und Auswertung der Qualitätsabnahmen zu erstellen. Im Zuge des Vorgehens sind Leistungskennzahlen der Qualitätsabteilung zu entwickeln und ein Sollprozess zu designen.

Leoben, im Februar 2015 o.Univ.-Prof. Dr. mont. Hubert Biedermann

Lehrstuhl für Wirtschafts- und Betriebswissenschaften

Eidesstattliche Erklärung

Ich erkläre an Eides statt, dass ich diese Arbeit selbständig verfasst, andere als die angegebenen Quellen und Hilfsmittel nicht benutzt und mich auch sonst keiner unerlaubten Hilfsmittel bedient habe.

Affidavit

I declare in lieu of oath, that I wrote this thesis and performed the associated research myself, using only literature cited in this volume.

Ort, Datum

Arkadiusz Lasisz

Gleichheitsgrundsatz

Aus Gründen der Lesbarkeit wurde in dieser Arbeit darauf verzichtet, geschlechtsspezifische Formulierungen zu verwenden. Es wird ausdrücklich festgehalten, dass die bei Personen verwendeten maskulinen Formen für beide Geschlechter zu verstehen sind.

Danksagung

Ich bedanke mich beim Vorstand des Lehrstuhls für Wirtschafts- und Betriebswissenschaften an der Montanuniversität Leoben, Herrn o.Univ.-Prof. Dipl.-Ing. Dr.mont. Hubert Biedermann, der es mir ermöglicht hat, diese Masterarbeit an seinem Institut zu schreiben.

Insbesondere möchte ich meinem Betreuer, meinem Vorgesetzten und Initiator dieser Arbeit, Herrn Erwin Haas, Leiter der Qualitätsabteilung und Qualitätsmanager der Sandvik Mining and Construction Materials Handling GmbH & Co KG in Leoben, danken. Auf seine Erfahrung und Unterstützung konnte ich stets zählen.

Für die Betreuung seitens des Lehrstuhls Wirtschafts- und Betriebswissenschaften durch Frau Dipl.-Ing. Dr.mont. Kristin Samac sowie Frau Dr. Susanne Lind-Braucher möchte ich mich herzlichst bedanken.

Bei meinen Eltern möchte ich mich für die Unterstützung bedanken. Einen speziellen Dank möchte ich meiner Mutter aussprechen, die den Glauben an die Beendigung meiner studentischen Laufbahn nicht verloren hatte.

Herzlich bedanken möchte ich mich bei meiner Frau und Freundin Diana Dzantieva, die mir immer eine mentale Stütze, sowie mein Antrieb war. Gleichzeitig musste sie auf viel gemeinsame Zeit während des Masterstudiums und der Anfertigung der Arbeit verzichten.

Kurzfassung

Ohne eine gut funktionierende Organisation mit angemessenen und strukturierten Prozessen kann kein Produkt in erforderlicher Qualität erzeugt werden. Somit müssen Strukturen, Prozesse, Schnittstellen der Abteilungen innerhalb der internen Organisation gelenkt werden. Zusätzlich muss die Komplexität der Projekte, die große Anzahl von Produkten, die zu planen, zu realisieren, zu bewerten und zu sichern sind, in geeigneter Weise behandelt werden, um eine nachhaltige Qualität zu sichern.

Die Masterarbeit gibt zunächst einen theoretischen Überblick über die Qualitätssicherungs- und Kontrollaktivitäten innerhalb des Beschaffungsprozesses im Anlagenbau und Konstruktion.

Der praktische Teil befasst sich mit der Analyse der Ist-Situation der Planungs- und Kontrolltätigkeiten im Rahmen der Qualitätsabteilung der Fa. Sandvik am Standort Leoben/ Österreich. Die selbst entwickelten Optimierungen, Verbesserungen von Prozessen werden beschrieben. Zusätzlich ist auch die verbesserte, transparent und benutzerfreundlich gewordene Software, Teil der Arbeit, die zusammen mit Programmierern vorangetrieben wurde. Hier werden auch Anpassungen zum Prozess aufgezeigt, unter der Berücksichtigung der Schnittstellen zu den Abteilungen innerhalb der Beschaffungskette.

Als Ausblick sollen diese Optimierungen innerhalb des Planungs- und Abnahmeprozesses, in Zusammenarbeit mit der weiterentwickelten Software „QC Planning“ als Teil von PROSQUID in allen global vorhandenen Sandvik Mining Produktionseinheiten vorgestellt und den Mitarbeitern der Qualitätsabteilungen als Standard geschult werden.

Abstract

Without a well working organization with adequate and structured processes no product in required quality can be produced. Thus structures, processes, interface problems of the departments within the internal organization have to be managed. Further the complexity of the projects, large number of products, which have to be planned, realized, assessed and secured, must be treated in an appropriate way to assure a sustainable quality.

This master thesis gives first a theoretical overview of the quality assurance- and control activities required within the supply process in plant engineering and construction.

The practical part deals with the analysis of the actual situation of the planning- and inspection activities within the quality department of Sandvik located in Leoben/Austria. The self-developed optimizations, improvements of processes are described. Further the improved, transparent and user-friendly software is part of this thesis, which has been promoted together with computer programmer. Here adjustments to the process are described, considering the interfaces to departments within the supply chain.

As an outlook those optimizations within the planning- and inspection process in cooperation with the developed software “QC Planning” as part of PROSQUID should be presented within all global existing Sandvik Mining production units and trained to employees of quality departments as a standard.

Table of Content

1 Introduction 1

1.1 Initial situation 1

1.2 Objective of the study 2

1.3 Structure of thesis 2

2 Quality Assurance and Control in Plant Engineering and Construction 4

2.1 Quality Assurance vs. Quality Control 5

2.1.1 Quality Assurance (QA) 6

2.1.2 Quality Control (QC) 6

2.1.3 Requirements and Tasks of Technical Quality Assurance and Control 7

2.2 Supplier/Customer Relationship for Plant Services 8

2.3 Supplier Quality Performance 9

2.4 Performing of Material Quality Inspections 11

3 Procurement Logistics 13

3.1 Procurement as Part of Procurement Logistics 16

3.1.1 Targets of Procurement 16

3.1.2 Process of Procurement 18

3.2 Supply Chain Management as Interface of Supplier with Customer 21

3.3 Supplier Management as Subtask of Procurement 23

3.3.1 Tasks of Supplier Management 25

3.3.2 Basic Methods of Supplier Evaluation 32

4 Structural and Operational Organization 41

4.1 Structural Organization 42

4.2 Operational Organization 44

4.3 Process Landscape 45

5 Process Management 47

5.1 Micro- and Macro Process Management 48

5.2 Business Process Management 50

5.3 Continuous Process Management (CPM) 51

5.4 Process Depiction and Visualization of Processes 54

5.4.1 Value Chain Diagram (VCD) 56
5.4.2 Event-Driven Process Chain (EPC)..57
6 Sandvik Mining and Construction Materials Handling GmbH & Co KG 61
6.1 Purpose and Task of SMCMH..61
6.2 Process Landscape 62
6.3 Quality in Procurement Process of SMCMH...65
6.4 QA/QC within Supply Chain of SMCMH...65
6.5 Existing Functions & Processes of QA/QC within SMCMH 67
6.6 “QC Planning” as QA/QC-Software Tool 69
7 Optimization of QA/QC-Activities within SMCMH..71
7.1 Actual Analysis and Evaluation of Weaknesses 72
7.1.1 Functions and Available Processes of QA/QC...73
7.1.2 “QC Planning” as Software used by QA/QC 75
7.2 Optimized Situation Based on Evaluated Weaknesses 78
7.2.1 Software “QC Planning” & “QC Planning Reporting”......................................78
7.2.2 Functions and Processes 83
8 Summary and Outlook 90

List of Figures

Figure 1: Quality assurance process ... 6
Figure 2: Quality assurance/inspection ... 8
Figure 3: The logistic chain of an industrial company ... 13
Figure 4: Target of procurement ... 17
Figure 5: Phase model of procurement ... 18
Figure 6: Procurement constellation ... 19
Figure 7: Depth of value added ... 23
Figure 8: Classification of supplier management ... 24
Figure 9: Responsibilities of supplier management ... 25
Figure 10: Systematic of structural organization ... 42
Figure 11: Graphic of line organization ... 43
Figure 12: Tasks in a linear process ... 45
Figure 13: Process landscape ... 46
Figure 14: Tasks in a linear process ... 47
Figure 15: Continuous evaluation of process ... 48
Figure 16: Model of a process-based quality management system ... 49
Figure 17: Sketch of process flow ... 51
Figure 18: Business process reengineering and Kaizen ... 52
Figure 19: Process model accord. EN IS0 9001: 20008 with integrated PDCA-cycle ... 53
Figure 20: Example of model “order processing” by EPC ... 55
Figure 21: Definition of model levels and possible deposit ... 56
Figure 22: Value chain diagram: Object type and example ... 57
Figure 23: Event-driven process chain: Object types and example ... 59
Figure 24: Office Sandvik Mining and Construction Materials Handling in Austria-Leoben ... 62
Figure 25: SMCMH-quality management process map ... 63
Figure 26: PROSQUID-structure ... 64
Figure 27: SMCMH-supply chain ... 66
Figure 28: Extract of organizational chart of SMCMH-supply chain ... 67
Figure 29: SMCMH-QA/QC-functions and process steps ... 68

Figure 30: PROSQUID-welcome-mask 70
Figure 31: Abstract of SMCMH-QA/QC-functions and process steps 73
Figure 32: “QC Planning”-mask 77
Figure 33: “QC Planning Reporting”-mask 77
Figure 34: Abstract of inspection standard 80
Figure 35: Specification with legend for IT/programmer 81
Figure 36: Screenshot of new mask of “QC Planning” 81
Figure 37: “KPI-QA/QC SMCMH Leoben 2014” (first page) 82
Figure 38: New optimized VCD of QA/QC 84
Figure 39: Legend of object types for new created inspection process 85
Figure 40: Legend of object types for new created inspection process 85
Figure 41: Abstract of quality process (step 18-23) 86
Figure 42: Abstract of visualized quality process (step 18-23) 87
Figure 43: Summary of initial and optimized process and functions 88
Figure 44: Summary of initial and optimized software 89

List of Tables

Table 1: Levels of quality 4
Table 2: Primary/Secondary sources of pre-selection 26
Table 3: Overview of types and tasks of audits 29
Table 4: Example of KPI´s of different business areas 31
Table 5: Methods of supplier evaluation 33
Table 6: Price decision analysis 34
Table 7: Scoring model 40
Table 8: Characteristics of CPM & BPR 52

List of Abbreviations

QA	Quality Assurance
QC	Quality Control
QMS	Quality Management System
PM	Project Management
EN	European Norm
ISO	International Organization for Standardization
COPQ	Cost of Poor Quality
AMR	Advanced Market Research
KPI	Key Performance Indicator
CIP	Continuous Improvement Process
ITP	Inspection- and Test Plan
PO	Purchase Order
JIT	Just In Time Delivery
SCM	Supply Chain Management
DVA	Depth Value Added
PDCA	Plan-Do-Check-Act
ROI	Return on Invest
MDR	Manufacturer Data Report
NDT	Non-Destructive Testing
R&D	Research and Development
IT	Information Technology
CPM	Continuous Process Management
BPR	Business Process Reengineering
ARIS	Architecture of Integrated Information System
EPC	Event-Driven Process Chain
VCD	Value Chain Diagram
SMCMH	Sandvik Mining and Construction Materials Handling GmbH & Co KG
PO	Purchase Order

1 Introduction

Within plant engineering and construction the supplier quality issues like non-conformance management, product recalls and product failures are nowadays fatal for global organizations and a challenge within avoiding them.

Complex contract structure between contractors, producers and their suppliers and sub-suppliers, inaccurate specifications, unexpected interfaces, responsibility-, communication problems and also cultural- and differences in mentality, as many national and international standards are a big challenge for the business project execution.

Nevertheless without a well working organization with adequate and structured processes no product in required quality can be produced. Thus structures, processes, interface problems of the departments within the internal organization as also the complexity of the projects, large number of products, which have to be planned, realized assessed and secured have to be managed in an appropriate way and sustainable quality.

Any interruption of the above mentioned internal and external factors acting on an organization or a company may lead to the loss of quality.

1.1 Initial situation

The quality assurance- and control activities are one of the big challenges for company Sandvik Mining and Construction and Materials Handling GmbH & Co KG (SMCMH) located in Austria/Leoben. The reason is based on the complexity of the projects and a large number of products, which have to be secured. SMCMH is a global player within plant engineering and construction and delivers turn key projects within the mining sector. The company has grown very fast within the last five years without adjusting their structures, processes and implementing them into the structural- and operational organization. For that reason the management decided to reengineer the complete management system in the last quarter 2014. As part of the initiation by the management and execution by the quality manager of the organization SMCMH, also the adjustment, development, optimization or change of the existing structures and processes within the quality department have been communicated. The quality department or QA/QC-department is part of the supply chain including the departments like procurement & expediting and logistics & transport. In general “QA” stands for quality assurance and “QC” means quality control. Actually “QC Planning” is a software tool that is currently used by QA/QC, which acts as a time- and authority based resource tool for the planning- and inspection process. Both, the existing planning- and inspection process including the software are part of initial investigation and have to be adjusted and optimized.

1.2 Objective of the study

The objective of this master thesis is the analysis of the actual situation of the planning- and inspection activities within the quality department of SMCMH. After the analysis of the planning- and inspection processes, including the existing software “QC Planning”, weaknesses and options for optimization are shown. Self-developed optimizations within the planning- and inspection process, like a new defined inspection standard, the implementation of documentation, evaluation and analysis of quality inspections into further developed software are presented. New created key performance indicators based on the inspection evaluation act as the input of supplier evaluation. Further, adjustments of the process, reference to the improved transparent software and integration of the possible supply chain department- and authority interfaces are the required outcome.

The general added value for the company SMCMH thus includes the:

- Optimization, development and visualization of the planning- and inspection process within the department QA/QC,
- Definition of inspection standards,
- Documentation, evaluation and analysis of quality inspections,
- Optimization of software “QC Planning” as part of PROSQUID,
- Optimization of department- and authority interfaces within the supply process for the planning- and inspection process.

As an outlook all above mentioned optimizations should serve as a standard and be presented/ trained to employees of other quality departments within all global existing Sandvik Mining production units.

1.3 Structure of thesis

This thesis consists in general of two parts. Chapter 2 until 5 deals with the theoretical input and background required for the task and investigation of this master thesis. The pages beginning from chapter 6 are describing the practical part of actual- and optimized situation within QA/QC-activities.

Within chapter 2 the definition and application of quality and the importance within plant engineering and construction is presented. Further the quality assurance is distinguished from quality control, resulting in the requirements and tasks in technical part of operation for business partners. Also the task of quality assurance and performing of inspections is short described on basis of documentation and resources needed for those actions.

Chapter 3 describes the procurement logistics as task of material- and informational flow with its strategic framework, the strategies and the supply principles. Here the term “procurement logistics” is the theoretical input for the important procurement process, where the department QA/QC, as part of the supply process delivers an important input. Further the targets and forms of procurement resulting with the processes and tasks as part of the procurement logistics are described. This acts as the connection to the task and assistance of quality within reaching the procurement target, following with the description of the term “supply chain management” as interface of supplier with customer. After the definition of procurement, their goals, the phase model for procurement and the interface with the supply chain, the supplier management as the supplier-customer relationship are further illustrated. The department QA/QC plays here an important role within supporting the procurement by activities like supplier selection and -analysis.

Chapter 4 describes the base of any coordinated, structured and organized company for the achievement of high quality. Operations or processes have to be well structured for the performance of business targets within the structural- and operational organization. By the process landscape a transparent overview of a company is achieved.

Further process management, as part of the structural organization is described within following pages of chapter 5. Business processes have to be adjusted to the permanent changing environment. A continuous change within process management is compared to a possible radical change, which results in a complete reengineering of processes. Further possible process depiction- and visualization methods are presented.

Within chapter 6 (which is the beginning of the practical part of this thesis) the company´s purpose and task, it´s existing process landscape with available used software within the QA/QC-department are described. The role and task of the department within the supply process is highlighted.

Chapter 7 is the main practical part of this master thesis, concluding the analysis of the existing situation with its strengths and weaknesses, following by optimization, improvement and development of QA/QC-activities within the supply process of SMCMH. Here the planning- and inspection process is the significant part of investigation. The used software has been developed to become a transparent and a user-friendly tool. A new created inspection standard, the implementation of documentation, evaluation and analysis of quality inspections into software resulting in key performance indicators for the input of supplier evaluation is the outcome of this work. Adjustments of process and reference to the improved software have been performed and integration of supply chain departments in questions related to possible interfaces, carried out.

Chapter 8 delivers the summary of this thesis and an outlook resulted by the investigation within this work.

2 Quality Assurance and Control in Plant Engineering and Construction

Within following pages the definition and application of quality and the importance within plant engineering and construction are presented. Further the quality assurance is distinguished from quality control, resulting in the requirements and tasks in technical part of operation for the business partners. Also the task of quality assurance and performing inspections are short described on basis of documentation and resources needed for those actions.

According to standard EN ISO 9000: 2008, quality is defined a set of permanent characteristic to fulfil the requirements. This is a standard, which is including the fundamentals and vocabulary of a quality management system.[1]

Quality can be applied either to product-, process- or system quality. Table 1 illustrates the different levels of quality within the view of an organization.

Table 1: Levels of quality[2]

	Quality on different levels		
Level	Product	Process	System (Organization)
Application	Output of a process Output orientated	Different steps lead to output	Ability to perform processes and produce products or deliver services
	Customer satisfaction	Quality is affected by processes and steps and their performance	People, organizational and infrastructural framework, which affect the quality of processes and thus products
	Customer value	Not only output- orientated but also input- orientated and the interaction of those activities	

Within plant engineering and construction the supplier quality issues like non-conformance management, product recalls and product failures are fatal for global organizations and a challenge within avoiding them. Nevertheless without a well working organization with adequate and structured processes no product in required quality can be produced. Companies need to proactively address their supplier quality issues before they can damage businesses operations and cause serious supply chain risks and financial losses; especially when current business conditions are unfavourable. Supply chain disruptions, discrepancy in supplier quality can

[1] Source: EN ISO 9001: 2008, p. 22
[2] Source: Pfeifer, T. (2001), p. 85

significantly reduce company's revenue, impact market share, increase production cost, threaten brand image and reputation, and lead to high "Cost of Poor Quality" (COPQ).[3]

COPQ are those costs which are associated with providing poor quality of products or services. Four areas of costs of quality can be distinguished:

- Internal failure costs (those associated with defects found before the customer receives the product or service),
- External failure costs (those associated with defects found after the customer receives the product or service),
- Appraisal costs (those incurred to determine the degree of conformance to quality requirements) and
- Prevention costs (those incurred to keep failure and appraisal costs to a minimum).

COPQ is the sum of the internal and external costs. A major target of the company is to have the COPQ at a minimum and all other costs in the appraisal and prevention areas.[4]

According to AMR Research Inc., which is an independent research industry analysis firm founded in 1986 and leading in its sector focused on global supply chain, almost 67% of the cost of poor quality can be attributed to supplier failure. For that reason user and customer are concerned about requirements to guarantee the quality of projects and success of operation, by reducing those COPQ and by counteracting against supplier failure. A systematic reduction can be achieved by an implementation of a Quality Management System (QMS) with integrated quality assurance (QA) and quality control (QC) within an organization.[5]

2.1 Quality Assurance vs. Quality Control

Quality assurance and quality control are not the same and has to be distinguished from each other when taking about quality. Nevertheless both subjects belong and are dependent form each other. Both terms are part of the quality management and are included in the DIN EN ISO 9000-series.

Quality management (QM) includes all functions and activities to be established by the management and employees of an organization, involved in determination of quality policy and its implementation supported by quality planning, quality assurance (QA) and quality control (QC). Thus the ISO 9000-series requires that an organization establishes standard processes, document control, maintaining the quality of system, with adequate, required and periodic certification. It requires a fixed operational- and structural organization.[6]

It outlines definitions and requirements of the documentation in a quality manual. A quality manual serves not only as a guide for the organizational personnel but also for a potential customer for the information of quality assessments and quality audits.[7]

---

[3] Source: MetricStream, http://www.metricstream.com/insights/onsite_inspection.htm (16.08.2015)
[4] Source: Six-Sigma-Material, http://www.six-sigma-material.com/Cost-of-Poor-Quality.html (17.08.2015)
[5] Source: MetricStream, http://www.metricstream.com/insights/onsite_inspection.htm (16.08.2015)
[6] Source: EN ISO 9001: 2008, p. 5 et seq.
[7] Source: De Medeiros, A. R.; Jacob, B. P. et al. (2013), p. 63

2.1.1 Quality Assurance (QA)

As per EN ISO 9000 the QA, which is part of the quality management, should provide confidence that quality requirements will be fulfilled. It concludes all planned and systematic activities to provide confidence that the supplier or producer will fulfill requirements by the customer or user for quality. Further the organization should provide confidence to its internal management, employees and other stakeholder that the requirements for quality are being maintained. It relates to the material, processes and procedures for ensuring the qualifications, assessment and the delivery meet certain standards.[8] The dependency of confidence and quality requirements for the producer/supplier and user/customer as per ISO 9000-definition is illustrated in figure 1.

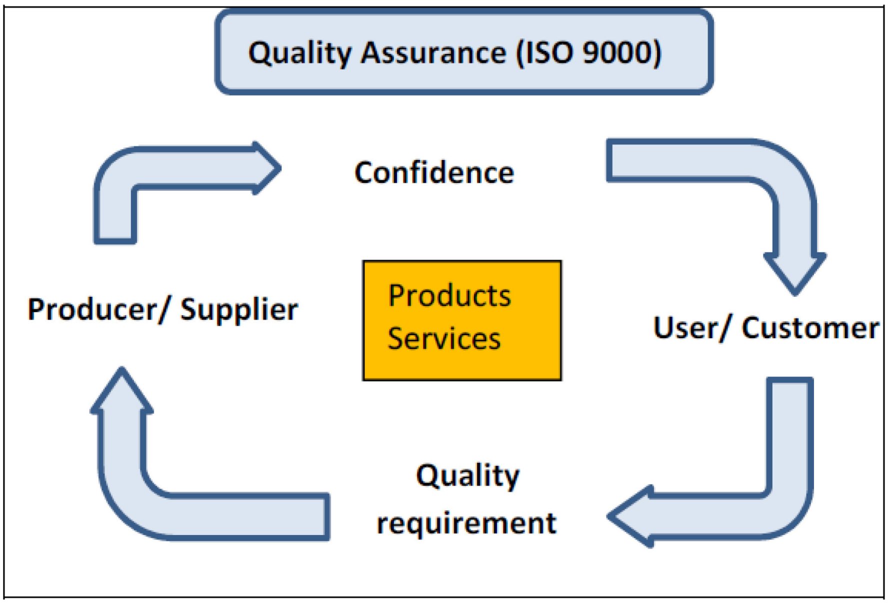


Figure 1: Quality assurance process[9]

QA is a wide concept that covers all systematic activities and policies implemented in a quality system within an organization. The QA framework includes in general:[10]

- Determination of adequate technical requirement of inputs and outputs,
- Testing of procured materials for its conformances to establish the quality, performance, reliability standards and safety,
- Proper receipt, issue of material and storage,
- Planning/ performing of audit and inspections of the intermediate and/or final output for conformance to technical, maintainability, reliability and performance requirements.

2.1.2 Quality Control (QC)

Quality assurance can be defined as the input for process required for the delivery of the required quality. Quality control on the other hand can be mentioned as the output in the aspect

[8] Source: EN ISO 9001: 2008, p. 28 et seq.
[9] Source: Caruette, J. P. (1997), Conference paper
[10] Source: BusinessDictonary.com, http://www.businessdictionary.com/definition/quality-assurance-QA.html (11.08.2015)

of the quality assurance process. It is a set of activities intended to ensure that the quality requirements are actual being met, eq. detection and measurement of the variability in the characteristics of the output and includes corrective response.

Quality has to be measured and/or assessed. A regulatory assessment by monitoring in a period has to be performed within the internal organization and also external at the supplier, manufacturer, etc. External quality assessments, including the processes and structures are either done by QC inspections and/or audits. QC-inspections give an “actual view” of the external output, audits on the other hand, are regular carried out assessments of the internal and external “quality work”. Establishing or measuring of internal and externally performance can be done by, e.g. key performance indicators (KPI`s).[11]

Definition and different kind of audits including the KPI´s are detailed illustrated in the below chapters as part of the supplier management and procurement process.

2.1.3 Requirements and Tasks of Technical Quality Assurance and Control

The statement that quality can only be manufactured but not controlled has it´s true core. The extensive QA-activities thus may cause an improvement of quality, but is not a guaranty factor for avoiding of difficulties.

The main tasks of planning, supervising and controlling of the performance and of inspection- and verification documents as part of QA are as follows:[12]

- Organization and execution of quality assurance and control of whole project in cooperation of project team,
- Detailed definition of mechanical properties of the material specifications as well as the further processing, assembling, testing, painting, packing in the form of an inspection- and test plan (ITP), based on technical regulations and harmonized product standards in agreement with supplier and client,
- Involvement in the supplier evaluation, selection and development as part of the procurement process and ensuring a consistent QA-controlling of the supplier in the global supplier market until the sub-suppliers,
- Supplier classification and rating on basis of evaluation,
- Support of the procurement department (dependent on company- determination of authority) in expediting- and/or supervision activities for the examination of fixed time deadlines, agreed delivery- and scope of supply and documentation,
- Execution of inspections on supplier sites, quality control of suppliers,
- Inspection of the supplier quality documentation & manufacturer data report (MDR),
- Determination of further actions if deviations occur (claim handling), including the documentation,
- Supervision, support and evaluation of test and failure analysis,
- Planning and execution of audits, assessments and inspections and evaluation,

[11] Source: EN ISO 9001: 2008, p. 39 et seq.
[12] Source: Giehl, M.; Käß, M. et al. (2010), p. 40 et seq.

- Classic quality assurance planning and/or in the form of supervision activities at site during erection and commissioning,
- Organizational cooperation within a constant technical and economic realization in the sense of a continuous improvement process (CIP).

Quality is a question and sense of internal and external efforts of a company to work in an effective and efficient manner to satisfy the requirements of the customer, stakeholder and produce quality in an agreed and required quality.

A quality control and quality assurance process should be detailed with the purpose to make out the procedures to be employed as project guidance and the means of ensuring compliance with them, in order to control the design, planning, manufacturing, construction, erection and installation. A competent and regular QA/QC process can counteract to a lot of quality problems within an organization, at supplier and on site.

2.2 Supplier/Customer Relationship for Plant Services

Within the plant engineering and construction the relationship of producer/supplier to user/customer based on providing adequate confidence and agreed quality requirements, is illustrated in figure 1 in chapter 2.1.1. For a manufactured product the "client" is the user, but for a plant inspection service, this confidence involves three "customers". The services of quality assurance and inspection on the other hand can be illustrated in figure 2. It defines that the quality assurance guarantees the quality of the service to the customer.

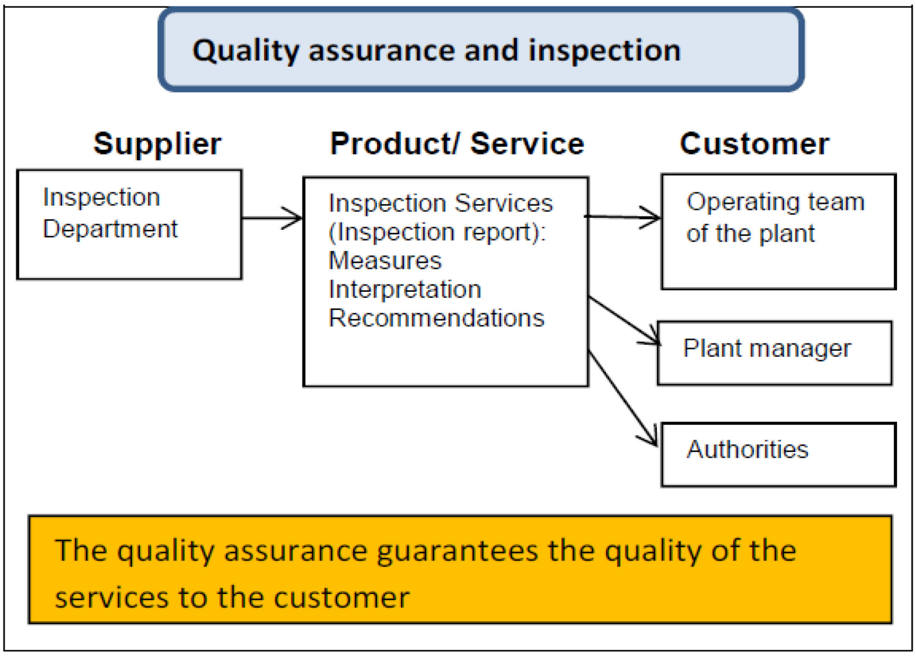


Figure 2: Quality assurance/inspection[13]

The first customer is the operator, who is using the equipment. For him the inspection is one of the bases of preventive and corrective actions and tools in preventing of any material defects.

[13] Source: De Medeiros, A. R.; Jacob, B. P. et al. (2013), p. 64

Further the site manager or company manager, who keeps a large share of liability if an accident occurs. As this kind of second "customer" wants to reassure the level of safety and quality of facilities, in many countries regulatory authorities (who regulate particular categories of equipment) are in charge of controlling the regulations. The customer may thus be either the operator, the operator`s management or regulatory authority.[14]

2.3 Supplier Quality Performance

One possibility to demonstrate the supplier`s skills, is to provide a management system and a certification. One of the nowadays mainly seen industry-independent standard is EN ISO 9001: 2008, which specifies requirements and development for a quality management system (QMS) for the need and ability of a company to provide products, which fulfill customer and applicable requirements and aims to enhance customer satisfaction.[15]

Nevertheless a quality management system is merely a requirement to provide high quality, however, no guarantee to achieve this.

The sense and purpose for the inspection of equipment, among all other means of prevention, is to reduce losses- the loss of damages, human live losses, property and environmental resource losses, production-, money losses and even loss in image and reputation of an organization.

To reduce and exclude (as far as possible), the risk of possible negative effects the quality issue by permanent assessing, auditing and inspecting of the material, components, equipment should within the mentality of everybody of an organization and the term "quality" should be understood as a guaranty factor for best image, reputation within the market and seen as a priority target of the management.

Quality Plan

At the very first step of possible project, the supplier or contractor is often required to submit a quality plan describing the resources and activities related to achieve the quality objectives for the specified scope of work or project to the client. This plan should describe the quality control system and procedures by the vendor. Such a plan can include following descriptions:[16]

- Design-, change-, planning control,
- Procurement control of material and services,
- Control of free issues material,
- Manufacturing control,
- Control of sub-contracted items and services,
- Special processes (e.g. welding, heat treatment, protective coatings),
- Inspection functions,
- Proving, factory acceptance and interfacing tests,

[14] Source: Caruette, J. P. (1997), Conference paper
[15] Source: EN ISO 9001: 2008, p. 9
[16] Source: Batten, P. R. (1987), Conference paper, p. 181

- Non-conformances and rectifications,
- Control of inspection equipment, gauge, recorders, etc.,
- Weight control,
- Preservation, packing and dispatch,
- Commissioning procedures,
- Operating and maintenance manuals,
- Documentation records and rectification.

This plan is only informing about the resource- and quality planning of the organization to the customer with evidence of the quality control system with procedures.

Quality Manual

To establish the adequate requirements, a company has to develop a quality programme within its quality system, consisting of documented activities, resources and events required for that system. Following information and evidence of quality is providing such programme:[17]

- Procedures with detailed description of tasks, purpose and scope of the activities and how they should be carried out,
- Detailed documentation with results of activities and tests and how they have to be recorded,
- Confirmation or certification which confirms that the activities and tests or services conform with specification.

Those above already fixed procedures and practices and general quality policies of a company are summarized in a quality manual.

Within the plant industry and construction, especially for the manufacturing of steel structure and mechanical components, such a quality manual can consist of following information:[18]

- General information (purpose, definitions, regulations and standards/codes),
- Scope of work (qualification of manufacturer, description of manufacturer´s work),
- Requirements to material, welding, manufacturing/fabrication, machining, painting, assembly, packing/loading and transport),
- Quality system (requirements to inspection- and test plan (ITP), control of non-conforming items, inspection-, measuring- and test equipment, manufacturers data report (MDR), etc.).

Such a document is subjected to the detailed description or specification of the QA/QC requirements for the fabrication of material, manufacturing, painting as well as assembling and packing, including transportation to required destination.

[17] Source: Batten, P. R. (1987), Conference paper, p. 179
[18] Source: Prein, R. (2012), p. 10

2.4 Performing of Material Quality Inspections

In general and contractually regulated, the supplier is responsible for the supply of the material, components or equipment in a quality level, no less than specified in the purchase order and to certificate the required, specified quality. Nevertheless it is the contractor`s concern to carry out random audits, assessments and inspections at supplier.

Material inspections are performed on basis of an ITP, which is defining the mechanical properties of material specifications as well as the further processing, assembling, testing, painting, packing in a form based on technical regulations and harmonized product standards. Further checklists are used as helping tools for the performance and assessing of the inspected company and product.

Inspection and Test Plan (ITP)

Basis of an inspection of material, components and equipment should be traceable and documented in writing, accompanied by an intelligent ITP, which is based on rational method. The required quality can be achieved by this controlled plan through hold points, witness and routines or reviews with full traceability, testing/inspection and documentation, uses of calibrated measurement devices and adaption of standards in order to ensure design quality through total control of processes, quality certification and follow all steps.

The ITP is a document which traces all steps and quality relevant requirements from the first until last recordable process step of component, material of equipment. The art of an ITP depends on the usage or application of project process, either during manufacturing, erection, commissioning, etc., thus project execution. In combination of a manufacturing or a time schedule it identifies all key points where quality-related activities, inspections and tests take place to verify the acceptance criteria and identify proposed hold and witness points.

All general requirements for the creation of an ITP are stated in the purchase order (PO) of the customer or referenced to a quality standard and expanded in the quality manual. Such an ITP has to be prepared by the supplier/producer and submitted to the customer/end user for acceptance before starting the application process. This document is going to be reviewed, indicted all activities to be witnessed by the customer/end user or his representative and to be approved by them. After that step the supplier is mandatory to inform customer/end user about indicated activities.

General Terminology used in ITP

Inspection- and test points or hold points are used to locate the stage in the manufacturing or production process where inspection and/or testing is planned to be performed in agreement between supplier, customer and end user. Terminology in an ITP can be defined as follows[19]:

- Inspection- and Test Point: A location or stage in the manufacturing cycle where inspection and/or testing are performed.

[19] Source: Prein, R. (2012), p. 10

- Witness- (W) and Hold Points (H): The customer shall be notified in writing or by other agreed procedure that an inspection- and test point is reached.
  - In case of a witness point (W), if the customer or his representative is not present at the designed time and place, the contractor or supplier shall continue with the inspection and/or test as defined.
  - In the case of a hold point (H), the contractor shall not proceed with the work without a customer being present, except when the contractor has been notified that he may proceed.
- Review (R): The process of verifying by examination of documentary evidence that nominated inspections and/or tests have been satisfactorily conducted. More details are defined in the "ITP-Manual" as part of the quality management system applied. ITP-Manual describes how such an ITP has to be created, with definitions, responsibilities and case of use.

QC Personal

The inspections are carried out by solid base technical educated and professional experienced inspectors. A specialized knowledge (welding, NDT (non-destructive testing), painting, etc.) are the basis for the different scope of work and inspection of material, equipment and components. Certifications in generalities and specialities of the personal are the key skills required for the performance for QC activities. Further the inspectors must be opened for new specific additional training, should have personal capacities that include powers of observation, of analytical thinking (for result interpretation) and of synthesis (for report writing), communication capabilities and physical abilities.

Inspections are performed by QC personal, which is direct working for the customer (mostly working in QA/QC department) or can be hired as a consultant from a professional company or agency, which is specialized for inspection- and/or expediting activities.

3 Procurement Logistics

This following chapter describes the procurement logistics as task of material- and informational flow with its strategic framework and the supply principles. Procurement logistics is the theoretical input for the important procurement process, where the department QA/QC plays an important role in the supply process. Thus, the target, process and forms of procurement are illustrated within following pages to show the required overview and background for the supporting activities of quality within this procurement area.

The term procurement logistics as part of the procurement and logistics refers in the area of business economics to the definition of process purchasing until the transport of the material to the receiving warehouse or production. It combines the sales logistics of supplier and production logistics of a company. It stands for the planning, design and management of the company supplying material flow and the accompanying information flows.[20]

Procurement logistics is part of the logistic chain of a company, which links the logistic systems of the client and the supplier. The logistic chain within the flow of material can consist of e.g. procurement, production, distribution and waste management, etc. The tasks of the procurement logistics are ranging from goods- receiving and inspection, warehousing and administration, stock management, through internal transport to planning, management and control of material and information flow.[21] The exact division of responsibilities depends on the size of the company, the corporate structure and the importance of procurement for individual companies in a particular case. The structure can be illustrated as in figure 3.

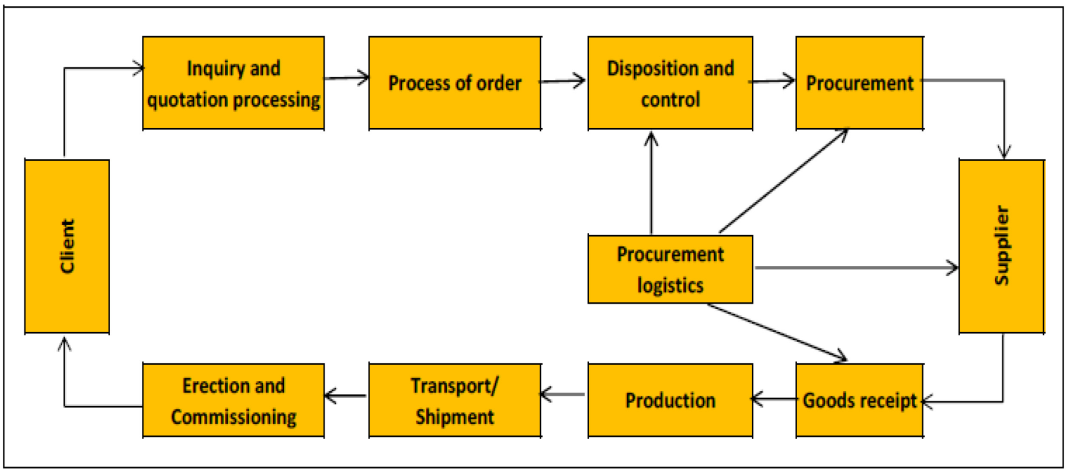


Figure 3: The logistic chain of an industrial company[22]

[20] Source: Wirtschaftslexikon24.com, http://www.wirtschaftslexikon24.com/d/beschaffungslogistik/beschaffungslogistik.htm (22.04.2015)
[21] Source: Frauenhofer-Institut für Materialfluss und Logistik, http://www.iml.fraunhofer.de/content/dam/iml/de/documents/OE%20320/Infoseiten%20Projekte/IS_Beschaffungslogistik.pdf (23.05.2015)
[22] Source: Arnolds, H.; Heege, F. et al. (2001), p. 128

Procurement logistics is part of the procurement management as also the logistics and forms the intersection of both business areas but has to be distinguished especially from the term procurement marketing. Areas of responsibility, such as influencing the procurement markets, procurement market research, development of legal and social relations with the suppliers and issues of remuneration policy and payment are excluded, as far those topics refer to the term procurement marketing. However, they are to be considered as a framework for the procurement logistics and dispositive settlement.[23]

The main task is to ensure all activities related with the type-, quantity-, quality- , space-, time-, and cost ("6 subjects of logistics") related operational performance of necessary material supply within the procurement of goods. With the help of the procurement logistics the chain between takeover of the materials from producer and the delivery to the client should be optimized.[24]

In following next pages the strategic framework of procurement logistics, the supply principles and the existing procurement logistics strategies are explained as information to the process flow of material and tasks required to enable the smooth transition from supplier to receiver.

Strategic Framework of Procurement Logistics

Strategic considerations for the positive performance of the operative work within the process have to take in mind. Following main points play an important role as the strategic framework of procurement logistic:[25]

- Overcoming space and time bridging: The fundamental problem of procurement logistics is the space overcome, if the required-covering goods in the procurement process are not yet available at the place of consumption. Thus, the object of procurement logistics is to provide the necessary goods purchased by the procurement in time. Therefore the time has to be regarded as the second strategic dimension of the procurement logistics. In addition to the deadlines and the time consumption of the logistic processes (transport, handling, producing, etc.) also issues of time bridging have to be considered, which present themselves as an interruption of flows of goods and warehouses.
- Sourcing concepts influence the procurement logistics profoundly: From a single source the need is fed by one source, while at multiple sourcing numerous delivery routes have to be controlled by the procurement logistics. Global sourcing as well as an outsourcing often leads to a greater distance and complexity. Modular sourcing is a complex requirement, as mostly variants and extensive (larger, heavier) procured goods have to be handled. In forward sourcing basic logistical procurement decisions have to be set long before the actual delivery.
- Optimization: The top priority is the procurement logistic optimum. The target is, to have the right quantity and quality at the right place and to minimize the resulting costs. It has evolved in the recent decades of a vision to an indispensable claim to the real procurement logistics.

---

[23] Source: Koppelmann, U. (2000), p. 17
[24] Source: Heiserich, O.- E.; Helbig, K. et al. (2011), p. 48
[25] Source: Arndt, H. (2006), p. 55

Supply Principles

Disposition of the amounts and dates is the central operating and permanent task of the procurement logistics, which enables the strategic requirements. The different quantity-time relationships can be distinguished by three different possibilities (supply principles):[26]

- Delivery of stock-/order quantity: When the (usually extended period of a comprehensive purchase order or project) identified needs will be delivered in the quantity ordered time before the first requirements date. The needs-based distribution is then regularly done from an internal storage. This is the rule in a more passive procurement logistics strategy.
- Delivery according to schedule: A need, a purchase order (PO) or contract amount is spread over several deliveries and delivery dates. An annual, quarterly or monthly requirement can be delivered weekly or often to reduce inventory. It may be one uniform distribution, so that according to the scheme the total= (number of deliveries) × (fixed delivery quantity) can be calculated, or the quantity can vary, which requires the timely retrieval or a rolling detailed planning. Ideal for delivery allocations are an active procurement logistics and approaches for logistics integration.
- Just in time delivery (JIT): It is a very timely delivery, neither too early nor too late. Typically the goods do not go into the warehouse, but are as close as possible provided to the place of consumption, which indeed leads to storage but lasts only very briefly. JIT requires a high degree of willingness to make the procurement logistics strategically and actively manage and enter into wide-ranging logistics integration with the JIT suppliers. The establishment of strategic procurement logistics systems as well as the disposition according to the JIT-principle is especially useful in continuous and well-predictable supply relationship.

The necessary distinction should not arise randomly, but its result of strategic decision based of analysis (value and frequency), also take into account aspects such as transport capacity, distance, delivery conditions etc.

For the positive implementation of the supply principles and to meet the increase of logistic requirement of the manufacturer, organizational design variants are possible:[27]

1. The suppliers of a defined area are associated with a single logistic provider, in the field carrier who collects the amounts retrieved from suppliers and is heading to the manufacturer. Benefits are here in the bundling of goods and the resulting lower transport costs for all involved.
2. Within another variant, a procurement logistics warehouse for production synchronous supply of its production is created in the immediate vicinity of the customer. The control problem of timely needs-based delivery can be solved by this this variant, where parts that are not able to deliver according to just-in-time principle.

---

[26] Source: Frauenhofer-Institut für Materialfluss und Logistik, http://www.iml.fraunhofer.de/content/dam/iml/de/documents/OE%20320/Infoseiten%20Projekte/IS_Beschaffungslogistik.pdf (23.05.2015)
[27] Source: Frauenhofer-Institut für Materialfluss und Logistik, http://www.iml.fraunhofer.de/content/dam/iml/de/documents/OE%20320/Infoseiten%20Projekte/IS_Beschaffungslogistik.pdf (23.05.2015)

3. With the transship concept the bundling of freights is realized. Here there will be no storage of goods, but merely a collection and handling in transshipment terminal. The organization of the flow of goods is the crucial task and requires high demands on planning and control systems.

3.1 Procurement as Part of Procurement Logistics

Procurement logistics has to be distinguished from the procurement and purchasing. The term “procurement” is often used as a generic term of purchasing and procurement logistics, where the purchasing ensures the legal availability (development, maintenance of the existing source of supply of the procurement market) and the procurement logistics, on the other hand, has the target in ensuring the physical availability (provision of the “6 subjects of logistics”) of the procured goods. The supply or procurement is the beginning of the logistic chain and therefore the beginning of the control of material flows.[28]

The main task of procurement is to supply the company with material, with the target orientated planning and realization of contract conclusion with suppliers.[29]

According ARNOLDS procurement includes all company- and/or market- related activities that are aimed, to make available the required, but not themselves prepared objects for the company. Objects are defined by different representatives of a comprehensive procurement studies, as personnel, investments, rights, material and information as input factors.[30]

The investigation within this thesis is concentrating on the understanding of procurement as the use of material goods (equipment and materials) and limited on services. The task of procurement or also called procurement management is defined and is part of the structural organization within a company. Following next pages describe the targets and the processes of procurement as link to the required quality activities included within the procurement.

3.1.1 Targets of Procurement

The goal is to secure the supply of a company with high quality products (goods and services) at low costs. The cooperation has to be done over the whole product life cycle with those suppliers, which meet the need of the company most efficient.[31]

In addition to the cost reduction target or low costs, also further procurement tasks, like quality/performance, flexibility and risk reduction with increasing uncertainty, complexity and specificity have to be managed and optimization of the inputs within the value- or supply chain. The main objectives have to coexist with and integrated into the procurement process.[32]

---

[28] Source: Frauenhofer-Institut für Materialfluss und Logistik, http://www.iml.fraunhofer.de/content/dam/iml/de/documents/OE%20320/Infoseiten%20Projekte/IS_Beschaffungslogistik.pdf (23.05.2015)
[29] Source: Fröhlich- Glantschnig, E. (2005), p. 1
[30] Source: Arnold, U. (1998), p. 3
[31] Source: Rink, C.; Wagner, S. (2007), p. 39
[32] Source: Irlinger, W. (2011), p. 16

Figure 4 illustrates the dependency of costs, security, flexibility and required quality within the procurement cycle.

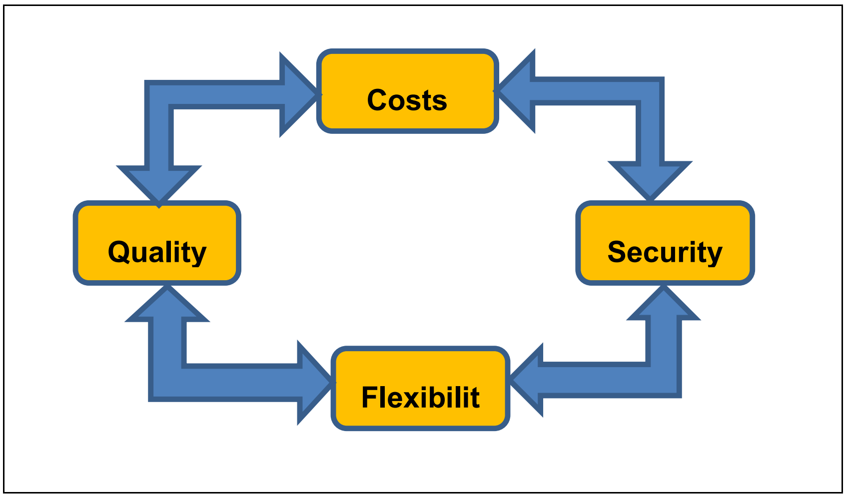


Figure 4: Target of procurement[33]

- **Quality**

  There is a strong dependence between the desired quality and the procurement and sales. The quality aspect mainly refers to the characteristics of the procured objects. Due to the assumed target competition between costs and quality, it is to find the best possible compromise between these two goals.[34]

- **Cost reduction**

  Within the term costs, procurement costs differ from functional costs. From the evaluated cost prices with quantities of procured input factors, procurement occupies a significant impact on the achievement of cost targets of all functional areas. Moreover, packing, transport, storage and insurance costs are covered by the procurement costs. The procurement functional costs however, include the costs of carrying out the procurement functions within the company. The optimization and reduction of costs is the first major group of procurement goals.[35]

- **Flexibility**

  The bigger the flexibility of the procurement within a company, the greater is the independence to the power of suppliers. Not the actual, but the assessment of the maneuver determines the power of dependency ratio.[36]

- **Security**

  An overlap with quality objects only exists, if due to the insufficient supply a lower quality is accepted to ensure the supply. Also the delivery time risk, just-in-time production or storage is a sufficient point of security. The reliability of the supplier is most important for

[33] Own illustration
[34] Source: Janker, G. C. (2008), p. 17
[35] Source: Koppelmann, U. (2000), p. 47
[36] Source: Fröhlich- Glantschnig, E. (2005), p. 8

the assurance of the supply. In extreme cases it can come to the unavailability of the agreed performance. If objects are easy to obtain, the security target is without importance and the focus can be more on the flexibility of procurement.[37]

The above mentioned targets are dependent on the weight of object as well the strategy, politics and procurement targets of a company. For the adjustment of the targets to assure the required quality, a permanent controlling has to be done key performance indicators (KPI`s) as part of the controlling activities to evaluate the targets. KPI´s are discussed in following chapters as part of supplier controlling.

3.1.2 Process of Procurement

To demonstrate the procurement or also called sourcing decision and to achieve a better decision result, KOPPELMANN developed a phase model of the procurement process. He divided the process of procurement into six successive phases:[38]

1. Situation analysis,
2. Needs analysis,
3. Procurement market analysis and –selection,
4. Supplier analysis and -selection and
5. Supplier negotiation as last step the
6. Procurement execution.

The complete procurement process of the phases can be illustrated as per figure 5 below.

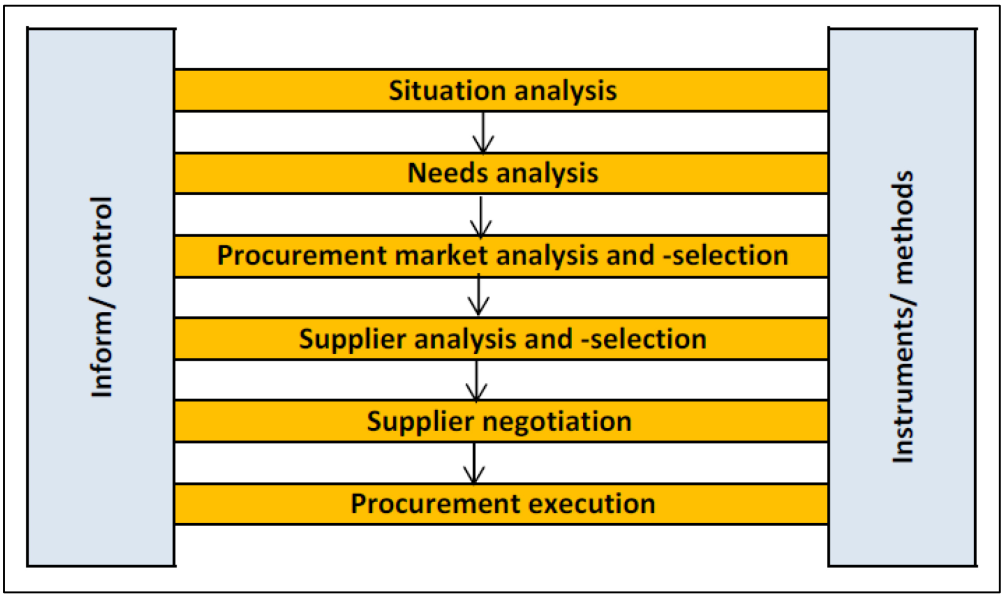


Figure 5: Phase model of procurement[39]

The importance within the success of a company lies in the interrelationships and feedback between the individual phases. The following explanations of the process steps should shortly demonstrate the core of the phases:[40]

---

[37] Source: Janker, G. C. (2008), p.17
[38] Source: Koppelmann, U. (2000), p. 45 et seq.
[39] Source: Koppelmann, U. (2000), p.47

Situation Analysis

The situation analysis generally refers to the decision background of each functional area within the company. For the procurement decision the purchasing constellation is initially decisive, which means the circumstances and conditions that effect the procurement action. The constellation sets the framework for actions and poses both opportunities and risks. A variation of this can gradually or abruptly enter (e.g.: quality deterioration of parts provided by a supplier or collapse in demand), which makes a constant monitoring of the procurement markets necessary.

Changes in the constellation can be induced through the procurement market (e.g.: price explosions), the sales market (e.g.: competition) the own company (e.g.: manufacturing defects) or the environment (e.g.: economic instability). Figure 6 illustrates the procurement constellation within the environment.

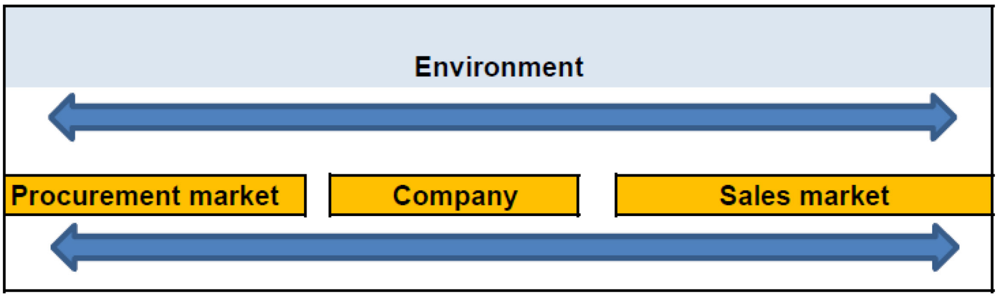


Figure 6: Procurement constellation[41]

According KOPPELMANN, the impact of constellations appear mere action routines as not sufficient and require an understanding of the context of action. In addition, for the analysis of the situation the pursued objectives, the derived strategies and activities including existing procurement potential are significant. The potential analysis provides information about strengths and weakness of a company, to support strategic decision-making processes. Potential short term limit the room of maneuver of the procurement. On basis of the potential analysis, current strengths and weaknesses of the company are identified. Where can potential useful be assembled, dismantled or remodeled? What are the benefits and what are the costs involved?

Needs Analysis

With the identification of needs the real procurement process begins. At this stage, requisitions are made that affect the entire additional decision support process. Therefore, the needs analysis is the “center of the procurement activity”. The necessary requirements can be divided into the object- and modality requirements. Often the focus is on the power and quantity of the object. Increasingly the time, location, payment, delivery, service and information win is in this area of modality requirements. In that stage, it is crucial, that the procurement areas reduce

[40] Source: Koppelmann, U. (2000), p. 75 et seq.
[41] Source: Koppelmann, U. (2000), p. 88

their tasks, not only on the execution of provisions of the other function areas, but contribute their own expertise with regard to material substitutions.

Procurement Market Analysis and -Selection

HARTMANN describes this phase as the “procurement market research” and sees in it the core area of the procurement market. It includes all activities that relate to the systematic gathering and processing of information, to obtain in-depth knowledge of the conditions and processes on existing or potential future procurement markets.[42]

Which markets are suitable to search for suppliers and what goals can be realized? A crucial factor is the competitive situation in the markets. Other features, according to which procurement markets can be differentiated, are costs, benefits and risks. Cost characteristics have led inter alia on global sourcing strategies (global sourcing), which are crucial in balancing of performance features, such as on-time delivery and procurement risks for choosing a procurement market.

Supplier Analysis and -Selection

Is the area defined as per previous step or process defined (on which the focus is), the next task is then within this phase, to find the suitable suppliers. The supplier evaluation is referred as the endpoint of the analysis. The supplier analysis is the basis for the selection of suppliers. At this point not the final decision for the supplier will be done, but should be determined the number of potential suppliers. This selection is the pre-selection and determines which supplier should be entered into negotiation.

Supplier Negotiation

Within this phase of procurement, the requirement request requisitions are to be enforced within the meaning of the economic principle at the lowest possible cost with the supplier. This principle precludes the incentive-contribution-theory. Here, the supplier should get as many incentives as possible, to make him interesting on a long-term business relationship. This has to be handled during supplier negotiation. In addition, suitable instruments for the negotiations must be found. These instruments need to be analyzed for object- and situation-specific substitutions and dependency structures, evaluated and act as a forecast for the future.

Procurement Execution

The last phase of the model and the process in comparison to the preceding strategic phase has an operational character. It includes the following aspects: The purchase order as formal completion of process, the procurement monitoring as quality-, quantity- and modality-supervision as well as the disposal. All phases of the procurement process will be accompanied by information and control activities and reactively connected. Here, the results of each phase and the entire procurement process with a priori defined objectives are compared.

---

[42] Source: Hartmann, H. (2002), p. 28 et seq.

The department QA/QC has in general a supporting function within the process of supplier analysis and -selection, supplier negotiation and procurement execution. The quality related functions and input will be detailed described within the chapters below.

Additional to the procurement processes the procurement control should be part of comprehensive procurement controlling, which accompanies the entire procurement process in term of planning-, control- and monitoring tasks.[43] Thus the procurement control provides on the one hand the conclusion of the individual process, and is on the other hand however, a permanent, ongoing task.

As per definition of ISO 9001, chapter 7.4.1, which defines the purchasing process, the organization shall ensure the conformity of the purchased products to the specified purchased requirements. The extent of control type and applied to the supplier and the purchased product shall be dependent upon the effect of the purchased product on subsequent product realization or the final product. The organization shall evaluate and select suppliers in accordance with the organization's requirements. Adequate criteria for selection, evaluation and/or re-evaluation shall be established and records of the results and any necessary actions arising from the evaluation shall be maintained.[44]

Within SMCMH the department QA/QC is part of the supply chain. It has to assure the purchased items and their release for transport to the further production or erection site. Thus the last step within the procurement process is the control of the goods. It gives a major input for the analyzing and valuation process of possible suppliers as the result of the evaluation. Detailed tasks and role of the QA/QC within the procurement process of SMCMH as part of the supply chain are described in chapter 6.4.

3.2 Supply Chain Management as Interface of Supplier with Customer

The role within the area of procurement is expanded by the interaction with supplier which leads to the definition of the supply chain management (SMC). Supply chain itself starts from the point where suppliers supply materials to manufacturer, which means the point of sale. SMC includes "all activities associated with the flow and transformation of goods from raw material stage (extraction), through the end user, as well as the associated information flow", which means all activities required for the supply from supplier to client. The interaction with the supplier within the logistic chain makes the importance within this area. There are different theoretical definitions within the aspect of supply chain, but until today there is no definitive definition of supply chain within the economic literature. A clear difference between the supply chain management and the term logistic chain is due to the different point of views not possible. In general logistics is dealing with operative- and supply chain with the strategic activities. Logistics is concentrating on the material- and informational flow. Supply chain, on the other hand, extend their activities to the participant cooperation of this value network in consideration of costs, time, quantity and quality to enable and harmonize an efficient and effective

[43] Source: Bogaschewsky, R. (2005), p. 43
[44] Source: EN ISO 9001:2008, p. 33

information interaction. In opposite to the logistic management the supply chain management can also deal with contractual and financial transactions.[45]

Independent of the different theories, all thinking approaches have their mutuality:[46]

A supply chain is the result of the internalization or externalization of the necessary for the provision of services economic values. SMC can be understood as a strategic-, cooperation- and integration orientated management conception, to increase the efficiency and effectiveness within the value- or supply chain. The concept goes beyond the logistic dimension. Due to the cooperation and integration the object of observation are at least information and material flows. Initiation of the supply chain and their control starts from the point of sale.

The basic model of supply chain management can be characterized on basis of following guidelines:[47]

- **Development of Core Competencies**: The desired performance from the end user can usually not be met by a single company. The customer expects a set of core competencies that puts him through a corporate network of services in a fast, cheap and excellent quality. As a result, the supply chain must focus on the management of networks with different partners in terms of core competencies, which mean different supplier.
- **Cooperation within Networks**: If the network participants reduce their depth of value added, the need for cooperation increases. For that reason an intensive information exchange is required before the actual service provision begins. As flexible units, the know-how is combined by the advantages of the smaller and bigger company resulting in effective and innovative partners.
- **Process and Cycle Life Reduction**: Increasing demands on the delivery time and reliability require the time orientated supply chain. The potential for success is thus based within the supply chain on the reduction of the business processes within the process orientated structural organization. Corporate cross- divisional processes increase the reaction time ability and reduce the uncertainty in the processes.
- **Reduction of Information Asymmetries**: The coordinated time- and form based transmission of information for planning, control, design and control of information transfer within the value chain partners is of importance and a challenge for the supply chain management.
- **Reduce of Complexity**: A large number of suppliers, a high productivity variety, a large number of customers, who receive via various sales and distribution channels their goods, act as environmental complexity drivers on the supply chain of a company. The consequence for the network user is in a high process- and interface variety. Thus appropriate strategies are required within the supply chain to eliminate and/or smooth those complexities. Further preventive actions are required for the future.

[45] Source: Arndt, H. (2006), p. 17
[46] Source: Arndt, H. (2006), p. 64
[47] Source: Wildemann, H. (1993), p. 6 et seq.

- **Quality Assurance**: The customer orientation within the supply chain is based on a comprehensive quality philosophy. This requires an adequate quality management system, which considers the influencing factor of quality with the customer-supplier relation. Quality objectives are reasonable factors for the customer satisfaction. For the insurance of the required quality, different concepts are part of the quality assurance and control activities. Controlling activities are governed by result orientated quality processes within the supply chain.

Choosing suppliers is very important in industries, because of the increase in competitiveness and globalization. Choosing the right suppliers, who can support the manufacturer`s strategies, decisions and continuous improvements is mainly related to many factors. Based on carried out studies, manufacturer showed that trust is considered one of the main concepts in choosing suppliers. It came after quality and shared almost the same importance as delivery.[48]

Supplier management plays thus an important factor and role within the procurement process and supply chain management.

3.3 Supplier Management as Subtask of Procurement

After the definition of procurement, their goals, targets and phase model for procurement and the interface with the supply chain, the supplier management as the supplier-customer relationship are further illustrated within this thesis. The department QA/QC plays here an important role within supporting the procurement by activities like supplier selection and -analysis.

The rapid technological change, shorter product life cycles and increase competition pose challenges to businesses in numerous industries. A continuing trend is the outsourcing of activities that are not part of the core competencies, to suppliers and service providers. As result of the strategic plans of those institutions or companies the value-added share of suppliers is growing.[49]

The depth of value added (also: depth of production) refers within the value chain as share of the in-house production of a company as part of the creation of goods. It describes in a value chain the fraction of the internal (company specific) production to the total production value of a company. The total production value of a company consists of internal production plus the sum of externally produced goods and services.[50]

$$\text{Depth of value added = (Real net output ratio)} \quad \frac{\text{internal production =}}{\text{total production value}} \quad \frac{\text{internal production}}{\text{internal production+external production+externally produced services}}$$

Figure 7: Depth of value added[51]

[48] Source: Ghazo, M., https://www.linkedin.com/topic/supply-chain-management?trk=pprofile_topic (24.04.2015)
[49] Source: Irlinger, W. (2011), p. 1
[50] Source: Adam, D. (2006), p. 62
[51] Source: Arnolds, H.; Heege, F. et al. (2001), p. 67

A depth value added (DVA) of e.g. 0% relates thus to a company that does not have an own production and therefor only does trading. A company with a DVA of 100% is completely independent of any purchasing of components or raw materials. Figure 7 illustrates the dependency of the internal to total production resulting in the depth value added.

The downward trend is partly due to the increasing complexity of products, which has led to a continuous growth specialization of suppliers. The companies are now not only divided to pure production, but also transferred to a large extend the research and development of parts and components to suppliers.[52] Hence the importance of supplier management is increasing steadily. The procurement sector has expanded to a considerable importance due to the decrease of the in-house or internal production and the share of value added provided by the suppliers. Suppliers therefore contribute significantly to the competitiveness of the company.

At lower value of DVA, the quality concept, which means quality management with the integrated QA/QC activities becomes more and more important, and therefore the supplier requirements, supplier selection criteria, development and care of suppliers grows with resulting in the interface to SMC. The supplier management forms in two ways the core area of the procurement. First, it is located in the center of the procurement process, and on the other hand, it is of crucial importance for the success of the procurement. Figure 8 illustrates the classification of procurement management within the already mentioned procurement model or process.

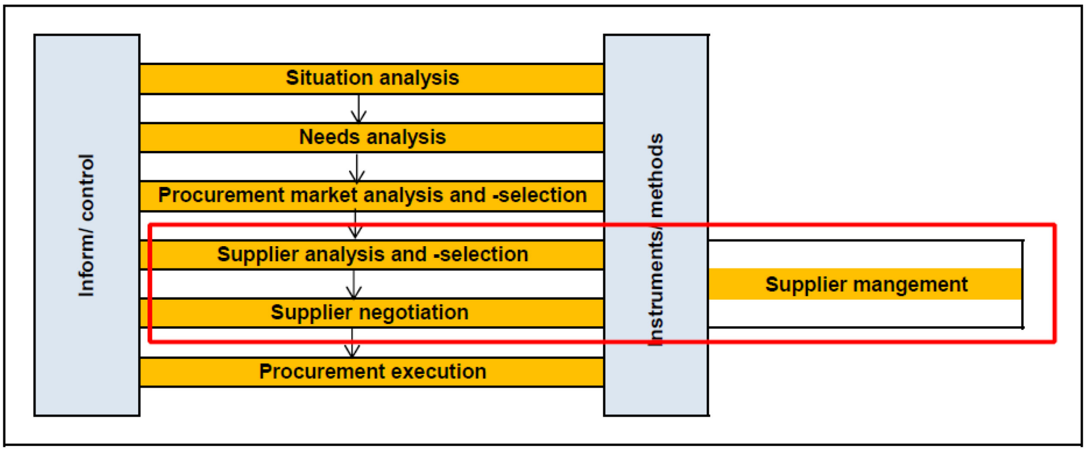


Figure 8: Classification of supplier management[53]

Thus, the focus of the supplier management is on the phases of analysis, selection of the suppliers and supplier negotiation. Decisive however, also the other procurement phases flow indirectly as basis for the decision of supplier management. For example, the procurement market selection or the needs assessment also influence the selection of potential suppliers. Only an isolated view makes no sense in considering the term as interaction of analysis,

[52] Source: Adam, D. (1998), p. 198 et seq.
[53] Source: Koppelmann, U. (2000), p.47

selection and negotiation.[54] The supplier management also contains the continuous evaluation, development, qualification of the supplier as well the relational management with them.[55]

In general, the term supplier management is dealing with the supplier-customer relationship. Within the literature there is a wide agreement that the interface between supplier and customer and the development of the relationship between both is the foreground of investigation.[56]

Analyzing, evaluation, selection and control of suppliers are of essential decision problems within dealing with the suppliers.[57]

JANKER describes supplier management in his comprehensive definition as the start with the identification of suppliers and leading to the strategic supplier management, including supplier-integrity, maintenance and development.[58] That can be described as the strategic and operative possibilities for investigation on a supplier. Areas of responsibility, such as influencing the procurement markets, procurement market research, development of legal and social relations with the suppliers and issues of remuneration policy and payment are excluded as far those topics refer to the term procurement marketing. However, they are to be considered as a framework for the procurement logistics and dispositive settlement but not investigated within this thesis.

3.3.1 Tasks of Supplier Management

Supplier management as a pure process can be better illustrated and shown as a sequence of events. The tasks itself, however are difficult to put into a process view. To capture the tasks, a model as shown in figure 9 can be used.[59]

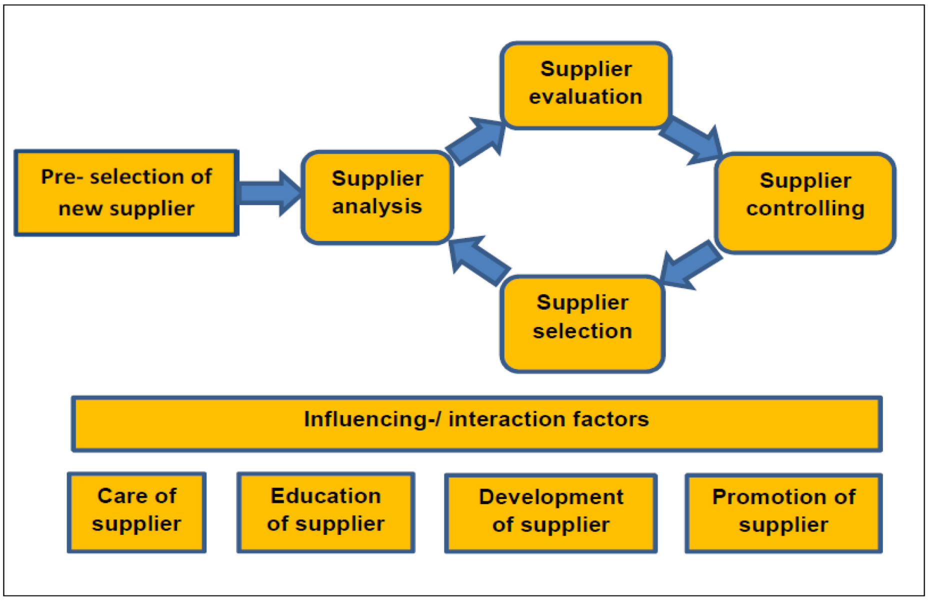


Figure 9: Responsibilities of supplier management[60]

[54] Source: Irlinger, W. (2011), p. 22 et seq.
[55] Source: Bogaschewsky, R. (2005), p. 42
[56] Source: Irlinger, W. (2001), p. 9
[57] Source: Fröhlich- Glantschnig, E. (2005), p. 10 et seq.
[58] Source: Janker, G. C. (2008), p. 33
[59] Source: Irlinger, W. (2011), p. 26 et seq.

In the focus there are four process steps, including the supplier evaluation, supplier controlling, supplier selection and supplier analysis. If a new product is introduced, the preliminary selection of new suppliers is added. As a means of influencing or controlling the supplier relationship, the company has the ability of integration, maintenance, promotion, education and the exclusion of suppliers. In following the main tasks of the supplier management are presented.

1. **Pre-Selection of New Supplier:**

To draw up a shortlist of suppliers, first they have to be identified and limited. First it must be examined whether the company already has suitable suppliers eligible for the new product in question. Moreover, to find new suppliers in the market it is the responsibility of the procurement market research. Primary and secondary sources can be distinguished to get information about possible supplier. Primary sources can be based of procurement markets data. Secondary data can be evaluated by information, which was first filtered for other purposes. Table 2 shows a summarization of possible primary and secondary sources for the pre-selection. Those data can be used for the purpose.[61]

Table 2: Primary/Secondary sources of pre-selection[62]

Primary sources	Secondary sources
Supplier survey	Publications
Self- disclosure	References
Company visit	Official statistics
Exhibitions	Company directory
Conference	Market reports
Market research institute	Internet
Contact with seller	Database
Offers	Advertisement
Trial delivery	Publications of supplier
Internal sources	Daily newspapers

- **Supplier Identification**
  First, the field of potential suppliers should be determined. Here it is useful to limit the determination for the pure procurement object and who is offering the appropriate item. The pure procurement object orientation has however the disadvantage that it relies on limited data. In this point it is of advantage to take also in consideration other companies, which do not offer exactly the same product, but want to expand its product

[60] Own illustration
[61] Source: Janker, G. C. (2008), p. 34 et seq.
[62] Source: Janker, G. C. (2008), p. 35

range according to requirement. For new parts, such as special products, the similarity to other products can be used for identification.[63] Here the search for similar products or method choice of supplier can be understood and the identification aspect is in the foreground. A selection of the supplier is done later.

- **Supplier Limitation**
  At this stage the supplier is going to be checked by the purchasing company for the containment. The target is to reduce the number of suppliers to eligible suppliers undergo the detailed process of supplier analysis and -evaluation.

Within this process the quantity of suppliers will be gradually reduced and progressively more detailed information will be delivered. Following tools are useful for the limitation:

- **Certification**
  As the suppliers are becoming increasingly part of the value chain, the verification of quality has become more complex. The demands on the performance and the entire business process of the supplier increased. One possibility to demonstrate the supplier`s skills, is to provide a management system and the certification. Here certificates can limit the choice for the suppliers.[64]
  As one of the most important standards for the development of the quality management system is the industry-independent series EN ISO 9000. The main point going beyond the company process model with demands of management responsibility, resource management, product realization and measurement, analysis and improvement is stated in EN ISO 9001.[65] The model of process-based- quality management system is illustrated in the standard as part of the continuous improved PDCA-cycle (Plan-DO-Check-Act). PDCA-cycle including the process based view of standard EN ISO 9001 as requirement of QM system is resented in below chapter of process management.

- **K.O.-Criteria**
  An additional way to narrow the selection of suppliers offers the knock out-criteria. If the supplier does not fulfill a minimum requirement, then he will be excluded. A just-in-time delivery can also be k.o.-criteria. Here, adjustments have to be done explicit for the requirement of the company and can vary accordingly in the dependency of the respective procured object.[66]

2. **Supplier Analysis**

The supplier analysis includes identification, preparation, processing and presentation of information on potential suppliers. The focus is on the exploration of performance, which is

[63] Source: Koppelmann, U. (2000), p. 239
[64] Source: Janker, G. C. (2008), p. 39
[65] Source: EN ISO 9001: 2008, p. 9
[66] Source: Janker, G. C. (2008), p. 40

recorded in a snapshot. The obtained information flows in the evaluation and selection of suppliers. Further, a supplier observation is done by documented performance within defined time and builds up on the results on supplier analysis.[67] The results of the procurement market research and the supplier questionnaire are collected and prepared for the supplier evaluation. The target of the supplier analysis is the precise knowledge about the performance to get a transparent view for the following supplier evaluation.

The performance can be measured by following tools:[68]

- **Audit (System, Process, Product)**

  The auditing of suppliers has the purpose to investigate systematically and comprehensively the performance of potential suppliers. For this purpose a questionnaire can be used, which should be adapted to the respective procurement object. Audits are information systems to get an effectiveness and problem appropriateness for the actions to come to the quality assurance. The target of an audit is, to uncover weakness, make suggestions for improvement and quality assurance activities and to check if the quality requirements are suitable to achieve objectives.

  Audits can be done internally within an organization (on behalf of the management) or external at supplier and/or producer by a second party- or third party auditors. Audits have to be performed only by a certified, notified body.

  In general there are three types of audits and they can be distinguished by process audit, product audit and system audit.

  - **Product audit**

    The product audit is the examination of the small number of finished products in accordance with the specifications. It occurs as subsequently declaratory inspection referred a snapshot from the perspective of the contractor. The product audit shall be separated from the inspection of incoming goods, as the place is always at the location of the supplier. In a regular manner, the quality check can also replace the product audit at the place of the incoming goods.

  - **Process audit**

    The target of the process audit is to uncover the weaknesses in quality effectiveness of service provisions. Here, the effectiveness of the actions used by the company to improve processes is measured, to avoid irreparable or costly mistakes, which have to be rectified. Errors should be detected by in- time intervention and elimination of failure cause. This involves the assessing the effectiveness of quality assurance elements that confirm the quality capability or the compliance and suitability of certain processes, activities and the identification of improvement actions.

[67] Source: Hartmann, H. (2002), p. 18
[68] Source: Pfeifer, T. (2001), p. 335 et seq.

- **System audit**

  A system audit is also the auditing of the quality management system. The aim is to make conclusions about the effectiveness. Based on the knowledge of the personal, the practical use and existence of the prescribed instruments for the quality assurance, the quality management system and its compliance are checked.[69]

The targets, subjects, specific requirements and responsible documents for an audit are listed in the table 3.

Table 3: Overview of types and tasks of audits[70]

	Product	Process	System
Target of the audits	Determine to what extend the product has the required quality	Determine to what extend the process operate according the specifications	Determine to what extend the actual available system match with the planned condition
Subject of the audit	End products Intermediate products Individual parts Services	Manufacturing process Administration process Service process	Overall system Subsystems Elements of systems
Specified requirements	Dimensions Weights Surface features Material specifications ...	Resources Settings Auxiliaries Working processes Process capability	Structural organization Process organization Monitoring of resources Documentation
Audit documents	Drawings Tables Product description	Job description Inspection plans Maintenance plans Setting plans...	Organizational directives QM- Manual Accident prevention regulations…

Other forms of audit may include the service audit, which may relate, e.g. to storage, transport and delivery of the supplier or the eco-audit, which documents the environmentally friendly production of the supplier: The eco-audit is a process in which a company is voluntarily checking its environmental behavior, improves and exposes. The core is the development of an environmental information system (environmental management), aiming a continuous improvement of environmental performance. The performance of those different audits should be performed simultaneously. The results of the supplier analysis forms the basis for the supplier evaluation, which is considered in detailed below.

[69] Source: Wildemann, H. (1993), p. 39 et seq.
[70] Source: Pfeifer, T. (2001), p. 355 et seq.

As result and due to the strong dependency on the delivery in an affectively and efficient matter, the supplier evaluation as task of a company is becoming of high importance to achieve procurement goals. Supplier evaluation as part of the supplier selection is thus a partial aspect of the supplier management in which the interaction with the supplier is of high importance within the industry sector.

3. Supplier Evaluation and -Selection

The supplier evaluation is a systematic evaluation of the performance of the selected supplier. The used evaluation criteria, features, characteristics, the procedure and the evaluation have to be defined. To get a comprehensive picture of the supplier, a sufficient number of departments have to be involved in the procurement process in dependency of the procured object. The assessment of suppliers is done by all involved departments in accordance with their specialization. Here, the procurement department of the company has the role of coordination and leadership of the evaluation activities, as this is the main interface of the company to the supplier.[71]

The evaluation must be transparent and uniform for both parties, eq. for supplier and customer, in order to create acceptance and inform the supplier of its job performance and enable it to derive measures. The evaluation should be carried out regulatory and aggregated in specific report form. The report serves both, the operational and the strategic management of procured company. The deduction of consequences is also provided.[72]

Qualitative and quantitative methods are used for the supplier evaluation and are shortly presented below chapter. The supplier evaluation is used on the one hand for the selection of a new supplier and on the other hand for the supplier controlling. Controlling is following the supplier evaluation and is a classification of the supplier, with derived consequences. Supplier controlling is described below.

4. Supplier Controlling

The supplier controlling is the ongoing review and monitoring of the performance of the supplier. The more important the supplier for the procurement object, the more detailed the controlling has to be done. Supplier structure analysis is one possibility to classify suppliers according to the importance of a company. The features, characteristics or key performance indicators (KPI`s) for the classification can be divided into supplier- and relationship characteristics.

Based on these features and combination of them, an overall performance of the supplier can be done and the supplier classified according the results. The classification is often done by broad categories, like “preferred supplier”, “to be developed supplier” and “prohibited supplier” or supplier can be divided, e.g. by ABC-analyze in homogeneous groups of suppliers, which are controlled by the same degree. The individual values are in practice different, as the number of available classes.

---

[71] Source: Janker, G. C. (2008), p. 44
[72] Source: Arndt, H. (2006), p. 85

The actual supplier controlling begins with the examination of the fulfillment of performance at supplier or the incoming goods inspection. The selected characteristics relate to the objectives of the customer, so called KPI`s.

In practice, often cross-functional areas are used for the criteria of KPI`s. Often involved business areas are within the technology, logistics, quality and procurement. The innovation potential of the supplier is also partially involved. The criteria may be quantitative or qualitative. In practice, the reference level of supplier evaluation is often the individual material group. Common criteria are e.g.: the ppm rate of supplied parts, the price, the payment conditions, the quantity and punctuality as well as the capacity to innovate of suppliers. The first mentioned criteria are objective and relative easy to measure, the capacity to innovate, however, is a subjective size and thus more difficult to measure.[73]

In table 4 examples of KPI´s are figured within mentioned business areas.

Table 4: Example of KPI´s of different business areas[74]

Technology indicators	Logistics indicators	Quality indicators	Procurement indicators
Innovative capability	Timeliness	ppm- rate	Price
Technology position	Quantity reliability	Service activities	Offer transparency
	Launch management	Certifications	
	Implemented systems	Results of supplier audits	

In order to ensure quality standards and security of sustainable supply, a control on basis of KPI`s are of crucial importance. With the help of a target-actual comparison between the required and actual quality-, time- and quantity dependent performances, trends can be identified and reveal performance deficits.[75]

The different kinds, significances and tasks of KPI`s are described within the part of the quantitative method within the supplier evaluation.

Independent to the supplier evaluation and preferences within an active supplier policy also the supplier influencing factors are of major importance for the success of procurement and thus the company.

Following influencing- and interaction factors can affect the performance and behavior of the supplier:[76]

- **Care of supplier**

  This is the most important instrument to influence the supplier. The task is to ensure good relationship with the supplier and the way to maintain the levels of supplier performance. With the care of the supplier a relationship of trust between customer and

[73] Source: Arnolds, H.; Heege, F. et al. (2001), p. 248
[74] Source: Arnolds, H.; Heege, F. et al. (2001), p. 250
[75] Source: Arndt, H. (2006), p. 94, et seq.
[76] Source: Arnolds, H.; Heege, F. et al. (2001), p. 228

supplier should be developed. The fulfillment of obligations, honesty towards suppliers and discretion in handling confidential information can make a valuable contribution.

- **Education of supplier**

  Not always when the company is dissatisfied with the services of the supplier, he will be replaced by another supplier. Education means in that context, that the customer can motivate the supplier for above-average performances. Both the recognition of good performance, as well as the target influence by penalties, if supplier performance does not meet the requirements, can be possible options for influencing the supplier in an adequate way. If an uncritical accumulation of minor errors is discovered, enhanced controls of deliveries are needed. If the errors occur over a longer period, a supplier discussion is required with a target agreement, to find out and define improvement actions to eliminate deficits.

- **Development and promotion of supplier**

  Development and promotion contains all activities to support existing and potential suppliers by the company. Thus, the purchasing company supports the supplier active in the provisions of a service, which is already one of its business activities. The aim is that the suppliers create their performance for the future, in terms of quality and cost considerations in a more efficient manner. It is important, that there is a partnership and communication between both parties. Those companies are successful, the withheld any information and maintain an ongoing and informal exchange of information with their supplier.

  Within the literature there are exact defined processes and possibilities described how to develop and promote a supplier, but this topic will not be detailed described in this thesis. The concentration is mainly on the main part of the supplier evaluation and their methods. The methods which are used for the evaluation, are up to the decision of the company and related to the applicability for the required supplier but should be equal selected to establish the comparability within the applicable suppliers. Basic methods are presented below.

3.3.2 Basic Methods of Supplier Evaluation

This chapter provides an overview of the basic methods, which can be used to evaluate suppliers.

According FRÖHLICH-GLANTSCHNIG, the first requirement for supplier evaluation is the consistent and comprehensible account of the objectives of a company. Especially the objectives of the functional areas and the instrumental objectives of the procurement, and their impact on the supplier evaluation are of critical importance. In general, the methods can be divided into quantitative and qualitative methods. It is not always possible to clearly define the methods, as often both qualitative and quantitative characteristics can act and influence the evaluation.[77]

[77] Source: Fröhlich- Glantschnig, E. (2005), p. 20 et seq.

Purely quantitative methods are usually based on metric scaled features, which can be presented in the form of equations and give an optimal solution. In contrast, qualitative methods are general influences on targets, without determining the exact extend. Thus qualitative methods are the subjective assessments and options.[78]
As mentioned in the chapter above, qualitative criteria are subjective and based on opinions and options, quantitative however, have objective size and thus easy to measure.
Table 5 shows an overview of the quantitative and qualitative methods, and thus as basis the objective and subjective assessments and options, which are used for supplier evaluation.

Table 5: Methods of supplier evaluation[79]

Supplier Evaluation	
Quantitative (objective) methods	Qualitative (subjective) methods
Balance- sheet analysis	Graphical methods
Price- decision analysis	Verbal methods
Cost- decision analysis	Numerical representation methods
Mathematical programming	
Indicators	

Both, the quantitative and qualitative methods can be short described as per description below:[80]

Quantitative Methods

For this kind of methods calculable criteria, which are connected to each other as a system of equations, are used. The relationship between the variables is to be captured in a mathematically evaluable form, in order to get the optimal solution for the applied method for supplier evaluation.[81] It is an objective method and relative easy to measure.

The main quantitative methods to evaluate suppliers are the balance-sheet analysis, the price- and the cost decision analysis, mathematical programming and the use of indicators, which are outlined below.

- **Balance-Sheet Analysis**

The balance-sheet analysis is a method of assessing and evaluating the economic success of a company. The balance sheet, the profit and loss account and the annual report of the supplier deliver series of numbers, which can be represented in a form of classification-, relation- and index numbers. The calculated indicators from the balance sheet can deliver the procured company an idea of economy liquidity, cost structure, performance and sales performance of the supplier. As far the figures are time based and have little predictive value, the balance sheet

[78] Source: Janker, G. C. (2008), p. 102
[79] Source: Fröhlich- Glantschnig, E. (2008), p. 23
[80] Source: Irlinger, W. (2011), p. 40 et seq.
[81] Source: Fröhlich- Glantschnig, E. (2008), p. 23 et seq.

analysis makes only sense for the use over years. Due to that reason it makes only sense to use this kind of analysis for a more long-term cooperation of the company with the supplier. Further only general company data of suppliers are used and must be supplemented by additional information from various functional areas. The knowledge of the development of the balance sheet may be in negotiations with the supplier of advantage. Planned price increases by the supplier can be therefore e.g. attenuated and objectification of the conversation be made possible.

A selection decision for or against a supplier purely based on this balance sheet analysis is therefore not possible.

- **Price-Decision Analysis**

The price-decision analysis is a generic term standing for three methods aligned on the price: price structure analysis, price monitoring and price comparison. They differ from each other regarding the examination, the examination target and its main field of application. The differentiation within price illustration analysis is illustrated as per table 6.

Table 6: Price decision analysis[82]

	Price structure analysis	Price monitoring	Price comparison
Object of investigation	Supplier price as composition of costs of components and profit	Change in the price of a product over time	Prices of different suppliers and different qualities
Target of investigation	Review for adequacy of the price as the basis of price negotiation	Forecast of future development as the basis of procurement planning and contract policy	Selection of product quality and supplier (as part of the offer comparison)
Main application area	Products, where customer can influence price level	Products, which have a high price variability	Products, which can be obtained in different process and qualities from different suppliers

The price structure analysis allows the user to test if the price used for negotiation is reasonable. The prices of the procurement object of suppliers are examined on basis of the cost and profit elements. The understanding of the calculation method of the supplier is required. Such negotiated prices are mostly found in those industrially manufactured products, which represent the custom-made items.

Price monitoring is used for the evaluation of the price of the procured objects over time. This allows the buyer to make predictions about future price trends and provides a valid basis for a cost-effective procurement planning and contract policy with suppliers. For products that have higher rate variability, such as internationally traded commodities, the price monitoring is of

[82] Source: Arnolds, H.; Heege, F. et al. (2001), p. 119

particular importance. This monitoring should not only concentrate on the products of the procurement product but also substitution materials.[83]

Price comparison is dealing with the selection of the supplier within the offer analysis, which is limited to the inclusion of price-determining factors. The prices of different suppliers and different qualities are compared and the best offer is determined. This application is used when whenever several suppliers offer products in various grades and costs. Price monitoring and price comparison is of crucial importance of the procurement practice.[84]

- **Cost Decision Analysis**

Within this analysis all those costs are considered, which additionally arise the company in choosing a supplier to the pure procurement price. One possibility is the cost ratio method. Here the total costs incurred during the ordering process, are determined like costs regard of quality, delivery and service. The portion of those costs will be determined and form the so called cost-ratio. The sum of the quality-, delivery- and service costs form the overall cost- ratio. Those costs will additionally be implemented into the supplier offered material price and are the real cost which arise for the supply. An extension of the costs can also be the implementation of risk- and safety factors. All those factors represent only a preliminary filter but the final decision for a supplier is only on the comparison of internal and external costs.[85]

- **Mathematical Programming**

The most common programs are linear programs, mixed integrated- and stochastic programs. The method of linear programming to evaluate suppliers usually connects the two previous discussed methods, like price decision analysis and cost decision analysis.

It is first checked by means of filter variables that suppliers are shortlisted and to be assessed. The most important singular target function for the procured object is set. In addition, all relevant and assessable characteristics of suppliers must be defined and determined. The selected variables are introduced as constraints into the program and specify the minimum and maximum requirements. For each supplier a value for the objective function is calculated, thus a ranking of supplier can be created. The supplier which best meets the objective function, is considered as optimal and is selected.[86]

- **Key Performance Indicators (KPI`s)**

In general KPI`s are quantifiable variables that inform by continuous compaction the complex reality on measurable facts. They give focused information on quantifiable ascertainable facts and development of the considered system. A system of indicators is a set of them, which stands on a meaningful relationship to each other, complement each other or explain and are

---

[83] Source: Arnolds, H.; Heege F. et al. (2001), p. 202 et seq.
[84] Source: Fröhlich- Glantschnig, E. (2002), p. 27
[85] Source: Fröhlich- Glantschnig, E. (1994), p. 29
[86] Sorce: Janker, G. C. (2008), p. 108

focused on a common subordinate goal. Indicators are characterized by the three parameters, like object, time and dimension.[87]

As far a company is trying to reach their performance-, and financial goals based on strategic-orientated philosophy, the key figures and goals are standing close to each other and are used to define success factors and measure progress for the achievement of business goals. For that reason KPI's need to be:[88]

- Results oriented,
- SMART (Specific, Measurable, Achievable, Realistic and Time-based), and
- Affect- behavior in a positive way.

Indicators should inform in a concentrated manner on numerically detectable, economic issues. Each supplier is assigned an identification number that expresses its quality and reliability. There are absolute individual values, sums, differences, averages and relative classification-, relationship- and index figures or indicators. As classification indicator of the supply quality (quality value numbers) can be taken into consideration, e.g. the number of error-free deliveries to the total deliveries of a supplier. Relationship indicators are characterized by having two numbers unequal dimensions, which are taken in consideration, such as cost per delivery. Index indicators changes are displayed over time, where volume- and price indicators are for the supplier evaluation of significance. A detailed description of the existing types of KPI`s are listed below:[89]

Types of Key Indicators

- Absolute Indictors
  - Individual indicator: Single numbers (number of employees, turnover, etc.).
- Relative Indicators or Ratios
  - Breakdown figures: Bring parts of a whole in conjunction. The part size is divided by the overriding total size of the same dimensions, e.g. proportion, percent, parts per thousand (fixed assets/total assets, equity ratio, foreigners, etc.).
  - Relationship figures: Combine variables that relates by substantive to each other. It is the quotient of two various numbers (equity ratio, Return on Invest (ROI), etc.). A first group of relationship figures are causing figures (motion size/position value, e.g. number of deaths/inhabitants, sales to product inventory. Equivalent figures are all relationship numbers where you can not relate the events to their inventory, such as student/teacher ratio.
  - Change- or index figures: Same figure is calculated for several periods to detect time changes (revenue growth rate). Quotient of two fundamental figures of the same type, but different in time, e.g. wage cost index, price index. The considered meter size is measured on a base size that is equal to 100 and to relate to it all other dimensions.

[87] Source: Thommen, J.-P.; Achleitner, A.-K. (2004), p. 96 et seq.
[88] Source: Boulifa W. et al. (2009), Conference paper, p.5 et seq.
[89] Source: Thommen, J.-P.; Achleitner, A.-K. (2004), p. 100 et seq.

Function of Key Indicators

On the one hand the key indicators are the basis for a functional target and on the other hand act as a control and steering function for the strategic and operational actions of a company. KPI`s as information of financial and non-financial performance have their strong role within the continuous improvement. Key indicators enable following function:

- Realization Control: Target/actual comparison at the end of a planning period.
- Internal comparison period: The period comparison of ratios allows the recognition of certain trends.
- Internal root cause analysis: Directly or in comparison with other figures the relationships and information can be obtained.
- Sector- and internal company comparison.

In general the key indicators can be used under the system orientated aspect for a) the analysis of the respective system status an b) to plan the system development. Under the controlling aspect key indicators a) serve as criteria for the control and steer the fulfillment of tasks and b) serve as criteria for monitoring the operation of production systems. KPI’s provide useful information about:[90]

- How well we are doing?
- If we are meeting our goals.
- If our customers (stakeholders) are satisfied.
- If our processes/action are in statistical control and where improvements are necessary?

If you cannot measure an activity, you cannot control it. If you cannot control it, you cannot manage it. Without dependable measurements, intelligent decisions cannot be made. Therefore, the role of KPI’s in driving improvement is, in simple manner, to allow effective and efficient management since it has allowed the following issues:[91]

Control: Measurements help to reduce variation against planned actions.

Self-Assessment: It allows the assessment of how well an action is doing, including improvements that have been made.

Continuous Improvement: It identifies process trends and determines process efficiency and effectiveness, as well as opportunities for improvement.

Management Assessment: Without measurements there are no ways to be certain we are meeting value-added objectives or that we are being effective and efficient.

The basic concept of performance measurement involves:

- Planning and meeting established operating goals/standards,
- Detecting deviations from planned levels of performance and,
- Restoring performance to the planned levels or achieving new levels of performance,

[90] Source: Boulifa W. et al., (2009), Conference paper, p.5 et seq.

[91] Source: Oak Ridge Institute for Science and Education, http://www.orau.gov/pbm/handbook/1-1.pdf (20.07.2015)

Qualitative Methods

Qualitative methods for supplier evaluation consider all essential criteria that are not precise measurable. The criteria are characterized by the inclusion of subjective assessments and differ according to the type of representation, the review and the degree of compaction of the evaluated criteria. Qualitative methods can be divided into graphical-, verbal- and numerical representation methods:[92]

- **Graphical Depiction**

Profile analysis and graphic supplier gap analysis are the most important graphical depiction methods using in supplier evaluation.[93] These methods enable direct comparison of different suppliers in clear reference of qualitative and quantitative characteristics.

  - **Supplier- Gap Analysis**

The supplier-gap analysis illustrates pictorially how far the supplier is away from different requirements. It can e.g. on the one hand be illustrates the required procured companies target profile and on the other hand the assessment of the suppliers itself. The deviations between the actual and the desired profile are visible through gaps on the criteria axes. The supplier whose actual profile match the desired profile one, is optimal. It may also be determined whether a supplier meets certain criteria or has weaknesses or where opportunities for improvement are. Different suppliers can be compared clearly in terms of their performance. The assessment of suppliers is described in terms of various characteristics and shown graphically.

  - **Profile Analysis**

Two or more suppliers can be compared graphically to each other by profile analysis. Depending on the relative weighting of criteria the optimal supplier can then be selected. With the help of this analysis by comparing the supplier over each year, his improvement or deterioration can be measured.

- **Verbal Depiction**

Among the methods of verbal presentation, which takes place mainly through the description of the supplier, the checklist process, the portfolio method and the supplier typologies are summarized.

  - **Checklist Process**

The checklist process is mainly used in praxis. The selection criteria, which are used in the assessment of the supplier, are stated in a list. Checklists are used primarily as a systematically structured reminder, but do not include the selection rule for a supplier.

  - **Portfolio Method**

The portfolio method is used in the field of procurement, to make strategic threats and opportunities visible. Recommendations and procurement policies can be derived in order to

---

[92] Source: Fröhlich- Glantschnig, E. (2005), p. 32 et seq.
[93] Source: Janker, G. C. (2008), p. 140

achieve balanced composition of suppliers. The portfolio method is a way for the holistic assessment of suppliers and procurement market segments.

- **Supplier Typologies**

Supplier typologies allow the allocation of suppliers in homogeneous classes as possible and are the result of compression processes of supplier evaluations, which can have qualitative and quantitative nature. For each of these classes a standard strategy can be supported by appropriate recommendations. An example of a supplier typology is the division into A-, B- and C-suppliers.[94]

- **Numerical Presentation**

Methods for the numerical representation are the grading system, the scoring method, the matrix approach and the cost-benefit analysis.

- **Grading System**

Grading systems provide a simple method for estimating the supplier. All relevant characteristics of the supplier are evaluated in relation to the requirements of the procured company. The values of the evaluation features can either be illustrated in a three-point system, for example, "always-often-rarely" or "good-average-poor" or differentiated in the form of a qualified grading system, e.g. a scale of 1 to 9.[95] A disadvantage of checklists and scoring methods is the non-weighted assessment of selection criteria. This deficiency is corrected by using following methods:

- **Scoring Method**

Within this method the selection criteria will receive an appropriate weighting of their importance. Maximum score methods, percent valuation methods and the scoring models which are commonly used in practice are part of the scoring method.

Within the maximum score methods a maximum achievable score is given (often 100 points). These will be distributed according to their importance to the evaluation criteria. According to the suppliers performance points for each criterion will be deducted. Preference is given to suppliers with the highest possible score.

In percent valuation methods each feature criterion has a fixed weighting factor. For each vendor, the degree of satisfaction for each instance by the appropriate factor is weighted. Within the content, the percent valuation method corresponds to the maximum score methods. The percentage degree of satisfaction for each attribute and the total value is calculated by putting the score achieved in relation to the maximum achievable score.

Within the frequently used scoring models, first a division into relevant main criteria is done. These main criteria are illustrated in table 7, based on sub-criteria review and then determine with different weights the score for the main criterion. The sum of the point values of all main criteria gives the total score (score) for the supplier. The suppliers with the highest scores are

[94] Source: Janker, G. C. (2008), p. 136
[95] Source: Hartmann, H. (2002), p. 71

considered the most appropriate. A common advantage of scoring methods is that the assessments of individual stakeholders are transparent in the evaluation. It is considered problematic, that in the aggregation of individual judgments on numerical values a nonexistent, quantitative objectivity is faked.[96]

Table 7: Scoring model[97]

Main Criteria Sub criteria	Weighting factor		Supplier 1 Points	Points weighted	Supplier 2 Points	Points weighted
1 Capacity	5%					
1.1 Minimum delivery quantity		25%	10		11	
1.2 Flexibility of quantity		25%	10		11	
1.3 Constancy of quantity		25%	10		11	
1.4 High quantity		25%	14		6	
Weighted part point value			11		9,75	
Weighted point value				**0,55**		**0,4875**
2 Quality	25%					
1.1 Experience of supplier		30%	12		11	
1.2. Constancy of performance		30%	14		11	
1.3 Product quality		30%	13		11	
1.4 Employee qualification		10%	11		6	
Weighted part point value			12,8		9,75	
Weighted point value				**3,2**		**2,885**
3 Logistic performance	20%			**2,3**		**1,91**
4 Payment performance	15%			**1,838**		**1,493**
5 Service performance	10%			**1,39**		**0,84**
6 Information performance	10%			**1,35**		**1,1**
7 Innovation performance	10%			**1,125**		**1,375**
8 Environment performance	5%			**0,2**		**0,73**
Sum	**100%**			**11,953**		**10,795**

- **Matrix Approach**

The target of this method is to attenuate the subjectivity of the above mentioned scoring method. The evaluation of the defined criteria, such as quality, cost and service is done in a team. Analog to the above mentioned method, weighting factors of sub criteria are formed and aggregated into an overall judgment.[98] Any procurement procedure shall be subjected to a

[96] Source: Janker, G. C. (2008), p. 120
[97] Source: Janker, G. C. (2008), 121
[98] Source: Janker, G. C. (2008), p. 136

separate assessment, whereby no formalization of the supplier evaluation can be achieved. For that reason, the effort for preparation of this method is usually not justified.

- **Cost-Benefit Analysis**

The basic concept of cost- benefit analysis is that each alternative offer is evaluated in its entirety by how big the contribution to achieve the procurement target might be. First a target system is installed and on basis of them appropriate target criteria are selected and weighted. The decision problem is presented in form of a mathematical approach as a target revenue matrix. The most favorable supplier is determined on basis of the subjective preference structure. This method is a very time-consuming procedure, which is often not justified from a cost perspective. Moreover, it seems problematic to derive all relevant characteristic criteria from the objectives. In addition, with this method, the problem of subjective assessments is not solved.

Within the use of supplier evaluation methods further supplementary approaches exist. These include the fuzzy sets, the analytic network process, activity based costing and further multivariate methods. As far they are used in praxis rather rare to the above mentioned methods, they are not described in detail within this thesis.

4 Structural and Operational Organization

The organization as part of a commercial orientated company strives to achieve profit and sustain a required quality. For that reason different structural, often networked tasks have to be established. To ensure the targets and to provide adequate performance an organization has to be created.

This part of the thesis is the base of any coordinated, structured and organized company for the achievement of high quality. Operations or processes have to be well structured for the performance of business targets. With a process landscape a transparent overview of a company is achieved.

The organization delivers the regulatory framework and relational structure for a company and can be presented in different ways, depending on whether you want to show the structure or processes. The term organization can be used structurally and institutionally. Institutionally meaning stands for a company or divisions. The functionally term of the organization, on the other hand, can be understood as the design of structural and procedural, operational or process-based structures of an organization. The structure represents the static part of the organization and the operation is the dynamic, time and space based part, on the other hand. Elements of organizational design include roles, organizational charts, communicational structures, organizational rules, processes and organizational aids for their performance.[99]

[99] Source: Gareis, R.; Stummer, M. (2006), p. 19

Further the QMS, as defined in EN ISO 9001: 2008, requires a structural and operational organization to achieve or demonstrate the sustainable and high quality of a company.

The description of the organizational structure is the understanding of “who” and “what”, which means the allocation of tasks, duties and responsibilities. The operational description is the answer of “how” and “when”, resulting in the documentation of processes, work instructions, etc.[100]

The structural organization delivers the organizational framework in which the processes take place. Thus the operational and structural organization stands close to each other.

4.1 Structural Organization

The term structural organization is concerned with the formation of organizational units within the elements, in general departments, teams, employees and shows the existing units.[101]

The most important connection factors are the tasks to be fulfilled within a company. In general those can be defined as the target for purposeful human actions. Those actions are performances that have to be ensured by the proper assignment of rights and obligations to authorities and efficient use of material resources. In order to be able to perform tasks in an orderly manner, they have to be divided into distributable subtasks. Those subtasks have to be merged to areas of responsibility and assigned to authorities of various positions and departments. This makes the potential base of the vertical structural organization.[102] The systematic of the structure is illustrated in figure 10.

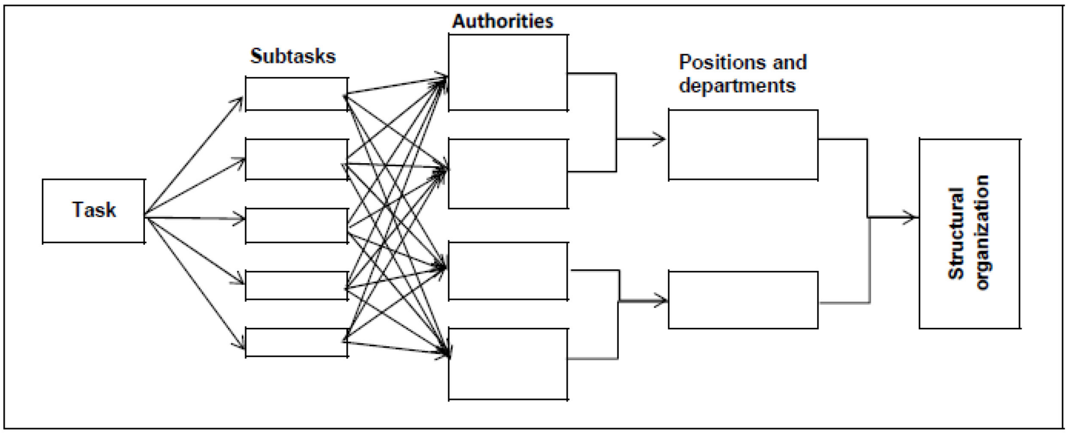


Figure 10: Systematic of structural organization[103]

The instruments for the design of structural organizations are organizational charts, job descriptions, role descriptions and action charts.

Organizational charts or organigrams show the job- and type of structure, e.g. if line-, staff-, or matrix organizations are present but they do not give the information of clear task, task structure and division of responsibilities. For those determinations, job descriptions are necessary. The

[100] Source: Adams, H. W; Rekittke, K. (1999), p. 46
[101] Source: Fischer, H.; Fleischmann A. et al. (2006), p. 1
[102] Source: Kosiol, E. (1962), p. 43 et seq.
[103] Source: Bleicher, K. (1991), p. 43

organizational chart is a simplified diagram of the organizational structure at a given time, in which rectangles serve as symbols for authorities and the connection lines express the official channel and hierarchical relationship between them. The structural organization deals also with the allocation of task complexes at the organizational levels as well as the design of instructions and communication relationships between those levels.[104] A simplified organizational chart as line organization is illustrated in figure 11.

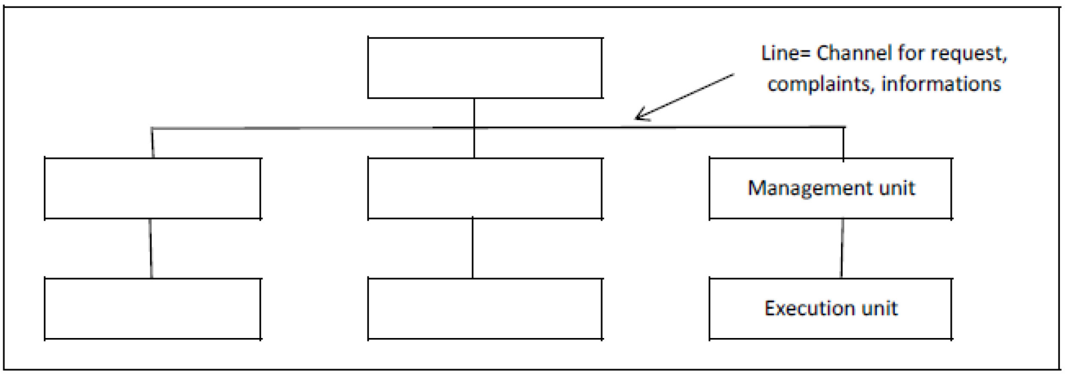


Figure 11: Graphic of line organization[105]

Job Description

The system "enterprise" consists of subsystems that fulfill certain tasks. The authority is the smallest organizational unit of an enterprise or company. It is a combination of one block of exercises, which can be met by one person or a group with the necessary competences and responsibilities. The organizational integration, that is, the directly subordinate authority and the deputies play an important role in the delegation process.[106]

The relevant leadership- and performance requirements for a position, as well as their integration into the organizational structure are described in the job description. Job descriptions not only fulfill organizational purposes, but also serve as a basis for the development of evaluation criteria, for the qualification of the employees and fulfill a valuable service in the demand planning. It is the task of the job creation to distribute different tasks on authorities to create an expedient organization. People get as job holder competencies and responsibilities.[107]

Competencies and Responsibilities

For the fulfillment of tasks the authority must have the right to act. The right to act is called competencies. With the allocation of duties and responsibilities, also the responsibility for the fulfillment arises. This allocation results in the responsibility for negligence and intentional fault and is an organizational tool. This process of transfer deals with delegation. To put in practice the skills with the delegation of tasks in accordance, the duties and responsibilities of each body

104 Source: Thommen, J.-P.; Achleitner, A.-K. (2004), p. 46 et seq.
105 Own illustration
106 Source: Ulrich, P.; Fluri, E. (1975), p.149
107 Source: Bleicher, K. (1991), p. 36

are defined in a job description. Delegation of competence is not equivalent to the responsibility delegation. By transferring responsibility of the delegating superior to a subordinate, the responsibility of the supervisor is not canceled. This results that the delegation of competence is not sharing of responsibility, but rather follows an addition of responsibility.[108]

Delegation

The management must ensure that the operational implementation is handled by the employees. It is therefore necessary that the management delegate tasks, duties and responsibilities to the next lower hierarchy, and the lower hierarchy to the next lower level, etc.

The term delegation thus refers to the transfer of competencies from top to bottom. It serves mainly to relieve the higher authority and adjudication of the act of the subordinate place. In addition, the competence delegation promotes employee development of motivation. It is important that delegation is transferred to sufficiently qualified employees and that these have the necessary motivation. In addition, the delegator has the duty to supervise his employees. The delegation of tasks and responsibilities is a necessity in everyday operations.[109]

The delegation of tasks to the line of an organizational chart is complemented by the appointment of various representatives. The cooperative relationship between line and representatives must be regulated. As per regulation often the representative is a monitoring- and advisory body. Cooperation between management and employees consists of the delegation of tasks. All delegated tasks shall be monitored by the delegating body. This shall be regulated in the organizational structure and continuously monitored for effectiveness and optimization opportunity.[110]

4.2 Operational Organization

While the structural organization has the focus on the distribution of tasks, the operational organization involves the control of activities to achieve those tasks.[111]

In praxis the structure represents the static part of the organization in which the dynamic, time and space based structural organization moves. Operational organization shows, how the processes of tasks are designed and how the work is divided. It centralises the relationships within a company and shows how the individual elements work together to meet the requirements of the company´s total system.

Processes are recurring work operations and the concrete implementation of the operational organization in the practice. A process "passes" the organizational structure partially or in extreme cases even completely. The process orientated view shows the right "flow" of chronological tasks. Processes are constructed on basis of the company`s strategy.[112] The relationship between task and process perspective shows figure 12.

[108] Source: Ulrich, P.; Fluri, E. (1975), p.148
[109] Source: Ulrich, P.; Fluri, E. (1975), p.164
[110] Source: Adams, H. W; Rekittke, K. (1999), p. 11
[111] Source: Kosiol, E. (1962), p. 43
[112] Source: Fischer, H.; Fleischmann, A. et al. (2006), p. 3 et seq.

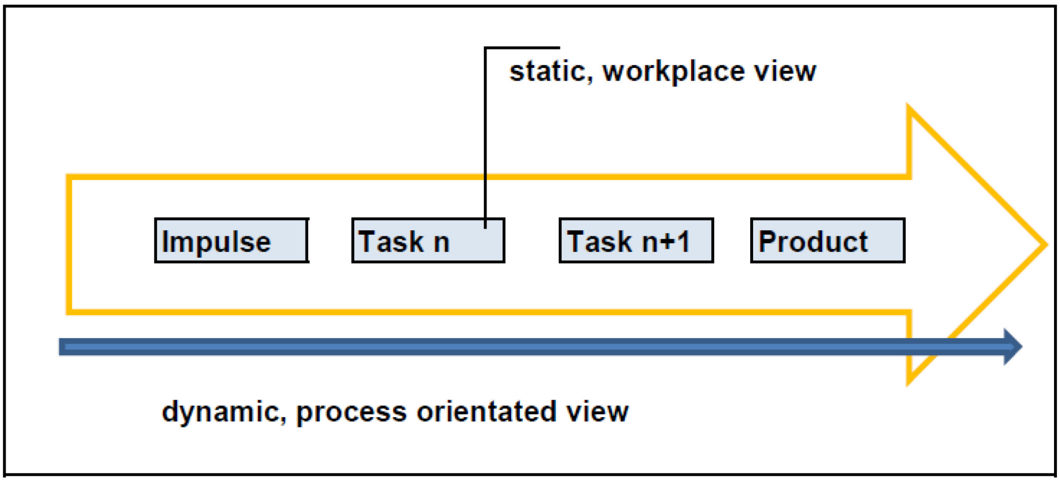


Figure 12: Tasks in a linear process[113]

Conclusion

Nowadays a company must be well organized and structured, in order to meet the high demands of the working structure. Increased production, different customer requirements and increase of technical equipment and systems make the proper organization, coordination communication within the employees and partners necessary to obtain high demand of performance and quality in an effective and efficient manner.

Of particular importance is the proper communication and coordination within the cooperating employees. The transparent delegation of tasks, competence and responsibility and appropriate cooperation arrangements have to be done. A fixed structure and process organization with instruction, selection and monitoring obligation represents a basic requirement for the operating and working organization.

In general the static structural organization “structures” the company`s organizational elements, while the dynamic operational organization describes how those elements work together. The operational organization shows the chronological correlations of tasks. With the definition of management-, core- and support processes a process landscape of the company can be created.[114]

4.3 Process Landscape

The process landscape or -map shows the total overview of a company and can be divided into the management-, business- and support processes. This is a transparent view for all processes within the company:[115]

- **Business Processes**: Are direct value added processes for producing the product or service. They are used for the direct fulfillment of the mission of the company. Processes may include: R&D, sourcing, production, logistic, transport or sales are part

[113] Source: Fischer, H.; Fleischmann, A. et al. (2006), p. 4
[114] Source: Fischer, H.; Fleischmann, A. et al. (2006), p. 3 et seq.
[115] Source: Binner, H. F. (1998), p.117 et seq.

of the business process. Further business processes are divided into core- and sub-processes.

- **Management Processes**: Give usually the targets to achieve and allow the objectives, e.g. for the provision of resources. It includes the strategic- and operational management.

  Support processes: Give working condition for the core- and management processes and required for the fulfilment of the processes.

  It may include: resources, finance, equipment or IT-systems form the frame within the support in business processes.

Those explanations are based on the model of process-orientated quality management system (EN ISO 9001: 2008).[116]

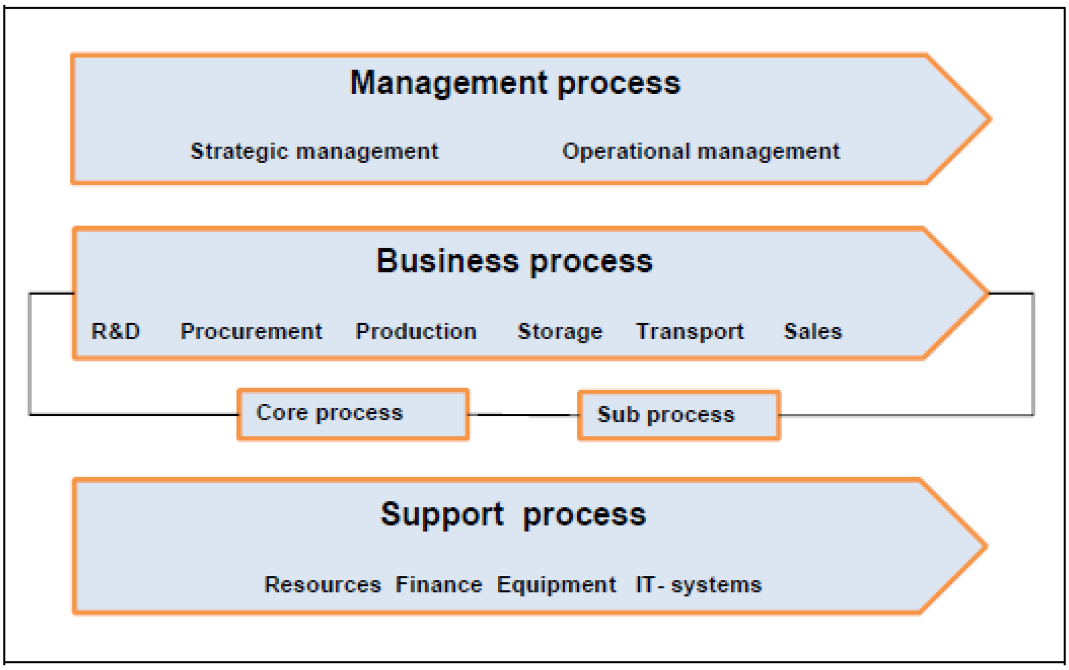


Figure 13: Process landscape[117]

The landscape is the main item of the company showing for extern and intern observer a transparent view and impression of how the company is constructed on basis of the operational view. A draft of a process landscape can be modeled as per figure 13. The creation can be performed in two different manners, based on the company´s philosophy and/or existing resources.

- “Top-down structure”: Based on the strategy of the company the processes are defined and described. When the processes, thus the politics and visions are fixed, systems are introduced for the business processes itself. This procedure can be described as a “top-down structure”.
- “Bottom-up approach”: Some leaders or managers see the design order from their experience on the other way round. On basis of the own existing, available own IT-

[116] Source: EN ISO 9001: 2008, p. 6 et seq.
[117] Own illustration

systems, processes have to be mapped as best as possible and the strategy must adapt to the product philosophy. This way of creation of the company´s mapping is called “bottom-up strategy”. In praxis this approach has it´s realistic core. In many cases it is simply too expensive to pursue individual solutions, that fit seamless into the strategy. Thus, the orientation of standardized systems and standardized processes (with some individual adjustments) are a quite common method and it is for no-competition-related processes a legitimate approach.[118]
Both strategies, dependent of the tasks are shown in figure 14.

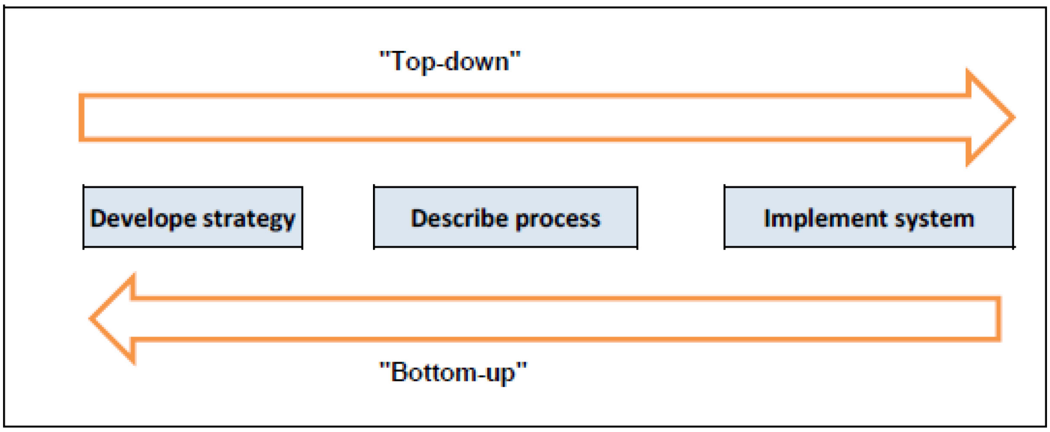


Figure 14: Tasks in a linear process[119]

5 Process Management

After the definition of the process landscape, the process management as part of the structural organization are described within following pages. Business processes have to be adjusted to the permanent changing environment. A continuous change within process management is compared to a possible radical change, which results in a complete reengineering of processes. Further possible process description- and visualization methods are presented within this chapter.

Process management is dealing with continuously repeated operations within a company, thus processes. It is used to implement process orientation, which considers the entire operating activities as a combination of processes. The basic idea of process management is that any kind of development, production, customer service, sales, etc. can be divided into processes. Those processes can be run parallel or in series to each other. “Process management comprises planning-, organisational- and controlling actions for the target orientated control of supply chain of a company in terms of quality, time, costs and customer satisfaction.”[120]

[118] Source: Fischer, H.; Fleischmann, A. et al. (2006), p. 16
[119] Source: Fischer, H.; Fleischmann, A. et al. (2006), p. 15
[120] Source: Gaitanides, M.; Scholz, R. et al. (1994), p. 3

Process management is the matter of primarily describing, displaying, shaping and continuously monitoring and improving the processes. The specification and target orientated system are the basis for investigation.

One of the main targets is the continuous evaluation between the strategic guidelines or requirements of the company and to enable the operating actions. KPI´s are (as mentioned in former chapter) as other tools e.g. used for necessary figure evaluation as comparability. The efficiency and effectiveness within the company own business processes is an important factor. The objective of the process is to establish as little resources and cost impact, e.g. the processes have to be efficient. The illustration in figure 15 shows the cycle of the process needed to reach the targets and a permanent evaluation followed by measurement.

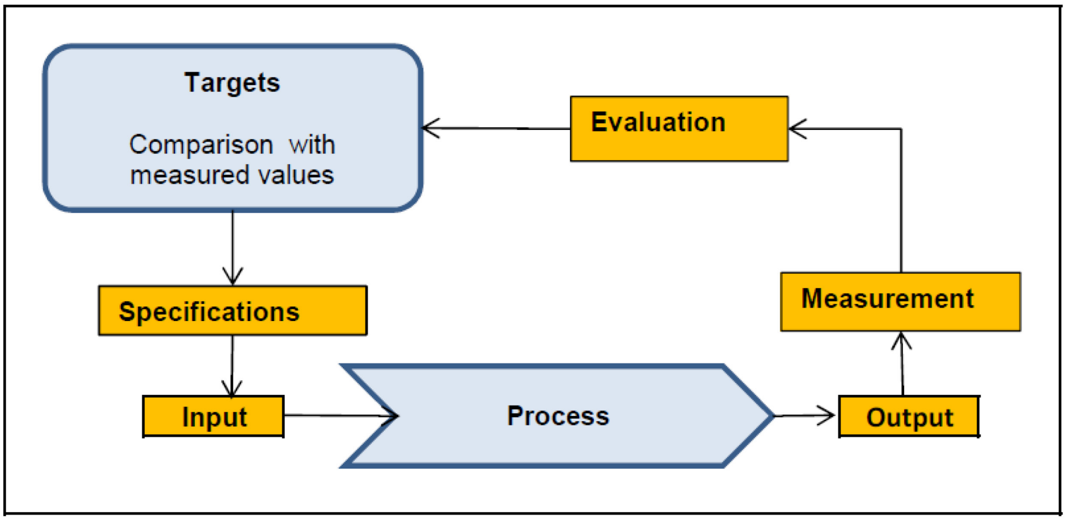


Figure 15: Continuous evaluation of process[121]

IT-systems e.g. support the automation of business processes. Properly applied, they contribute to reduce the complexity, reduce money and increase the agility of a company. For that reason, the control of the own processes and integrating into software or system is and important task of a company`s performance.

5.1 Micro- and Macro Process Management

Process management has the task in dealing with the macro- and micro process management, dependent on the question of what is the target of the investigation.

- Macro Process Management: The fulfillment of the tasks is based on the results of the strategic management of the company.
- Micro Process Management: The task is the identification of process and their interactions (process portfolios). Furthermore the definition of process owners, controlling of the processes and the definition of standards for micro process management. The objects of consideration are the individual processes. Tasks are planning of individual processes, including process definition, process structure planning, process scheduling, process organization planning, planning of process

[121] Own illustration

indicators KPI`s and controlling of individual processes, process control and creation of process reports, process optimization.[122]

As per definition of the International Standard stated in EN ISO 9001: 2008, which specifies requirements for a quality management system, the organization has to function effectively, determine and manage numerous linked activities.

An activity or set of activities using resources and manage of inputs to outputs to enable the transformation, can be defined as a process. An output of a process is often the next input for another one. The term "process approach" can be referred to the application of a system within an organization, together with interactions and identification of these processes, and their management to produce the desired outcome.[123]

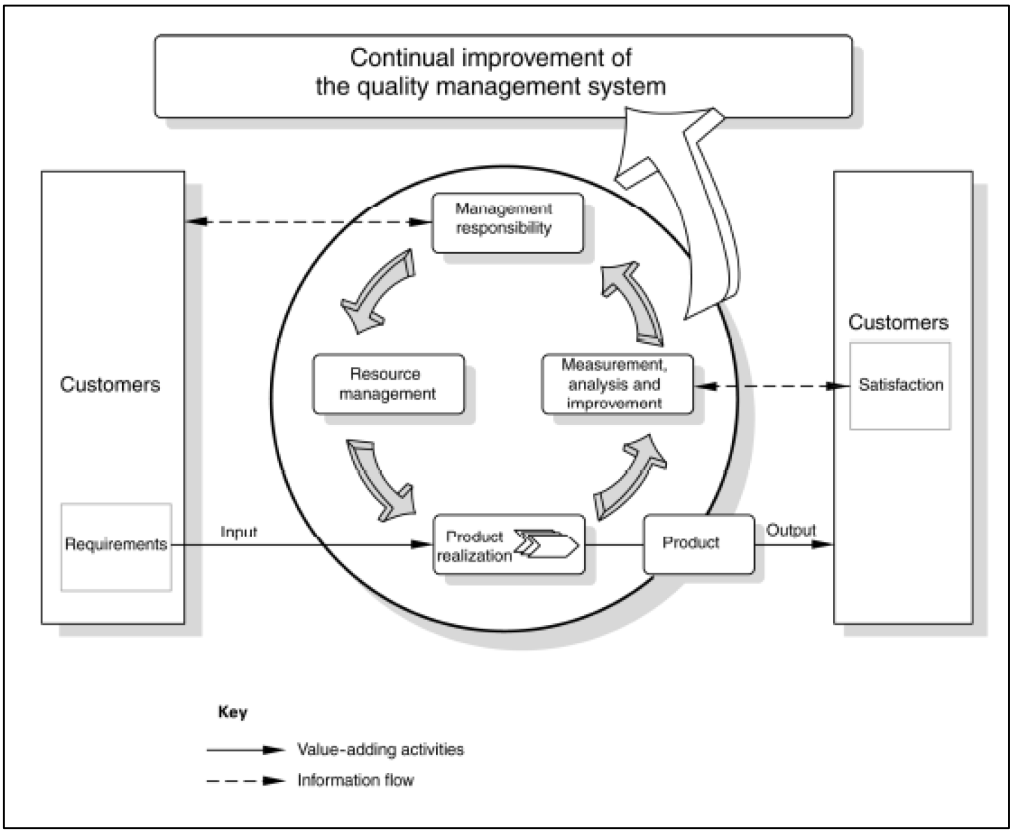


Figure 16: Model of a process-based quality management system[124]

When using process approach within the system of processes, an ongoing control over the linkage between them has to be established. Within a quality management system, such an approach includes the understanding and meeting of requirements, the need to consider processes in terms of added value, obtaining results of effectiveness and a continuous improvement of processes based on objective measureable values.[125]

The model of a process-based management system according EN ISO 9001: 2008 is illustrated in figure16. It covers all requirements of the International Standard and shows that the customer

[122] Source: Gareis, R.; Stummer, M. (2006), p. 73 et seq.
[123] Source: EN ISO 9001: 2008, p. 7
[124] See: EN ISO 9001: 2008, p. 9
[125] Source: EN ISO 9001: 2008, p. 7

plays the most important role within defining the requirements as input. This figure shows an overview of customer related requirements with a quality management system but do not shows processes of the organization at a detailed level.

Process management is the basis for the optimization of value-added processes within the supply chain management.

Within this thesis the focus is on the optimization of the micro processes, thus the individual process investigation of required department as part of the supply chain for the optimization of QA/QC-activities.

5.2 Business Process Management

Within the literature there are some definitions of processes within different sectors. The focus of this thesis, as the source for the practical part, is on business operational processes of a company, e.g. the flow of material, information under the application of operations and decisions. The business process contains both organizational and operational organization. It can be understood as the sequence of works to be done within the structural organization.

The process is describing the sequences of cross-functional activities with a beginning and an end, and clearly defined input and output. At least three different roles belong to a business process:[126]

- Role for the input of initiator,
- Role for the process itself,
- Role for the process performance or output.

One person can be responsible for different roles, thus also the initiator of the process can act as the receiver, e.g. a client starts a price inquiry (initiator of a business process) and gets as a result a price information (receiver of result or output). Processes define the necessary organizational and/or company-wide activities, resources and stakeholders for processing a business purpose triggering by an external or internal client to a desired result. The participants of the process are usually part of the organization. The structure organization is orientated on the functional- (procurement, construction, production, sale etc.), geographic- or groups of customer orientated requirements.

Within the process the different organizational units communicate with each other, synchronize their activities and exchange intermediate results. The result is then submitted to the internal or external receiver. In the process description itself different paths for different variations have to be established, as far processes can run simultaneous to each other or different tasks are required. Further two different types or definition of process have to be distinguished:[127]

- Static process (process description): The concrete operation is initiated by an event. The event describes the enter occurrence of a state, which can trigger a sequence of functions (e.g. “order received”).

[126] Source: Fischer, H.; Fleischmann, A. et al. (2006), p. 4 et seq.
[127] Source: Fischer, H.; Fleischmann, A. et al. (2006), p. 5 et seq.

- Dynamic process (process instance): It is the concrete processing of the description as a function. Function (activity) is the transformation of an input- into an output date (e.g. "enter the order").

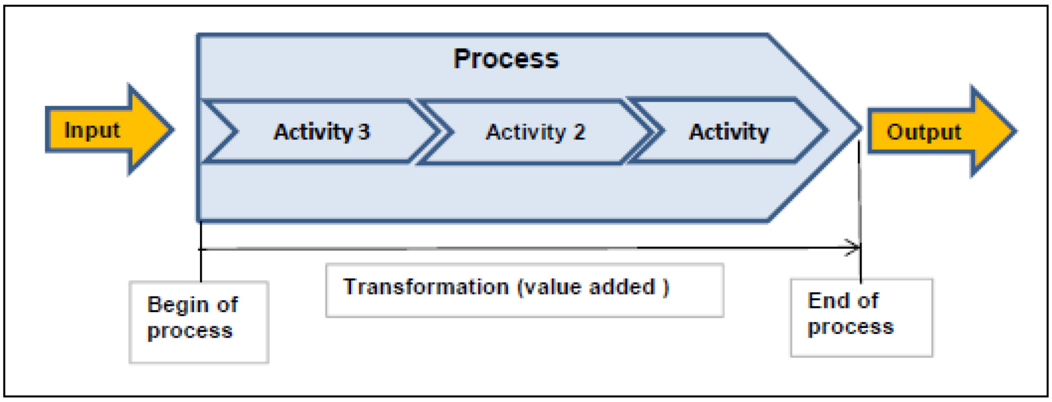


Figure 17: Sketch of process flow[128]

There is also a difference between the process and an activity. Within a process minimum two organizations and/or persons are involved. One is initiating the process and the other is executing adequate functions or operations. An activity on the other hand can be performed by only one person. Figure 17 sketches the process flow.

A process description with its symbols and terms and possible visualization methods are presented in chapter 5.4.

5.3 Continuous Process Management (CPM)

An organization must be continuous controlled and adjusted to the changing environmental conditions. Processes, tasks, authorities, resources and targets for the operation of "life" of the implemented processes find their context in a continuous process management. In addition to the accompanied process implementation, the main task of a continuous process management (CPM) is a constant, incremental improvement of the operational organization. The improvement measures must be in accordance to the specific business objectives and is based on the existing organization and involving all process participants. CPM therefore has similarities to the concept of the continuous improvement process (CIP), the Japanese Kaizen which see the improvement within small steps. Kaizen deals with the transition from the functional to a process-orientated structural organization. CPM has to be distinguished from process-orientated reorganization or business process reorganization (BPR), which is characterized by a unique approach and specific trigger, in which the company is new formed without taking account existing organizational processes and structures.[129]

In general such reengineering projects are initiated by the top management (top-down) and often performed and accompanied by external business consultants. The reengineering projects have the risk of failure and lack of the acceptance among employees. The Japanese Kaizen based on existing structures and processes is initiated and continuous improved by the

[128] Source: Becker, J.; Kugeler M. et al. (2012), p. 71
[129] Source: Becker, J.; Kugeler M. et al. (2012), p. 303

employees (bottom-up) of existing processes. The main differences between both concepts are illustrated in table 8.

Table 8: Characteristics of CPM & BPR[130]

Continuous process management (CPM)	Business process reengineering (BPR)
Orientation on existing tasks and processes	redefinition of tasks and processes (understanding of process and reconstruction)
Incremental and continuous improvement process	Innovative, single change process
Focus on single process sections possible	Fundamentally holistic process view
Building on existing organizational structures (interface management)	First introduction of process organization (interface strategy)
Consideration of all organizational targets/ efficiency criteria	Unilateral prioritization of process efficiency; resource efficiency through IT-usage
Relative stability at controlled change	Radical change
Bottom-up method	Top-down method

Both methods are completely different from each other. Due to the permanent changing environment within the global market area, the method of CPM is more common within business units than BPR. Both concepts are not inevitable exclusive from each other: With a reengineering project it is possible to perform big changes in a relative short time, e.g. a new structural organization. Afterwards improvements can be converted over a long time in detail as part of the Kaizen.[131]

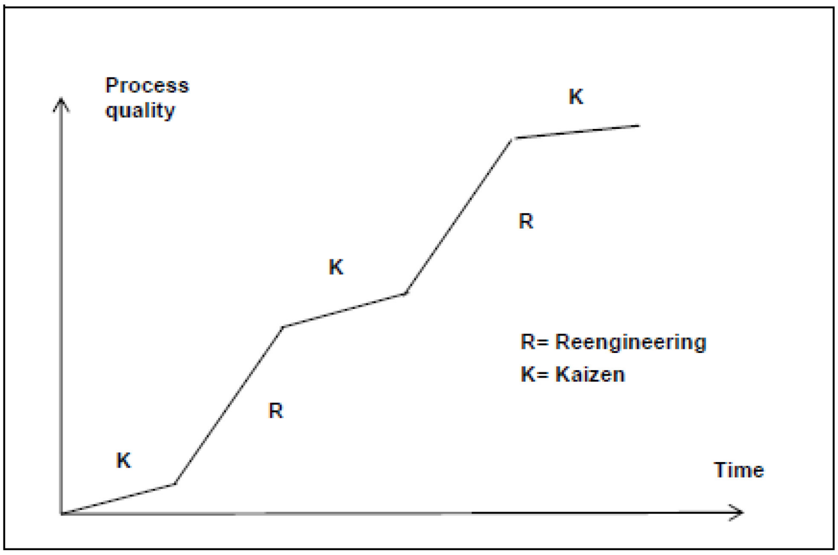


Figure 18: Business process reengineering and Kaizen[132]

[130] Source: Bogaschewsky, R. (2005), p. 250
[131] Source: Bogaschewsky, R. (2005), p. 220 et seq.
[132] Source: Arndt, H. (2006), p. 77

Process-orientated management tools such as process controlling or workflow management can only be introduced gradually and put existing and robust processes ahead. As far the instruments of planning, steering and control fall within the scope of process management, the establishment of a CPM is therefore the logical consequence of a process-orientated reorganization of the company. Process management implies the process orientation throughout the company and is not limited to core processes but includes the ratio of processes to the existing corporate departments.[133]

Business process reengineering vs. Kaizen is shown in figure 18, dependent on time and process quality.

The process orientated approach within EN ISO 9001: 2008, section can be understood as:[134]

- Systematically searching for the process architecture,
- Setting and weights of criteria to assess of a process,
- The measuring and testing of a process, and
- Measures to achieve the planned results.

As already mentioned, the EN ISO 9001 standard defines the requirement for quality management system based on a process model, which brings together the components of a QMS in a structural context. EN ISO 9001 consists of two control loops. In the one hand there are the requirements and wishes of the customer and on the other hand the connection and transition to the second loop. It controls all activities, which are needed to improve all management processes to increase the customer satisfaction and improve efficiency.

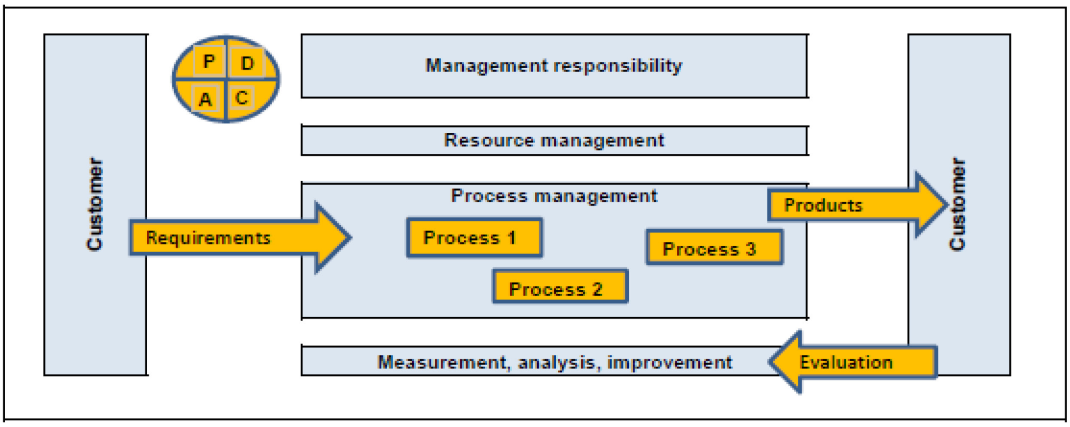


Figure 19: Process model accord. EN IS0 9001: 20008 with integrated PDCA-cycle[135]

The CIP is divided into phases plan (P), do (D), check (C) and act (A). The methodology is known as "Plan-Do-Check-Act" (PDCA) and can be applied to all processes. Figure 19 illustrates process model according EN ISO 9001 with an integrated PDCA-cycle. PDCA can be briefly described as follows:[136]

---

[133] Source: Becker, J.; Kugeler M. et al. (2012), p. 306
[134] Source: EN ISO 9001: 2008, p. 7
[135] Source: EN ISO 9001: 2008, p. 9
[136] Source: EN ISO 9001: 2008, p. 7

- Plan: establish the objectives and processes necessary to deliver results in accordance with customer requirements and the organization's policies.
- Do: implement the processes.
- Check: monitor and measure processes and product against policies, objectives and requirements for the product and report the results.
- Act: take actions to continually improve process performance.

Process Controlling

A process has to be structured, understandable, consistent and flexible. KPI´s help determine if a process meets the requirements or the adequate quality. KPI`s are strong process-specific-orientated. While the classical controlling concept deals with the monitoring of the costs, in the context of processes, following terms are part of investigation and to be checked:[137]

- Cycle time,
- Quality,
- Software adaption,
- Methodical consistency,
- Efficiency,
- Flexibility,
- Customer satisfaction,
- Costs,
- Deviation from targets,
- Adjustment of capacities.

The target system of a company and its elements, the individual sub-objectives or target components are primarily set and modified by the main stakeholders, investors and the employees. The achievement and measurement of the targets is performed by the use of KPI`s. The center of process evaluation is the target-actual comparison. The continuous improvement is performed and monitored and have to be controlled to fulfill and be in accordance to time-cost-quality target by the use and running of the PDCA-cycle.

KPI`s are also performance indicators and supporting figures used for the planning, measurement and evaluation of “input-processes-output”-relationship. A detailed description, the forms, use and functions of KPI´s are described in the mentioned chapter “supplier evaluation”.

5.4 Process Depiction and Visualization of Processes

Structured modeled processes allow by the use of graphical presentations a detailing up to function level and give transparency over the interdependence of individual steps. This makes it possible to the employees to understand the usefulness of operations, and thus they can also deliver a potential input for innovation across the company.

[137] Source: Fischer, H.; Fleischmann, A. et al. (2006), p. 40 et seq.

Within the software based ARIS-Toolset (Architecture of Integrated Information Systems) there are different process models existing, which visualize and model the operational structural- and operational organization, dependent on the identified or required prospects, eq. between data-, functional-, organizational-, control- or performance view. Business processes can be depicted or visualized by the most common used and transparent "event- driven process chain" (EPC) or the "value chain diagrams" (VCD).[138]

Within the various process models a set of object types with a defined meaning are used. EPC consists e.g. of functions, events, connectors, edges, and optionally of various other types of objects such as points, organizational units, application systems, data-object types. One example is the object type organizational unit, both used in an organizational chart as well as in a process model. An object type can be represented, depending on the modelling language by different symbols. A function is presented in an EPC by a rectangle with rounded corners. In a VCD, however, a function is a left rightward arrow. Within the modelling, the distinction between objects and object occurrences is of importance. Objects represent instances of an object type, regardless of the use of this object in a process model. An object is e.g. "authority" and the corresponding object type "account manager".[139]

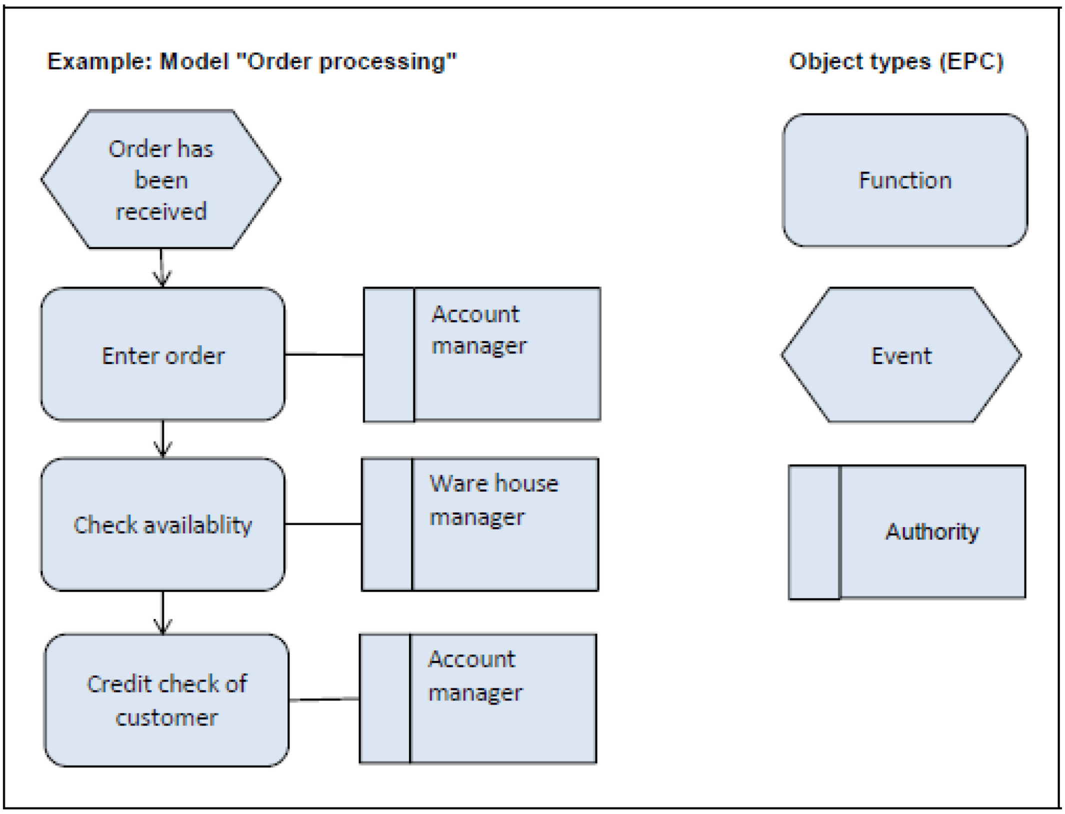


Figure 20: Example of model "order processing" by EPC[140]

An example of such a process "order processing" modelled by an EPC is shown in figure 20. As already mentioned, the used model type (VCD or EPC) is dependent of the requirement, the

[138] Source: Arndt, H. (2006), p. 96
[139] Source: Gaitanides, M.; Scholz, R. et al. (1994), p. 64 et seq.
[140] Own illustration

supported perspective and information needed for the user. VCD and EPC are different but complement each other. When diagrams are modelled in the Software ARIS, then it is possible to navigate between both models. By double-click on one of the value chain in the VCD, the required EPC opens. A combination of model types VCD and EPC are illustrated in figure 21. Within the first two levels the value chains are implemented resulting in EPC`s within level three.

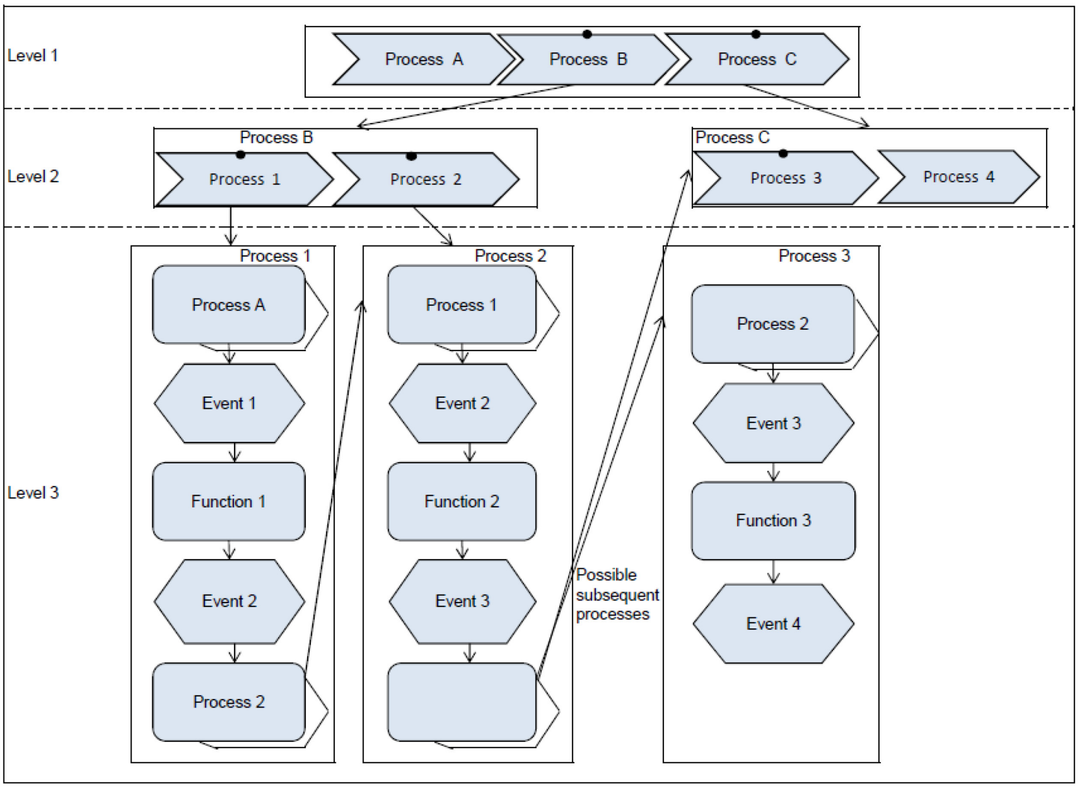


Figure 21: Definition of model levels and possible deposit[141]

In chapter 5.4.1 and 5.4.2 both model methods are presented and described in detail.

5.4.1 Value Chain Diagram (VCD)

VCD`s are used to represent the sequence of functions that contribute to the value of a product. VCD´s use the object type “function”, which may be associated with other functions in a predecessor-/successor relationship or a hierarchical relationship.

[141] Source: Becker, J.; Kugeler M. et al. (2012), p. 92

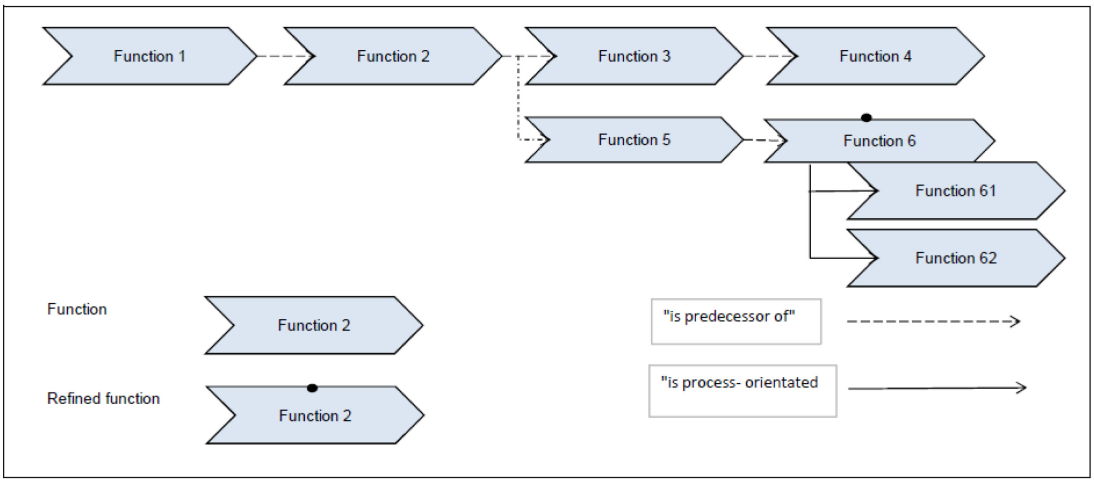


Figure 22: Value chain diagram: Object type and example[142]

As part of the process modelling, VCD`s are preliminary used as a highly aggregated overview of processes/functions. They serve as the specification of core processes of a company and are the entry point to the process models. They usually do not contain any details regarding involved organizational units, application systems or details of the control flow (e.g. the distinction in and/or branch). Therefore they are not suitable for detailed description of processes.[143] An example with object types of such VCD is illustrated in figure 22.

5.4.2 Event-Driven Process Chain (EPC)

A widely used notation for representing processes is the event-driven process chain (EPC). It allows a graphic modeling of control flows, which are also suitable for model users without fundamental modeling-, technical knowledge and is a transparent tool. EPC`s are part of the architecture integrated information system ARIS and provide condition-, or event nets using three basic elements. Following elements can be implemented into an EPC:[144]

- Functions: Functions represent operations and activities, transmit as active note in- and output data and have decision-making authority over the future course of the process. In the most common EPC-notation they are graphically represented by round rectangles.
- Events: Events represent sequence-relevant characteristics of state. In contrast to functions, the events neither consume time nor money. It is possible to distinguish four main types of events:
    - The event marks a new process (e.g. “order is created”) and the final status of an existing process object (e.g. “order is canceled”, “project is finished”). It is often the start or an end event of a process.
    - The event belongs to an attribute change in the process object (e.g. “statement is tested”, “order is urgent”), which must not be made necessarily known to the information system (e.g. “customer called”, “truck arrived”).

[142] Source: Becker, J.; Kugeler M. et al. (2012), p. 66
[143] Source: Arndt, H. (2006), p. 95
[144] Source: Arndt, H. (2006), p. 95, et seq.

- o The event describes the arrival of a certain time (e.g. "reminder date is reached").
- o The event represents a change in stock that triggers a process (e.g. "amount of money is below", "credit limit is exceeded").

Events are presented in common notation of an EPC as hexagons and do not have decision-making authority. The meet two tasks: First they solve functions (triggering events, e.g. "bill has to be booked"), and on the other hand they document a reached state of one or more finished functions (e.g. "bill is booked").

- Connectors: For modeling of non-linear process gradients, serve logical connectors (logical operators). If it comes within a process chain to splitting, then it is output link. If multiple sub-processes run in one place, it is an output link. The connectors can be divided into:
  - o AND-link ("a and b"), which is presented within a process model by the AND-symbol  ,
  - o XOR-link ("either a or b"), which represents the exclusive OR and is reproduced by the symbol XOR  and alternative ,
  - o IOR-link ("a or b" and "either a or b [a and b], represented by the inclusive OR-symbol  .

Same or different operators can follow one another directly. If an input-link has a corresponding output-link, the two join operators must match.

For the creation or visualization of a business process by an EPC, there are two requirements, arising from the importance of the object types and events:

- Each process chain has to begin and end with one or more events. This not only ensures that the initial and final conditions of the process are specified, but this also corresponds to the real state of affairs, that each function must be preceded by a trigger and that each function leads to a state change. As long an EPC describes a sub-process, the connection to up-or downstream processes is done by a process guideline.
- After an event neither IOR nor XOR connector can follow, otherwise it would not be clear for the model reader, for whatever reason, one or more of the subsequent process strands would be executed. This information is delivered in a correctly modeled IOR or XOR branch this by the subsequent events.

Beyond these basic notation rules, EPC´s can be enriched on demand by a number of additional object types. Data, organizational units, application systems and services are relevant object types:

- Data: Product information, client address, production plans, etc. can be assigned to the individual functions via an input or an output relationship (Create, Read, Upload, Delete). The representation of the user data takes place in the process model. By assigning an event they contribute to the detailed characterization of the state in which represented by the event. For both purposes the symbols of the corresponding data model, such as clusters, entity type, relationship type and attribute are used.

- Organization: By linking the functions with the organizational units or departments, it becomes clear whom task, competence and responsibility vested in the function implementation. Furthermore, relationships are maintained, such as “must be informed about” or “participates in”. This additional disclosure is responsible within the process analysis for the identification of organizational interfaces along a process.
- Application Systems: If the functions are handled with IT support, this can be described by specifying the application-system and/or type. Media breaks can be shown in this way very simple within the process analysis.
- Services: For functions and also processes in total, input- and output services can be set. Those services can be either tangible (e.g. product) or intangible (e.g. service). By visualizing the services, the partial contributions of individual functions get transparent. It may also be purely internal products (e.g. production order).

Figure 23 illustrates the main modeling elements of an EPC and the way they are used.

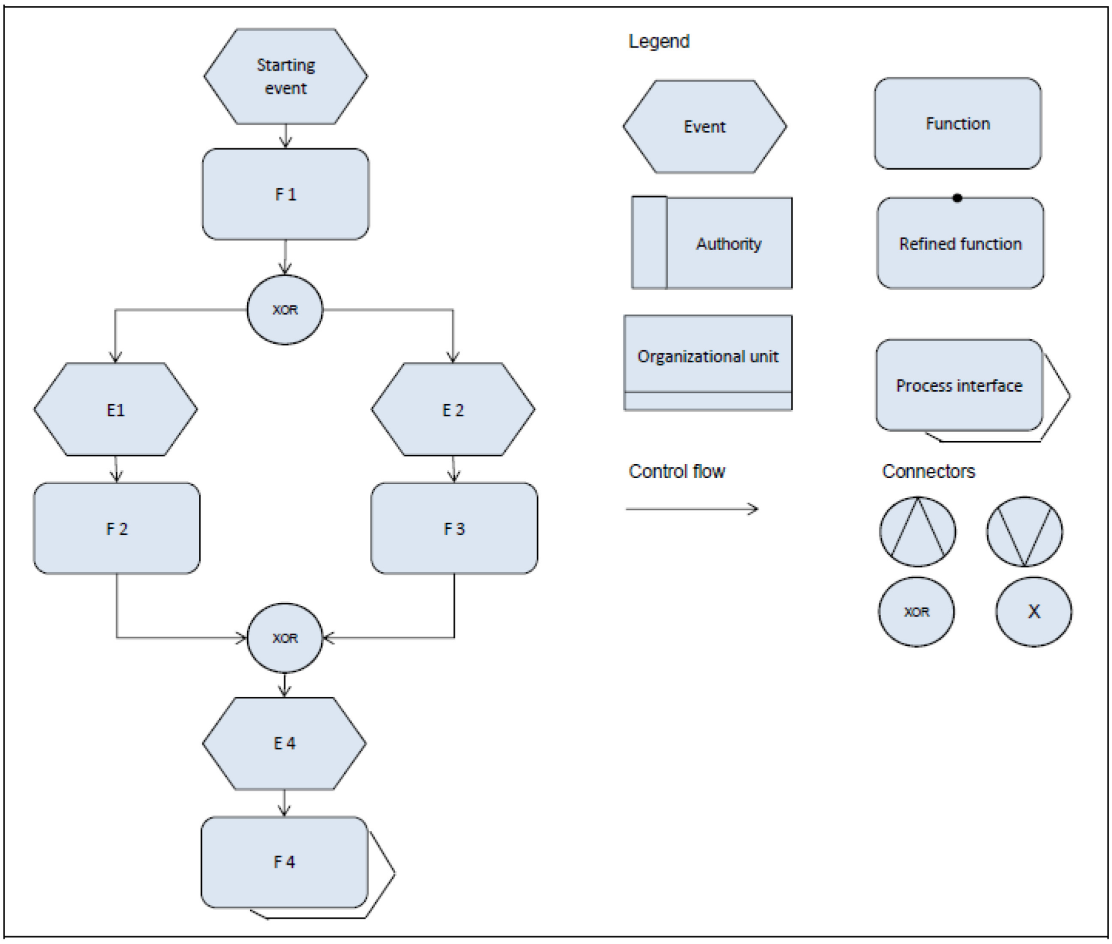


Figure 23: Event-driven process chain: Object types and example[145]

[145] Source: Becker, J.; Kugeler M. et al. (2012), p. 71

Summary of modeling rules

The already above indicated rules for the correct design of an EPC are listed here again in a compact way:[146]

- The beginning and the end of an EPC consists always of one or multiple events,
- A function always follows and event and an event follows a function,
- Organizational units and information objects are always connected with functions and not events,
- Events and functions have only one incoming and one outgoing edge,
- Link operators have either more incoming and one outgoing edges or one incoming or more outgoing edges,
- One single event may not be followed by either one inclusive nor exclusive OR: Events do not make decisions,
- Process paths are connected with the same operator which was used for the separation,
- Within braches there are many paths possible.

The theoretical input and background of quality assurance- and control activities within the supply process gives the foundation for the task and investigation of the practical part. Following pages of this thesis concentrate on the analysis of the actual situation of the planning- and inspection activities within company Sandvik, located in Leoben/Austria. The company´s tasks and purpose are illustrated on the one hand, and on the other hand the strengths and weaknesses of quality assurance- and control activities are analysed, followed by possibilities of optimization and improvement within this area.

[146] Source: Arndt, H. (2006), p. 102

6 Sandvik Mining and Construction Materials Handling GmbH & Co KG

Within this chapter the company´s purpose, task and its existing process landscape are described. The QA/QC-department is highlighted with its role and task, processes and available used software as part of the supply process.

Company Sandvik, located in Sweden/Sandviken is a high-technology and global industrial engineering group, which manufactures advanced special alloys and ceramic materials, industrial tools, mining and construction equipment.

The Sandvik Group is organized into five business areas: Sandvik Mining (equipment, tools and services for the mining industry), Sandvik Machining Solutions (tools and tooling systems for advanced metal cutting), Sandvik Materials Technology (innovative metallurgy and R&D materials/products), Sandvik Construction (engineering and construction for equipment/tools and services in breaking, drilling and crushing niches) and Venture (value generation by promoting profitable growth of small and medium-sized businesses of particular interest for Sandvik Group). In 2013, the Group had about 47,000 employees and sales of just over 87 billion SEK in over 130 countries.[147]

Sandvik Mining and Construction Materials Handling GmbH & Co KG (SMCMH) located in Austria/Leoben, is part of the business area Sandvik Mining belonging to the offering area of Mining Systems. As far this thesis is only concentrating on the location of Sandvik Group in Leoben, it will be named in the following descriptions with "SMCMH".

6.1 Purpose and Task of SMCMH

SMCMH is responsible as a worldwide competence center "Center of Excellence-Mobile Machines" in the areas of open pit mining and materials handling with around 160 employees. As a strategic advantage with the near location to the Mining University Leoben with the intensive and very good cooperation, SMCMH is specialized in development, engineering and delivery of plants and machines for the handling of bulk materials, like coal and ores for the industry area mining, energy, harbour and metallurgy. The office located in Austria/Leoben is shown in figure 24.

With the departments like sales, project management, engineering and design, procurement & expediting, logistics & transport, quality assurance & control (as one), projects are going to be planned, developed, constructed, financed, transported, erected, commissioned and supervised by SMCMH. Thus turn-key projects are handled by SMCMH from contract tender until handover of the machines for the mining sector. The export proportion of SMCMH, as part of a global player is 100% with main markets located in Australia, North-South America, Africa and Southeast Asia. Machines like e.g. stacker, reclaimer, spreader, ship loader & -unloader, belt wagen, conveyor systems are handled by SMCMH.

[147] Source: SMCMH (2015), Sandvik Group-Company Presentation 2015, p. 2 et seq.

Figure 24: Office Sandvik Mining and Construction Materials Handling in Austria-Leoben[148]

SMCMH is ISO 9001: 2008 certified and represents the existing quality management system, which provides confidence that quality requirements will be fulfilled and concludes all planned and systematic activities that the supplier or producer will fulfill requirements of the customer. It relates to the material, processes and procedures for ensuring the qualifications, assessment and the delivery meet certain standards.[149]

SMCMH consists of a fixed operational- and structural organization involved in determination of quality policy and its implementation supported by quality planning, quality assurance (QA) and quality control (QC), which also should establish standard processes, document control, maintaining the quality of system, with adequate, required and periodic certification.

6.2 Process Landscape

The management-, business- and supporting processes are available and shown in a transparent landscape in the form of a VCD. The value chain diagram shows for the internal and external observer a clear structure of the company and fulfils the sequence of works to be done within the SMCMH`s-operational organization. It defines the available organization and activities for processing the business to achieve the desired result.

The structure has been created historical by a "top-down structure", based on the strategy of the management and thus the processes have been described and implemented into the system. The process landscape of SMCMH is created within the existing web based system PROSQUID and helps to show and document the processes. Independent of the existing and used software SAP, MS Office, Lotus Notes, etc., SMCMH and the complete Mining Systems Group is working with PROSQUID.

[148] Picture by Saria C. (2015)
[149] Source: EN ISO 9001: 2008, p. 28 et seq.

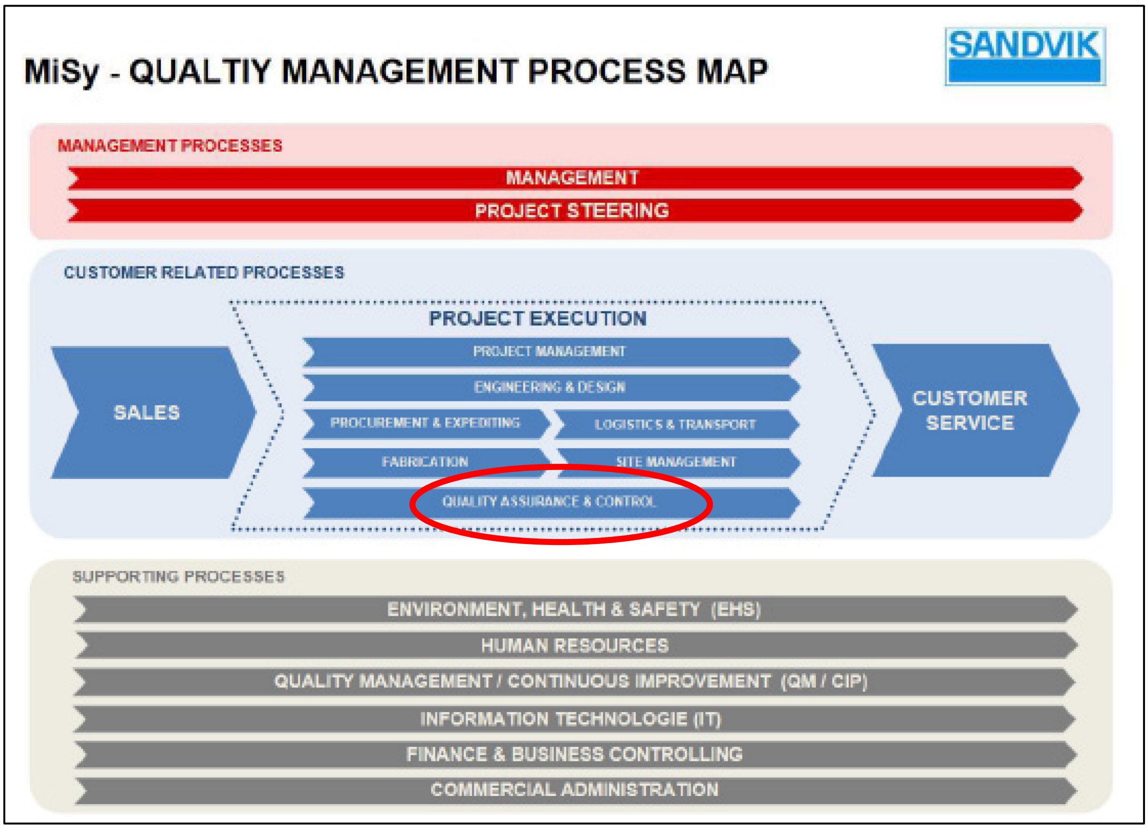


Figure 25: SMCMH-quality management process map[150]

The processes of SMCMH are structured in three areas:

- Management Processes,
- Customer Related Processes,
- Supporting Processes.

Figure 25 shows the quality management process map of SMCMH which is integrated into the software PROSQUID.

The management process consists of the "management" and "project steering". The business- or customer related processes itself consist of "sale", "project execution" and "customer service". The supporting processes belong e.g. to the departments IT, human resources, finance & controlling, etc. Within SMCMH every department has it`s process responsible person or authority, which represent the department in case of quality management issues. Those persons, also named "QM-representatives" are entitled to see all processes but can only edit and change their own department-processes or data. How the process map can/should be used by all employees and especially how the related processes and data can be changed and edited by the responsible QM-representatives or process owner are summarized and detailed described in the Sandvik-internal document "PROSQUID_ProcessMap_Manual_Leo". The tool PROSQUID, which is a SMCMH-used software is described in chapter below.

[150] See: SMCMH-Sandvik Processmap, http://prosquid.at.sandvik.com/processmap/Processmap-Dateien/slide0022.htm (10.09.2015)

The task and practical part of this thesis is concentrating on the optimization, improvement of the quality related processes and thus the QA/QC-department or "Quality Assurance & Control", which is outlined in red in the above SMCMH-process map of figure 25.

Additional of the existing and used software SAP, MS Office, Lotus Notes, etc., SMCMH and the complete Mining Systems Group is working with PROSQUID. This web based tool is described in following pages, as far all functions, processes, and/or working tools which are required for the investigation of thesis are implemented into this system.

PROSQUID

"PROSQUID" is a server based, especially for Sandvik customized project management tool. The name itself consists of two syllables- "PRO" and "SQUID". The first explains the use in PROject management or can stand for "PROfessional". The second syllable is the English description for squid or octopus, which can carry out through several arms several activities simultaneously. This nice characterization for the system can be illustrated in figure 26.

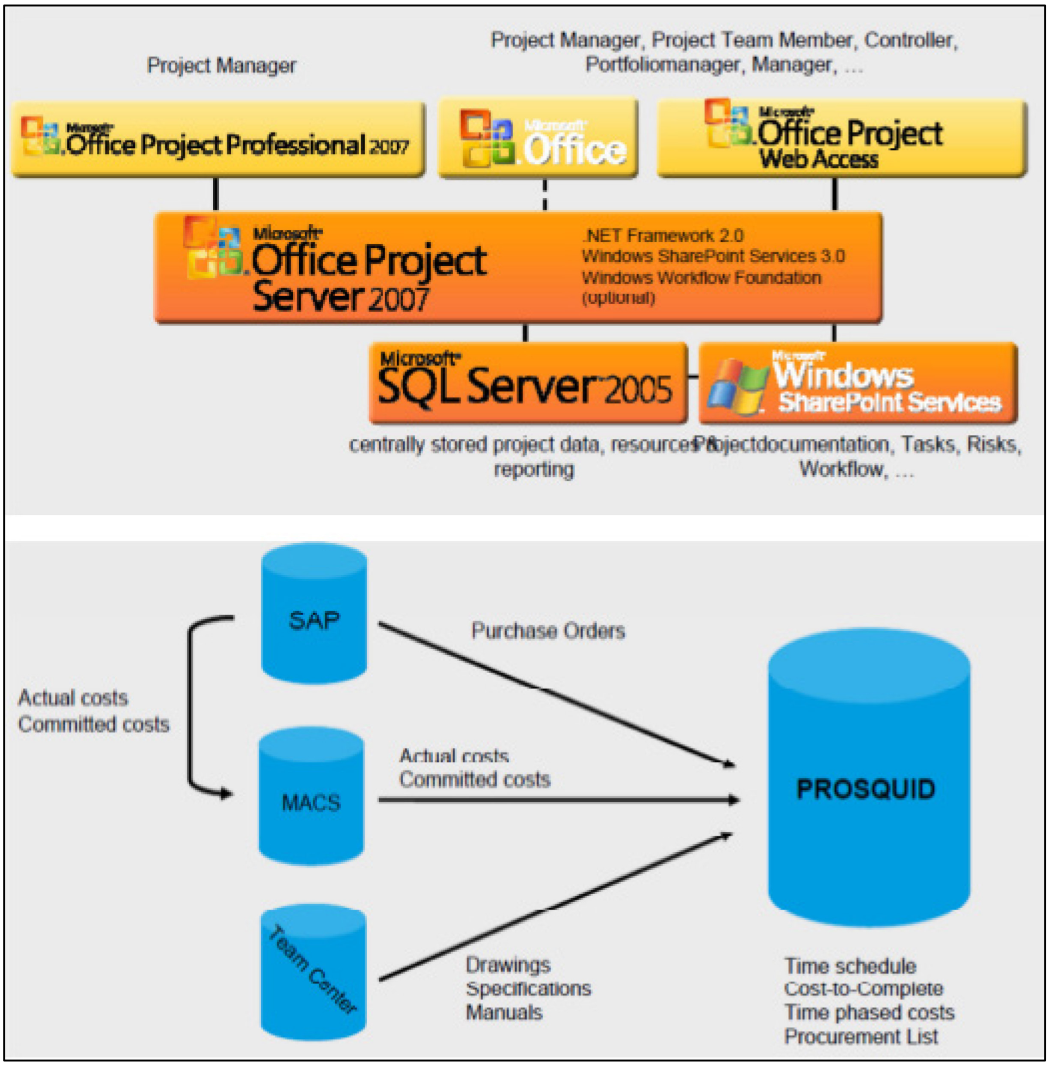


Figure 26: PROSQUID-structure[151]

[151] See: SMCMH (2010), Sandvik intern_PROSQUID MH Acadamy 2010, p. 12

As it is based on different Microsoft-applications and has also interfaces to other systems, like SAP, it can extract and merge information. For that reason it is a good comparison to the squid with its tentacles.

The access to PROSQUID is available through Internet Explorer. The perquisite is that you are registered in Sandvik network, sitting either at workplace of Sandvik Mining or by a client VPN by external access. Individual projects are managed by this software.

PROSQUID has the interface to other systems like SAP, team center or MACS. Thus PROSQUID acts like the known software “projectplace”, as a share-point server, database and information tool for all projects within Mining Systems to handle the projects. Employees of different departments and roles of functions working within Sandvik Mining group are acting in project business using the system.

6.3 Quality in Procurement Process of SMCMH

As per definition of ISO 9001, chapter 7.4.1, which defines the purchasing process, it is mentioned that the organization shall ensure that the purchased products are conform to specified purchase requirements. The extent of control type and applied to the supplier and the purchased product shall be dependent upon the effect of the purchased product on subsequent product realization or the final product. The organization shall evaluate and select suppliers in accordance with the organization's requirements. Adequate criteria for selection, evaluation and/or re-evaluation shall be established and records of the results and any necessary actions arising from the evaluation shall be maintained.[152]

Nevertheless a quality management system is merely a requirement to provide high quality, however, no guarantee to achieve this. As mentioned in chapter 3, quality has in general in the process of procurement a supporting function within the process of supplier analysis and -selection, supplier negotiation and procurement execution. The department QA/QC has similar helping activities within the procurement process of SMCMH.

6.4 QA/QC within Supply Chain of SMCMH

Within SMCMH quality-related tasks and processes are performed by the QA/QC-department. The quality assurance- and control activities are one of the big challenges. The reason is based on the complexity of the projects and a large number of products, which have to be secured.

As per organization definition, the supply chain consists of the department logistics & transport, procurement & expediting and quality assurance & control. Figure 27 illustrates the supply chain-configuration. Additional to the supporting function for the procurement process, the QA/QC-department (as part of the supply chain), has to assure the required quality of the purchased material or service. Further this department has to control/inspect the material or service before transporting them from the supplier to the further production- or erection site.

[152] Source: EN ISO 9001: 2008, p. 33

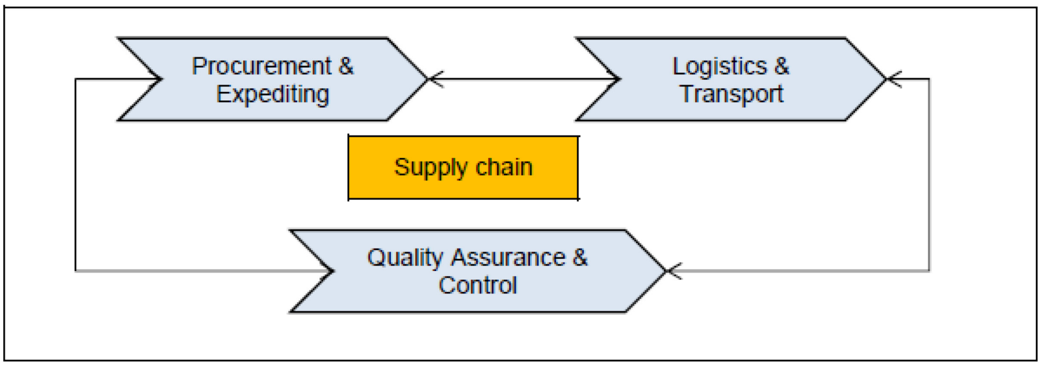


Figure 27: SMCMH-supply chain[153]

The overall tasks of the quality process as support within the procurement are reflecting the technical quality assurance and control mentioned in chapter 2.1.3. Activities done by the QA/QC-department of SMCMH, as support for the procurement logistics and procurement within the supply chain can be summarized and extracted from further responsibilities as follows:[154]

- Involvement in the supplier evaluation, selection and development as part of the procurement process and ensuring a consistent QA-controlling of the supplier in the global supplier market until the sub-suppliers,
- Supplier classification and rating on basis of evaluation,
- Support of the procurement department (dependent on company-determination of authority) in expediting- and/or supervision activities for the examination of fixed time deadlines, agreed delivery- and scope of supply and documentation,
- Execution of inspections on supplier sites, quality control of suppliers,
- Determination of further actions if deviations occur (claim handling), including the documentation,
- Planning and execution of audits, assessments and inspections and evaluation,
- Classic quality assurance planning and/or in the form of supervision activities at side during erection and commissioning,
- Organizational cooperation within a constant technical and economic realization in the sense of a continuous improvement process (CIP).

An extract of the organizational chart belonging to the complete SMCMH-supply chain is shown in figure 28. The department QA/QC is outlined in red.

[153] Own illustration
[154] Source: Giehl, M.; Käß, M. et al. (2010), p. 40 et seq.

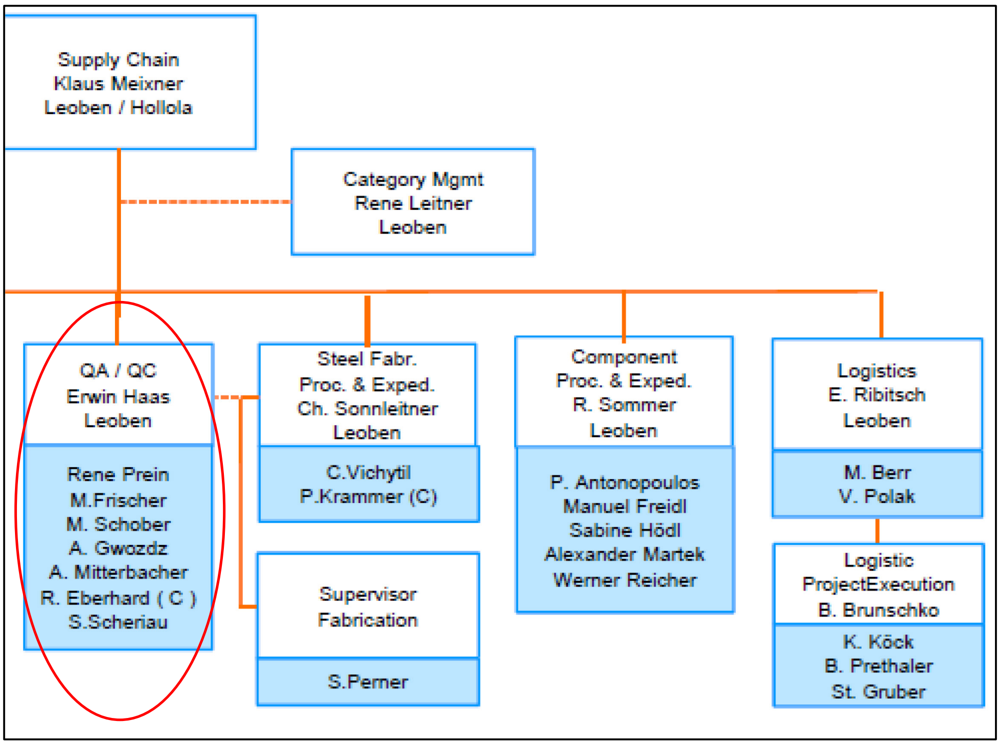


Figure 28: Extract of organizational chart of SMCMH-supply chain[155]

6.5 Existing Functions & Processes of QA/QC within SMCMH

The “quality assurance & control” or QA/QC-processes are defined within the “project execution” belonging to the QA/QC-department.

The process depiction or visualization within the SMCMH is working similar to the software ARIS, as described in chapter 5.4, but integrated in the web based system PROSQUID. If diagrams are modelled with the software ARIS, then it is possible to navigate between the models. By double-click on one of the value chains in the VCD, the required EPC related processes open.

This is similar working within SMCMH, with the exception that after selection of the function button, the department-required functions or process steps opens. Figure 29 shows the current existing QA/QC-functions with integrated documents like forms and templates and processes required for the responsible functions. The term “R” stands for responsible-, “S” for support- and “I” for informational authority for the required function. The function e.g. “quality planning” is outlined in red to show its scope of work, roles and responsibilities including available documents for this process step as an example.

[155] Source: SMCMH (2015): Organizational Charts_PA Mining Systems, p. 7

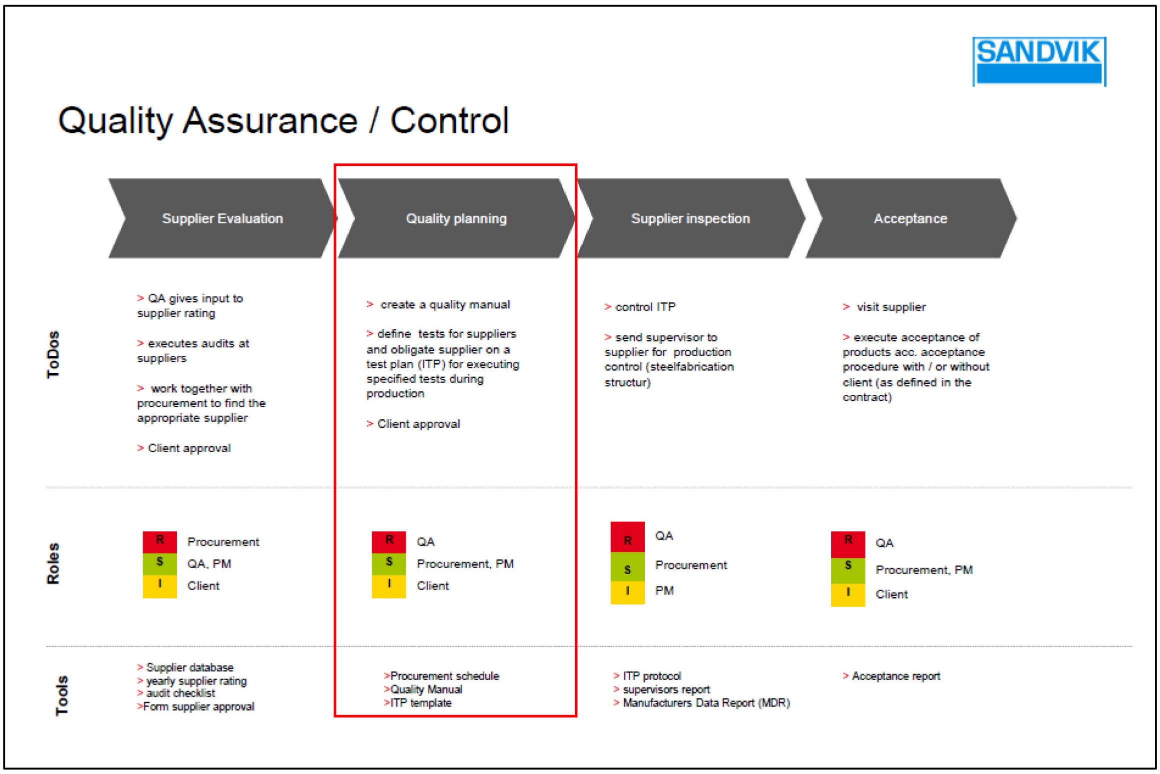


Figure 29: SMCMH-QA/QC-functions and process steps[156]

Following main functions as a VCD with an overview of scope of work are defined within the QA/QC-responsibility and roles within the process steps as per figure 29:[157]

- Supplier Evaluation:
  - QA gives input to supplier rating,
  - Execute audits at supplier,
  - Work together with procurement to find the appropriate supplier,
  - Client approval.

  Within this function the QA has a supporting role (S) for the responsible procurement department (R). The basis for those step are the available supplier data base, yearly supplier rating, audit checklists and form of supplier approvals.

- Quality Planning:
  - Create a quality manual,
  - Define tests for supplier and obligate supplier on a test plan (ITP) for execution specified tests during production,
  - Client approval.

  The QA is within this function or process step the responsible department, where procurement and project management (PM) act as support.

[156]Source: SMCMH, http://prosquid.at.sandvik.com/processmap/EditProcess.aspx?ProcessUID=68b4fc6e-921d-4c86-a5d7-065df4800f8f (11.02.2015)
[157] See: SMCMH, http://prosquid.at.sandvik.com/processmap/EditProcess.aspx?ProcessUID=68b4fc6e-921d-4c86-a5d7-065df4800f8f (11.02.2015)

Procurement schedule, quality manual and ITP template act here as the required reference documents.

- Supplier inspection:
  - Control ITP,
  - Send supervisor to supplier for production control (steel fabrication structure).

  Also within this process step the QA is responsible and the department procurement act as support and PM as an information unit.

  ITP protocol, supervisors report and manufacturers date report (MDR) are the required documents for this step.

- Acceptance:
  - Visit supplier,
  - Execute acceptance of products according acceptance procedure with/without client (as defined in the contract).

  Here the acceptance report acts as a required document and the main responsibility is within QA department. Procurement and PM act as support.

Within all the functions and process steps the client is involved and has to be informed.

Available requirement documents like ITP`s, manuals, form and templates, work instructions and processes required for the process steps or functions are available within the database of quality department.

Independent of above mentioned standard QM-documents, one process representing quality activities within SMCMH, named “PRQA04_QC-Inspections.doc” rev.2 dat. 03.02.2014, is currently available. This document is describing the inspection procedure in the QA/QC-department of steel structure and key components. The process is attached as **appendix A**. This process summarizes the last three mentioned functions of figure 29 and description as scope of work that means the term “quality planning”, “supplier inspection” and “acceptance”, but will not be implemented within this page due to space-saving reasons.

6.6 “QC Planning” as QA/QC-Software Tool

“QC Planning” is a tool which is integrated in PROSQUID and used by the QA/QC-department. The sense of this tool is to plan of QC-activities within the procurement process after ordering execution. “QC Planning Reporting” acts as the result of the “QC Planning” or is the output of data integrated into “QC Planning” and is part of this. It is the output of the resource plan within a required time period, e.g. by the input of time- and authority based resource into “QC Planning”. The report should deliver the answer, how many inspections, when and by whom they will be performed over a desired time. Figure 30 below shows the welcome-mask of PROSQUID, in which both mentioned tools are outlined in red.

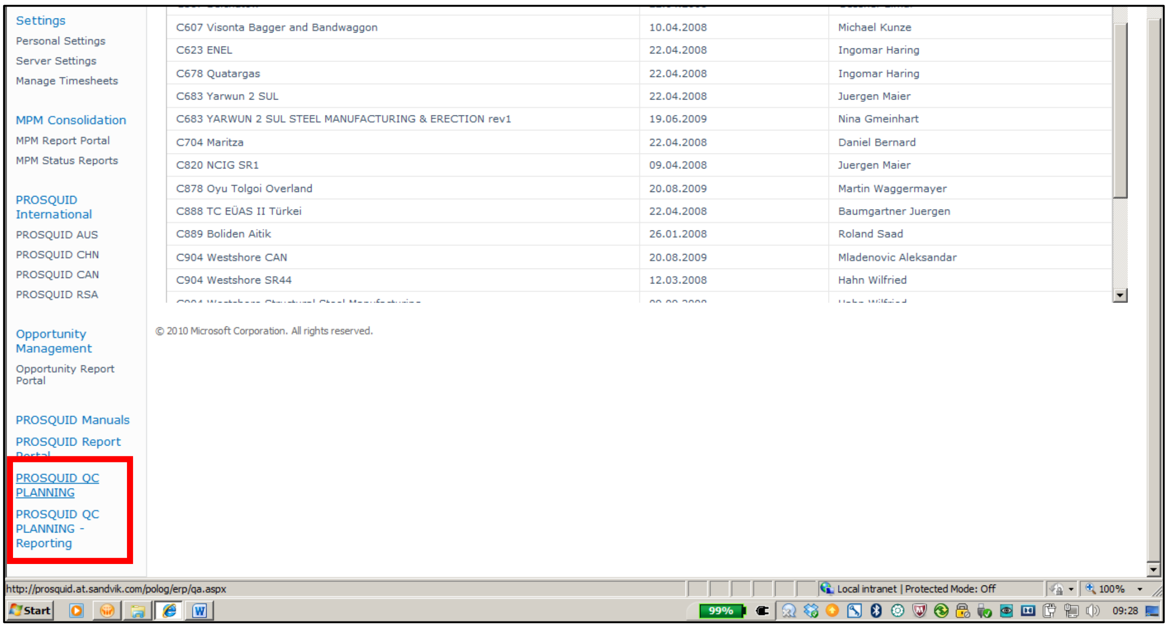


Figure 30: PROSQUID-welcome-mask[158]

Function of "QC Planning"

After procurement execution, which is the last procurement step of process described in chapter 4.2.6, the purchase department creates a purchase order (PO) and uploads this PO with all the contract integrated commercial and technical parts (as negotiated with supplier) into the used software SAP.

The available software "QC Planning" extracts from SAP the incurred PO and required integrated commercial and technical elements of contract. In general the PO itself consists of different integrated information like PO-number, PO-date, name of purchaser, project name, purchased material as per position number within PO, PO-value, delivery date, Incoterms of delivery, etc.

Those mentioned information, integrated into the system should act the QA/QC as the input for further activities desired for planning- and inspection process.

[158] SMCMH, http://prosquid.at.sandvik.com/PWA/default.aspx (14.02.2015)

7 Optimization of QA/QC-Activities within SMCMH

As described in chapter 2, to withstand the growing internationalization and globalization within project execution, resulting in challenges, first of all structures, processes, interfaces to other departments within the internal organization have to be considered with requirements of ISO 9001: 2008 to achieve the planned business goals.

Within the last five years SMCMH has grown very fast without adjusting their structures, processes to the changed environment and/or implementing them into the structural- and operational organization. This was the reason for the management-decision to reengineer the complete quality management system (QMS). The request has been introduced by the management of SMCMH beginning of last quarter 2014. As part of the initiation by the management and execution by the quality manager, also a development, change and adjustment or optimization of the existing structures and processes within the QA/QC-department have been communicated within organization.

All quality-related tasks and processes of SMCMH are performed by the QA/QC-department. In simple words, the QA/QC-department as part of the supply chain is responsible for the assurance of the required quality of the purchased material or service and to control/inspect them before transport from the supplier to the further production- or erection site. Due to the complexity and high quantity of the products, which have to be secured and controlled, concrete activities like planning, documentation and evaluation of inspections, integrated in transparent processes are of main importance within the QA/QC, considering all interfaces to intern stakeholders.

This practical part concludes the analysis of the existing situation with its strengths and weaknesses, following by optimization, improvement and development of quality-activities within the supply process of SMCMH. Following chapter describes the actual- and planned or optimized situation within the QA/QC-department as task for the master thesis.

The specific task requested by SMCMH for the practical part of work includes:

- The actual analysis of the planning- and inspection process within QA/QC-department,
- The identification of weak points and possibilities of optimizing the planning and inspections,
- Determination of inspection standards,
- Definition of documentation, evaluation and analysis of quality inspections,
- Development of key performance indicators,
- Optimization, development and visualization of the planning- and inspection process,
- Optimization of software “QC Planning” as part of PROSQUID and implementation into process,
- Optimization of department- and authority interfaces within the supply chain for the planning- and inspection process.

Thus all existing functions and processes with the available software within QA/QC are target of investigation and optimization. The specified tasks are the basis for the actual analysis and evaluation of weaknesses within this area. Evaluated weaknesses of the processes and the used software are summarized as a conclusion within following pages.

Chapter 7.1 describes SMCMH with its strengths and weaknesses as a whole organization and chapter 7.2 and 7.3 the existing functions/processes and used software of QA/QC-department.

7.1 Actual Analysis and Evaluation of Weaknesses

SMCMH is ISO 9001: 2008 certified and represents the existing quality management system consisting of a fixed operational- and structural organization.

The main processes for doing business are defined within the existing SMCMH-process map, as described in chapter 6.2. Thus the total overview of the company is clear divided into the management-, business- and supporting processes and show a transparent overview of the departments which are responsible for the individual functions and activities to achieve the planned business target.

Nevertheless, the fast historical grow of SMCMH as a result of a high development within the mining market and increase of projects, the individual works of quality management-activities have been neglected and requirements not adjusted to the rapid change. The main weakness within the SMCMH affects the topics like interfaces, communication, transparency and informational flow. Thus investigation within this thesis concentrates on the individual processes of internal QA/QC and the interface to other department as optimization, improvement or adjustment.

Within the main functions and process different departments are involved. Theoretical there are existing clear responsibilities, but the interfaces between them are neither clear defined nor well done in practice. One of the possible reasons for this weakness exist in the theoretical “island thinking”, where every department is doing their own agendas and internal work. This disturbs the smooth flow of the defined general process, resulting loss of data and facts within the interfaces. This parallel fact leads to problems in informational- and communicational flow, resulting in problems in transparency and redundant work or data. One example for this is the use of different software systems. The department procurement and logistics & transport are mainly using SAP, QA/QC on the other hand has no access to that system and works with PROSQUID. The use of those parallel systems within the organization was a historic strategic, mainly financial management decision. As the communication and interfaces between the departments are not sufficient, sometimes department “A” do not know what department “B” is doing and who is responsible, etc.

Independent of the quality department, it was also the task of every department to analyze their internal structures, processes, documents which are responsible to concentrate the synergies to the main business target as a whole team and improve the interfaces within SMCMH.

QA/QC is very strong acting and cooperating with the departments procurement and logistic & transport. Those three departments belong to the supply chain.

As per specific task requested by SMCMH, structures, processes and available software have been checked and analyzed for their actual status and suitability.

Within internal PDCA-meetings with the QA/QC-manager, QA/QC-team members and my person as “QM-representative” of the quality department, the status of available functions, processes and the existing software “QC Planning” have been analyzed and weaknesses recognized.

7.1.1 Functions and Available Processes of QA/QC

As in chapter 6.2 described, the functions and processes of “quality assurance & control” are defined within the “project execution” of existing process map, belonging to the QA/QC-department. The existing QA/QC-functions with integrated documents like forms and templates and processes required for the responsible functions are illustrated in figure 29. Independent of available QM-documents, there is one available process representing quality activities within SMCMH, named “PRQA04_QC-Inspections.doc” rev.2 dat. 03.02.2014. This document is describing the inspection procedure of QA/QC-department of steel structure and key components.

Within the available functions or process steps in the form of a VCD like “supplier evaluation”, “quality planning”, “supplier inspection” and “acceptance”, the QA/QC-authority role act either as responsible or support. For the last three mentioned functions, thus from quality planning, quality inspections until acceptance, one process as per **appendix A** is available.

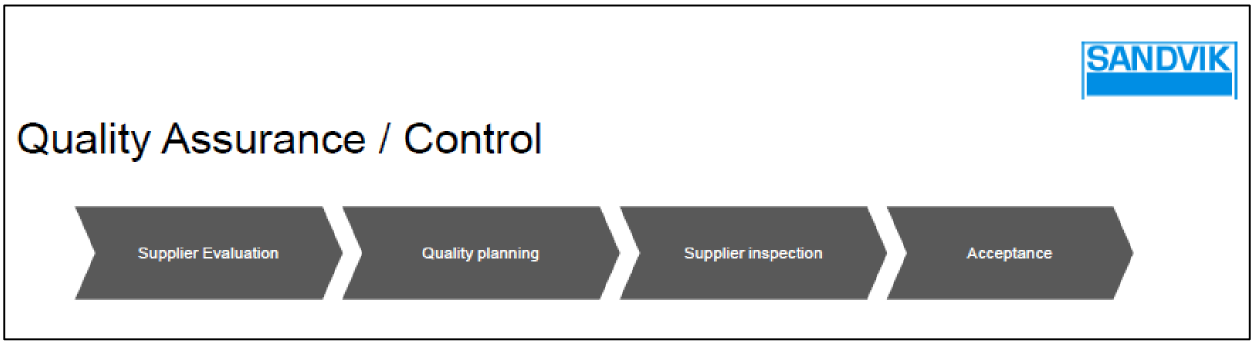


Figure 31: Abstract of SMCMH-QA/QC-functions and process steps[159]

Figure 31 outlines the existing functions and process steps as abstract of mentioned existing QA/QC-steps in chapter 6.5. Those single functions or steps have been analyzed for their status, suitability, strength and compared with the available process “PRQA04_QC-Inspections.doc” rev.2 dat. 03.02.2014. Further weaknesses have been recognized with results as follows:

- **Supplier Evaluation**: Within this step QA/QC acts as a support function for the procurement department. Supplier evaluation, which has been described as part of supplier management in chapter 3.1 is a subtask of procurement. QA/QC gives here the required input, like the input for supplier rating, execution of audits and working together with procurement to find the appropriate supplier.

[159]Source: SMCMH, http://prosquid.at.sandvik.com/processmap/EditProcess.aspx?ProcessUID=68b4fc6e-921d-4c86-a5d7-065df4800f8f (11.02.2015)

Analyzed weakness and missing points within “supplier evaluation”:

- Authority- or responsible interfaces of departments like engineering, logistics & transport for the scope, which are dealing with supplier evaluation.

- **Quality Planning:** This process step acts for QA/QC-department as the main planning of QA-activities beginning from project meeting and order placement until the approval of the ITP & time schedule with supplier. Those processes include steps 1-7 of “PRQA04_QC-Inspections.doc” rev.2 dat. 03.02.2014 as per **appendix A**.
  Further this step also should implement the resource-planning of QC-inspections to give information how many inspections, when and by whom they will be performed over a desired time. This information is missing yet in the process and function. The software “QC Planning” which is integrated in PROSQUID, acts here as the required resource-based planning tool as defined in chapter 6.6.

Analyzed weakness and missing points within “quality planning”:

- Issue of an ITP-draft as input for supplier negotiation,
- Definition of quality validation & test requirements for purchased items, agreed internal within SMCMH and with client,
- Determination of inspection standards,
- Placing of orders in SAP by procurement department,
- Resource-planning (as per software QC Planning) for process and function,
- Check and approval of supplier ITP´s,
- Required responsible-, authority interfaces of other departments,
- Depiction and visualization of process.

- **Supplier Inspection:** This step begins with the general control-activities or QC-work. Within the process, the steps 8-13 are describing the preparation of inspection until the inspection itself as per steps 14-17 of “PRQA04_QC-Inspections.doc” rev.2 dat. 03.02.2014 in **appendix A**.

Analyzed weakness and missing points within “supplier inspection”:

- Documentation, evaluation and analysis of quality inspections,
- Supplier key indicators based on inspections as input for supplier evaluation,
- Required responsible, authority interfaces of other departments,
- Settled information from department QA/QC to logistic & transport for release of inspected items in case of non-conformities occur during inspection,
- Depiction and visualization of process.

- **Acceptance:** This step reflects and belongs to supplier inspection step.

Analyzed weakness and missing points within “acceptance”:

- Complete step to be reengineered, deleted and/or integrated into supplier inspection

Conclusion and Evaluated Weaknesses of Functions and Process of QA/QC

As a result of internal PDCA-meetings with the QA/QC-manager, QA/QC-team members and my person as QM-representative, the status has been analyzed and weaknesses recognized within the planning- and inspection process of the department QA/QC.

As described in chapter 7.1, most of the weaknesses are based on the fast historical grow of SMCMH without the involvement and adjustments to the rapid change as per CIP, which is part of the PDCA-cycle defined in ISO 9001: 2008. Further the main weakness within the SMCMH affects the topics like interfaces to other departments, communication, transparency and informational flow by existing theoretical "island thinking".

In general following weaknesses have been recognized and can be summarized within the planning- and inspection processes of QA/QC as follows:

- No process relation to QA/QC-functions,
- Missing transparency of process,
- No process relation to available software QC Planning,
- No inspection standards,
- No settled release information for transport,
- No adequate documentation, evaluation and analysis of inspections,
- Missing interfaces to other departments,
- Structure of functions or scope of work to be reengineered.

7.1.2 "QC Planning" as Software used by QA/QC

As described in chapter 6.6, "QC Planning" is a tool which is integrated in PROSQUID and used by the QA/QC-department. It acts as information-database of available documents, like PO and all commercial and technical elements of contract, which have been integrated into SAP by the procurement department after procurement execution or creation of new PO. This information is the basis and input for QA/QC as part of planning- and inspection activities.

Further there is a tool named "QC Planning Reporting" and should be the result of the "QC Planning". It should be the output of the resource plan within a required time period, e.g. by the input of time- and authority based resource into "QC Planning". The report delivers the answer, how many inspections, when and by whom they will be performed and at which supplier over a desired time.

The QC Planning is thus actually a tool for the planning of inspections and part of QC-activities as software-integration within process step of resource based function describing "quality planning". The available software QC Planning extracts from SAP the incurred purchase order (PO) and required integrated commercial and technical elements of contract. In general the PO itself consists of different integrated information like PO-number, PO-date, name of purchaser, project name, purchased material as per position number within PO, PO-value, delivery date, Incoterms of delivery, etc. Within QA/QC this information is very important and the input to plan the QC-activities or inspections. Due to transparency of this thesis a sequence of screenshots illustrating the detailed functionality will be avoided and only a short description of operation within both tools is presented below with general masks.

Short description of “QC Planning” for resource-planning:

As already described, the procurement department integrates the PO with integrated parts of PO into the system SAP. QC Planning extracts from PO all integrated values. The steps of resource-planning for the required PO are as follows by QA/QC:

1. QA-responsible of QA/QC has to define the PO-position if quality position or item is relevant or not or needs further quality investigation or not,
2. Responsible QA-engineer has to be defined and assigned to the position,
3. Nominated QA-engineer has to define the witness- (W) and hold-points (H) as per defined/approved ITP from supplier and set the preliminary dates for planned inspections on basis of defined supplier manufacturing time schedule. The terminology and task of the ITP and required points are described in chapter 2.4.

Within SMCMH both relevant points for the inspection process are defined as follows:[160]

“H” (Hold Point):
Client shall be notified in writing or by other agreed procedure, at least fifteen days prior to the forthcoming inspection and/or test activity date.
The sub-contractor shall not proceed with the work without a quality release of Sandvik and/or the client being present, except where Sandvik and/or the client has notified the sub-contractor, in writing, that work may proceed.

“W” (Witness Point):
Sandvik shall be notified in writing or by other agreed procedure, at least fifteen days prior to the forthcoming inspection and/or test activity date. In the case of a witness point if Sandvik and/or client’s quality representative are not present at the designated time and place, the sub-contractor shall proceed with the inspection and/or test as defined.

Such “W”- or “H” points within an ITP of components or steel structure can define e.g. the testing of a gear unit, material testing, NDT inspection of the welds, painting inspection, dimensional inspection, packing inspection, etc.

Within the “QC Planning” it will be defined what kind of PO-positions are “quality-relevant items” within the procurement process, nominated to responsible QA/QC personal or authority and when those PO-positions or items are planned to be inspected. All other “not quality-relevant items” which are standard components, mostly named “off shelf”- material, are not part of QA/QC-activities and will not be traced back by this department. This information serves not only for QA/QC, but further departments involved within the supply process but as a resource-based (personal and time) information tool.

The general mask of “QC Planning” is shown in figure 32. Here an example of a purchased item is highlighted in red with required information extracted from PO. Within this position the item has been marked as “quality relevant” and the responsible QA-engineer assigned. That means that the purchased component “bucket wheel drive” at supplier “Zollern Getriebetechnik” for SMCMH-project “C1858 Neyveli 2×700BWE” with Pos. 0003 of PO-number: 7000059620, PO-value of EUR 365 329 and delivery date of 16.01.2015 has been defined as “quality-relevant

[160] See: Prein, R. (2012), p. 10

item" and Mr. Schober Manfred has been assigned as the responsible QA-engineer (step 1 of resource- planning). With following input the responsible QA-engineer continues with step 3, the input of witness- (W) and hold- points (H) as per ITP from supplier and set the preliminary dates for planned inspections in accordance with manufacturing time schedule.

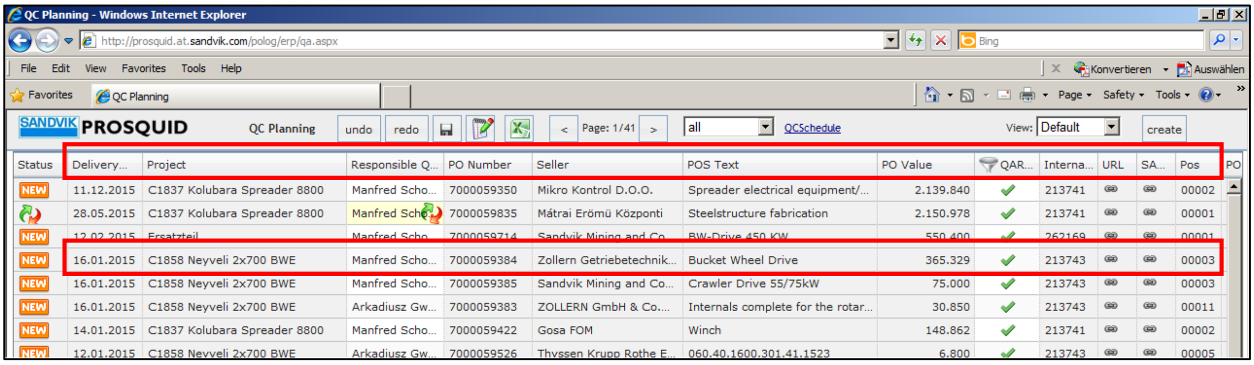


Figure 32: "QC Planning"-mask[161]

In simple words the outlined position 003 of the purchase order 7000059384 defines that item "bucket wheel drive" has been marked as "quality relevant" (after setting the green checkmark) by quality and will be traced back. Further it informs other departments, by "whom" and "when" possible inspections are going performed (based on defined ITP-steps in combination with time schedule of supplier).

<u>Short description of "QC Planning Reporting":</u>

"QC Planning Reporting" acts as the result of the "QC Planning". It is the output of the resource-plan within a required time period, e.g. by the input of time- and authority based resource into "QC Planning". The report should deliver the answer, how many inspections, when and by whom they will be performed and at which supplier over a desired time. The general mask of "QC Planning Reporting" is shown in figure 33. Here a time period from 20.05.2014 to 31.12.2014 is outlined and highlighted in red, which shows a list of assigned QA-engineers for upcoming inspection within this period.

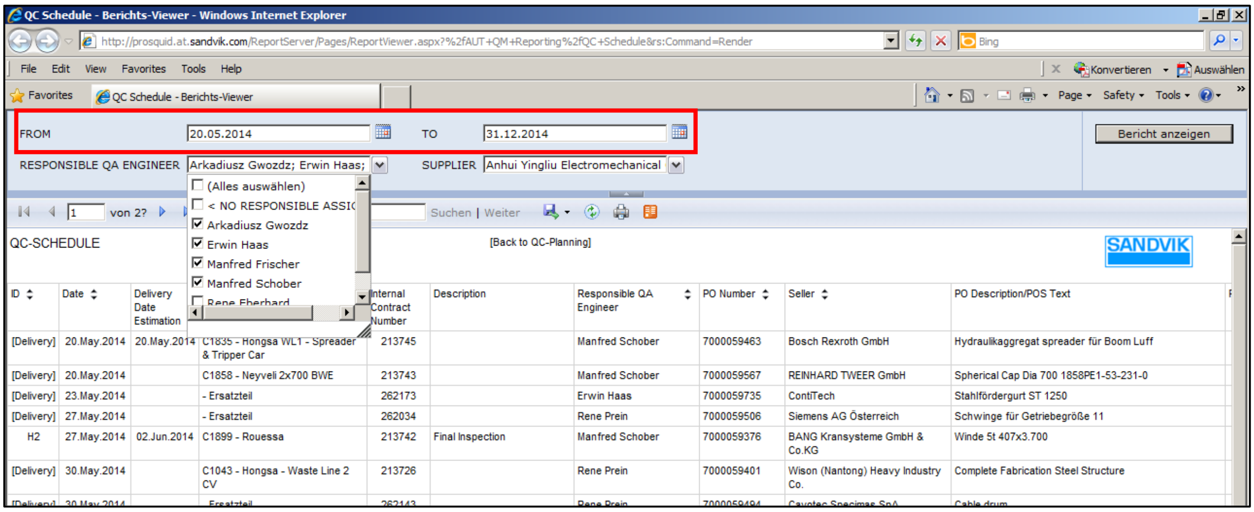


Figure 33: "QC Planning Reporting"-mask[162]

[161] See: SMCMH, http://prosquid.at.sandvik.com/polog/erp/qa.aspx (12.03.2015)

Conclusion and Evaluated Weaknesses of Software

As a result of internal PDCA-meetings with QA/QC-manager, QA/QC-team members and QM-representative of quality department, the status has been analyzed and weaknesses points have been defined. Missing transparency and user- friendliness have been detected as the key-reasons for the decision of improvement, optimization and development of the existing software “QC Planning”.

Analyzed weakness and missing points of both software tools can be summarized as follows:

- Not user-friendly,
- No transparency,
- Quality of data to complex,
- No inspection standards available (for the definition of quality relevance of purchased items/equipment),
- No availability of documentation, evaluation and analysis of quality inspections,
- No availability of performance indicators of inspections,
- No reference and integration to existing quality process.

7.2 Optimized Situation Based on Evaluated Weaknesses

Based on mentioned weakness points, evaluated in PDCA-meetings, actions for the self-developed optimization, improvement of QA/QC-activities within the procurement process are going to be presented in this chapter. Improvements, developments and optimizations have been carried out within the planning- and inspection process, within definition of inspection standards, documentation, evaluation and analysis of inspections. As a result, key performances have been created and defined. Adjustments of process and reference to the improved software have been performed and integration of departments for this supply process in questions related to possible authority-interface carried out.

The task for this practical work has been delegated by the QM and QA/QC-manager to my person as QM-representative of QA/QC. It was the target to eliminate the evaluated weaknesses. Except the software-programming of “QC Planning” and “QC Planning Reporting”, all optimizations and improvements within the planning- and inspection process and specifications created for the software-programming have been self-developed. Detailed actions and steps for the achievement of the objective are described below.

7.2.1 Software “QC Planning” & “QC Planning Reporting”

Specifications and requirements have been created in cooperation with the QA/QC-manager and me on basis of witnessed weakness points during PDCA-meeting. As mentioned in chapter 7.1.2, the predominant points are characterized by the low software-transparency for the department QA/QC. In cooperation with the IT and PROSQUID-programmer a possible solution for the improvement and optimization of the software has been discussed during internal

[162] See: SMCMH, http://prosquid.at.sandvik.com/polog/erp/qa.aspx (12.03.2015)

meetings with QA/QC-manager and my person. Practical possible software-realization has been agreed on basis of a "to-do list" and the implementation has been tested and supervised.

After a time period of some months (beginning with the definition of specifications, the realization and implementation by the IT and programmer into "QC Planning" and check by the QA/QC for the functionality of the system, all above mentioned weakness points have been eliminated.

Due to transparency of this thesis a detailed sequence of screenshots illustrating all the functionalities, optimizations, improvements and developments will be avoided. Only a short description of operations within both tools will presented below.

- **Optimized, improved and developed points:**

1) "QC Planning" has become more user-friendly and a transparent tool:
   The mask of "QC Planning" and "QC Planning Reporting" has become clear and user-friendly. Information not needed has been waived.
2) The complexity of data has been reduced:
   All useless data extracted from PO have been eliminated. All required information has been compressed as minimum as possible for the requirement of inspection-planning. Project, internal contract number, PO-number, PO-text (PO-position) with amount, PO-value, PO-date & delivery date are the minimum data, which are required for QA/QC-activities. The documents like PO and the integrated commercial and technical parts of the order are linked by a small button and can be easy extracted.
   With this required information from procurement, the main time- and authority based planning begins, as described in chapter 7.1.2. Here the steps of quality-planning, like definition of QA-responsible or authority to quality relevant PO-position, the time based definition to the witness- (W) and hold-points (H) of supplier-ITP in cooperation with the available time schedule are described.
   A further development for the data reduction and improvement of transparency are the predictable "W"- and "H"- points, which are now available in a sub-window and no more in columns.
3) Additional to the software optimizations, a new inspection-standard process with an overview of components which have to be assured and controlled has been self-created. It defines the purchased quality-relevant parts and components which are going to be inspected and where a supplier-ITP is required. On basis of this document it has become clear, which items for the projects needs quality investigation. In the past it was not defined what exactly has to be traced back by QA/QC and should be treated as quality-relevant or is only a standard item. Further it is a transparent document, especially for the definition for the responsibility and quantifications of inspection-planning and execution. An abstract of this standard showing mechanical components like drives and hydraulic and lubrication with approved suppliers is shown in figure 34.

Overview of all mechanical components with approved supplier

Mechanical components	Quality relevant; inspections (yes/no)	Sandvik ITP available (yes/no)	Sandvik ITP template	Approved supplier
Drives / Antriebe				
Long travel drive/ Fahrwerksantrieb	yes	yes	ITP_FQA14.03	Siemens Tübingen PIV Brevini CH Schäfer Stiebel SEW Zollern Herbertingen Lenze Schnyder
Slew drive/ Schwenkwerksantrieb	yes	yes	ITP_FQA14.03	
Spillage drive/ Antrieb für Kratzkettenförderer	yes	yes	ITP_FQA14.03	
Winch/ Winde	yes	yes	ITP_FQA14.03	
Spout drive/ Antrieb für Förderrüssel	yes	yes	ITP_FQA14.03	
Crawler drive/ Raupenfahrwerke	yes	yes	ITP_FQA14.03	Siemens Penig / Voerde SMC Zeltweg Keller Kalmbach Hansen Eickhoff Zollern Dorsten PIV Bag Homburg Benzlers SEW Stiebl Elecon
Conveyor drive/ Bandantrieb	yes	yes	ITP_FQA17.00	
BW drive/ Schaufelradantrieb	yes	yes	ITP_FQA14.03	
Hydraulic and lubrication				
Hydraulic cylinder / Hydraulikzylinder	yes	yes	ITP_FQA25.00	Montanhydraulik Ruhfus Neuson Aros

Figure 34: Abstract of inspection standard[163]

The new self-created inspection-standard process is attached as **appendix C** “PRQA07_Inspection standards” rev.2 dat.11.04.2105. The list gives an overview of all mechanical and electrical components required for the complete project or mining machines. Mechanical equipment is categorized as drives, hydraulic and lubrication, cast and forged parts, ropes, steel structure & components (operator cabins, E-houses, grabs, dedusting unit, etc.). Electrical parts include transformers, e-motors, cable drum, etc.

4) The possibility of documentation, evaluation and analysis of quality inspections has been implemented into the software: The main target of the optimization of this software was the documentation of the inspection results and the further use of this data for the input for supplier evaluation. This step of “QC Planning”-optimization is the implementation of the function or VCD “quality inspections” within QA/QC (as addition to “quality planning”). Thus both processes and functions can be supported by “QC Planning”. Following “to-do´s” within the specification, required for the programmer have been agreed:

   - A new link to every inspection- “W”- and “H”- point has to be integrated for the documentation of the inspection, where the inspection report can be uploaded.
   - It must be able to evaluate the inspection result by a check-box. It was agreed to use a grade system 1-5, where “5” is negative and “1-4” positive. Further in case of the selection of the grade “2-5” it should be able to insert witnessed supplier-quality problems by a pull-down menu, to rate the supplier. Figure 35 shows the e.g. a self-created specification describing the required field with legend for the programmer to implement it into the software.

[163] Own illustration

Date:	Format 19.03.2015
Type of inspection	➢ Intermediate inspection ➢ Test run / Functional test ➢ Final inspection ➢ Office inspection
Evaluation	1… Approval or approval for further processing (all Q- requirements are fulfilled) 2… Approval for rework (some actions necessary, all Q- requirements are fulfilled) 3… Approval for rework (minor deviation from the Q- requirements) 4… Approval for rework (deviation from the Q- requirements) 5… Delivery stop and new inspection necessary (serious Q- requirements are not fulfilled)
Q-Problem	➢ Function ➢ Welding ➢ Painting ➢ Packing ➢ Documentation/MDR ➢ Other (own input field)

Figure 35: Specification with legend for IT/programmer[164]

Parallel to that the agreed evaluation-grade from 1-5 has also been implemented by the quality-department into all available checklists, which are required as an inspection-template for all quality-relevant electrical and mechanical components purchased by procurement. On basis of those checklists, in combination with the ITP, the purchased items are checked by the quality inspector during execution of witness- or hold tests at supplier. Thus the evaluation of inspection ranging from 1-5 can be directly done by QC during/after inspection and the results integrated into the software.

All specifications have been implemented by the IT and programmer and found satisfactory by QA/QC.

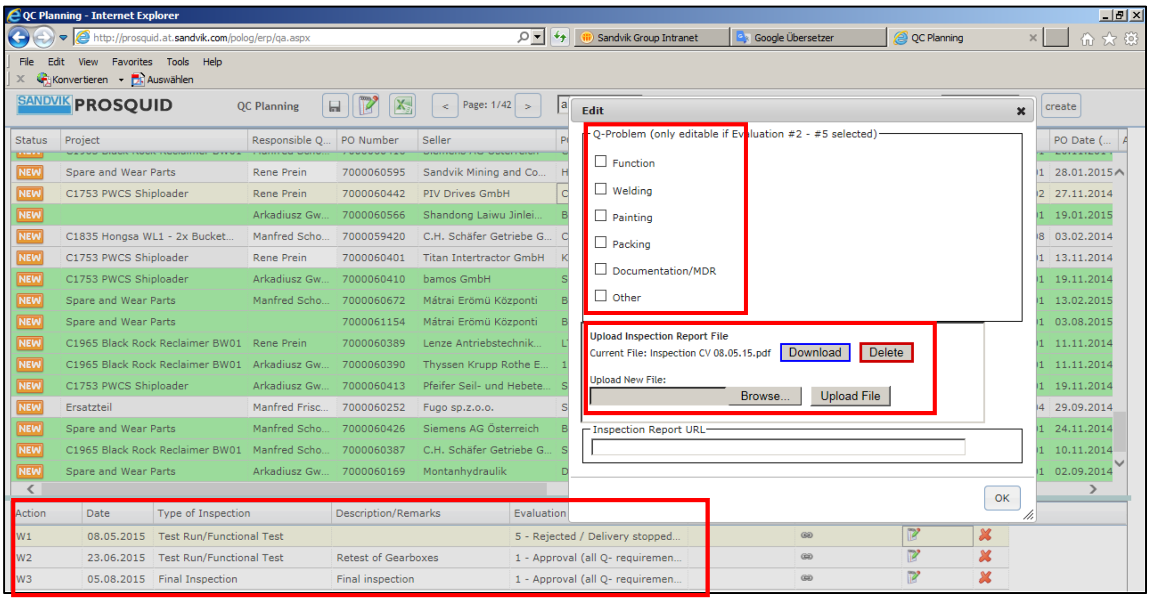


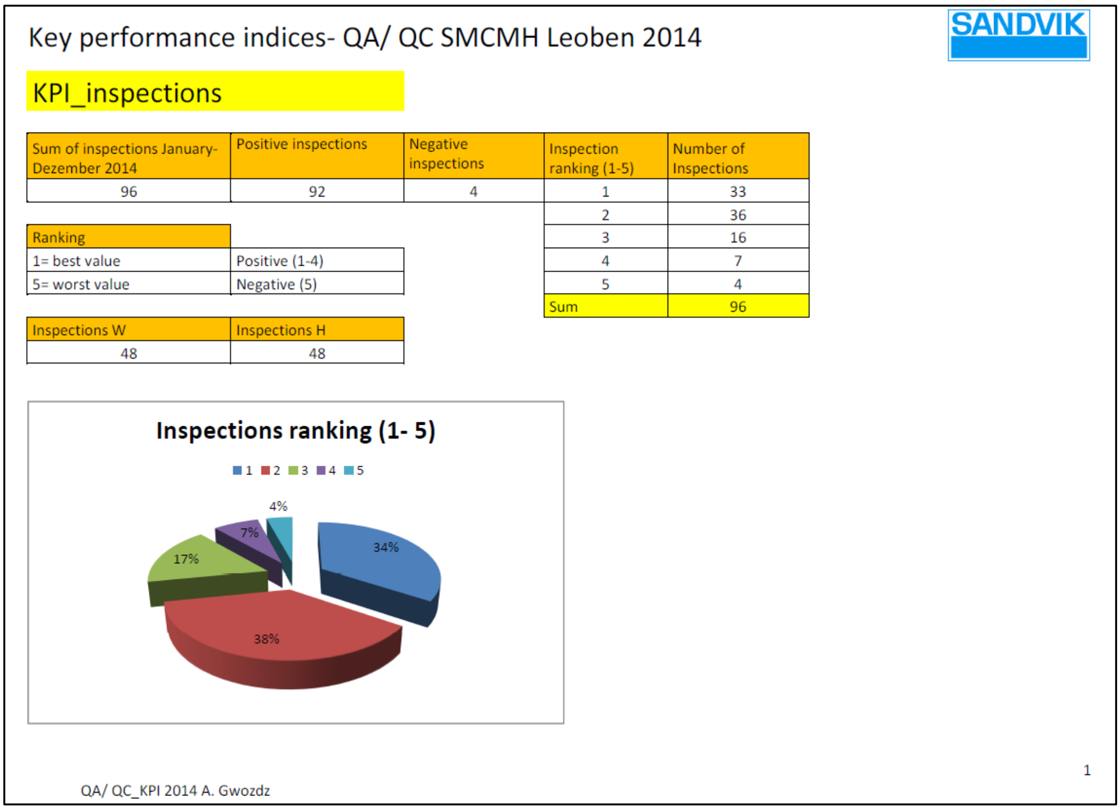
Figure 36: Screenshot of new mask of “QC Planning”[165]

[164] Own illustration

A screenshot in figure 36 shows the new adapted specification, where “Q-problems”, like function, welding, painting, etc. can be implemented with the uploaded inspection report into “QC Planning”. The type of inspection, like intermediate inspection or test run/functional test and evaluation from1-5 can be inserted by using a pull-down menu.

5) Based on the evaluation of mentioned inspections and the rating of the supplier, additional performance indicators have been created and visualized. Quantity of inspections and the results over a time period have been used as the input parameter for KPI`s.

The specification-basis for the programmer was a self-constructed and visualized file “Key performance indices- QA/ QC SMCMH Leoben 2014”. This document has been created to show essential performance indicators, which have been evaluated within the period of 2014. Figure 37 shows the first page of evaluated KPI´s based on inspections carried out. The complete document is attached as per **appendix E** his file has been used as the input or specification for the programmer to create and visualize a possible mix of absolute and relative KPI´s.


Key performance indices- QA/ QC SMCMH Leoben 2014

SANDVIK

KPI_inspections

Sum of inspections January-Dezember 2014	Positive inspections	Negative inspections
96	92	4

Inspection ranking (1-5)	Number of Inspections
1	33
2	36
3	16
4	7
5	4
Sum	96

Ranking	
1= best value	Positive (1-4)
5= worst value	Negative (5)

Inspections W	Inspections H
48	48

QA/ QC_KPI 2014 A. Gwozdz

1

Figure 37: “KPI-QA/QC SMCMH Leoben 2014” (first page)[166]

First those indicators should deliver the performance of QA/QC-activities and further give an input for the supplier evaluation by rating values. This information includes:

- Number of inspections over a desired time

[165] See: SMCMH, http://prosquid.at.sandvik.com/polog/erp/qa.aspx (12.03.2015)
[166] Own illustration

- Number of positive (1-4) and negative (5) inspections over a desired time
- Ranking of supplier on basis of inspections

Performance indicators for the QA/QC-department and supplier have been developed and visualized within several meetings with the programmer in a new created "QC Planning Reporting", which gives an overview of available KPI´s over a desired time. **Appendix F** shows the new created "QC Planning Reporting" of QA/QC, which visualizes the agreed KPI´s.

6) The use of "QC Planning" has been integrated into the new created quality process and functions.

Additional to already mentioned optimizations and improvements also further adjustments, concerning the transparency have been done, but will not mentioned within this thesis. The detailed description of this system has been integrated into the new created manual SMCMH-document "PROSQUD_QC Planning- Manual_ver.1" by the IT/programmer.

Chapter 7.2.2 describes the optimization of the functions and processes (considering the software improvement).

7.2.2 Functions and Processes

Based on actual status analysis and evaluated weaknesses as per chapter 7.1.1, actions have been done for the optimization, improvement and adjustment of the existing QA/QC-functions and the available process. The optimization of the existing VCD and process has been treated as a CPM- or CIP-project. As per description in chapter 5.3, the treatment as a continuous process management (CPM) has been chosen, due to existing actual status and orientation on existing tasks and processes. The picket out "bottom-up method" as definition of CPM had the orientation on existing status, as an incremental and continuous improvement process with building on existing organizational structures resulting in a relative stable and controlled change. A redefinition or complete reengineering or a radical change as a "top-down method" was not necessary.

Within internal PDCA-meetings with the QA/QC-manager and me as QM-representative the functions have been analyzed and the process adjusted and aligned. The analysis of those functions based on status analysis and evaluation of weaknesses have been described in chapter 7.1.1.

- **New created VCD or Functions within QA/QC**

The new VCD or QA/QC-functions have been created and can be implemented into process map of PROSQUID. The functions with defined "to-do`s" and roles of responsibility have been defined, optimized and adjusted as follows:

1) **Supplier Evaluation & Rating**: The responsible role of this function has the procurement department. The QA/QC, PM, logistics & transport give the input to supplier rating, by e.g. witnessed supplier performance, the inspection result and supplier KPI`s. Supplier analysis (carried out by audits) and -selection including client approval is also a supporting item for the procurement.

2) **Quality Planning**: Creating of a Q-manual and ITP´s, definition of test and obligation of supplier for execution (as defined in ITP) and planning of witness- and hold points at the supplier by the use of software "QC Planning" is within the responsibility of QA/QC. A supporting role has here the procurement, PM and engineering.
3) **Quality Inspection of Components and Steel Structure:** Here the QA/QC is responsible for the planning, preparation for the inspection and execution and the implementation of results into "QC Planning". Within the responsibility is also the MDR-check or sending a supervisor in case of a permanent check of manufacturing of e.g. steel structure at supplier. Procurement supports here the QA/QC. PM, engineering and logistics & transport play within this step an informational role. Here the logistics & transport has to be informed by QA/QC, if the inspection items are released for shipment and the inspection was satisfactory or not.
4) **Claim Handling:** Investigation of claim, root cause analysis and definition of corrective actions with supplier are part of this defined function.

Figure 38 illustrate the defined functions of QA/QC, which can be directly integrated into the process landscape of QA/QC within PROSQUID.

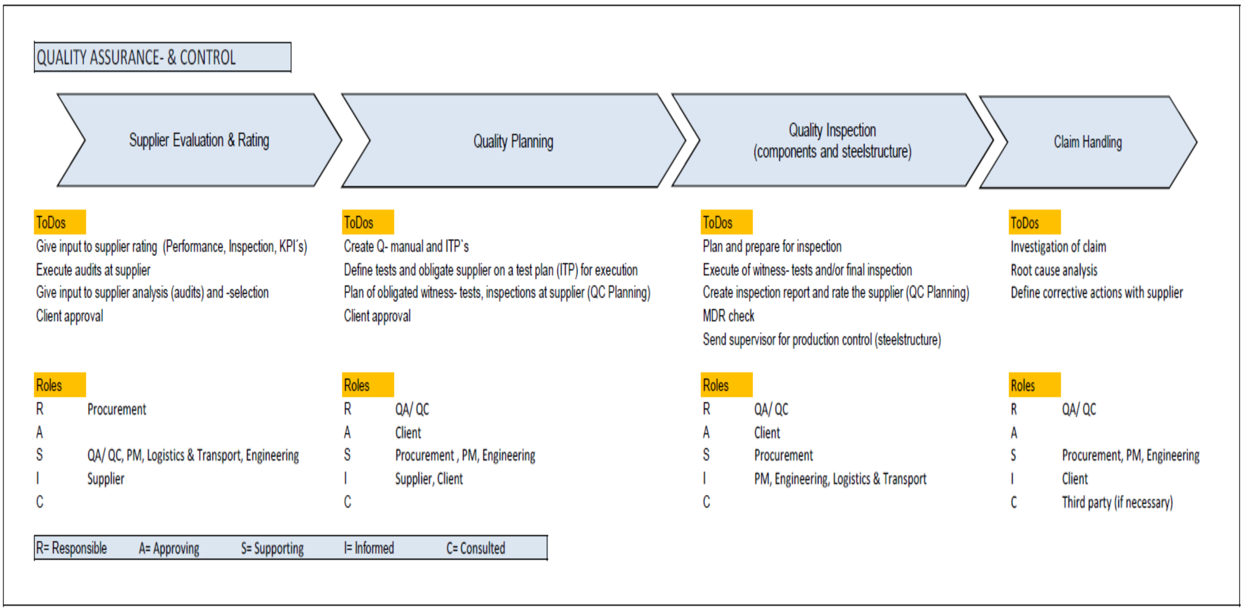


Figure 38: New optimized VCD of QA/QC[167]

[167] Own illustration

- **New created Process within QA/QC**

Based on the new created QA/QC-functions in combination of the optimization of "QC Planning", the process has been adjusted, improved and the weaknesses eliminated. The legend of symbols which have been used for the process are defined in figure 39.

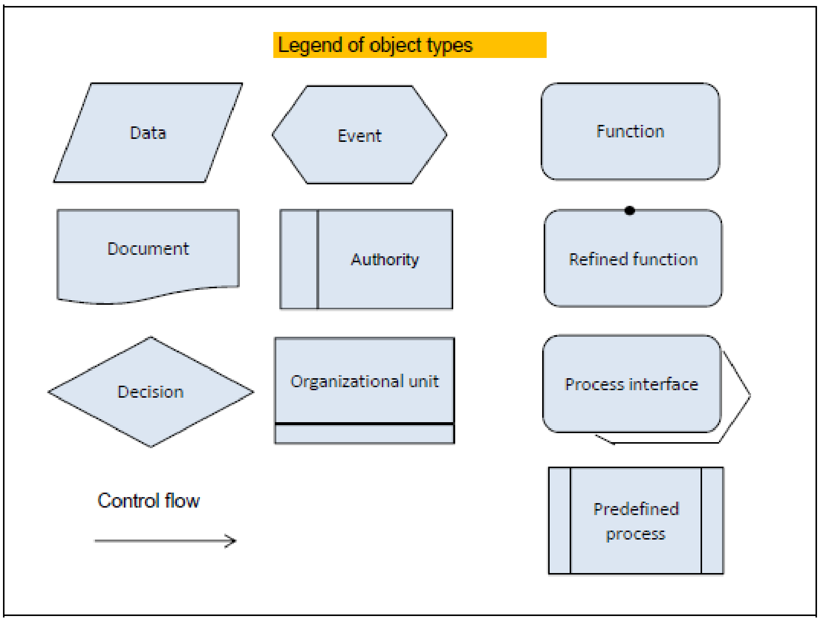


Figure 39: Legend of object types for new created inspection process[168]

The "quality planning" with its "to-do´s" and roles has defined within the steps 1-15. Steps 16-23 of process describe now the function "quality inspections". The new created process of QA/QC describes in detail steps 1-23, thus the quality planning and the inspection itself. Figure 40 illustrates all steps as an abstract of the new created new optimized VCD as per figure 3.

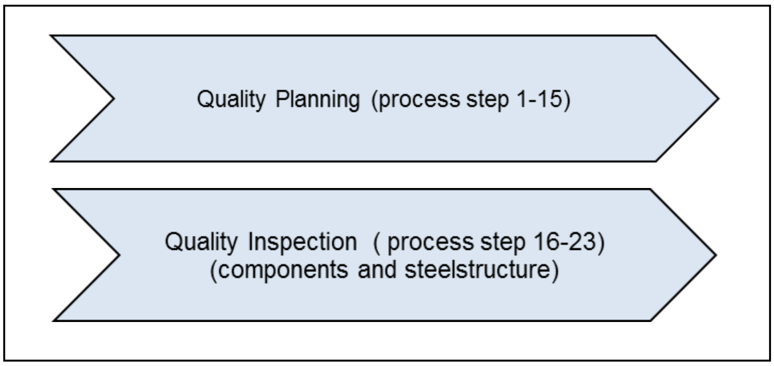


Figure 40: Legend of object types for new created inspection process

An abstract of the "quality process", which describes steps 18-19 (which is part of the function "quality inspections"), is shown in figure 41, where the steps have been highlighted in red. Step 18, e.g. defines on the one hand the documentation, evaluation of inspection and on the other hand the rating of supplier in software "QC Planning", which leads to KPI`s delivery. It also defines the decision tree if the inspected material is released after the inspection or not and

[168] Becker, J.; Kugeler M. et al. (2012), p. 71

concludes in step 20 the new settled release information for transport. The document for transport is attached as per **appendix G** "F.QA.31_Quality release note for transport" dat. 20.05.2015. For the QA/QC the complete process ends with step 23 and the collection of the quality documents from supplier, like the MDR and finalized by the storage of the documents in defined data base for further actions.

			Responsible/ Cooperation/ Information			
Step	**Process step**	**Doc. Output**	**R**	**C**	**I**	**Description**
18	*Document, evaluate the inspection and rate the supplier (QC Planning)*	*QC Planning & QC Planning Statistics*	*QC, EE*			*KPI´s delivery by QC Planning Statistics & input for supplier evaluation "PRQM.07_Supplier-Rating"*
19	*Decision for shipment* ***(yes / no)*** ***No = 19 yes = 21***	*Inspection report*	*QC, EE, CL*	*SU*	*PM, QA, Eng, Log, PR*	
	no					
20	*Actions to be taken by supplier*	*Inspection report, todo list*	*SU*	*QC, EE*		*Non conformances agreed in the inspection report to be remedied by supplier*
21	*Control of the actions*	*e- mail, photo*	*QC, EE*	*SU*		*By repeated inspection (if necessary) or by e-mail/ receipt of missing documentation, adequate photos*
	yes					
22	*Release for shipment*	*Inspection report, "F.QA.03_Quality release note for transport"*	*QC, EE*	*SU*	*PM, QA, Log, PR*	*Quality release document to be sent to transport department and supplier*
23	*Collect and check the final supplier MDR acc. the ITP*	*Final MDR acc. to the ITP*	*QC, EE, QD*			*Storage of documents under Y:\CXXXX\Project Docu-ments\0900 QUALITY\MDR*

Figure 41: Abstract of quality process (step 18-23)[169]

[169] Own illustration

Further a process visualization based on used symbols as defined in chapter 5.4 describing the EPC (event-driven process chain) has been added to process description.

The visualization of the process from steps 18-23 are shown in figure 42. The visualization methods have been used on basis of the theoretical input of this thesis and summarized in figure 39, which define the legend of use object types.

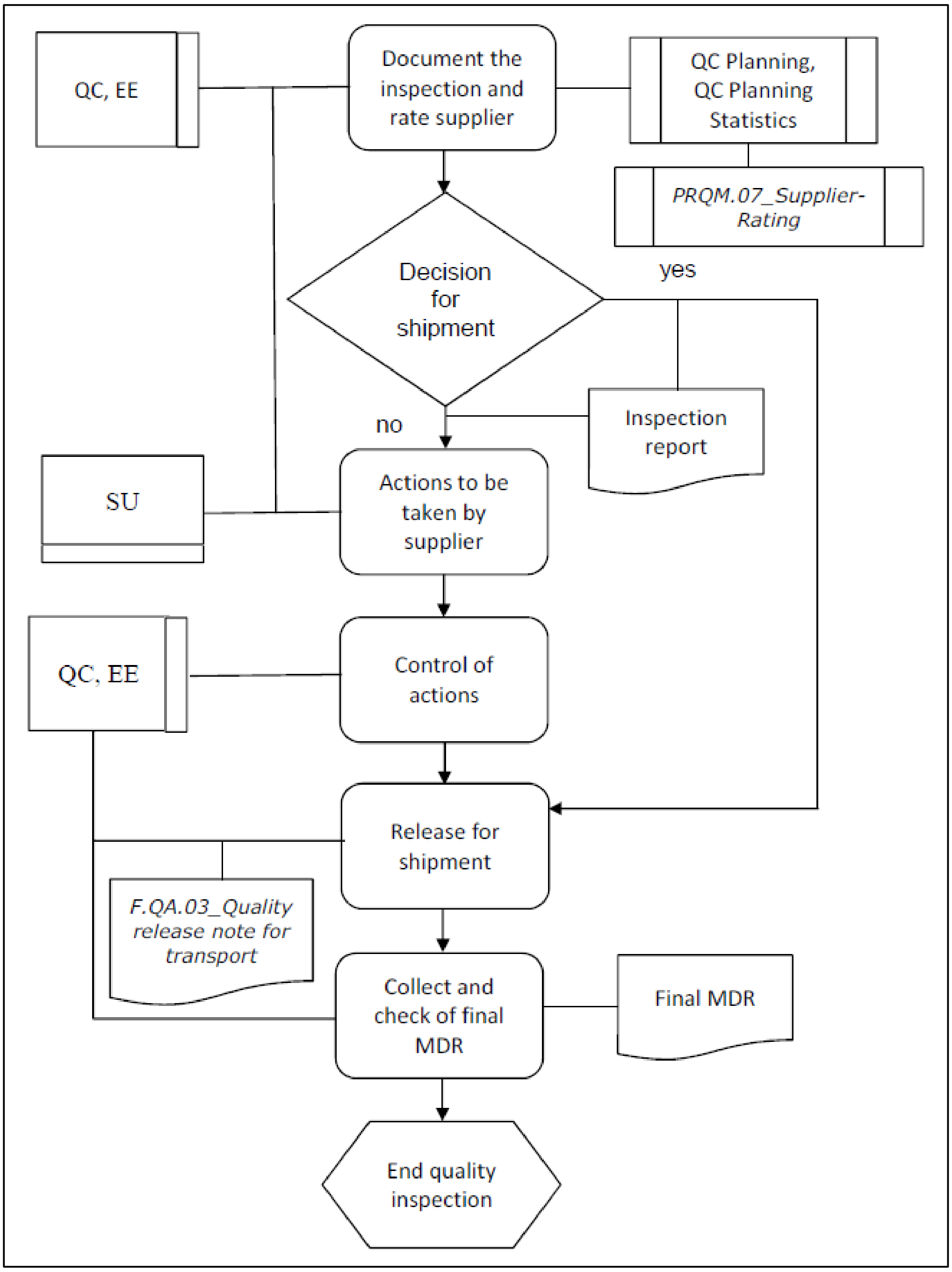


Figure 42: Abstract of visualized quality process (step 18-23)[170]

The complete new process with visualization is as **appendix B** "PR.QA.04_QC-Inspections" rev.3 dat. 13.05.2015. Following points can be summarized as the optimization within the new created process:

[170] Own illustration

1) Process has become transparent
2) Process has adequate relation to QA/QC-process map or -functions
3) Process has become now related to available software “QC Planning”
4) New settled release information for transport created as per document in **appendix G** “F.QA.31_Quality release note for transport” dat. 20.05.2015
5) Adequate documentation, evaluation and analysis of inspections and rating by KPI´s has been implemented in cooperation with the improved software “QC Planning”
6) Interfaces to other responsible departments within the planning- and inspection process are available

The optimized situation of the functions of value chain diagram and the inspection process can be summarized in figure 43. It points out all the main advantages reached by the optimizations, improvements and developments, based on the evaluated weaknesses mentioned in the practical part of this thesis.

Initial situation	Optimized situation
Process and VCD-functions	
• Missing responsible-, authority interface to other departments • No inspection standards • No adequate documentation, evaluation and analysis of quality inspections • Missing key performance indicators • No settled information for transport • No process relation to QA/QC-functions • No process relation to available software QC Planning • Missing transparency of process • No visualization of process	• Interfaces to other departments within all functions integrated • New inspection standard created and implemented into process • Quality inspections are documented, evaluated and analysed in software • KPI´s as a result of inspection evaluation have been created, visualized in software and implemented into process • Process relation to software QC Planning available • The new inspection process consists of VCD “quality planning” (step 1-15) and “quality inspection” (step 16-23) and is related to both functions • Complete process has been visualized

Figure 43: Summary of initial and optimized process and functions[171]

Figure 44 on the other hand shows and summarizes the initial vs. optimized situation of the software QC Planning. The mask has become user-friendly, useless information and the complexity of data has been reduced and eliminated. A new inspection-standard as an overview of Q-relevant mechanical and electrical components has been created. A new possibility of documentation, evaluation and analysis of quality inspections is implemented. Based on evaluation of inspection and rating of supplier, additional KPI´s have been created and visualized in QC Planning Reporting. An integration of software into inspection process has been done.

[171] Own illustration

Initial situation	Optimized situation
Software "QC Planning" & "QC Planning Reporting"	
• Not user friendly • No transparency • Quality data too complex • No inspection standard available (for the definition of quality relevance of purchased items/equipment) • No availability of documentation, evaluation and analysis of quality inspections • No availability of performance indicators of inspections • No reference and integration to existing quality process	• Mask has become user-friendly, useless information has been waived • Complexity of data has been reduced and useless data from purchase order have been eliminated. • New inspection-standard as an overview of Q-relevant mechanical and electrical components has been created • Possibility of documentation, evaluation and analysis of quality inspections implemented • Based on evaluation of inspection and rating of supplier, additional KPI´s have been created and visualized in QC Planning Reporting. • Integration of software use into inspection process

Figure 44: Summary of initial and optimized software[172]

Conclusion

Within plant engineering and construction the biggest percentage of the cost of poor quality (COPQ) can be attributed to the supplier failure. User and customer are concerned about requirements to guarantee the quality of projects and success of operation, reducing risks and costs. Nevertheless without a well working organization with adequate and structured processes no product in required quality can be produced.

Within SMCMH, the QA/QC-activities in cooperation with the relevant members of the supply chain play an important role for the business target. Due to the complexity and high quantity of products, which have to be secured and controlled a well working planning- and inspection process is of main importance within QA/QC. Problems in communication, interfaces and informational flow lead to redundant work and disturb the smooth flow.

For that reason improvement, development and optimization has been carried out within the planning- and inspection process, within definition of inspection standards, documentation, evaluation and analysis of inspections. As a result, KPI´s have been created and defined. Adjustments of process and reference to the improved, transparent software have been performed and integrated to supply chain processes in questions related to possible interface for scope of work.

[172] Own illustration

8 Summary and Outlook

Within plant engineering and construction the supplier quality issues like non-conformance management, product recalls and product failures are nowadays fatal for global organizations and a challenge within avoiding them.

Complex contract structure between contractors, producers and their suppliers and sub-suppliers, inaccurate specifications, unexpected interfaces, responsibility-, communication problems and also cultural- and differences in mentality which are part of the project business, as many national and international standards are a big challenge for the project execution.

Nevertheless without a well working organization with adequate and structured processes no product in required quality can be produced. Thus structures, processes, interface problems of the departments within the internal organization as also the complexity of the projects, large number of products, which have to be planned, realized assessed and secured have to be managed in an appropriate way and sustainable quality.

As per request by the management of SMCMH, beginning of last quarter 2014 to reengineer the complete quality management system, also a development, change and adjustment or optimization of the existing structures and processes within the QA/QC-department have been communicated. The task was to analyse, optimize, develop and adjust those structures and processes to the structural- and operational organization, considering the interfaces to other departments within the internal organization.

The improvement, development and optimization within the planning- and inspection process, the definition of inspection standards, documentation, evaluation and analysis of inspections, resulting in creation of KPI`s have been created and defined as task of this thesis. Adjustment of process and reference to the improved, transparent software have been performed and integrated to supply chain processes in questions related to possible interfaces.

The optimizations and innovations within the planning- and inspection process in cooperation with the new transparent and user- friendly software “QC Planning” should be presented within all global existing Sandvik Mining production units with further trainings for QA/QC-employees and be used as a standard in relation to the planning- and inspection process.

References

Adam, D. (1998): Produktions-Management, 7. Aufl.. Berlin Heidelberg: Springer Gabler Verlag. ISBN: 978-3-663-01589-5

Adams, H. W.; Rekittke, K. (1999): Praktische Rechtskunde für Produktionsmanager: Ein Weg zur gerichtsfesten Organisation. München: Carl Hanser Verlag. ISBN 3-446-21214-0

Arndt, H. (2006): Supply Chain Management: Optimierung logistischer Prozesse, 3. Aufl.. Wiesbaden: Gabler Verlag. ISBN 3-8349-0374-4

Arnold, U. (1998): Beschaffungsmanagement, 2. Aufl.. Stuttgart: Schäffer-Poeschel Verlag. ISBN: 3-791-092212-0

Arnolds, H.; Heege, F.; Röh, C.; Tussing, W. (2003): Materialwirtschaft und Einkauf, 10. Aufl.. Wiesbaden: Gabler Verlag. ISBN: 978-3-8349-3742-1

Batten, P. R. (1987): Quality Assurance for Subsea Installations, Advanced Production Technology Ltd. Conference Paper at International Conference 5-6 March, London, UK, 1987. Document ID: SUT-AUTOE-v11-177. ISBN 0-86010-861-9, p.177- 190

Becker, J.; Kugeler M.; Rosemann, M. (2012): Prozessmanagement: Ein Leitfaden zur prozessorientierten Organisationsgestaltung. 7. Aufl.. Berlin Heidelberg: Springer Gabler Verlag. ISBN 978-3-642-33843-4

Binner, H. F. (1998): Organisations- und Unternehmensmanagement: von der Funktionsorientierung zur Prozessorientierung. München: Hanser Verlag. ISBN 3-446-19375-8

Bleicher, K. (1991): Organisation: Strategien - Strukturen – Kulturen, 2. Aufl.. Wiesbaden: Gabler Verlag, 1999. ISBN 3-409-31552-7

Bogaschewsky, R. (2005): Global Sourcing – wettbewerbsstrategische Bedeutung und methodische Unterstützung. In: Fröhlich- Glantschnig, E. (Ed): Marketing im Perspektivenwechsel. Berlin: Springer Verlag, ISBN 3-540-26290-3, p. 31–58.

Buolifa, W.; Zaid, M. (2009): Role and benefits of key performance indicators (KPIS) in driving HSE management system improvements. Conference Paper at Offshore Mediterranean Conference and Exhibition, 25-27 March, Ravenna, Italy. Document ID: OMC-2009-043

Caruette, J. D. (1997): Equipment Inspection And Quality Assurance, Total/ France. Conference Paper at 15th World Petroleum Congress, 12-17 October, Beijing, China, 1997. Document ID: WPC-28268

De Medeiros, A. R.; Jacob, B. P.; Chaves, A. M.; Da Silva, D. M. L.; Santa Maria, E.; Alessandri Junior, R. (2013): Quality Assurance and Control Considerations in HDD Shore Approach Crossings. In: ISOPE (Ed.): Proceeding of the Twenty-third (2013) International Offshore and Polar Engineering Anchorage, Alaska, USA, June 30-July5, 2013. ISBN 978-1-880653-99-9

EN ISO 9001: 2008: Quality Management Systems- Requirements. Technisches Komitee ISO/TC 176, Quality management and quality assurance, in Zusammenarbeit mit Technischen Komitee CEN/SS F20 Quality assurance.

Fischer, H.; Fleischmann, A.; Obermeier, S. (2006): Geschäftsprozesse realisieren: Ein praxisorientierter Leitfaden von der Strategie bis zur Implementierung. Wiesbaden: Vieweg & Sohn Verlag/ GWV Fachverlage GmbH. ISBN-10: 3-8348-0053-8

Fröhlich- Glantschnig, E. (2005): SWOT-Analyse – Möglichkeiten einer strategischen Beschaffungsanalyse. In: Fröhlich- Glantschnig, E. (Ed): Marketing im Perspektivenwechsel. Berlin: Springer Verlag. ISBN 3-540-26290-3, p. 1–16

Gaitanides, M.; Scholz, R.; Vrohlings, A.; Raster, M. (1994): Prozessmanagement: Konzepte, Umsetzungen und Erfahrungen des Reengineering. München: Carl Hanser Verlag. ISBN 3-446-17715-9

Gareis, R.; Stummer, M. (2006): Prozesse und Projekte. Wien: MANZ`sche Verlags- und Verlags- und Universitätshandlung. ISBN 3-214-082267-1

Giehl, M.; Käß, M.; Nothdurft, R.; Bareiß, M; Sabel, T. (2010): Anforderungen an eine Technische Qualitätssicherung - Vom Neubau bis zum laufenden Betrieb. In: Anforderungen an eine Technische Qualitätssicherung, VGB PowerTech 3/2010, S. 38-42

Hartmann, H. (2002): Materialwirtschaft: Organisation, Planung, Durchführung, 6. Aufl.. Gernsbach: Deutscher Betriebswirte Verlag. ISBN: 3-8886-40094-8

Heiserich O.- E.; Helbig K.; Ullmann W. (2011): Logistik: Eine praxisorientierte Einführung, 4. Aufl.. Wiesbaden: Gabler Verlag. ISBN: 978-3-8349-1852-9

Irlinger, W. (2011): Kausalmodelle zur Lieferantenbewertung. Dissertation der Universität Passau, 2011. Wiesbaden: Gabler Verlag, 2012. ISBN 9-783-834-97186-9

Janker, G. C. (2008): Multivariate Lieferantenbewertung: Empirisch gestützte Konzeption eines anforderungsgerechten Bewertungssystems, 2. Aufl.. Wiesbaden: Gabler Verlag. ISBN: 3-834-91156-8

Koppelmann, U. (2000): Beschaffungsmarketing, 3. Aufl.. Berlin: Springer Verlag. ISBN: 3-540-66271-5

Kosiol, E. (1962): Organisation der Unternehmung, 2. Aufl.. Wiesbaden: Gabler Verlag. ISBN: 3-409-88454-9

Pfeifer, T. (2001): Qualitätsmanagement: Strategien, Methoden, Techniken, 3. Aufl.. München: Carl Hanser Verlag, 2001. ISBN: 3-446-41277-8.

Prein, R. (2012): Inspection and Test Plan Manual FQA.05.00, unpublished internal document. Sandvik Mining and Construction Materials Handling GmbH & Co KG, Leoben, 25.09.2012

Prein, R. (2012): Quality Manual for Steelstructure and Mechanical Components FQA.02.00, unpublished internal document. Sandvik Mining and Construction Materials Handling GmbH & Co KG, Leoben, 26.09.2012

Rink, C.; Wagner, S. (2007): Lieferantenmanagement: Strategien, Prozesse und systemtechnische Unterstützung, In: Brenner, W.; Wenger, R. (Ed): Elektronische Beschaffung. Berlin: Springer Verlag. ISBN: 978-3-540-34017-1, p. 39–62

Sandvik AB (2015): Sandvik Group-Company Presentation 2015, Sandviken, 25.04.2015

SMCMH (2015): Sandvik intern_PROSQUID MH Acadamy 2010, Leoben, 01.10.2010

SMCMH (2015): Organizational Charts_PA Mining Systems, Leoben, 03.04.2015

Thommen, J.-P.; Achleitner, A.-K. (2004): Allgemeine Betriebswirtschaftslehre: Umfassende Einführung aus managementorientierter Sicht, 4. Aufl.. Wiesbaden: Gabler. ISBN 3-409-43016-4

Ulrich, P.; Fluri, E. (1975): Management, 4. Aufl., Bern, Stuttgart: Paul Haupt Berne, 1986. ISBN 3-258-03632-2

Wildemann, H. (2000): Supply Chain Management. München: Transfer-Centrum-Verlag. ISBN: 3-9311-51148-0

Wildemann, H. (1993): Unternehmensqualität: Einführung einer kontinuierlichen Qualitätsverbesserung. Arbeitspapier, TCW-Transfer-Centrum für Produktionslogistik und Technologie-Management, Technische Universität München

Internet

BusinessDictonary.com (2015): Quality Assurance (QA). URL: http://www.businessdictionary.com/definition/quality-assurance-QA.html (access: 11.08.2015)

Frauenhofer-Institut für Materialfluss und Logistik (2015): Beschaffungslogistik. URL: http://www.iml.fraunhofer.de/content/dam/iml/de/documents/OE%20320/Infoseiten%20Projekte/IS_Beschaffungslogistik.pdf (access 23.05.2015)

Ghazo, M. (2015): Supplier Chain Management and Supplier- Selection Service Management. URL: https://www.linkedin.com/topic/supply-chain-management?trk=pprofile_topic (access 24.04.2015)

MetricStream (2015): Site Inspections: Road Map to On-Time Supplier Quality Assurance. URL: http://www.metricstream.com/insights/onsite_inspection.htm (access: 16.08.2015)

Oak Ridge Institute for Science And Education (2015): Development Processes. URL: http://www.orau.gov/pbm/handbook/1-1.pdf (access 20.07.2015)

Six-Sigma-Material (2015): The Cost of Poor Quality (COPQ). URL: http://www.six-sigma-material.com/Cost-of-Poor-Quality.html (access: 17.08.2015)

SMCMH (2015): Sandvik Processmap. URL: http://prosquid.at.sandvik.com/processmap/Processmap-Dateien/slide0022.htm (access 10.09.2015)

SMCMH (2015): Sandvik Processmap. URL: http://prosquid.at.sandvik.com/processmap/EditProcess.aspx?ProcessUID=68b4fc6e-921d-4c86-a5d7-065df4800f8f (access 11.02.2015)

SMCMH (2015): PROSQUID- Overview. URL: http://prosquid.at.sandvik.com/PWA/default.aspx (access 14.02.2015)

SMCMH (2015): PROSQIUD- QC- Planning. URL: http://prosquid.at.sandvik.com/polog/erp/qa.aspx (access 12.03.2015)

Wirtschaftslexikon24.com (2015): Beschaffungslogistik. URL: http://www.wirtschaftslexikon24.com/d/beschaffungslogistik/beschaffungslogistik.htm (access 22.04.2015)

Appendix

Content

A- “PR QA04_QC-Inspections” rev.2 dat. 03.02.2014
B- New “PR.QA.04_QC-Inspections” rev.3 dat. 13.05.2015
C- “PR.QA.07_Inspection standards” rev.2 dat. 11.04.2015
D- New optimized VCD of QA/QC
E- Key performance indices- QA/QC SMCMH Leoben
F- New QC Planning Reporting of QA/QC
G- “F.QA.31_ Quality release note for transport” dat. 20.04.2015

A- "PRQA04_QC-Inspections" rev.2 dat. 03.02.2014

SANDVIK	PROCEDURE	PR no.:	PR QA04
	QC Inspections	Revision	02
		page:	1 of 4

1. Aim and purpose

Description of the inspection procedure in the QA/QC department for steelstructure and key components

2. Scope

QA/QC Department of the PPU Leoben

3. Definitions

QAP	Quality assurance project manager
PO Log	Overview of all orders in Prosquid
QI	Quality inspector
ITP	Inspection& testing plan
CL	Client
SU	Supplier
QD	Quality documentation

4. Modification

Vers.	***Page***	***Modification***
01	*alle*	*New version*
02	*3 and 4*	*Paragraph 7, Safety instructions for Auditors and inspectors* *Paragraph 8, Definition of quality relevant components*

5. Responsibilities

- see process descriptions

Created: E. Haas Checked and approved: M. Frischer Date: Feb. 3[th] 2014

Nur die online Version dieses Dokumentes ist gültig. Die ausgedruckte Form unterliegt nicht dem Änderungsdienst und ist ungültig!

SANDVIK	PROCEDURE	PR no.:	PR QA04
		Revision	02
	QC Inspections	page:	2 of 4

6. Description of process

responsible/ cooperation/ information

Step	Doc-Input	Process step	Doc-Output	R	C	I	Description
1	Prosquid PO Log	Project Meeting	Minutes, PO Log	QAP	PM		
2	PO Log	Check the orders in PO Log	PO Log	QAP	PR		
3	PO, PO Log	Sign the quality relevant key components	PO Log	QAP	Eng		Depends on the components and the reliability of the supplier
4		Assignment of the Quality Inspector to the order	PO Log	QAP	QI		
5	contract, Spec	Issue an ITP draft	ITP	QI	QAP		
6		Clarify the ITP & time schedule with subsupplier	ITP	QI	SU		
7	ITP	Approval of the ITP & time schedule with the client	ITP, time schedule	QAP, CL	QI		Approval with the customer, if necessary
8		Planing of the inspection	eMail, time schedule	QI	SU		
9	PO Log	Preparation of the inspection, collection of all docs	P/O, Contract, drawings, spec, ITP	QI			Check & study all docs for the inspection
10	quality docs	Claim and check the pre-quality documentation of the supplier	quality docs	OI			

	PROCEDURE	PR no.:	PR QA04
SANDVIK		Revision	02
	QC Inspections	page:	3 of 4

11	drawings, specs	Meeting with the responsible project engineer	drawings, specs	QI	Eng		Decision of the QI, if this meeting is necessary
12		Request the business trip	Lotus Notes	QI	QA, PM		
13		Ready for inspection; information to the client	eMails	QI	SU		
14	Order, drawings, spec, ITP	Inspection ot the components acc. to checklist	Inspection report	QI, SU	CU		
15	Order, drawings, spec, ITP	Issue and check the inspection report	Inspection report	QI			
16	Inspection report	Distribute and archive the inspection report	Inspection report	QI	QD		
17	ITP	Claim and check the final quality documentation of the supplier	final quality docs acc. to the ITP	QI			

7. Safety instructions for Auditors and inspectors

QA/QC employees on supplier sites must wear the following personal protection equipment (PPE) obligatory:

- *Safety shoes*
- *Reflective vest*
- *Safety glasses*

	PROCEDURE	PR no.:	PR QA04
SANDVIK		Revision	02
	QC Inspections	page:	4 of 4

Wearing of ear protection and helmets depends on the conditions of the supplier site, but for steel structure supplier these PPE's are also obligatory.

A safety instruction must be done by the supplier, before the QA/QC employee will visit the production or workshop.

8. Definition of quality relevant components

An ITP must be issued for quality relevant components and at least one inspection must be done, quality relevant components are:

- *Main Steel Structure*
- *Drives*
- *Shafts*
- *Cast and forged parts*
- *Crawler links*
- *Ropes*
- *Slew bearing*
- *Belts*
- *Hydraulic components*

Other Criteria are the costs of a component and also the reliability of the supplier

9. Templates and applicable documents

- Inspection and testing plan (ITP)
- MDR, Quality documentation of the supplier, NDT test reports, material inspection certificates
- Final inspection report

B- New “PRQA04_QC-Inspections” rev.3 dat. 13.05.2015

SANDVIK	Procedure Quality Inspections	PR.QA.04 Version 03

1. Aim and purpose

Description of the inspection procedure in the QA/QC department for steelstructure and key components

2. Scope

QA-/QC department of the PPU Leoben

3. Definitions

PO Log	*Overview of all orders in Prosquid,*
QC Planning	*Prosquid- tool of QA/ QC for planning, documentation, evaluation of inspection and rating of supplier*
QA	*Quality assurance manager*
QC	*Quality control manager*
QA/ QC	*QA/ QC manager*
ITP	*Inspection and test plan*
CL	*Client*
SU	*Supplier*
QD	*Quality documentation*
PM	*Project manager*
EE	*Electrical engineer*
PR	*Procurement*
PO	*Purchase order*
Eng	*Project engineer*
Log	*Logistics*
MDR	*Manufacturer Data Report*

4. Modification

Vers.	***Pages, Appendix***	***Modifications (italic)***
01	*all*	*New Version*
02	*3 and 4*	*Paragraph 7, Safety instructions for auditors* *Paragraph 8, Definition of quality relevant components*

Created:	A. Gwozdz	Checked & approved:	E. Haas, K. Meixner
Date:	13.05. 2015		Page 1 of 10

03	*all*	*Paragraph 8 deleted, Adjustment of process, integration of interface to departments, integration of info of inspection standard, implementation of release note for transport, process targets, Integration of QC Planning, process flow chart*

5. Process targets and performance figure (KPI's)

Process responsibility:	*QA/ QC Manager*
Area, general procedure:	*Procurement*
Input:	*Purchase order*
Output:	*Release for shipment*
Figures (KPI's):	*Evaluation of inspection and supplier rating*

6. Applicable documents or templates

- *Inspection and test plan (ITP)*
- *MDR (material certificates, test reports, NDT, paint protocols, etc.)*
- *Final inspection report and checklist*
- *CXXXX-QA-03_Rev00-ITP Schedule FQA03.00.docx*
- *Quality release note for transport_FQA31.00.docx*

7. Distribution

QM MAP or Link:
„http://prosquid.at.sandvik.com/processmap/Processmap-Dateien/slide0022.htm"

8. Responsibilities

Defined in below description of process

9. Description of process

Responsible/ Cooperation/ Information

Step	Process step	Doc. Output	R	C	I	Description
1	Project Meeting on basis of Prosquid- PO Log	Minutes of Meeting, PO Log	PM	EE, Eng, PR, QA Log, QA		
2	Issue of ITP draft and Q-manual for supplier negotiations	ITP draft Q- Manual	QA, EE	PR, Eng		Acc. to contract, specification during negotiation with supplier
3	Definition of components to be inspected	CXXXX-QA-03_Rev00-ITP Schedule FQA03.00	QA, EE	PM, CL	QA/QC	acc. to ITP schedule for whole project
4	Placing orders at suppliers	Orders in SAP	PR	Eng		
5	Check the orders in the QC Planning	QC Planning	QA	PR		
6	Sign the quality relevant key components	QC Planning	QA, QC, EE			Depends on the components and acc. to inspection standard process "PR.QA.07_Abnahmestandards" & ITP schedule for whole project
7	Assignment of the quality inspector (QC) to the order	QC Planning	QA	QC, EE		

SANDVIK	Procedure Quality Inspections	PR.QA.04 Version 03

8	*Check of incoming supplier ITP accord. contract , specification and PO*	*ITP*	*QC, EE*	*Eng*		
9	*Approval of the ITP & time schedule with the client & define tests and obligate supplier on the ITP for execution.* *Plan of obligated witness tests, inspections at supplier in QC Planning*	*ITP, time schedule, QC Planning*	*QC, EE*	*QA, CL*		*Approval with the client, if necessary, further actions, points / hold-points in the ITP to be defined*
10	*Planning of the inspection*	*e- mail, time schedule*	*QC, EE*	*SU, CL*		*Inspection with client (if mandatory)*
11	*Preparation of the inspection, collection of all docs as per QC Planning*	*PO, contract, drawings, spec, ITP*	*QC, EE*			*Check & study all docs for the inspection*
12	*Check the pre-quality documentation of the supplier*	*Quality docs, MDR*	*QC, EE*			*Quality docs to be requested from supplier*
13	*Meeting with the responsible project engineer, if necessary*	*Drawings, specs*	*QC, EE*	*Eng*		*Decision of the QI, EE, if this meeting is necessary*
14	*Request and approval of the business trip*	*Lotus Notes/ Travel data base*	*QC, EE*	*PM,* *QA/QC*		
15	*Invitation of client*	*e- mail*	*QC, EE*	*SU, CL*		*Invitation, if necessary*
16	*Inspection of the components acc. to*	*Inspection*	*QC, EE,*	*CL*		*Inspection on basis of order,*

SANDVIK	Procedure Quality Inspections	PR.QA.04 Version 03

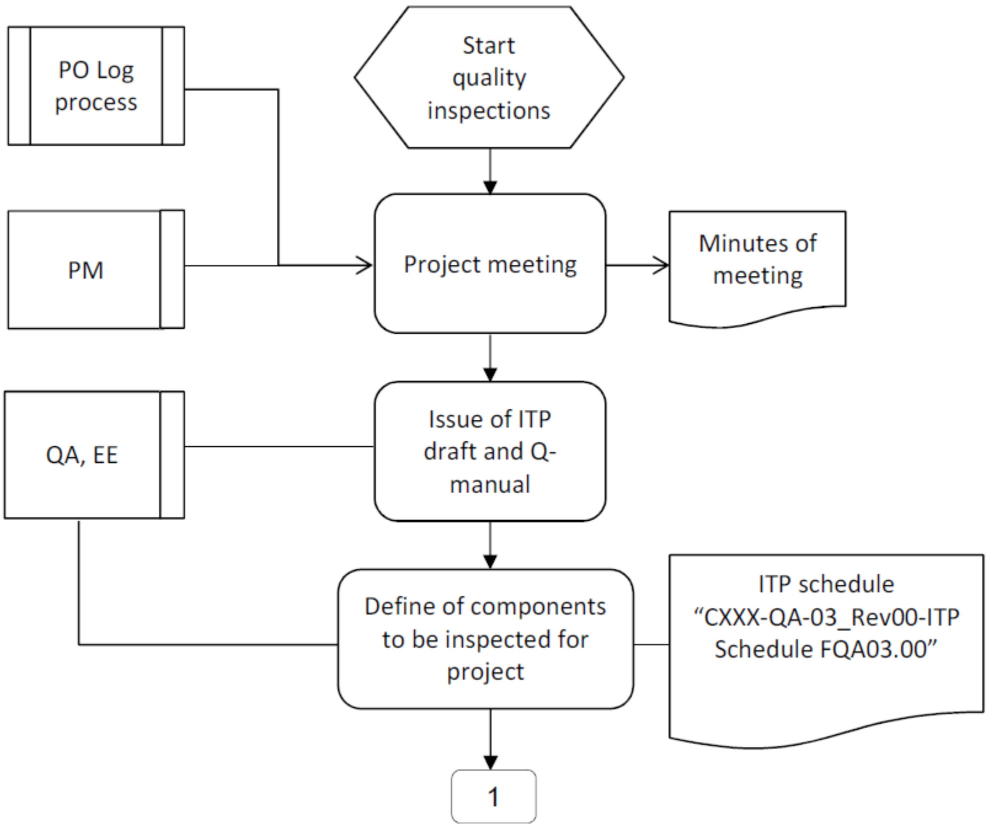
	checklists	*report*	*SU*			*drawings, specs, ITP*
17	*Distribute and achieve the inspection report.*	*Inspection report*	*QC, EE*		*PM, QA, QA/QC, Eng, Log, PR*	*Storage of document under Y:\CXXXX\ Project Docu-ments\0900 QUALITY\Subis\ ... & QC Planning*
18	*Document, evaluate the inspection and rate the supplier (QC Planning)*	*QC Planning & QC Planning Statistics*	*QC, EE*			*KPI´s delivery by QC Planning Statistics & input for supplier evaluation "PRQM.07_Supplier-Rating"*
19	*Decision for shipment* ***(yes / no)*** ***No = 19 yes = 21***	*Inspection report*	*QC, EE, CL*	*SU*	*PM, QA, Eng, Log, PR*	
	no					
20	*Actions to be taken by supplier*	*Inspection report, todo list*	*SU*	*QC, EE*		*Non conformances agreed in the inspection report to be remedied by supplier*
21	*Control of the actions*	*e- mail, photo*	*QC, EE*	*SU*		*By repeated inspection (if necessary) or by e-mail/ receipt of missing documentation, adequate photos*
	yes					

j

22	*Release for shipment*	*Inspection report, "F.QA.03_Quality release note for transport"*	*QC, EE*	*SU*	*PM, QA, Log, PR*	*Quality release document to be sent to transport department and supplier*
23	*Collect and check the final supplier MDR acc. the ITP*	*Final MDR acc. to the ITP*	*QC, EE, QD*			*Storage of documents under Y:\CXXXX\ Project Docu-ments\0900 QUALITY\MDR*

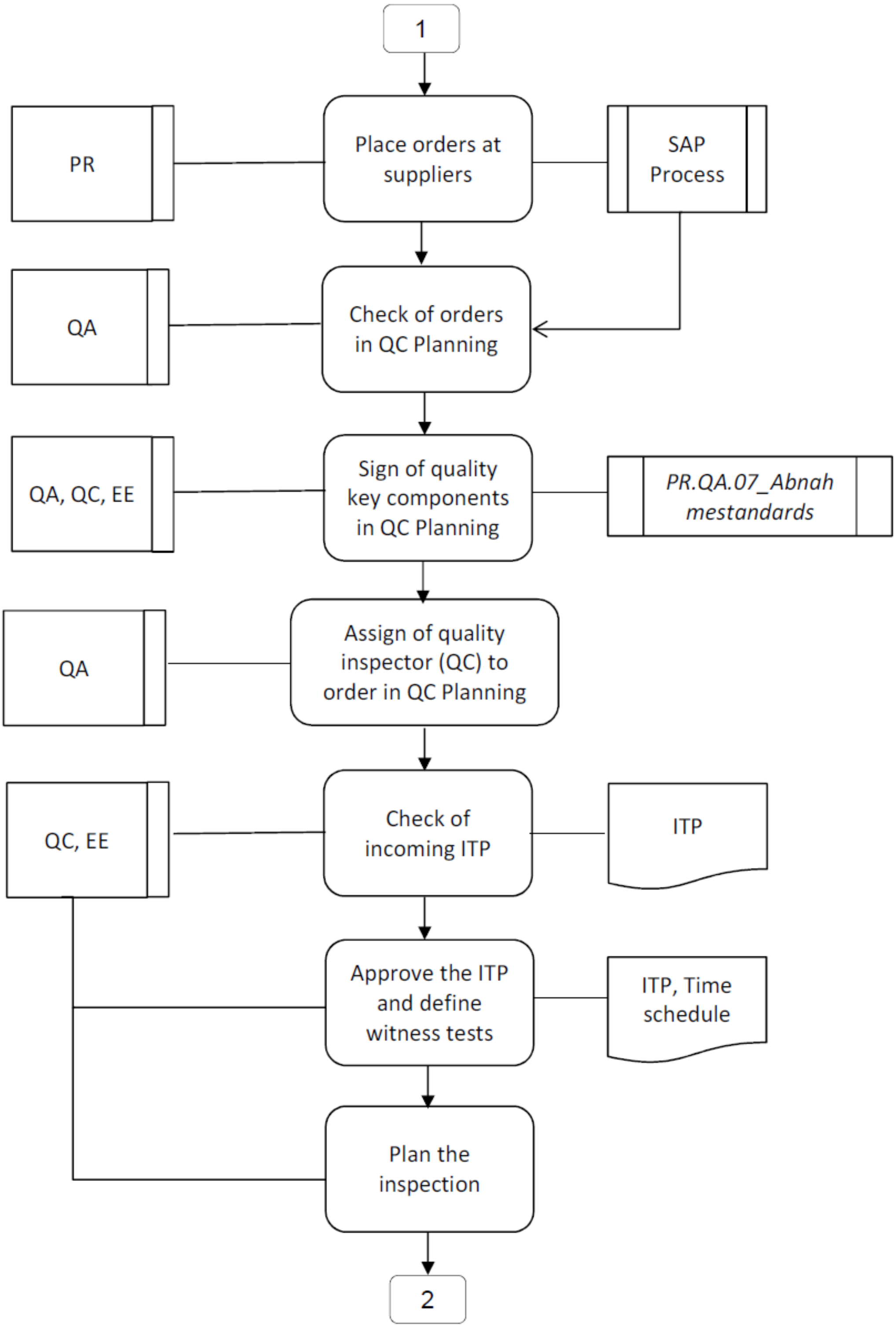
Remark:
- *Step 1- 15: "Quality Planning"*
- *Step 16- 23: "Quality Inspection"*

10. Process flow chart

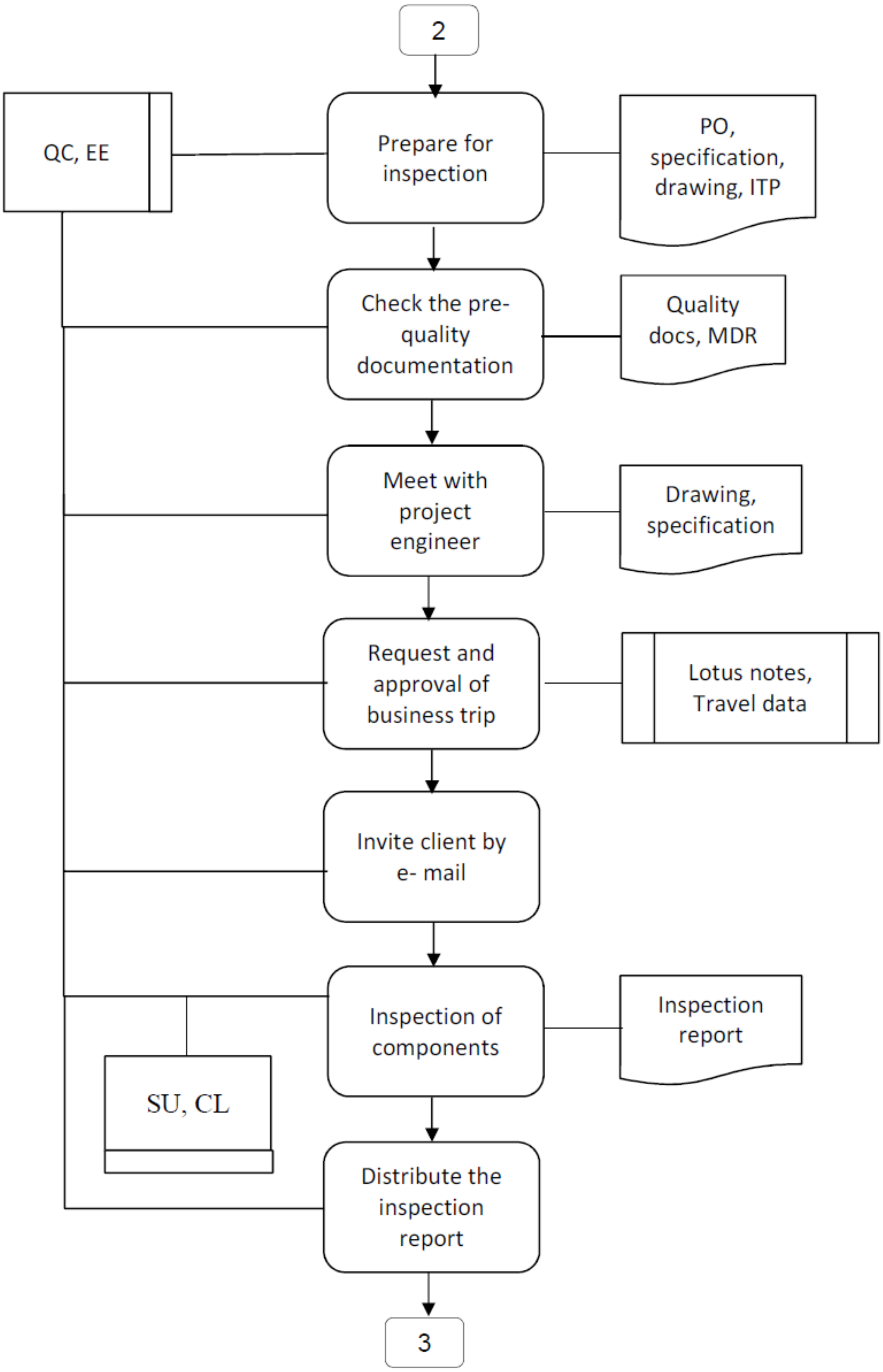


k

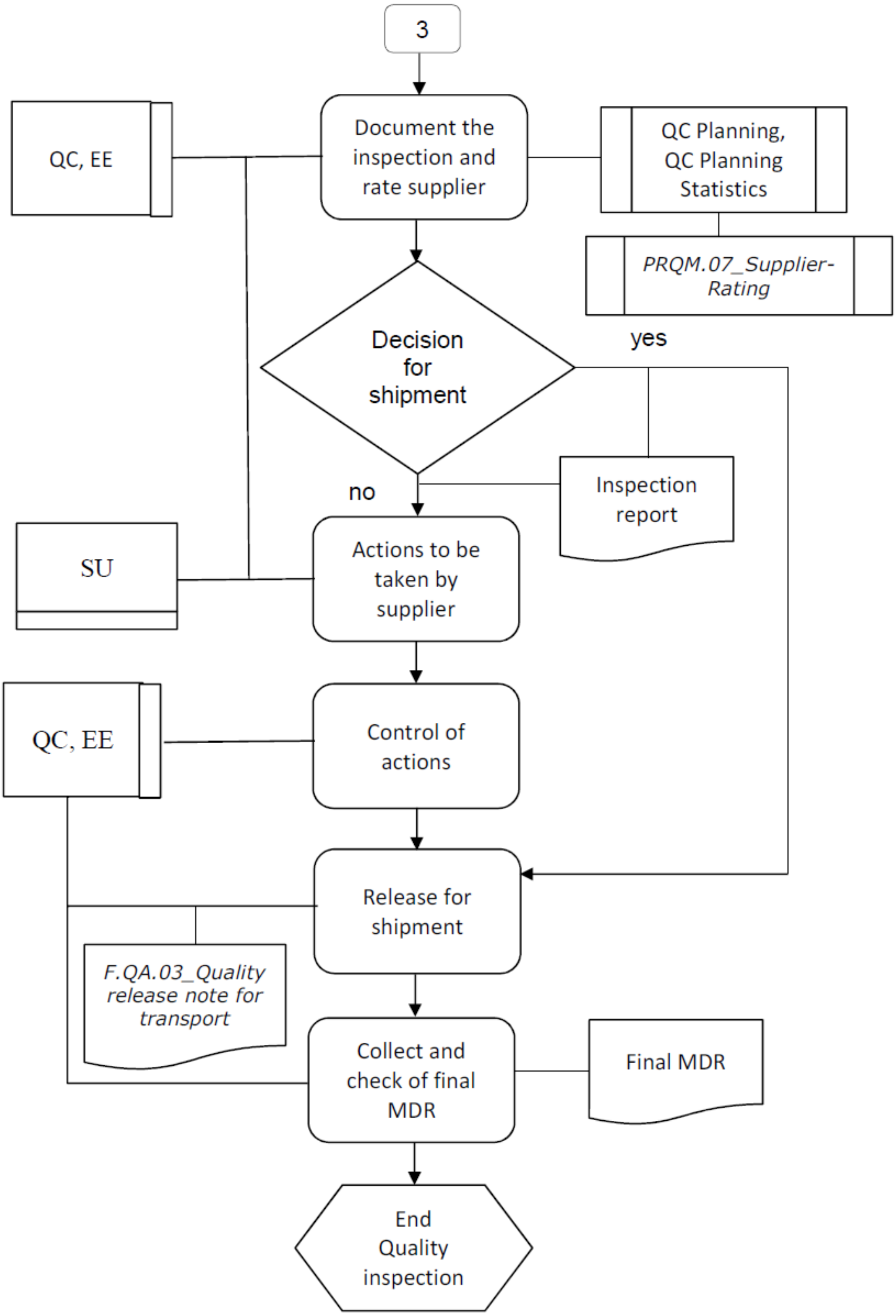
SANDVIK	Procedure Quality Inspections	PR.QA.04 Version 03



SANDVIK | Procedure Quality Inspections | PR.QA.04 Version 03



SANDVIK	Procedure Quality Inspections	PR.QA.04 Version 03



11. Safety instruction for auditors and inspectors

QA/QC employees on supplier sites must wear the following personal protection equipment (PPE) obligatory:

- *Safety shoes*
- *Reflective vest*
- *Safety glasses*

Wearing of ear protection and helmets depends on the conditions of the supplier site, but for steel structure supplier these PPE's are also obligatory.

A safety instruction must be done by the supplier, before the QA/QC employee will visit the production or workshop. The Sandvik quality inspectors and electrical engineers have to demand the safety training from the supplier.

C- “PR.QA.07_Inspection standards” rev.2 dat. 11.04.2015

SANDVIK	Procedure Inspection standards	PR.QA.07 Version 02

1. Aim and purpose

Definition of quality- relevant parts and components, that are inspected and the project-specific definition of inspections.

2. Scope

QA/ QC, Electric Engineering, Project Management

3. Definitions

ITP	*Inspection and test plan*
QC Planning	*Software in Prosquid for the planning and documentation of inspections*

4. Modification

Vers.	***Pages, Appendix***	***Modifications (italic)***
01	*all*	*New Version*
02	*all*	*English translation*

5. Process targets and performance figure (KPI’s)

Process responsibility:	*QA/ QC Manager*
Area, general procedure:	*Sourcing and Quality assurance/ supervision of components*
Input:	*Purchase order*
Output:	*ITP and inspection report*
Figures (KPI’s):	*Number of inspections per time and supplier*

6. Applicable documents or templates

Annex: Overview of the quality- relevant components of SMCMH- approved suppliers for mechanical and electrical parts ("Overview inspection standard_FQA75.06.").

7. Distribution

QM MAP or Link:
„http://prosquid.at.sandvik.com/processmap/Processmap-Dateien/slide0022.htm"

8. Description of process

In general, following components are inspected to assure the quality and function of the machines, like

- *Main steel structure*
- *Drives*
- *Shafts*
- *Casting and forged parts*
- *Crawler links*
- *Ropes*
- *Slew bearings*
- *Belts*
- *Hydraulic components*
- *Panels*
- *Transformer*
- *Motors*

Further important factors are the costs of the components and the reliability of the supplier.

The quality- relevant components which are inspected are specified in detail in table "Overview inspection standard_FQA75.06."

For all quality- relevant components approved supplier- ITP`s are required.

In general quality- relevant items and components are inspected according the known/ approved suppliers as stated in the table "Overview inspection standard_FQA75.06." and large purchase volume.

The responsible Quality inspector is responsible for the inspection of the mechanical components acc. Prosquid- QC Planning.

The responsible Electrical project engineer is responsible for the inspection of the electrical components.

Project specific inspection planning

To implement the project- specific requirements and customer needs, additional to the Prosquid- QC Planning and ITP schedule is created per project. The ITP Schedule have to released by the project manager and client.

9. Annex

Overview of the quality- relevant components of SMCMH- approved suppliers for mechanical and electrical parts:

Table/ document: "Overview inspection standard_FQA75.06."
Place of table/ document: "Y:\QM System\Project Documents\Quality Assurance and Control\Inspection_Electical_components")

Overview of all mechanical components with approved supplier

SANDVIK

Mechanical components	*Quality relevant; inspections (yes/no)*	*Sandvik ITP available (yes/no)*	*Sandvik ITP template*	*Approved supplier*
Drives / Antriebe				
Long travel drive/ Fahrwerksantrieb	yes	yes	ITP_FQA14.03	Siemens Tübingen PIV Brevini CH Schäfer Stiebel SEW Zollern Herbertingen Lenze Schnyder
Slew drive/ Schwenkwerksantrieb	yes	yes	ITP_FQA14.03	
Spillage drive/ Antrieb für Kratzkettenförderer	yes	yes	ITP_FQA14.03	
Winch/ Winde	yes	yes	ITP_FQA14.03	
Spout drive/ Antrieb für Förderrüssel	yes	yes	ITP_FQA14.03	
Crawler drive/ Raupenfahrwerke	yes	yes	ITP_FQA14.03	Siemens Penig / Voerde SMC Zeltweg Keller Kalmbach Hansen Eickhoff Zollern Dorsten PIV Bag Homburg Benzlers SEW Stiebl Elecon
Conveyor drive/ Bandantrieb	yes	yes	ITP_FQA17.00	
BW drive/ Schaufelradantrieb	yes	yes	ITP_FQA14.03	
Hydraulic and lubrication				
Hydraulic cylinder / Hydraulikzylinder	yes	yes	ITP_FQA25.00	Montanhydraulik Ruhfus Neuson Aros
Hydraulik power pack / Hydraulikeinheit	no	Supplier ITP	- - -	Bosch Rexroth
Lubrication/ Schmierung	no	no	Drafts available	Delimon
Hydraulic buffers/ Hydraulik- Puffer	no	no	Drafts available	Römer
Cast and forged parts				
Wheels / Räder	yes	no	ITP_FQA65.01 & ITP_FQA64.00	Karl Georg Xtec uznia Glinik Bonatrans

s

Slew bearing / Drehlager	yes	yes	ITP_FQA71.00	Rothe Erde SKF LYC IMO
Shaft / Welle	yes	yes	ITP_FQA16.00	Metalurgia Gröditz
Crawler links/ Kettenglieder	yes	yes	ITP_FQA26.00 ITP_FQA27.00	Fugo, Yingliu motex Titan Intertractor
Crawler complete assembly/ Raupenfahrwerk	yes	yes	ITP_FQA33.00	Titan Intertractor Trackone Häggbloom Caterpillar
Gear rim / Zahnkranz	yes	no	ITP_FQA68.02	SMC Zeltweg August Fehn
Ropes				
Suspension ropes / Abspannseile	yes	yes	ITP_FQA15.00	Pfeifer
Ropes/ Seile	no	yes	ITP_FQA77.00	Pfeifer Teufelberger Casar
Steel structure & components				

t

Steelstructure/ Stahlbau	yes	yes	ITP_FQA01.00	Stalkon Imasa TZME Sunhel Rainbow Unex KSK Pelfa Elfe Wison Sembawang LMG Stahlbau Pichler SAB MEKK STT Metalna Senovo Prafer Polimex Mostostal
Operator Cabin / Bedienerkabine	yes	yes	ITP_FQA61.00	Rothermel Metagro Clemessy ISB Stahlhandel Brieda MVK Troubsko
E-house / E-Haus	yes	yes	ITP_FQA61.00	Siemens / Modutec Clemessy Gföller Prvini Electro
Grab / Greifer	yes	no	Drafts available	Nemag SMAG
Dedusting unit / Entstaubungseinheit	yes	yes	ITP_FQA54.00	GEA Deichmann Delta Neu
Crusher/ Brecher	yes	Supplier ITP	- - -	Sandvik SMC Svedala, Bergneustadt

u

Crane/ Krane	yes	no		Austrian Stahlcranes Utrans Schmiedl
Other components				
Pulley/ Trommel	yes	ja	ITP_FQA66.01	SMC Haparanda Jiaozuo Creation SMC Bayswater SMC Vespasiano SMC Schöppenstedt
Bolts/ Schrauben	yes	no	- - -	ITH Max Mothes
Rail clamp/ Schienenzangen	no	no	Drafts available	Hillmar
Idler/ Rollen	yes	no	ITP_FQA67.02	SMC Schöppenstedt DBT Thangshan
Belt / Fördergurt	yes	Supplier ITP	Drafts available	Veyance Sempertrans Dunlop Shangdong Aneng
Belt cleaner/ Gurtabstreifer	no	no	- - -	Hosch Schulte Strathaus
Bearing & Sealing/ Lager und Dichtung	no	no	- - -	SKF Schäfler FAG INA NSK
Coupling/ Kupplung	no	no	Drafts available	SKF Schäfler Voith SiemensFludex
Rope sheeves / Seilrollen	no	no	- - -	Bamos
Chain / Ketten	no	no	- - -	Karl Jungbluth Titan Intertractor
Magnetic seperator/ Magnetseperator	no	no	Drafts available	IFE MEC Delachaux
Metal detector/ Metalldetektor	no	no	- - -	Eriez Sesotec Thermo Fisher

Cable reeler/ Kabeltrommel	yes	Supplier ITP	Drafts available	Conductix Wampfler Stemmann Cavotec Hartmann & König
Elevator/ Aufzug	yes	no	- - -	De Jong Liften
Belt weightning device/ Gurtwaage	no	no	- - -	Kukla Schenk Process

Important requirements:
- For all quality relevant components are approved ITP's from the supplier required
- Randomly inspections are allowed by approved supplier

Overview of all electrical components with approved supplier

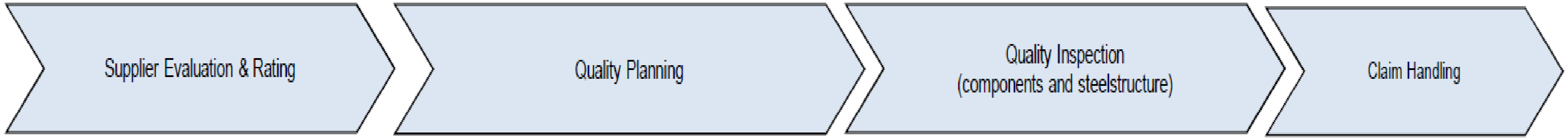
SANDVIK

Electrical equipment & components	Quality relevant; inspections (yes/no)	Sandvik ITP available (yes/no)	Sandvik ITP- template	Approved supplier
Transformer / Transformator (< 500 kVA)	no	no	Control of the 3.1 inspection reports necessary	Siemens ABB Schneider QTC
Transformer / Transformator (≥ 500 kVA)	yes	Supplier ITP	Drafts available	
E- Motors (< 250 kW)	no	Supplier ITP	Control of the 3.1 inspection reports necessary	ABB WEG Siemens VEM Toshiba
E-Motors (≥ 250 kW)	yes	Supplier ITP	Drafts available	
Special motors / Sonder Motoren (Schleifringläufer)	yes	Supplier ITP	Drafts available	
Panels / Schaltanlagen	yes	Supplier ITP	Drafts available	Siemens ABB Schneider Moeller/Eaton
Rheostatic starter / Widerstandsanlasser	yes	Supplier ITP	- - -	Pape & Olbertz
Cable reeler / Kabeltrommel	yes	Supplier ITP	Drafts available	Conductix Wampfler Stemmann Cavotec Hartmann & König
Elevator/ Aufzug	yes	no	Drafts available	De Jong Liften
Cable trays / Kabeltrassen	no	no	- - -	Niedax, Obo Bettermann
Field devices / Feldgeräte	no	no	- - -	Turck P&F D&K Schmersal E&H IFM
Lightning / Beleuchtung	no	no		Phillips
Magnetic seperator / Magnetseperator	no	no	- - -	IFE MEC Delauchaux
Metal detector / Metaldetektor	no	no	- - -	Eriez Sesotec
Belt weightning device / Bandwaage	no	no	- - -	Kukla Schenk Process

Important requirements
- For all quality relevant components are approved ITP's from the supplier required
- Randomly inspections are allowed by approved supplier

D- New optimized VCD of QA/QC

QUALITY ASSURANCE- & CONTROL



Supplier Evaluation & Rating	Quality Planning	Quality Inspection (components and steelstructure)	Claim Handling
ToDos	**ToDos**	**ToDos**	**ToDos**
Give input to supplier rating (Performance, Inspection, KPI's)	Create Q- manual and ITP`s	Plan and prepare for inspection	Investigation of claim
Execute audits at supplier	Define tests and obligate supplier on a test plan (ITP) for execution	Execute of witness- tests and/or final inspection	Root cause analysis
Give input to supplier analysis (audits) and -selection	Plan of obligated witness- tests, inspections at supplier (QC Planning)	Create inspection report and rate the supplier (QC Planning)	Define corrective actions with supplier
Client approval	Client approval	MDR check	
		Send supervisor for production control (steelstructure)	
Roles	**Roles**	**Roles**	**Roles**
R Procurement	R QA/ QC	R QA/ QC	R QA/ QC
A	A Client	A Client	A
S QA/ QC, PM, Logistics & Transport, Engineering	S Procurement , PM, Engineering	S Procurement	S Procurement, PM, Engineering
I Supplier	I Supplier, Client	I PM, Engineering, Logistics & Transport	I Client
C	C	C	C Third party (if necessary)

R= Responsible A= Approving S= Supporting I= Informed C= Consulted

E- Key performance indices- QA/QC SMCMH Leoben

Key performance indices- QA/ QC SMCMH Leoben 2014

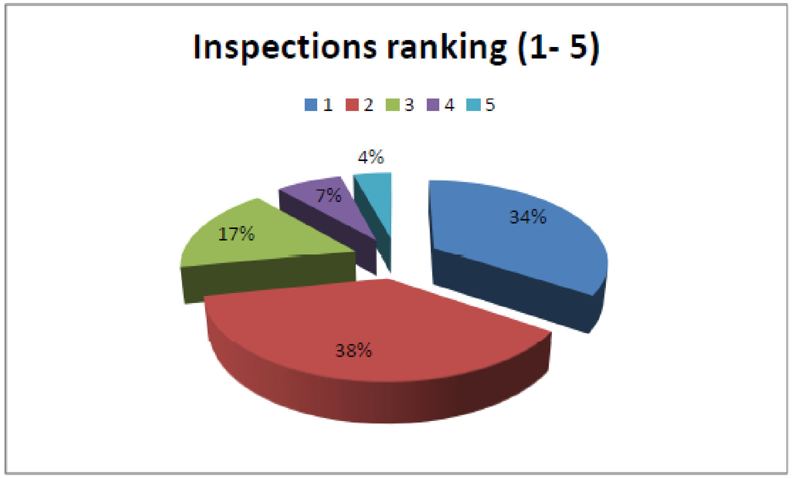
SANDVIK

KPI_inspections

Sum of inspections January-Dezember 2014	Positive inspections	Negative inspections	Inspection ranking (1-5)	Number of Inspections
96	92	4	1	33
			2	36
			3	16
			4	7
			5	4
			Sum	96

Ranking	
1= best value	Positive (1-4)
5= worst value	Negative (5)

Inspections W	Inspections H
48	48

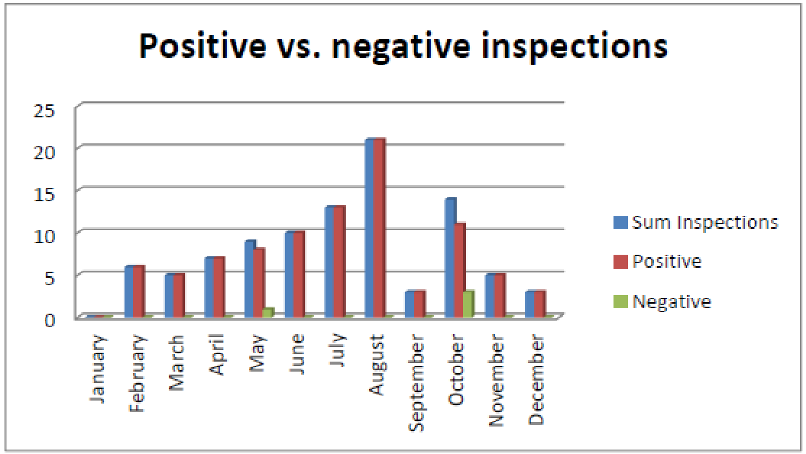


QA/ QC_KPI 2014 A. Gwozdz

1

Key performance indices- QA/ QC SMCMH Leoben 2014

Month	Sum Inspections	Positive	Negative
January	0	0	0
February	6	6	0
March	5	5	0
April	7	7	0
May	9	8	1
June	10	10	0
July	13	13	0
August	21	21	0
September	3	3	0
October	14	11	3
November	5	5	0
December	3	3	0
	96	92	4



2

Key performance indices- QA/ QC SMCMH Leoben 2014

SANDVIK

KPI_suppliers

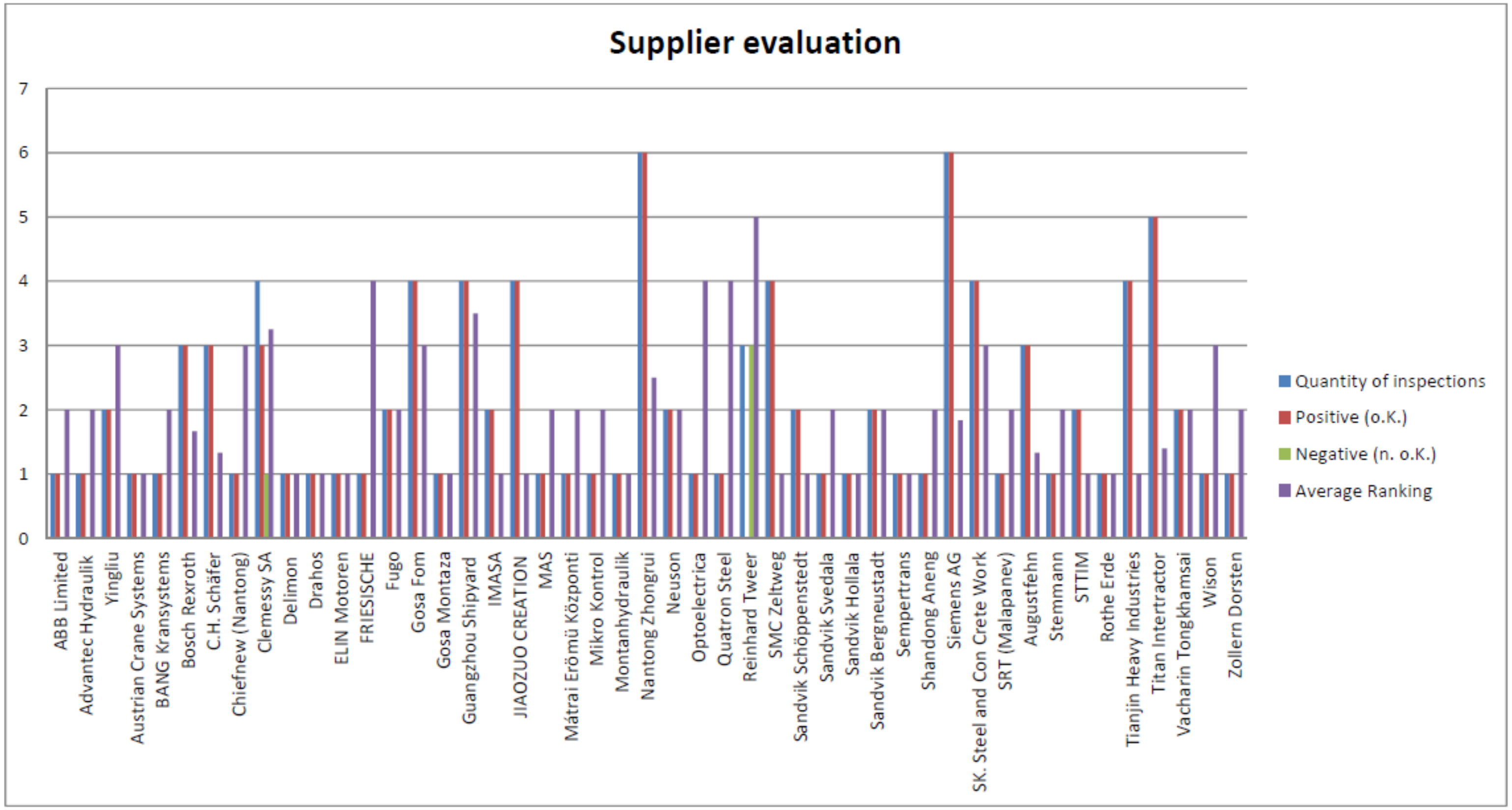
Supplier	Quantity of inspections	Positive (o.K.)	Negative (n. o.K.)	Average Ranking
ABB Limited	1	1	0	2
Advantec Hydraulik	1	1	0	2
Yingliu	2	2	0	3
Austrian Crane Systems	1	1	0	1
BANG Kransystems	1	1	0	2
Bosch Rexroth	3	3	0	1,666666667
C.H. Schäfer	3	3	0	1,333333333
Chiefnew (Nantong)	1	1	0	3
Clemessy SA	4	3	1	3,25
Delimon	1	1	0	1
Drahos	1	1	0	1
ELIN Motoren	1	1	0	1
FRIESISCHE	1	1	0	4
Fugo	2	2	0	2
Gosa Fom	4	4	0	3
Gosa Montaza	1	1	0	1
Guangzhou Shipyard	4	4	0	3,5
IMASA	2	2	0	1
JIAOZUO CREATION	4	4	0	1
MAS	1	1	0	2
Mátrai Erömü Központi	1	1	0	2
Mikro Kontrol	1	1	0	2
Montanhydraulik	1	1	0	1
Nantong Zhongrui	6	6	0	2,5
Neuson	2	2	0	2

Key performance indices- QA/ QC SMCMH Leoben 2014

SANDVIK

Optoelectrica	1	1	0	4
Quatron Steel	1	1	0	4
Reinhard Tweer	3	0	3	5
SMC Zeltweg	4	4	0	1
Sandvik Schöppenstedt	2	2	0	1
Sandvik Svedala	1	1	0	2
Sandvik Hollala	1	1	0	1
Sandvik Bergneustadt	2	2	0	2
Sempertrans	1	1	0	1
Shandong Aneng	1	1	0	2
Siemens AG	6	6	0	1,833333333
SK. Steel and Con Crete Work	4	4	0	3
SRT (Malapanev)	1	1	0	2
Augustfehn	3	3	0	1,333333333
Stemmann	1	1	0	2
STTIM	2	2	0	1
Rothe Erde	1	1	0	1
Tianjin Heavy Industries	4	4	0	1
Titan Intertractor	5	5	0	1,4
Vacharin Tongkhamsai	2	2	0	2
Wison	1	1	0	3
Zollern Dorsten	1	1	0	2

Key performance indices- QA/ QC SMCMH Leoben 2014

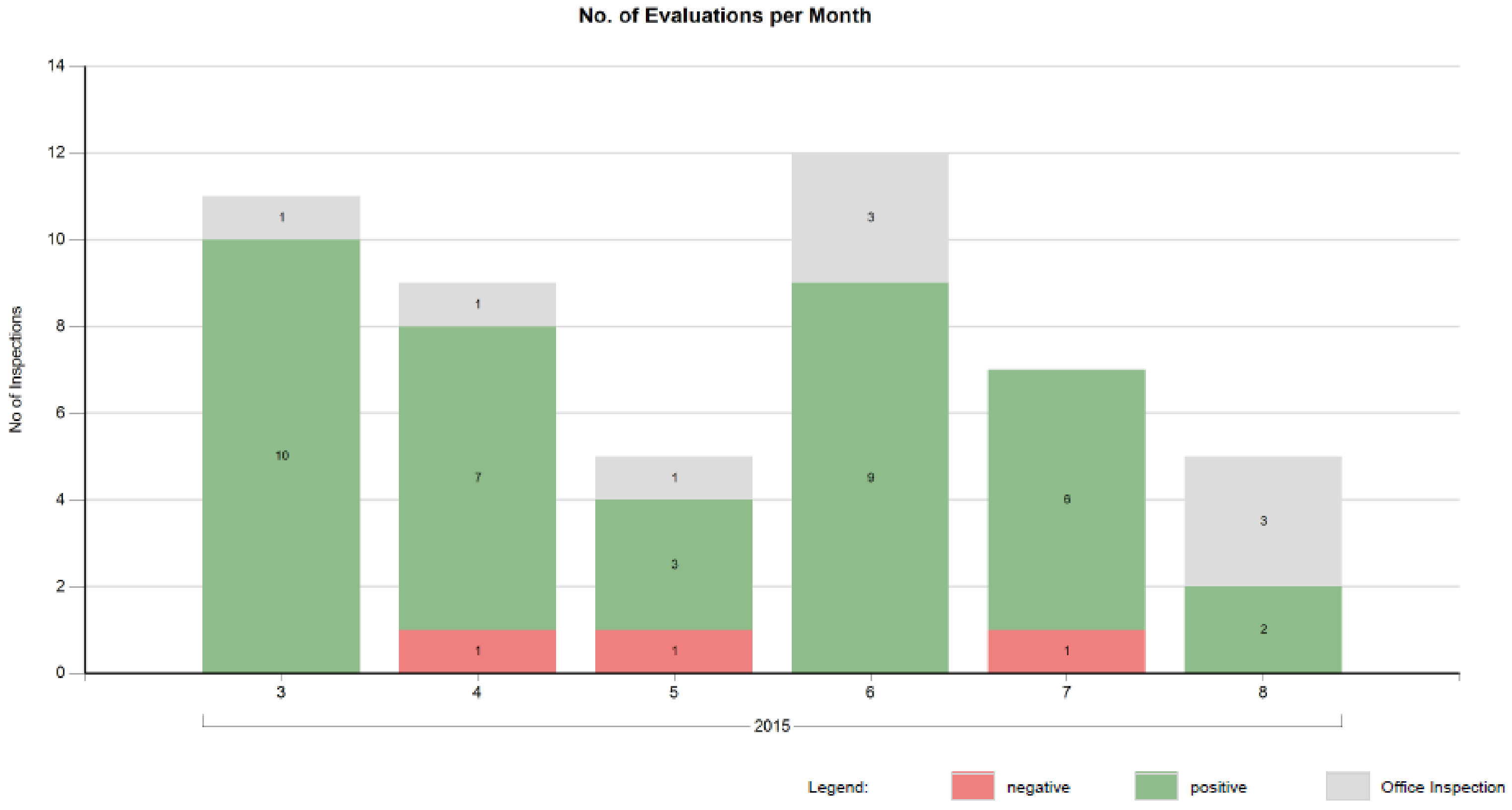


F- New QC Planning Reporting of QA/QC

QC STATISTICS
INSPECTIONS BETWEEN 26/02/2015 AND 27/08/2015

SANDVIK

INSPECTION EVALUATION



PRINTED ON 16/10/2015 BY SANDVIK\argwozd

Page 1 of 5

QC STATISTICS
INSPECTIONS BETWEEN 26/02/2015 AND 27/08/2015

SANDVIK

	2015							
Evaluation	Mar	Apr	May	Jun	Jul	Aug	**Total**	**Total**
Negative	0	1	1	0	1	0	**3**	**3**
Positive	10	7	3	9	6	2	**37**	**37**
Office Inspection	1	1	1	3	0	3	**9**	**9**
Total	**11**	**9**	**5**	**12**	**7**	**5**	**49**	**49**

PRINTED ON 16/10/2015 BY SANDVIK\argwozd

QC STATISTICS
INSPECTIONS BETWEEN 26/02/2015 AND 27/08/2015

SANDVIK

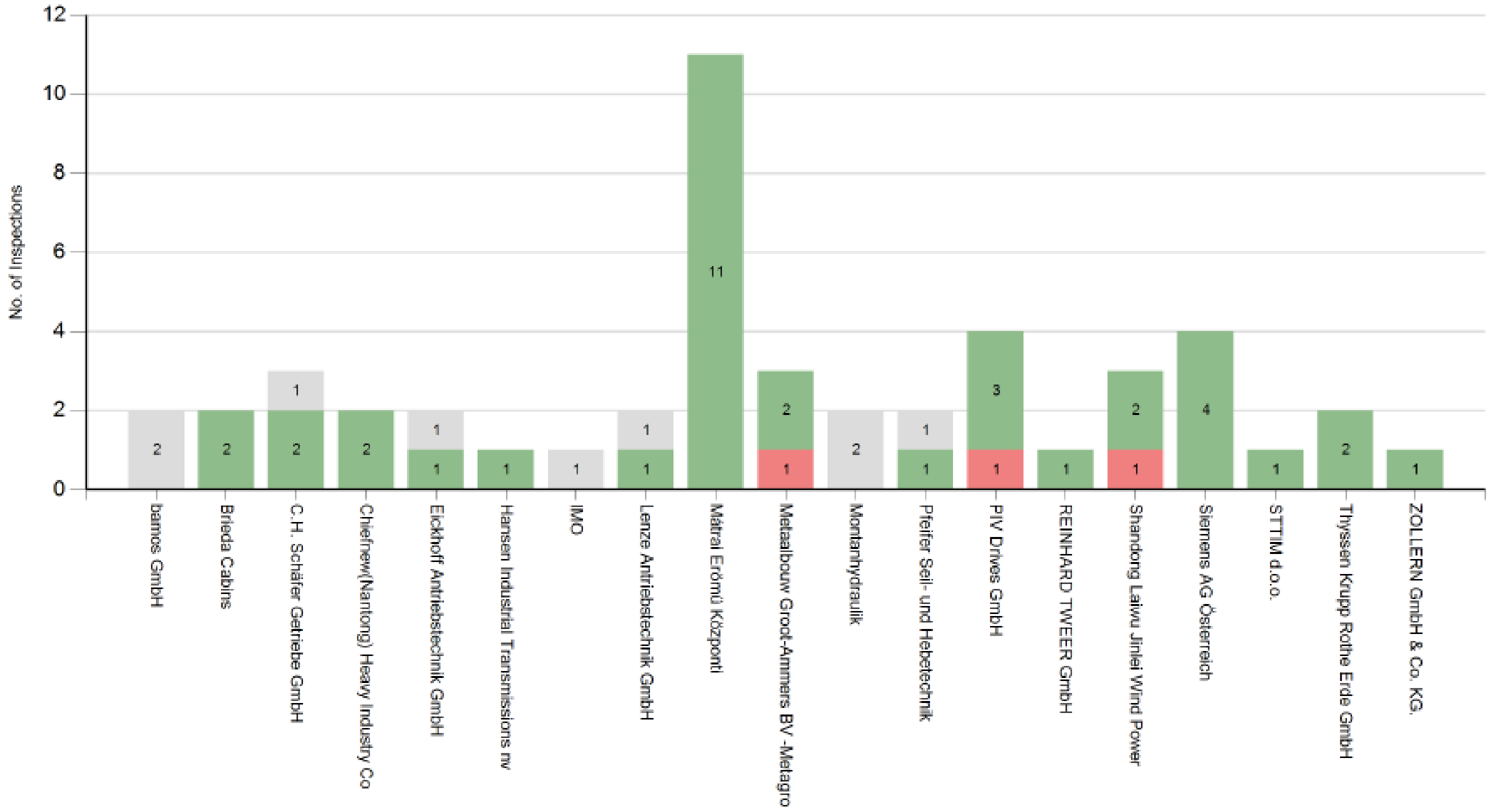
SUPPLIER EVALUATION

Supplier	Negative	Positive	Office Inspection	Average Rating
bamos GmbH	0	0	2	1
Brieda Cabins	0	2	0	1
C.H. Schäfer Getriebe GmbH	0	2	1	1.67
Chiefnew(Nantong) Heavy Industry Co	0	2	0	3
Eickhoff Antriebstechnik GmbH	0	1	1	1
Hansen Industrial Transmissions nv	0	1	0	2
IMO	0	0	1	1
Lenze Antriebstechnik GmbH	0	1	1	2
Mátrai Erömü Központi	0	11	0	1.73
Metaalbouw Groot-Ammers BV -Metagro	1	2	0	2.67
Montanhydraulik	0	0	2	1
Pfeifer Seil- und Hebetechnik	0	1	1	2
PIV Drives GmbH	1	3	0	2.5
REINHARD TWEER GmbH	0	1	0	1
Shandong Laiwu Jinlei Wind Power	1	2	0	2.67
Siemens AG Österreich	0	4	0	1.75
STTIM d.o.o.	0	1	0	1
Thyssen Krupp Rothe Erde GmbH	0	2	0	1.5
ZOLLERN GmbH & Co. KG.	0	1	0	1
Total	3	37	9	1.8

QC STATISTICS
INSPECTIONS BETWEEN 26/02/2015 AND 27/08/2015

SANDVIK

Supplier Ranking

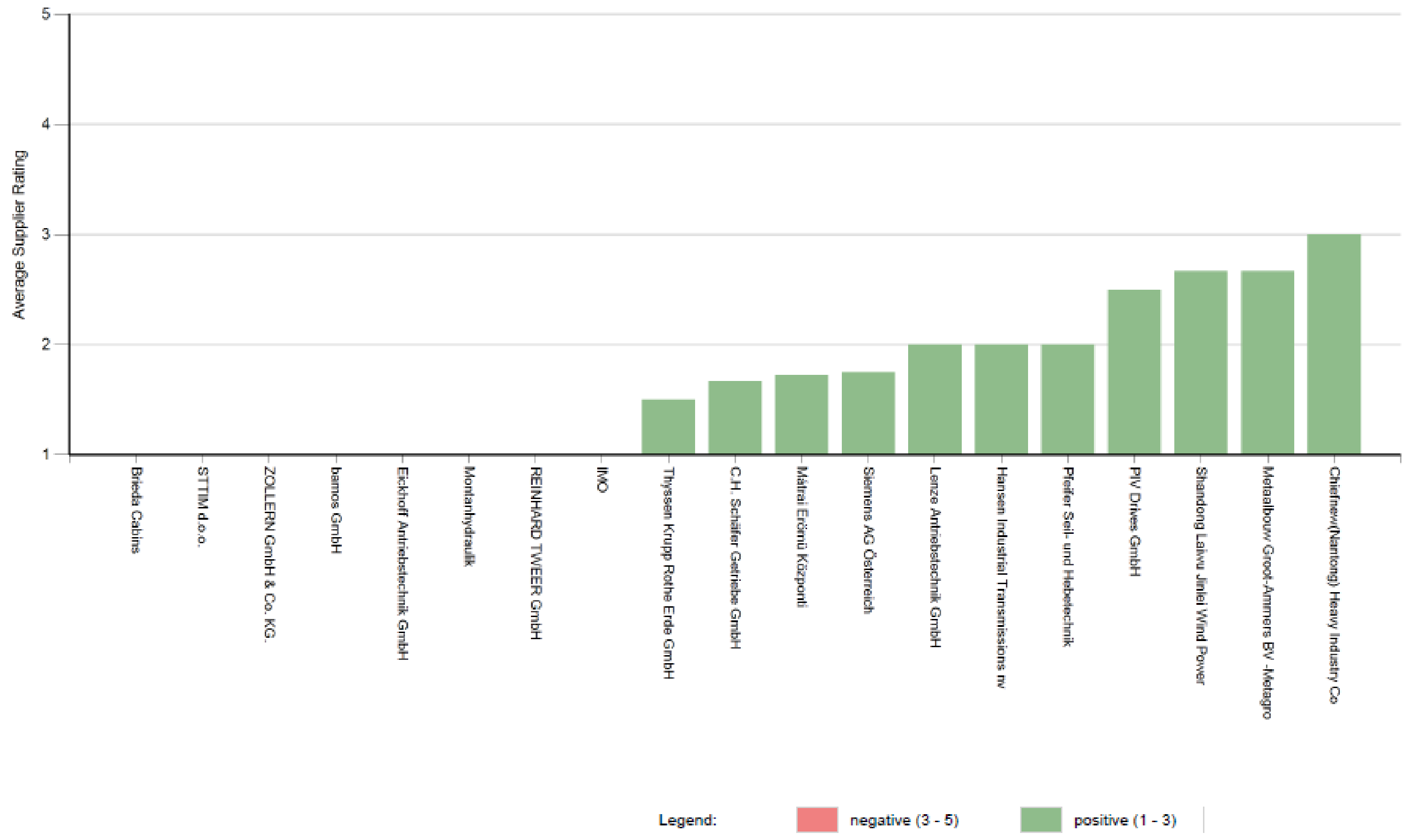


PRINTED ON 16/10/2015 BY SANDVIK\argwozd

Page 4 of 5

QC STATISTICS
INSPECTIONS BETWEEN 26/02/2015 AND 27/08/2015

SANDVIK



PRINTED ON 16/10/2015 BY SANDVIK\argwozd

Page 5 of 5

G- “F.QA.03_Quality release note for transport” dat. 20.04.2015

SANDVIK
Mining & Construction
Materials Handling

XX.XX.20XX

Supplier XXX
Sandvik Order No.: 0XX/70000XXXXX

QA/ QC- RELEASE NOTE OF MATERIAL FOR TRANSPORT

The items listed below are approved by Sandvik QA/ QC- Department and released for further transport activities.

If an inspection has been carried out at supplier, all non- conformances have been rectified by supplier in accordance with the inspection report dat. XX.XX.20XX and checked by QA/ QC.

Order Pos.	Quantity	Material description
	X of X	

The release is given in accordance with specifications and purchase order requirements.

The Release Note does not release the manufacturer / supplier from the response or his duty of warranty, just also not, when lacks were found after delivery, commissioning or within the warranty period.

SANDVIK Mining and Construction
Materials Handling GmbH & Co KG

QA/QC- Responsible

XXX

F.QA.31_Quality release note for transport 20.04.2015 1 of 1