BUSINESS PROCESS ANALYSIS OF AN OPTOELECTRONIC SECTOR COMPANY

Process modeling and analysis in a German SME

Constanze Charlotte Engelhardt

Work Project presented as partial requirement for obtaining the Master’s degree in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa
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by

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Project Work presented as partial requirement for obtaining the Master’s degree in Information Management, with a specialization in Information Systems and Technologies Management

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Finally, I would like to sincerely thank everyone who supported me unconditionally in completing this work project, because it is yours too.

To all, thank you.
ABSTRACT

Business Process Management (BPM) is applied in many enterprises and is well known for improving the competitiveness and sustainability of a business. However, in Small and Medium-sized Enterprises (SMEs) BPM practices are alarmingly low, despite of the potential positive impacts BPM yields. The problem is that SMEs often have limited resources, the absences of a cross-functional mind-set and a lack of strategic clarity. BPM reduces operational inefficiencies and supports innovative practices which are essential for success, if adopted as a management paradigm across the enterprise. This work project will analyze the current state of value-added business processes in a German high-tech SME, along with its problems and inefficiencies to create standardized models for business operations. Therefore, the goal of this work is to explore the potential of BPM and current technologies, based on the analysis of a company that operates as a high-tech enterprise in the optoelectronic sector.

KEYWORDS

BPM; Optimization; BPMN; Modeling; High-tech SME
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<tr>
<td>A</td>
<td>Accounting</td>
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<tr>
<td>ABC</td>
<td>Activity Based Costing</td>
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<td>ABM</td>
<td>Activity Based Management</td>
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<tr>
<td>ABPMP</td>
<td>Association of Business Process Management Professionals</td>
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<td>BPEL</td>
<td>Business Process Execution Language</td>
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<td>BPM</td>
<td>Business Process Management</td>
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<td>BPTrends</td>
<td>Business Process Trends</td>
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<td>BPMI</td>
<td>Business Process Initiative</td>
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<td>BPMN</td>
<td>Business Process Management Notation</td>
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<td>BPR</td>
<td>Business Process Reengineering</td>
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<td>C</td>
<td>Commercial</td>
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<td>CPS</td>
<td>Cyber-Physical Systems</td>
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<td>CPPS</td>
<td>Cyber-Physical Production Systems</td>
</tr>
<tr>
<td>D&amp;P</td>
<td>Development and Production</td>
</tr>
<tr>
<td>ERP</td>
<td>Enterprise Resource Planning</td>
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<tr>
<td>g.A.</td>
<td>General Accounting</td>
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<tr>
<td>IaaS</td>
<td>Infrastructure as a Service</td>
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<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
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<td>IoT</td>
<td>Internet of Things</td>
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<td>ITAR</td>
<td>International Traffic in Arms Regulations</td>
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<td>KPIs</td>
<td>Key Performance Indicators</td>
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<td>M&amp;D</td>
<td>Marketing and Distribution</td>
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<td>NT</td>
<td>Night Tronic</td>
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<td>OMG</td>
<td>Object Management Group</td>
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<td>RF</td>
<td>Radio Frequency</td>
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<td>RFID</td>
<td>Radio Frequency Identification</td>
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<tr>
<td>PaaS</td>
<td>Platform as a Service</td>
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<td>P&amp;L</td>
<td>Procurement and Logistics</td>
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<td>QMS</td>
<td>Quality Management System</td>
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<td>RMA</td>
<td>Return material authorization</td>
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<td>RPA</td>
<td>Robotic Process Automation</td>
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<tr>
<td>SaaS</td>
<td>Software as a Service</td>
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<tr>
<td>SME</td>
<td>Small and Medium-sized Enterprises</td>
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<td>TQM</td>
<td>Total Quality Management</td>
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<td>Wfm</td>
<td>Workflow Management</td>
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<td>WLANs</td>
<td>Wireless Local Area Network</td>
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<td>WMANs</td>
<td>Metropolitan Area Networks</td>
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<td>WPANs</td>
<td>Wireless Personal Area Networks</td>
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<td>WSN</td>
<td>Wireless Sensor Network</td>
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<td>WWANs</td>
<td>Wireless Wide Area Networks</td>
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<td>UML</td>
<td>Unified Modeling Language</td>
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1. INTRODUCTION

Nowadays, the turbulent environment is more demanding than ever before and organizations have always had to adapt to a changing world (Lankhorst & Matthijssen, 2016). In recent years, it has been noticed that enterprises are increasingly focusing on their business processes (Ho, Jin, & Dwivedi, 2009; Ko, Lee, & Wah Lee, 2009). Business processes are an asset of corporations which have direct impact on the attractiveness of products and services, as perceived by the market. Furthermore, business processes also determine tasks, jobs and responsibilities, as well as shaping the work of each employee. As a fact, processes determine the potential of an enterprise to adapt to new cases and to comply with fast growing number of legislative requirements. They affect the revenue potential as much as they shape the cost profile of an enterprise (Dumas, Mendling, La Rosa, & Reijers, 2012).

The important role of processes has been widely recognized, but an overall discipline promoting the importance of process as well as providing integrated Business Process Management (BPM) mythologies has been lacking for a long time. A major reason of this may be why process thinking is still not as common as cost awareness, or employee focus as well as ethical considerations (Vom Brocke & Rosemann, 2010). Furthermore, with the growth of a company, they spread their geographic presence to cover more regions across the world. Therefore, business processes become more complex, inefficient and expensive. There are many reasons, such as lack of visibility about processes, poor monitoring capabilities and others, which cause inefficiency along the processes (Ramaraju & Juturu, 2007). Although many organizations are involved in process initiatives, only a small number of companies follow a holistic approach and focus on the level of organizational processes (Neubauer, 2009).

1.1. CONTEXT

The company under study, namely IEA Mil-Optics is focusing their operations on their day-to-day business. In the current state, BPM is not practiced yet in the company and there are only a few processes documented. IEA Mil-Optics is a high-tech company, producing night vision products and acts as a supplier for military and law-enforcement. It is one of the leading companies in the sector of optoelectronics, characterized by high quality requirements for all products. Particular attention is paid towards new technologies, which are pursued through the continuous development of their own know-how system solutions. Due to the increased requirements in the field of security and the fight against global terrorism, the market is expected to grow strongly in the future (Löffler, 2017).

In this work project, the critical situation of several value-added business processes is analyzed by modeling respective existing processes. Processes are considered from purchasing through to sales of various products. After that, improvement opportunities are suggested for each business operation regarding the use of current technologies, to optimize the existing processes throughout the company. The main advantages for the company after the work project will be a better understanding of how the work is performed, as well as it is intended to convey a better understanding about the responsibilities and tasks of the individual employees. Further, value will be added to the transformation of processes to meet the objectives of the company.
1.2. Motivation

To be a competitive organization, an enterprise needs to assure that all processes that make up a common value chain are integrated and support each other (Harmon, 2007). According to O’Neill & Sohal (1999), enterprises need to align all functional areas to be accurately integrated. This refers to the importance of cross functional teams, where the value of BPM is recognized as a crucial source for competitive advantage. In recent years, many concepts have been created regarding BPM. Thereby, concepts as workflow management (Wfm) and business process reengineering (BPR) have been established. Nowadays, BPM is a topic which is increasingly moving into focus (Ko et al., 2009). Hammer (1990a) describes the role of BPM as crucial in creating sustainable competitive advantage and as establishment as a novel approach to the management of processes, with the aim of creating radical improvements in performance. In a more recent case study, Dave (2017) investigates a construction company using semi-structured interviews to study the processes of six departments. The study aims to demonstrate a need for a structured business process improvement while organizational processes are restructured. Thus, the study suggests that also small business units and its processes can affect the overall value chain in a major way. Therefore, stressing the importance of analyzing process interdependencies between organizational units (Dave, 2017).

In every industry sector, it is necessary to be a competitive organization to counteract the competition and to meet customer requirements. With emerging technologies, new or improved products will be offered on the market. Until now, IEA exists without worrying about clients, as the company increases its sales continuously. Therefore, only small changes as well as extensions of departments in the company were made. To meet the increased demand of the existing clients, it is planned to employ more workers. To be competitive in the future, it is indispensable to improve inefficient processes with the intention to successfully implement future enhancements and structural changes. To define a new process or transform those that already exist, the first step is to understand the current state of the company and the business (Weske, 2007). For achieving a better understanding of the business processes, the explicit representation is the core concept. If activities and their relationships are identified and represented by business process models, stakeholders can communicate these processes in an efficient and effective manner, and potentials for improving them can be developed.

At the beginning of this work project, the documented processes are analyzed, followed by a survey of the value-added processes through interviews with various employees of the company. Afterwards, the process modeling of several products is done with the intention to criticize them and proposing appropriate improvements. The main advantages for the company is a better understanding of the performed operations and their relationships within the company. Another advantage is a better understanding of the responsibilities and task of each individual employee. Furthermore, cost, time and the need of resources of the performed operations can be reduced after the optimization of the existing processes. Further advantages and benefits of this work project for the company are: growth of productivity, interdepartmental communication and coordination enhancement, increased efficiency and quality, improved service, higher seed in process execution, monitoring of results and identification of inefficiencies. According the Association of Business Process Management Professionals (ABPMP, 2009), it is important to understand the maturity of the organization in process management, which will help to define the level of analysis preparation needed.
Therefore, ABPMP (2013) defines process maturity as an trait and capability that defines the current state of the enterprise’s move to understand and manage processes. Assessments can be useful for establishing a baseline of existing capabilities and to align the organization on the current state. Furthermore, they are also useful to identify and address any gaps. The framework from Forrester Research Process divides Process Maturity into five levels, as following:

0. - Nonexist: Not understood, not formalized and need is not recognized.
1. - Ad hoc: Occasional, not consistent, not planned and disorganized.
2. - Repeatable: Intuitive, documented, understood and occurs as needed.
3. - Defined: Documented, predictable, evaluated, occasionally and understood.
4. - Measured: Well-managed, formal, often automated and evaluated frequently.
5. - Optimized: Continuous and effective, integrated, proactive and usually automated.

The company under study is still in an early stage of maturity, namely the level of repeatable. Therefore, the position of the company in this process journey, can help properly set performance measurement capability expectations and shows a clear road to improve monitoring, measurement, and reporting (ABPMP, 2013).

1.3. Objectives

Considering the problems identified previously, the focus of this work project is placed on the modeling and analysis of several value-added business processes for the company, along with its problems and inefficiencies to create standardized models for internal business operations. Therefore, the goal of this work is to analyze the existing processes in different departments and to provide proposals for improvements. This is done with various products along the value chain from purchasing to sales, in different departments such as procurement, logistics, production and workshop. Following, an evolutionary approach as well as using an BPM approach and current technologies, improvements opportunities are suggested and if correctly implemented, costs, time and resources can be reduced, as well as improvements of operational excellence.

To achieve this goal, further specific objectives are:

1. Literature review to apply the best improvements;
2. Collecting and studying of existing documented processes;
3. Identifying and definition of key processes in the company which should be analyzed;
4. Survey of the identified processes in the company;
5. Modeling of the defined processes with BPMN 2.0;
6. Critical analysis and proposals for improvements of the defined processes;
7. Further work, transformation of value-added processes based on the analysis presented in the project that best fits the business objectives.
2. WORK PLAN

The following chapter presents the project phases to reach the objectives, as well as the used tool. Furthermore, the schedule for the work project is introduced.

2.1. PROJECT PHASES

Figure 2.1 presents the four fundamental stages of the project. The detailed description of each stage follows the figure.

![Figure 2.1- Project Phases](Image)

To achieve the main goal, the following specific objectives should be attained:

- Goal settings

To achieve the goal, the project begins with an analysis of the current company situation, in terms of business processes. In this first phase, value-added processes in different departments with various products are identified for the later proposed improvements. After that, key processes are defined for modeling and analysis of business processes. Existing business processes documents are studied and used as a starting point for the later modeling.

- Literature review

In the second phase, a literature review which introduces the most important theoretical background of BPM is conducted, to understand the relevance of the topic as well as to anticipate the main difficulties that may arise during the project. The literature review helps to find the best way to apply process improvement to suit the most appropriate BPM framework for the company. The research is necessary for the correct modeling of business processes with critical success factors. The presented improvements and recent trends in manufacturing are used to guide the proposed improvements.

- Survey and modeling of processes

Value-added processes of the company are modeled using business process modeling notation (BPMN) and the Bizagi Process Modeler. One of the main problem in the company is that they have no graphical representation of any processes. They only have several documented processes, written in several Word documents or PowerPoint slides as bullet points. However, because of some new guidelines and additional processes, it’s been decided to make a new survey of respective processes. For this work project, various methods for gathering information are used. The first method is the observation of daily business operations, which is done with responsible employees of defined processes. By this, day by day observation prompted several insights, leading to the next methods: Interviews and workshops with respective employees.
The information gathered from these interviews is used for modeling, as well as analyzing the problems and inefficiencies which are identified throughout the company.

- Analysis of processes and proposals for improvement

In this phase, the critical situation is analyzed and opportunities for improvement are proposed under the BPM approach and current technologies. Based on the analysis, inefficiencies, redundant activities, inconsistent information and processes which aren’t measured, controlled or are too time consuming, are revealed.

2.2. TOOLS / RESOURCES

According to Davis & Brabänder (2007), BPM is described as a structured management approach that uses management practices, policies, methods, metrics and software tools. BPM aims to organize all aspects of the design, specification, implementation, operation, measurement, analyzes and optimization of business processes to effectively and efficiently reach business objectives.

A number of process modeling tools were evaluated, including Bizagi Process Modeler, ARIS Express, BPMN.io., Modelio, Camunda and ADONIS:Community Edition. The chosen tool for this work project is Bizagi Modeler 3.1. Bizagi. BPM Suite contains a total of three sub-tools: Bizagi Modeler (design process maps) Bizagi Studio (build process apps), and Bizagi Engine (run Bizagi enterprise-wide). The Bizagi Modeler suits all necessary requirements for this project. It is a free business process modeling and documentation tool, enabling visual design, document and the simulation of business processes in an easy way by using BPMN (Business Process Model and Notation). It enhances productivity, efficiency and promotes sustainable growth over the long term. Furthermore, BPMN models can be extended to BPEL (Business Process Execution Language) to automate processes (Bizagi, 2014).

The main benefits of Bizagi Process Modeler are (Bizagi, 2014):

- Easy to use, no programming skills required. Innovative interface due drag and drop;
- Free;
- Documents can be exported into different formats, such as Word, PDF, Web pages, Share Point or Wiki;
- The tool is based on BPMN notation;
- Bizagi supports the service for Modeler Collaboration.
2.3. CHRONOGRAM

Table 2.1 describes the schedule of the work project.

<table>
<thead>
<tr>
<th>Section</th>
<th>2017</th>
<th>2018</th>
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<tr>
<td></td>
<td>Aug</td>
<td>Sep</td>
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<tr>
<td>1. Introduction</td>
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<td>Definition of objectives and motivation of the project</td>
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<td>Problem definition</td>
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<td>2. Literature review</td>
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<td>3. Interviews and collection of existing flowcharts</td>
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<td>4. Survey of value-added processes to model</td>
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<td>5. Process modeling of defined processes</td>
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<td>6. Critical review of processes and improvements</td>
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<td>7. Results and discussion</td>
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<td>8. Conclusion</td>
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<td>9. Update of literature review</td>
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<td>Supervisors Review</td>
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Table 2.1- Chronogram

Source: Own drawing

Milestones:

1. Delivery of proposal for Project Work;
2. Information for modeling received;
3. Process modeling and critical review finished;
4. Preliminary report;
5. Project Work report finished.
3. LITERATURE REVIEW

This chapter presents the necessary concepts for the development of the work project. It starts with the exploring of the BPM standards and related fields, such as BPM life cycle and BPMN as well as a brief description of the optoelectronic sector. Furthermore, recent developments and future trends in manufacturing are elaborated.

3.1. BUSINESS PROCESS MANAGEMENT

3.1.1. Concepts

Processes are existing everywhere and in every organization as in governmental, non-profit organization, or enterprises, where a number of processes have to be managed (Dumas et al., 2012). The actual process improvement methods affiliate their roots back to the work done by (Porter, 1985) on value chains, Hammer (1990a) work on business process reengineering (BPR) and Davenport & Short (1990) work on information technology and business process redesign. The latter two works address the integration of technological innovation within business processes and are trying to align business strategies with changing technological trends (Dave, 2017). The development of process-oriented thinking arises from the development of Total Quality Management (TQM) at Toyota and other Japanese manufacturing companies (Deming, 1982), as well as the improvement technique “Lean Thinking” (Dave, 2017). (Ohno, 1982) was the pioneer of “Lean Thinking”, he identified seven different waste categories within the production process and proposed that these should be eliminated or optimized to improve process efficiency (Dave, 2017). Recently, TQM processed into the process optimization strategies of Six-Sigma and Lean Manufacturing (Ho et al., 2009).

The business process reengineering (BPR) movement began in 1990 with the publications of two papers: Michael Hammer’s “Reengineering Work: Don’t Automate, Obliterate” and Thomas Davenport and James Short’s “The New Industrial Engineering: Information Technology and Business Process Redesign” (Davenport & Short, 1990; Hammer, 1990). Theorists like Hammer, Champy, and Davenport emphasize that companies need to think in terms of comprehensive processes, which is similar to Porter’s value chain (Harmon, 2007). Hammer & Champy (1993) defined BPR as a fundamental rethink and radical redesign of business processes to generate improvements in critical performance measures, such as cost, quality, service and speed. Moreover, managing business processes is also influenced by information technology (IT) which can be retraced to Hammer, stating that organizations should “reengineer” their business with the use of modern information technology to radically redesign their business processes in order to achieve dramatic improvements in their performance (Hammer, 1990). BPR and BPM must be distinguished. Whereas the former refers to the radical reconstruction of existing business processes, the latter is more iterative, incremental and practical related in fine-tuning business processes (Ko et al., 2009). Kohlbacher (2010) describes the difference between BPR and BPM as follows: BPR is a single project concerned with the radical redesign of business processes, whereas BPM refers to the ongoing management and optimization of an organization based on its business processes. Among the various definitions of an process, a classic definition is given by ABPMP (2009), defining a process as a set of activities or behaviors performed by humans or machines for achieving a goal, or for solving a specific problem.
Dumas et al. (2012) describes a business process as a collection of inter-related activities, events and decision points which include several actors and objects, and lead to an outcome with value at least for one customer. This definition is related to ABPMP (2009), which defines a business process as an “end-to-end” job, going beyond functional limits and crossing any functional boundaries to generate value for the client. In a further notion, BPM does not only covers the representation of business processes, but also additional activities which contain concepts, methods and techniques to support the design, administration, configuration, enactment, and analysis (Weske, 2007). Furthermore, BPM is described as structured approach that is made in an organization to continuously analyze and improve fundamental activities such as manufacturing, marketing, communications and other key elements of a company’s operations (Zairi, 1997).

The ABPMP (2013) views BPM as a management discipline that treats business processes as assets. Because of this, organizational goals can be achieved through the definition, engineering, control and commitment to the continuous improvement of business processes. BPM integrates IT and business process expertise with the aim of transforming isolated business efforts into integrated and measurable cross-functional activities, in order to deliver operational and strategic competitive advantage (Lederer Antonucci & Goeke, 2011). The principal idea in BPM is to optimize an organization’s business process by eliminating activities that do not add value and to improve process fluency within the limits of organizational functions (Kujansivu & Lönnqvist, 2008), in an efficient and effective manner (Lederer Antonucci & Goeke, 2011). According to Peppard (2000), different departments in an organization still operate as silos and as a result horizontal end-to-end customer processes are still not well understood or defined throughout the whole company. Companies should embrace change, it is one of the means for handling the challenge of improving the company’s business processes for optimizing performance and enhance competitive advantage (Trkman, 2010).

Silvestro & Westley (2002) have determined the process of two UK-based companies. One was the division of a large multi-national electronics company, and the other a major retail organization. Because of the BPR, the companies could achieve increased market responsiveness, better collaboration between functions and alignment of organizational objectives. However, there were also some disadvantages of the BPR initiatives. They identified a duplication of functional expertise and increased operational complexity, resulting in an escalation of cost, the emergence of horizontal silos. In addition, there are inconsistencies in the execution of functional decisions between processes and general erosion of the efficiency of the operations network (Silvestro & Westley, 2002). According to these limitations, the adoption of BPM alone will not bring any contribution to either their operational or strategic goals of an organization. Moreover, BPM can help in the execution of a strategic program by enabling a better match between the organizational strategy and the their business processes (Trkman, 2010). In fact, BPM inherits from the continuous improvement philosophy of Total Quality Management (TQM), as well as other principles and techniques such as operational management, Lean and Six Sigma. BPM combines the named philosophies with the capability offered by modern IT, hence to an optimal alignment with business processes and the performance objectives of an organization (Dumas et al., 2012).
3.1.2. BPM Life Cycle

As Dumas et al. (2012) defined BPM, “as a body of methods, techniques and tools to discover, analyze, redesign, execute and monitor business processes” (Dumas et al., 2012, p. 5). They reflect this definition as the fact that business processes are the focal point of BPM, which involves different phases and activities in the lifecycle of business processes. In the literature, there are several BPM lifecycles models available which are different from the one proposed by ABPMP (2009). The BPM lifecycle by ABPMP (2009) is structured in six steps and establishes those activities that comprise managerial practice in BPM. These six steps include: planning, analysis, design and modeling, implementation, monitoring and control as well as refinement. The lifecycle model proposed by Dumas et al. (2012), views BPM as a continuous cycle comprising with the following phases (see fig. 3.1). This lifecycle is best suited to develop the work project, because of the more detailed steps. The phases of the lifecycle are described in the following section.

![BPM Lifecycle](image)

**Process identification**

In the first phase of the BPM lifecycle, a business problem arises, and other relevant processes related to the problem are identified, delimited and linked. The result of these phase is a new or updated process architecture, which provides a global understanding of processes at the organization and its relations. Depending on the case, the identification of processes can be done in parallel with performance measure identification.
Process discovery

In the second phase (“AS-IS” process modeling), documentation is done of the current state of each relevant processes. This can be done in the form of one or more “AS-IS” process models.

Process analysis

In the third phase, the identification and documentation of problems associated with the “AS-IS” processes takes place, and when possible quantified using performance measures. The result is a structured collection of issues, which are normally prioritized according to their impact, and occasionally also in terms the estimated effort required to resolve them.

Process redesign

In the phase of the process redesign (process improvement), process changes are identified. These can help solve the identified issues in the previous phase and enable the organization to meet the performance objectives. The basis for the next phase is given through the result of this phase with the “TO-BE” process model.

Process implementation

In this phase, the preparation and execution are done with the required changes to move from the “AS-IS” process to the “TO-BE” process. This phase comprises two aspects which are organizational change management and process automation. The former one is related to a set of activities required to change the way of working with all participants who are involved in the process. Process automation is the development and deployment of IT systems or enhanced versions of existing IT systems, that supports the “TO-BE” process.

Process monitoring and controlling

When the redesigned process is running, the next phase is to collect and analysis of data to determine the level of success of the process performance, to meet the performance measures and performance objectives. Once inefficiencies, discrepancies, barriers and errors have been identified, corrections are initiated. If new issues arise, it will trigger a repeated life cycle of the BPM process.

3.1.3. Process Architecture

In the phase of process identification it is necessary to define the set of business processes and to establish a clear criteria for prioritizing them (Dumas et al., 2012). The process architecture, which represents the business processes and their interrelations is the output of the process identification. There are different criteria which can be taken into consideration for determining which chain of operations is forming an independent business process and which ones are part of another process. Accordingly, there are several sights on categorizing a business processes. The value chain model from Porter is one of the most influential ones, which distinguishes two categories of processes: core processes (primary activities) and support processes (support activities). Core processes include the essential value creation of an organization such as production of goods and services for which customers pay.
Furthermore, it covers inbound logistics, operations, outbound logistics, marketing and sales, and services. Support processes are necessary in order to facilitate the execution of the primary processes. This comprise infrastructure, human resources, technology development, and procurements. This set of two categories can be extended by a third one which is the management process. Therefore, from a strategic point of view, primary, support, and management processes should be distinguished. There are several approaches for defining a process architecture in literature. The approaches developed by Dijkman leads to a process architecture on level one along two dimensions: case types and business functions. A case type classifies the types of cases that are handled in an organization such as products or services that is delivered to a customer. A function classifies the function of an organization, in other words something that on organization does. They consist of one or more sub-functions (Dumas et al., 2012). In order to be a competitive organization, it is necessary to assure that all processes that make up a common value chain are integrated and support each other (Harmon, 2007).

### 3.1.4. Process modeling

Various organization have realized the importance of process modeling, but there are still organization who have concerns regarding time and effort in developing and maintaining process models (Ramaraju & Juturu, 2007). In 2005 the BP Trends (Business Process Trends) conducted the first market survey “The State of the BPM Market”, whereas the sixth and latest one was published in 2015 with a response of over 100 respondents throughout the world (Harmon & Wolf, 2016). The answers to the question (see table 3.1) “Are business processes documented and kept up to date?” of 2005 and 2015 are similar. Most organization “Occasionally” keep their process documented. The level of “Most Times” were indicated with 14% in 2015, which is a lower value compared to 2005 with 23%.

<table>
<thead>
<tr>
<th>Are business processes documented and kept up to date? Please indicate your organization’s overall level of performance.</th>
<th>2005</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never (0%)</td>
<td></td>
<td>4%</td>
</tr>
<tr>
<td>Occasionally (1-30%)</td>
<td>46%</td>
<td>50%</td>
</tr>
<tr>
<td>Frequently (31-60%)</td>
<td>24%</td>
<td>29%</td>
</tr>
<tr>
<td>Most Times (61-99%)</td>
<td>23%</td>
<td>14%</td>
</tr>
<tr>
<td>Always (100%)</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>97%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3.1 - Work process documented, and documentation is kept up to date.

Source: (Harmon & Wolf, 2016, p. 4)

At various stages of the BPM lifecycle, business process models are crucial. There are many reasons why to model a process, such as a simple understanding of the process as well as the sharing of our understanding of the process with the people who are involved (Dumas et al., 2012).
In 1946, flow diagrams were one of the first approaches to visualize a business process, developed by Goldstine and Neumann (Rosemann, 2006). Historically, there is a broad variety of different diagramming notations available for describing a process. One of the first notations was introduced by Geary Rummler and Alan Brache in their popular book, “Improving Performance” in 1990. The notation was called “Rummler-Brache” notation and further formalized in the IBM notation called “LOVEM”. Some of the Rummler-Brache concepts were linked into the Object Management Group’s UML Activity Diagrams. In 2004, a new notation was created, the “Business Process Modeling Notation” (BPMN), through the Business Process Initiative (BPMI) group who brought most of the major business process modeling tools vendors together (Harmon, 2007).

According to ABPMP (2009), process modeling includes a set of skills and processes that provide insights and understanding and enable analysis, design and performance measurements. Furthermore, an end-to-end perspective of organizations primary, supporting and management processes are provided (ABPMP, 2009). The model of a process enables an organization to analyze all relationships between their products, processes, people and systems, and helps to fight complexity. Question can be answered such as how different parts are connected, who is responsible for what and what are the essential business processes, as well as what is redundant (Lankhorst & Matthijssen, 2016). Rosemann (2006) mentioned two complexity drivers of a process model, modeling complexity and process complexity. The first one refers to the way process modeling is approached and the second one to the complexity of the process itself. Thereby, a process model can be seen as a mirror, which reflects it and allows a deeper focus on the elements of interest (Rosemann, 2006). A process model contains icons that represent workflow, data flow, events, decisions, gateways and other elements of the process itself (ABPMP, 2013). Multiple perspectives, notation and diagrams are enabled through a business process model (Burlton, 2014). A brief description of the icons is given in section 3.1.8.

### 3.1.5. Modeling of the current state „AS-IS“ and future state “TO-BE”

When it’s time to analyze a specific business process, it usually begins with an analysis of what is currently being done. This is referred to the process diagram that documents the existing process as the “AS-IS” process diagram (Harmon, 2007). To assess the current state, this involves sessions, workshops, and interviews with the concerned subject matter experts, people who own the process as well as the ones who execute and use the process. When process documentation already exists, it is suitable to use it as a starting point for discussion, as well as organizations brochures which can also be utilized for providing insight into the organizational processes (Sharma, 2015). To capture more information for process modeling, there are several different ways as direct observation, one-on-one interviews, structured workshops, web conferencing or written feedback (ABPMP, 2009).

According to ABPMP (2013), the current state “AS-IS” is mentioned in the stage of process discovery where the understanding of the current situation of the company cannot be omitted. These understanding includes the complex network of the company with customers, suppliers, collaborative partners, workers, rules, financial history, market and more. In order to guide the evolution of the company, the current state is critical in designing an implementable change or change roadmap (ABPMP, 2013).
After the understanding of what is currently being done, alternative workflows can be generated and compared with the current one. The first speculative alternative diagrams are called “COULD-BE” process diagrams and finally the new generated process is called “TO-BE” diagram (Harmon, 2007). The “TO-BE” process diagram is the main output of the process redesign phase, because it addresses the identified issues in the “AS-IS” process diagram (Dumas et al., 2012).

3.1.6. Performance measurement

When it’s time to analyze a business process there is no single way to do that. In the beginning of the analysis topics, methods and tools are all dependent on the nature of the process and the available information (ABPMP, 2013). For an successful organizational change, which do not always require an radical change, an effective formulation of process alternatives is needed including evaluations, and implementation of the selected processes (S. Lee & Ahn, 2008). According to ABPMP (2009), “if you can’t measure it, you can’t manage it” (ABPMP, 2009, p. 103), this statement expresses the importance, that an organization should not invest time and resources to improve a process if they do not know what they have to measure to improve. The manager’s awareness of the necessity to design and control a company from a process-oriented perspective increases. As a result, the company should be strictly aligned to the requirements of the customers (Leyer, Heckl, & Moormann, 2015). In the literature, several process performance dimensions can be found. Dumas et al. (2012) mention four process performance dimensions which are: time, cost and quality as well as a fourth dimension which gets involved in the equation once the issue of change has to be considered, which is called flexibility. These performance dimensions can be refined into several process performance measures called key performance indicators (KPIs). According to ABPMP (2009), they mentioned four fundamental process performance metrics which are: time, cost, capacity and quality. There are other metrics, such as efficiency and effectiveness, which are usually a function of one or more of the four fundamental metrics.

**Time** - is a measurement of process duration, which measures the time it takes between the beginning and end of the process;

**Cost** – is a metric of monetary value associated with a process, which include two types, resource and opportunity cost. Resource cost is needed to complete a process, measures the monetary value which is associated with the recourse (human or otherwise). Opportunity cost is the value which is escaped form the process by not getting the resultant output of the process;

**Capacity** – is an amount or volume of an output associated with a process;

**Quality** – is generally used to measure in percentage terms, it expressed the value of the real in relation to optimal maximum in terms of process, that can be presented by satisfaction, variation, and error or rate of defect.

According the effective metrics, there are usually referred to as KPIs with 12 characteristics, which are (ABPMP, 2009):

1. Alignment with corporate strategies and objectives;
2. An owner, which can be an individual or group who is responsible for the accountability of the outcome;
3. Predictive, measurement of the value of business drivers and are leading indicators of desired performance;

4. Actionable, and timely provided information on how users can intervene to improve performance;

5. Users focusing on a few high value activities, or on the overall effectiveness of the process;

6. Straight, easy to understand and not based on complex indexes that managers don’t know how to influence directly;

7. Balanced and linked to what is being measured and not compete and confuse;

8. Transformative, which encourages positive changes in the organization;

9. Standardized, which guaranties more effective measurements, including standard definitions, rules and calculations;

10. Context-driven performance by applying goals and limits so that users can measure their progress over time;

11. Reinforced, can be enhanced by including compensation or incentives;

12. Relevant, the need of a periodically review and update due the gradually loss of their impact over time.

To measure a process there are two methods which can be used: manual, where data is collected manually, or through an automated method using of sophisticated software including BPM suits. If the date is collected manually it can be placed in a spreadsheet or modeling tool, or even drawn on paper. ABPMP (2009) mentioned four process performance management critical success factors which are:

1. Focusing on both people and process;

2. Ensure the understanding of the entire process;

3. Ensure the understanding of how the process is tied to operational performance metrics for the organization and align compensation to it;

4. Ensure that those who design and approve the activities are the same people who do the activities.

To sum it up, in order to improve a given business process it is necessary to analyze the process performance in-depth. Criteria to determine process performance such as indicators, measures, and figures must be defined beforehand. It is a challenge to select the “right” criteria, due the fact that there is no agreement in theory or practices on how to do this best (Leyer et al., 2015).
3.1.7. Transformation

According to ABPMP (2009), they define the process transformation as a planned evolution of business processes using a well-defined mythology and disciplined approach to ensure that a business process continues to meet business objectives. Depending on the level of maturity in an appropriate manner and timeline, the organization will adopt various methods to monitor and respond to these factors to solve individual situations. Regarding the purpose of transformation, Sharma (2015) defines several tools and techniques which can be used to gain an understanding of the current status, and to define and design new ways of working to achieve breakthrough results. Some of the tools and techniques are: process analysis, productivity analysis, customer analysis, functional analysis, business process modeling, value stream mapping, best practice analysis, competitive analysis, market trends, lesson learning log, life-cycle analysis, organization analysis, performance metrics, financial metrics, investment analysis, quality tools, data analysis, and cost analytics. In the literature, there are many tools and methodologies available.

Neubauer (2009) mentioned the following as process management methods: Balanced Scorecard, benchmarking, TQM, Six Sigma, value-oriented management, and Lean Management. ABPMP (2009) mentions several familiar improvements methodologies which are Six Sigma, Lean, TQM, activity based costing and activity based management, as well as performance improvement models. In the survey of BPTrends, they also investigate a question related to process improvement programs in organizations which was “Are process improvement programs in place to identify and improve problems and defect?” (Harmon & Wolf, 2016, p. 20) (see table 3.2). They mentioned two process improvements programs, (1) process redesign which results in a project team undertaking a major effort to fix broken or deficient processes or (2) to generate new, more effective processes and continuous process improvement that incrementally improves existing processes. In 2015 most organization are “Occasionally” involved in process improvement, compared to 2005 fewer organization are doing it “Frequently” (Harmon & Wolf, 2016).

<table>
<thead>
<tr>
<th>Are process improvement programs in place to identify and improve problems and defect? Please indicate your organization’s overall level of performance.</th>
<th>2005</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never (0%)</td>
<td>13%</td>
<td>12%</td>
</tr>
<tr>
<td>Occasionally (1-30%)</td>
<td>33%</td>
<td>54%</td>
</tr>
<tr>
<td>Frequently (31-60%)</td>
<td>34%</td>
<td>18%</td>
</tr>
<tr>
<td>Most Times (61-99%)</td>
<td>16%</td>
<td>13%</td>
</tr>
<tr>
<td>Always (100%)</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3.2 - Are process improvement programs in place?

Source: (Harmon & Wolf, 2016, p. 20)
According to APBPM (2009), the following improvement methodologies are described in more detail.

**Six Sigma**

The Six Sigma approach was developed by Motorola in 1996 (Neubauer, 2009) and is a specific measure of quality, used to improve quality and to reduce costs (Hammer, 2002). Furthermore, it is a disciplined, data-driven approach and methodology for eliminating defects based on statistical data from manufacturing to transactional and from product to service with the use of six standard deviations between the mean and the nearest specification limit (ABPMP, 2009). Furthermore, Six Sigma can be characterized not only as an statistical measure, but also as an goal that reaches near perfection for performance improvement and as an management system to achieve lasting business leadership and world-class performance (Pande & Holpp, 2002). From the statistical view, it describes how a process is performing and in order to achieve Six Sigma, a process must not produce more than 3.4 defects per million opportunities. A defect is defined as anything outside of customer specification and an opportunity as the total quality of chances for a defect. This can be easily calculated using a Six Sigma calculator (ABPMP, 2009).

**Lean**

The origin of Lean philosophy is Toyota and focuses on the reduction of seven wastes: overproduction, waiting-time, transportation, processing, inventory, motion and scrap (ABPMP, 2009). Moreover, Lean involves both process redesign and improvement, as well as it concerns the enterprise (Flow Kaizen) and process level (Process Kaizen). Flow kaizen focuses on improving the flow of the high-level value stream, whereas the elimination of waste is related with process kaizen (Harmon, 2007). According to ABPMP (2009), organization should develop and review checklists to review product designs. In addition, “Lean Thinking” has been practiced in government and commercial, manufacturing and service sectors. It is about getting the right things, to the right place, at the right time, in the right quality while minimizing waste as well as being flexible and open to change.

The key Lean principles are:

- Perfect first-time quality: zero defect detection, revelation and clarification problems at the source;
- Waste minimization: eliminating non-value-adding activities and safety nets, maximize use of scarce resources (people, capital, and land);
- Continuous improvement: cost reduction, quality improvement, production enhancement and share of information;
- Pull processing: products and services are requested by the final consumer and not pushed from the production end;
- Flexibility: production of different mixes or greater diversity of products quickly, without sacrificing efficiency at lower volumes of production;
Building and maintaining a long-term relationship sharing suppliers through collaborative sharing of risks, costs as well as information sharing arrangements.

TQM

TQM focuses on continuously improving and sustaining the quality of products and in its extension also of services (Dumas et al., 2012), to meet or exceed customer requirements (ABPMP, 2009). Furthermore, it focuses on process measurement and controls as a mean of continuous improvement. In TQM, statistical analysis is used to identify defect and monitor process behavior as well as opportunities for improvement.

Activity Based Costing and Activity Based Management

The methodology of Activity Based Costing (ABC) is used to measure costs and performance of cost objects, activities and resources (ABPMP, 2009). In this case, activities are consumed by cost objects and resources are consumed by activities. Resource cost are assigned with activities while these are based on their use of those resources. The reassignment of cost objects (outputs) are caused by activity costs. This methodology incorporates casual relationships between cost objects and activities between activities and resources. According to Dumas et al. (2012), the concept of ABC is used to assign indirect cost to products and services, and to individual customers. In other words, human resources and machinery are often shared by different product and services, and they are used to serve different customers. The discipline of Activity Based Management (ABM) is focusing on the management of activities within business processes as the route to continuously improve both the value received by customers and the profit earned in providing that value. These discipline uses ABC and performance measurements in order to influence management actions (ABPMP, 2009).

Performance improvement model

In the mid-1990s, the Rummler-Brache methodology became the most widely used, systematic business process methodology. Rummler and Brache developed a framework, that shows a single diagram, where everything is related to everything else (Harmon, 2007). Based on human performance improvement, it can be used to understand the alignment of the human resource central to the performance of one or more value chains (ABPMP, 2009). The framework is segmented in three levels of performance: (1) an organizational level, (2) a process level, and (3) a job or performer level. They also introduce a matrix that crosses their three levels with three different perspectives, which are: goals and measures, design and implementation issues, and management. The aim of the Rummler-Brache methodology is to help organizations who are involved in business process change to understand the scope of the problem and it provides the foundation on which all of today’s comprehensive process redesign methodologies are based (Harmon, 2007).

3.1.8. Business Process Model and Notation (BPMN)

A well suited way to express orderings between activities of a business process are graphical notations (Weske, 2007). In the literature, there are several process modeling approaches available. However for this work project, Business Process Model and Notation (BPMN) (Object Management Group (OMG), 2011; White, 2004) was selected because of the ease with which it can illustrate business processes and accessibility to non-experts, as well as the BPMN models can be enhanced to business process execution language to automate the process workflows (Dave, 2017).
Today, BPMN is a widely used standard for process modeling with the latest version BPMN 2.0. In 2011, BPMN was published as a standard by the Object Management Group (OMG) (Dumas et al., 2012). According to ABPMP (2013), BPMN 2.0 is useful for presenting a model to multiple audiences, to simulate a business process with a process engine and to execute a process. Weske (2007) states BPMN as, that the primary goal of BPMN is to provide a notation that is easy to understand by all business users, from the business analysts who create the initial designs of the processes, to the technical developers responsible for implementing the technology who will perform those processes, and finally, to the business people who manage and monitor those processes (Weske, 2007). In BPMN, rounded rectangles represent the activities and diamond shapes are represented as control nodes (gateways). The connections between activities and control nodes are through arcs (flows) that determine the order in which the process is executed (Dumas et al., 2012).

To develop an BPMN diagram, there are two conflicting requirements which create a simple mechanism for creating business process model, as well as being able to handle the complexity inherent to business processes. Thus, graphical aspects of the notation into specific categories are organized, which provide a small number of notation categories and the diagram reader can easily recognize the basic types of elements and understand the diagram. Furthermore, some additional variations and information can be added to meet complexity requirements, without dramatically altering the look-and-feel of the diagram. They are four basic categories of elements: flow objects, connecting objects, swimlanes, and artifacts (White, 2004). Table 3.3 presents the main graphical notations and its description.

<table>
<thead>
<tr>
<th>Category</th>
<th>Element</th>
<th>Description</th>
<th>Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Objects</td>
<td>Event</td>
<td>A cycle represents an Event, something that “happens” during a course of a process. They affect the flow of the process and normally have a cause “trigger” or an impact “result”. Three types are available, which are based on when they affect the flow: Start, Intermediate, and End.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Activity</td>
<td>A rounded-corner rectangle represents an Activity and is a generic term for work that organizations perform. It can be atomic or non-atomic (compound). The types are: Sub-Process and Task (rounded rectangles).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gateway</td>
<td>A diamond shape represents a Gateway and is used to control the divergence and convergence of Sequence Flow. It will determine decisions, forking, merging, and joining of paths. Internal Markers will imply the type of behavior control.</td>
<td></td>
</tr>
<tr>
<td>Connecting Objects</td>
<td>Sequence Flow</td>
<td>A solid line represents a Sequence Flow and is used to show the order (the sequence) that activities will be performed in a Process.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Message Flow</td>
<td>A dashed line represents a Message Flow and is used to show the flow of messages</td>
<td></td>
</tr>
</tbody>
</table>
between two separate Process Participants (Business entities or business roles) that send and receive them. Two separate Pools will represent the two Participants.

| Association | A dotted line represents an Associations and is used to associate data, text and other Artifacts with flow objects. They are used to show the inputs and outputs of activities. |
| Swimlanes | Pool | A Pool represents a Participant in a Collaboration and acts as a “swimlane” as well as a graphical container for partitioning a set of Activities form other Pools (usually B2B situations). |
| Lane | A sup-partition within a Pool is represented by a Lane, and will extend the entire length of the Pool, either vertically or horizontally. |
| Artifacts | Data Object | To show how data is required or produced by activities is represented by Data Objects. They can represent a singular object or a collection of objects and are connected to activities through Associations. |
| Group | A rounded corner rectangle drawn with a dashed line represents a Group. It does not affect the Sequence flow and can be used for documentation or analysis purposes. |
| Annotation | A mechanism for a modeler are Annotations that provide additional text information for the reader of a BPMN Diagram. |

Table 3.3 - Basic Modeling Elements

Source: (Object Management Group (OMG), 2011; White, 2004)

### 3.2. Optoelectronic Industry

#### 3.2.1. History

Light has always been fundamental for life and humans. In the optoelectronic field, research has made a huge bound forward in the last few decades, and light is no longer used to lighten our surroundings only. Light consists of photons, proven to have excellent attribute for carrying information. The optoelectronic sector is a technical field that makes use of the attributes of light, based on the science of geometric and physical optics. Nowadays, light is combined with modern electronics, mechanics and software, which has been widely used within application in the field of industry and as customer areas. There is a rapid growth in the optoelectronic industry and there is no signs of waring off (Optronics, 2013).
The first functional model of the image converter tube was demonstrated in 1934 by Walter Schaffernicht. Initially, research focused on television and immediately thereafter for military application such as night vision and signals, light telephony, optical distances detonators, and homing devices (Maier, 2002). The use of night vision devices began in the World War II, and came into wide use during the Vietnam War (MarketsandMarkets, 2015). Night vision devices gather the existing ambient light, including moonlight, starlight, or infrared light, through the front lens. The lens is made of photos which are converted to electrons by passing through a photocathode tube. The result of this chemical and electrical process is a visible light, which the users sees through the eyepiece, a clear, green-hued image, amplified recreation of the scene (Technavio, 2015).

3.2.2. Current Situation

At the beginning was the light. Light has made life on our earth possible. Light is energy, is inexhaustible and protects the environment. More than 70 percent of information we take over light, light connects, is the internet. Light is a universal tool, offers solutions, often the only solution, often revolutionary. Light is today a 250 billion-euro world market. (Goetzeler & Leibinger, 2009, p. 4).

Light provides decisive stimuli and solutions in numerous branches of industry and areas of application for the current and future challenges of the economy, science and society (Löffler, 2017). Photonics has developed into a globally courted growth sector. In many areas of photonics such as laser technology, lighting or microscopy and imaging, German organizations are among the world market leaders. Furthermore, for Europe is the photonic sector among the five most important key technologies with the greatest growth potential (Bundesministerium für Bildung und Forschung, 2011). The demand in the night vision device market has remained robust due to the modernization of military and law enforcement agencies across the globe. In the market of night vision device, the current trend is characterized by the transition towards lightweight, low-cost, and efficient and effective night vision devices (MarketsandMarkets, 2015).

The night vision devices are segmented by products which are night vision goggles, night vision cameras, night vision scopes and other. The customer segments are divided into military and civil. Key market drivers are continuous investment in military segment, lower cost of night vision devices compared to thermal imaging devices and a growing number of wildlife photographers. Key trends are the use of graphene for night vision devices, adoption of snooper scope in smartphones (a night vision scope that makes smartphones function like a night vision devices) and growing popularity of night vision systems in automotive sector. Key market challenges are the adoption of thermal imaging devices and government regulations on use of night vision devices. In 2015, the global market for night vision devices accounted $5.63 billion and a market growth rate of 4.62%. America is the leader of the global night vision devices market with a market share of 56%. Europe, the Middle East and Africa accounted 29% of the market share with $1.63 billion in 2015. The investment in the military sector in Germany was $36.6 billion in 2015. The global market size is expected to reach $7.26 billion by 2020 (Technavio, 2015).
In recent years reserved military spending in Europe slowed sales in sub-areas of security and defence technologies due the outsourcing of production sites. In the coming years, it is expected that there will not be any more significant production relocations and the military spending will increase (Löffler, 2017).

The company under study has no thoughts about a possible decline of customers so far and the future of a growing customer is promising. According to that, IEA can increase its competitiveness even more by means of improved processes. Therefore, it is indispensable to improve inefficient process with the intention to successfully implement future enhancements and structural changes.

3.3. Recent Developments and Future Trends in Manufacturing

The increasing digitization and networking around the real and digital world creates massive changes, both in the personal and business environment. The next industrial revolution is enabling new business models, and hence forcing organization once again to optimize their core and support processes (Strobel, 2017). This trend corresponds to the progress of industrial revolutions, in which higher efficiency in production systems is continuously increased. Many features, characterizing the recent modern manufacturing system technology, such as lean, virtual, and rapid response systems, two features stand out and are sure to be carried over into a next generation of manufacturing, namely intelligent manufacturing and integrated manufacturing. Not only by the market demand, but also by technological advances is the evolution of integrated and intelligent manufacturing technology driven. According to Chen (2017), he mentioned 10 major technologies as key elements of the new manufacturing paradigm, that include fundamental elements such as big data analytics, cloud computing, applications, and mobile devices. They are also supporting elements such as three-dimensional (3D) printing or additive manufacturing, robotic automation, advanced materials, virtual or augmented reality, the industrial internet, and cyber-physical systems (CPS) (Chen, 2017). Therefore, intelligent manufacturing plays an important role in industry 4.0. Typical resources are converted into intelligent objects so that they can recognize, act and behave within a smart environment (Zhong, Xu, Klotz, & Newman, 2017). In fact, digital transformation has various potentials for industrials companies, such as custom designed goods which can be produced rapidly and flexibly in small quantities. Not only big enterprises but also SMEs could benefit from these potentials by establishing new processes, products and business models. Recent technologies and future trends to improve processes for the company under study are described in the following section (Müller & Hopf, 2017).

3.3.1. Industry 4.0 and IoT (Internet of Things)

The first industrial revolution is led back through the introduction of mechanical production facilities with the help of water and steam power. The second one follows the introduction of electrically-powered mass production based on the division of labor. The use of electronic and IT systems that further automate production was characterized through the third industrial revolution, followed by the fourth one which is based on CPS (Bartevyan, 2015). CPS are systems of collaborating computational entities which are in intense connection with the physical world and its on-going processes, providing and using, at the same time, data-accessing and processing services available on the internet (Monostori, 2014). Cloud computing, ubiquitous and internet of things (IoT) are technology enabler which must be connected to existing IT architecture. A foundation for integrating smart products, production means and manufacturing systems into the IT architecture can be
provided, if the transparency created through the enterprise architecture management is used to manage, monitor and develop it further (Strobel, 2017).

To create networks incorporating the entire production process that convert companies into a smart environment is possible by using IoT. CPPS encompass smart machines, warehousing systems and production facilities that have been designed digitally and feature end-to-end information and communications technology (ICT)-based integration, along the value chain (Kagermann, Wahlster, & Helbig, 2013). The support of a CPPS enables communication between people, machines and products. The elements of a CPPS act in a way, that they can acquire and process data, self-control tasks and interact with humans via interfaces. Through CPS, the development of new business models and services is expected (Monostori, 2014). New models will also enable SMEs to use service and software systems that are unable to afford under current licensing and business models. Industry 4.0 does not only refer to the optimization of existing IT-based processes, but also to unlock the potential for even more differentiated tracking of both detailed processes and overall effects on a global scale, which was previously impossible to record (Kagermann et al., 2013).

### 3.3.2. Enterprise Resource Planning (ERP) and Cloud Computing

Nowadays, most tasks in business organizations are supported by software systems, such as ERP systems, supporting all kinds of business processes and considering all resources necessary for the success of the enterprise (Kurbel, 2013). It helps the company to share and transfer information across all functions units inside and outside the company. The result of using an ERP system could be in form of higher quality, reduced time-to-market, improved communication, supporting in decision making, higher productivity, shortened lead times and lowered cost (Abd Elmonem, Nasr, & Geith, 2016). Especially in large companies, ERP systems are widely used. Recently, ERP systems are considered in SMEs to improve efficiency to stay competitive (Kilic, Zaim, & Delen, 2015). SMEs cannot exclusively use product and philosophies of large software vendors, because they have not enough resources to apply or implement products and process of large vendors (Žemlička & Král, 2016). Another option using ERP systems is the acquisition of Free and Open Source ERP software (Stefanou, 2014) or over a cloud (Abd Elmonem et al., 2016). Cloud computing takes place over the internet and provides scalability, reliability availability and lower costs. The cloud-based ERP system is accessed through the user browser over the internet without installing and configuring the system on the user side. However, there are also challenges in cloud ERP systems such as security, performance risks and bottlenecks.

According to Abd Elmonem et al. (2016), Cloud computing can be defined as a computing environment which provides availability, scalability, and flexibility of computer reassures at a deferent level of abstraction with low running costs. Cloud computing can be provided as Software as a Service (SaaS), PaaS (Platform as a Service), and IaaS (Infrastructure as a Service) (Xu, 2012). SaaS, refers to the end users or business and it concerns the delivery of a software application over the internet to multiple users, cloud ERPs belongs to this category. The middleware is delivered through PaaS which contains tools, services and platforms targeted at the software developers, to allow them to build SaaS application. Computing power hardware and software towards administration are delivered through IaaS (Abd Elmonem et al., 2016).
3.3.3. Robotic Process Automation (RPA)

According to the Institute for Robotic Process Automation and Artificial Intelligence (IRPAAI, n.d.), RPA is the application of technologies that allow employees in an organization to configure a computer software (robot) to capture and interpret existing application for processing a transaction, manipulating data, triggering responses and communication with other digital systems. The phenomenon is also called digital services, software robotics and service automation (Lacity, Willcocks, & Yan, 2015). RPA tools are made to imitate the same manual paths taken by a human, by using a combination of user interface interaction or descriptor technologies (Gartner, 2016). “Robotics” are software tools, that have been developed to simplify the delivery of business processes. These software robots offer improved business efficiency, data security and effectiveness, enhanced productivity, reduced cycle time, improved accuracy and compliance (Diepeveen, Matcher, & Lewkowicz, 2016). According to Lacity and Willcocks et. al. (2015), they agreed that automation can reduce costs, improve services quality, increases accuracy, correct first-time processing, improvements in regulatory compliance etc. The RPA software is suited to replace humans (for so called swivel chair) processes, where humans takes input form one set of system (e.g. email), process those inputs using rules, and enter the output into systems of record (e.g. ERP system) (Willcocks, Lacity, & Craig, 2015b).

According to Gartner (2016), the most suited processes for RPA have a high transaction throughput of structured digitalized data, with relatively fixed processing paths and/or user interfaces, which do not change frequently, and are rule-based activities. Furthermore, RPA tools achieve the best functionality if they have direct access to the data and applications. Therefore, processes are more appropriate for RPA when they have little or no need for remote access tools. Not suitable for most of RPA tools are processes with unstructured data. Rule-based processes can be also suitable, even if they are not performed regularly. According to L. Willcocks, Lacity, & Craig (2015a), highlighted that the most suited processes for RPA are those where the degree of process standardization, transaction volumes, rules-based process and process maturity are all high. There are several providers for automation software such as Blue Prism, Automation Anywhere, Cleaton, IPsoft, and UiPath. The RPA software is easy to configure, by dragging, dropping and linking icons that represent steps in a process. Business operations people do not need programming skills and they can be trained to independently automate processes within a few weeks. Furthermore, RPA is a lightweight IT, as it does not disturb underlying computer systems (Willcocks et al., 2015b).

3.3.4. Automatic Identification (Auto-ID) systems

Automatic identification is a technique that serves the technically supported identification, collection and transmission of data. In recent years, automatic identification and data acquisition (Auto-ID) systems are widely used in procurement and distribution logistics, trade, business with material flow and operating data acquisition systems. These technologies are implemented throughout, including technologies such as barcodes, smart labels, biometrics, mobile data acquisition, radio frequency identification (RFID), speech recognition, chip and magnetic card applications. The information is provided automatically to objects, such as people or goods and they enable to meet the demands for fast, cost-effective, and intergraded data collection (Helmus, Meins-Becker, Laußat, & Kelm, 2009).
3.3.5. Wireless communication networks

Wireless communicating technology enables the communication of anything with anything else, between people and between artifacts. The proliferation of radio frequency (RF) and microwaves techniques has resulted in various low-cost broadband wireless solutions, ranging from the last meter connection of wireless personal area networks (WPANs), to medium range networking in wireless local area networks (WLANs) (30 m to 100 m), as well as last mile connection in cellular systems, wireless wide area networks (WWANs) or metropolitan area networks (WMANs). Therefore, the access for the last meter in a WPAN is accomplished by the introduction of Infrared Data Association, RFID, Bluetooth, ZigBee and ultra-wideband (Ng, Sim, Tan, & Wong, 2006). In recent years, two key technologies for ubiquitous computing which are RFID and wireless sensor networks (WSN), have attracted considerable attention because their use revolutionized diverse application areas (Mitrokotsa & Douligeris, 2010).

Wireless sensor network (WSN)

A WSN constitutes a subset of wireless networking applications, focused on enabling connectivity without the use of wires to sensors and actuators (Gutiérrez, Callaway, & Barrett, 2004). WSN can be defined as a group of smart devices, referred to as sensors, which are able to sense and transmit information about the environment in which they are deployed. The sensors collect information for users, interested in monitoring and controlling a given phenomenon and transfers them to collected point (sink node) (Diallo, Rodrigues, & Sene, 2012). There are several potential applications for WSN such as industrial control and monitoring, home automation and consumer electronics, security and military sensing, asset tracking and supply chain management, intelligent agriculture and health monitoring (Yang & Cao, 2008). Furthermore, there are several different wireless communications technologies such as light communications, which include technologies like the Infrared Data Association and inductive fields, that have been extensively used for RFID applications. Further technologies are ultrasound, which is similarly to inductive fields, but require high energy from the network coordinator and radio frequency, which does not require an unobstructed line-of-sight (Gutiérrez et al., 2004). Another technologies which are used in WSN are Bluetooth and ZigBee (Prasad, 2015).

Radio identification (RFID)

In recent years, there has been a growing interest in the use of RFID to digitalize the manufacturing information to automate the manufacturing process. They support information flow in process-linked applications, minimize the need for reworking, improve efficiency, reduce line stoppages, and replenish just-in-time materials on the production line. Furthermore, RFID can also assist in automating assembly-line processes, which reduce labor and cost, as well as minimizing errors (Lee, Cheung, & Kwok, 2009). A RFID is an automatic identification technology based on radio frequency waves to read encoded digital data (A Zebra Technologies White Paper, 2013). A RFID system contains of different components, including an RFID tag, which is the identification device attached to the item to be tracked and an RFID reader and antenna, which are devices that can recognize the presence of RFID tags and read the information stored on them. A RFID middleware is needed to process the transmission of information between the reader and other applications. RFID can be divided into three main types which are active tags, semi passive tags, and passive tags (Lee et al., 2009).
Active tags use a battery to power the tag transmitter and receiver to broadcast their own signals to readers within the life of batteries. Semi passive tags have built-in batteries to power the chips circuitry, resist interference and circumvent a lack of power from the reader signal due to long distance. Passive tags derive their power from the field generated by the reader, but they have no active transmitter to transmit the information stored. The reader (interrogator) sends and receives RF data to and from the tag via antennas and consist of a transmitter, a receiver, and a microprocessor (Lee et al., 2009).

Limitations of RFID

RFID technology is being adopted widely for various applications. However, the technology has certain issues that are hindering its implementation in many organizations. With the implementation of RFID, additional infrastructure such as hardware and software, services, costs, and storage facilities are required. Furthermore, there are also barriers that range from a lack of industry-wide standards, adoptions of appropriate, understanding of total cost and necessary infrastructures to consumer privacy violations concerns. The lack of industry standard results into heavy amount of implementation cost, as retailer organizations require their vendors to supply RFID tagged products.

In addition, RFID creates huge volumes of data, 10 -100 times more than compared to the obtained data from conventional barcode systems, which is difficult to manage (Owunwanne & Goel, 2010). According to Owunwanne and Goel (2010), they propose the implementation of RFID using cloud computing to mitigate the mentioned challenges, especially for SMEs. According to that, SMEs would not need to establish a new IT infrastructure to implement RFID because they are very expensive. The problem with the huge amount of data can be also handled using cloud. On the could the RFID data is semantically filtered under a specific application of need, makes use of its relative platform and infrastructure over the network and then stored on a specific server.

To apply industry 4.0 practically, entrepreneurs should be open-minded and recognize new products, technologies and connected services. Furthermore, goals and processes should be defined clearly so that improvements can be applied step by step. At the beginning, systems for data acquisition could be integrated into manufacturing (e.g. barcode reader or RFID). In addition, mobile devices with an appropriate software can be used as an assistance system to provide role and task specific information, that can be useful for repair or learning processes (Müller & Hopf, 2017). In manufacturing, they are often still static business processes and they are implemented through extremely inflexible software systems. However, business processes cannot simply be replaced overnight by service-oriented systems. Because of this it will be essential to integrate new technologies into older ones and old systems will need to be upgraded with real-time enabled systems (Kagermann et al., 2013).

RFID applications

Applications for RFID range from highway toll collection, public transportation, controlling building access, animal tracking, developing smart home appliances, remote keyless entry for automobiles, locating children (Mitrokotsa & Douligeris, 2010), patient and people tracking through to the supply chain of retail and manufacturing (Owunwanne & Goel, 2010). Furthermore, there are also applications scenarios using RFID and WSN in diverse areas of science and engineering such as fire detection, monitoring shipping containers, the condition of weapons in battlefields and managing cattle (Mitrokotsa & Douligeris, 2010).
Difference between RFID and WSN

RFID are mainly used to identify objects or track their location without providing information about the physical state of the object (Mitrokotsa & Douligeris, 2010), whereas WSN are usually deployed to observe objects in areas of interest or to sense environment (Ahmed, Siyal, Tayyab, & Nawaz, 2015).

Barcode and the difference between RFID

Barcodes can be used in manufacturing process at every step, starting with the identification of the numerous components and ingredients needed in the production process such as inventory, finished goods and shipping packages (Jones, n.d.). The barcode consists of a binary code by stringing together vertical, parallel bars of different widths and spaces. There are different labeling codes available such as one-dimensional (1D), 2D, 3D or even 4D. The 2D codes can be read from left to right and from top to bottom, which allows a higher storage capacity of data. The 3D barcode is increasing the information density per unit area compared to the 2D code by coding the information into patterns consisting of colored dots. In the case of the 4D barcode, the 3D code is extended by another dimension, namely the time, it requires a screen because it cannot be printed an on object. The information from a barcode is read in with optical barcode readers and then further processed (Helmus et al., 2009). Compared to a barcode, RFID has several advantages such as tags that contain responsive microchips, which can store as well as transmit dynamic data, do not require a line of sight, and possess high security (Lee et al., 2009).

Unlike a barcode, RFID require higher investments. Therefore, process requirements or technical arguments must account for the economic feasibility of RFID adoption. The basic technical advantage of RFID is that the code carrier may store many pieces of information on very little space which can be modified, extended, or exchanged automatically. With the use of RFID there is no line of sight needed for process monitoring, which allows easy automatic reading of the tags. In addition, process data management can be automated, allowing process data to communicate automatically between the operations, rather than using manually written papers. Compared to a barcode, it can be used theoretically in the same way as RFID tags without user memory, but if process data are no longer manually written on paper, workers must identify internal transfer units by their labels. Therefore, barcode labels would require time-consuming manual scanning with a line of sight (Günther, Kletti, & Kubach, 2008).

3.3.6. Fog Computing

Cloud computing has served as an effective way to process and store data. However, there are challenges such as the increasing demands of real time or latency sensitive applications and the limitations of network bandwidth, which still cannot be solved by using cloud computing only. As a complement to the cloud solution, a new computing paradigm known as fog computing has been proposed (Hu, Dheilm, Ning, & Qiu, 2017). It is a highly virtualized platform that provides computing, storage, and networking services between end devices and cloud computing, which is usually located at the edge of network where the data is kept for the end users (Bonomi, Milito, Zhu, & Addepalli, 2012).
Therefore, it provides a new breed of applications and services to end users with low latency, high bandwidth, and location-awareness and thus gets the name as fog, which is analogously a cloud close to the ground. Due the fact that fog computing is usually cooperated with cloud computing, end users, fog and cloud together form a three layer service delivery model (Yi, Hao, Qin, & Li, 2015). Applications that suits best for fog computing are these one with low latency requirements (Aazam & Huh, 2014), such as application for health care, urgent services, and CPS (Dastjerdi & Buyya, 2016). According to (Yannuzzi, Milito, Serral-Gracia, Montero, & Nemirovsky, 2014), they argue that a smart combination of fog and cloud computing is the most plausible bet for building an adaptable and scalable platform for IoT. The new paradigm of using fog computing as a middleware between cloud and IoT objects, or even pure fog-IoT architecture have been discussed in many works (Aazam & Huh, 2014; Bonomi et al., 2012; Dastjerdi & Buyya, 2016).

3.3.7. Quality management ISO9001

The ISO 9001 standard specifies the requirements for quality management system (QMS), with the last standard ISO 9001:2015 launched in 2015. It helps companies to be more efficient and improve customer satisfaction. A management system therefore offers the possibility of defining the processes of a company to achieve its goals. Thus, a quality management system provides the ability to define how a company can meet the needs of its customer and other stakeholders affected by their work. This standard is based on the idea of continuous improvement. Companies must define their own objectives and continuously improve their processes to achieve them. Ones these goals have been achieved, they must be reassessed to ensure continuous improvement. There are many benefits that the ISO 9001 can bring to the organization, as it enables a more efficient way of working as all processes will be aligned and understood by everyone in the organization (International Organization for Standardization, 2015a).

There are seven quality management principles underlying the ISOs quality management standards, which are: customer focus, leadership, engagement of people, improvement, evidence-based decision making and relationship management (International Organization for Standardization, 2015b). Worldwide, there are more than 1.1 million organizations certified according the requirements of ISO 9001 (International Organization for Standardization, 2017). Besides the benefits of a quality management system, there are also some internal barriers specially for SMEs such as lack of financial resources, lack of management and/or staff knowledge, lack of employee involvement/motivation, lack of management and/or staff time and cultural differences between disciplines. External barriers are for example lack of support schemes, lack of sector specific implementation tools, uncertainty about the value of QMS in the market place and different stakeholder demands (Rajković, Aleksić, Milićević, & Ćudić, 2008).
4. WORK PROJECT

4.1. EXAMINATION OF THE COMPANY

The high-tech company IEA Mil-Optics is producing night vision products and acts as supplier for military and law-enforcement. The company has been in the market for 17 years and employs 12 people. Night Tronic (NT) devices are mounted in their own production site, that consists of more than 3000 squares meters including office, laboratory, exhibition and storage rooms. A specialty is the development of interface systems such as gunsight mountings, light modules for safety helmets and weapons, as well as night vision devices that are company owned, or foreign optical periscope which are fitted. Thus, the company has many product variants and offers individual system solutions. IEA is also a representative for one of the largest night vision companies, L3-Warrior Systems Division Insight, USA, which produces light and laser modules, night vision devices on image intensifier tubes base and thermal imaging devices.

Development and constructions, as well as testing and modification takes place in the company, whereas the prototypes are produced externally. After the final testing, the series production is released at the supplier, which gives the company a lower level of production. The company’s product concepts are linked to existing developments with modern production methods, new materials and others, to offer customers optimal problem solutions, as a functionally crucial component of an overall system. Customers include national and international authorities, military and private individuals. In table 4.1, the main products with the highest turnover are presented. The company owns products which can be classified in different categories, which can be further subdivided into subcategories (components). These are distributed either as a single product or as a complete system solution (equipment). Products which are produced by the company itself are highlighted in grey (own production) in the table.

<table>
<thead>
<tr>
<th>Product category</th>
<th>Sub-category</th>
<th>Product</th>
<th>Components</th>
<th>Trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night vision devices</td>
<td>Image intensifier tubes</td>
<td>AN PVS 15 - Night vision goggle L3 (ITAR)</td>
<td>- Item</td>
<td>- System</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AN PVS31 - Night vision goggle L3 (ITAR)</td>
<td>- Item</td>
<td>- Item</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FGE - Fusion goggle enhanced L3 (ITAR)</td>
<td>- Item</td>
<td>- System</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NT 940 - Night vision device (own production)</td>
<td>- Housing, - Tube, - Item</td>
<td>- System</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NT 920/PVS14 - Night vision device (own production)</td>
<td>- Housing, - Tube, - Item</td>
<td>- System</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NT 940/PVS7 - Night vision device (own production)</td>
<td>- Housing, - Tube, - Item</td>
<td>- System</td>
</tr>
<tr>
<td>Thermal imaging</td>
<td>MTM/WTM - Mini thermal monocular (Authority)</td>
<td>- Item</td>
<td>- System</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pulsar Helion XP (Civilian)</td>
<td>- Item</td>
<td>- System</td>
<td></td>
</tr>
</tbody>
</table>
Table 4.1 - Products offered by the company
Source: Prepared by the author

For example, the product-set (i.e. system solution) AN/PVS 31 consists of the following components: device, cable, filter cover assembly, manual instruction, quick reference guide, batteries, case, eyecup, lens tissue and cord (neck). Furthermore, customers can also buy equipment such as lens hoods, bags, cases, headrests and others. Devices which are produced by the company L3-Warrior Systems Division Insight, are governed by the International Traffic in Arms Regulations (ITAR), which is a set of the United State government regulations that control the export and import of defense-related goods and services on the United State Munitions List (USLegal, n.d.). Process flows which contain ITAR products deviate from the processes that do not contain ITAR products due the specific regulations.

Figure 4.1 shows the organizational structure, which also represents the functional organization. The fields of activity of the departments are described below.
- **Management**: responsible for the coordination of all employees in P&L, M&D, and D&P, and project transactions.

- **Procurement and Logistics (P&L)**: responsible for purchasing, goods receiving (quality control) and goods output, finishing goods, warehouse and shipment.

- **Marketing and Distribution (M&D)**: responsible for sales and service activities of various products. Acquisition of new customers and market research. Employees are specialized in different product types. Furthermore, clearance, import and export licenses as well as trade fair organization are further tasks.

- **Development and Production (D&P)**: responsible for development and construction of interface systems (gunsight mountings, light modules for safety helmets and weapons, night vision devices), foreign part assembly, weapons editing, final assembly and maintenance of night vision devices, mounting of semi-products, prototype testing and modification of different devices.

- **Accounting (A)**: responsible for accounts payable and receivable, accounting. Financial accounting and balance sheet accounting is taken over by an accountancy firm.

- **General Administration (g.A.)**: responsible for personal administration, general organization, insurances, building technology, outdoor facilities and cleaning.

The top level shows the management, which is taken over by the managing director, followed by the departments and the associated employees. The management of the employees is done by a cooperative management style and planning is based on the countercurrent process. Sub-plans are derived from the master plan of the management. These sub-plans are broken down to the respective employees, for which they are each independently responsible. The employees are also responsible for their own work processes, because of this, only special tasks need to be coordinated with the management. The versatile fields of activities of the employee’s function is cross-divisionally, which is why tasks within a field of activity are managed by at least two employees. This is done in which one employee acts as an executive and one as a controller, and in the case of a staff failure a representative is always available. This is partly done but not consistent. Team meetings are not being held regularly. Thus, there is some inefficiency in the inter-divisional information chain, that creates functional barriers. Targets and strategies are not documented and only partially known, and therefore not transparent and comprehensible to all employees. The company operates their daily work only with the help of easy excel sheets. There is no ERP system available.

In addition, employees who are affected by changes in certain processes are only partially informed. Fields of activity are insufficiently described in the job description, as well as the respective responsibilities and representatives. The tasks are regulated in the worker’s employee agreement only, which is very superficially defined. Fixed work processes and process instructions are partially documented and implemented but are not standardized. One of the biggest problem is that there is no completely transparent understanding of the related processes and their operations in the company. The company is not yet certified to a quality management standard. Processes are designed customer oriented. Employees can mostly coordinate their work processes independently and the implementation of the working procedure is only partly controlled.
Due this structure, there is a poor communication between some departments and sometimes processes are carried out incorrectly. Suppliers can usually be chosen by the employees themselves and there is no supplier assessment available. Customer satisfaction is not measured and recorded as well as the complaints are not recorded and evaluated. Due this fact, no sufficient conclusions can be determined. The improvement process is only partially implemented and insufficient documented. However, improvements will be implemented as quick as possible but mostly without documentation and administrative expenses. As the company handles the repair and service of L3-Warrior products for Europe, documentation of these processes is required which must comply with the ITAR regulations. These procedural instructions were previously only documented in text form as bullet points in several PowerPoint documents.

### 4.2. EXISTING PROCESSES

In this phase, existing processes which are documented by the general administration are studied. The processes that occurs most frequently were recorded in text form as bullet points in several Word or PowerPoint documents (see appendix: A., 1.-9.). These are available in the company’s computers drive and every employee has access. After analyzing the various instructions with the corresponding process steps, it is found that these can be divided by the company’s function, which is presented in table 4.2.

<table>
<thead>
<tr>
<th>Logistics</th>
<th>Distribution</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Goods receipt (general)</td>
<td>- Order fulfilment</td>
<td>- NT devices assembling</td>
</tr>
<tr>
<td>- Goods receipt (ITAR)</td>
<td>- Loaned devices (e.g. NT 940)</td>
<td>- Repair L3 devices</td>
</tr>
<tr>
<td>- Goods output (general)</td>
<td></td>
<td>- Repairs NT devices</td>
</tr>
<tr>
<td>- Goods output (ITAR)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2 - Procedural instruction of the company overview

Source: Prepared by the author
Table 4.3 presents the description of the instructions.

<table>
<thead>
<tr>
<th>Document</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goods receipt (general)</td>
<td>Procedure for processing the incoming goods of parcels. One variant is with delivery note and one is without one (see appendix: A. 1.)</td>
</tr>
<tr>
<td>Goods receipt (ITAR)</td>
<td>Procedure for processing the incoming goods of all ITAR devices (see appendix: A. 2.).</td>
</tr>
<tr>
<td>Goods output (general)</td>
<td>Procedure for processing the outgoing goods including checking and packing. One variant is with optical devices and the other one is with night vision devices (see appendix: A. 3.).</td>
</tr>
<tr>
<td>Goods output (ITAR)</td>
<td>Procedure for processing the outgoing goods of ITAR devices including checking and packing. One variant is with optical devices and the other one is with night vision devices (see appendix: A. 4.).</td>
</tr>
<tr>
<td>NT devices assembling</td>
<td>Procedure for assembly of night vision devices with tube, box, assemblage, etc. (see appendix: A. 5.).</td>
</tr>
<tr>
<td>Repair L3 devices</td>
<td>Procedure for processing repairs of L3 devices. One variant is that the devices can be repaired immediately and the other devices cannot be repaired immediately (see appendix: A. 6.).</td>
</tr>
<tr>
<td>Order fulfilment</td>
<td>The procedure for the order placement describes the instruction for the EDV technical creation of an order after receipt of the order by the customer (see appendix: A. 7.).</td>
</tr>
<tr>
<td>Repairs NT devices</td>
<td>Procedure for processing repairs of night vision devices. One variant is that the devices can be repaired immediately and the other devices cannot be repaired immediately (see appendix: A. 8.).</td>
</tr>
<tr>
<td>Loaned goods for the customer</td>
<td>Procedure for the loaned goods to the end customer of NT devices e.g. NT 940 (see appendix: A. 9.).</td>
</tr>
</tbody>
</table>

Table 4.3 - Procedural instructions of the company detailed

Source: Prepared by the author
5. PROJECT DEVELOPMENT

5.1. PROCESS ARCHITECTURE

To define the primary processes and its related processes, it is necessary to interview different employees that are involved in these processes. A general overview of the company’s processes is presented in the Figure 5.1. In this work project, the analysis is focused on the value-added processes (primary processes) for the company, according the value chain model from Porter (1985). The following figure 5.1 presents the process architecture of the company which is based on the model of Porters value chain.

![Diagram of Process Architecture]

* Source: Prepared by the author and based on (Porter, 1985)
Table 5.1 presents a more detailed process architecture that has been defined with the example of a self-produced product and one which is sold directly. The dimension business function presents the main function of the company and the associated processes steps. In the case type dimension, the two products are presented which is further subdivided in civil clients and authorities.

<table>
<thead>
<tr>
<th>Night Visor Devices</th>
<th>Business Functions</th>
<th>Case Types</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Product</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NT 940</td>
<td>AN/PVS31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Civil</td>
<td>Authority Civil Authority</td>
</tr>
<tr>
<td>Procurement</td>
<td>Purchasing</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Approval clearance</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td></td>
<td>Approval licenses</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td>Logistic</td>
<td>Receive goods</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Approval clearance</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td></td>
<td>Incoming goods control</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Store goods</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Goods output</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Approval clearance</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td></td>
<td>Goods output control</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Goods complement</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td>Production</td>
<td>Assembling of goods</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Perform quality testing</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Categorizing</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Approval for sales</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Repairs</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td>Sales</td>
<td>Generate lead</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Order fulfilment</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td></td>
<td>Approval licenses</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td></td>
<td>Presentation/Demo</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td></td>
<td>Sell goods</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Logistic</td>
<td>Goods output</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Approval clearance</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td></td>
<td>Goods complement</td>
<td>(x)</td>
<td>(x)</td>
</tr>
<tr>
<td></td>
<td>Goods output control</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Delivering</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Accounting</td>
<td>Receive payment</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Table 5.1 - Case types and business function of image intensifier tubes

Source: Prepared by the author

5.1.1. Identification of Processes

At any level, processes can be defined, from enterprise-wide processes to processes run by a single person (Sharma, 2015). Some of the processes presented in the previous chapter are only documented in several Word or PowerPoint documents. Until now, there is no graphical notation available and the instructions which are available are partly outdated. Thus, there is no transversal view of activities available. For this reason, it is necessary to revise the existing documents as well as recording the undocumented processes and translate them into a new, more expressive and up-to-date language, namely under the uses of BPMN 2.0.
Furthermore, a more transparent view of different departments is given by pools and lanes. In the following sections, new process diagrams which are identified during the project development are presented. Table 5.2 presents the primary processes of one self-produced product, one L3 product which is sold directly under the ITAR regulations and several services of the company. Products can be sold either as a single, with equipment or a complete system solution.

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>NT 940</strong></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td><strong>Goods receipt (general)</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>General goods receiving, include all goods except those of L3 devices.</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td><strong>Assembling of goods (NT 940)</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Assembling and production of NT 940 devices.</td>
<td></td>
</tr>
<tr>
<td>1.2.1</td>
<td><strong>Tube and housing assembling</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td>1.2.2</td>
<td><strong>Goods receipt (general)</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td>1.2.3</td>
<td><strong>Goods output (general)</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td>1.3</td>
<td><strong>Order fulfilment</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Includes the receipt of the order form the customer to the invoicing.</td>
<td></td>
</tr>
<tr>
<td>1.3.1</td>
<td><strong>Goods receipt (general)</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td>1.4</td>
<td><strong>Goods complement</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Includes the assembly of products with complementary equipment.</td>
<td></td>
</tr>
<tr>
<td>1.4.1</td>
<td><strong>Order fulfilment</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td>1.4.2</td>
<td><strong>Goods receipt (general)</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td>1.4.3</td>
<td><strong>Assembling of goods (NT 940)</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td>1.5</td>
<td><strong>Goods output (general)</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>General goods receiving, include all goods except those of L3 devices.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>AN/PVS31</strong></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td><strong>Goods receipt (ITAR)</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Goods receiving of AN/PVS31 or other L3 devices from L3-Warrior Systems or any authority customer (loaned devices).</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td><strong>Loaned PVS31</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Loaned process for all L3 or other devices from USA.</td>
<td></td>
</tr>
<tr>
<td>2.2.1</td>
<td><strong>Order fulfilment</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td>2.2.2</td>
<td>Goods receipt (ITAR)</td>
<td>Sup process</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>2.2.3</td>
<td>Goods output (ITAR)</td>
<td>Sup process</td>
</tr>
<tr>
<td>2.2.4</td>
<td>Repair L3 devices</td>
<td>Sup process</td>
</tr>
<tr>
<td>2.3</td>
<td><strong>PVS31 complement</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Includes the assembly of products with complementary equipment.</td>
<td></td>
</tr>
<tr>
<td>2.3.1</td>
<td>Goods receipt (ITAR)</td>
<td>Sup process</td>
</tr>
<tr>
<td>2.3.2</td>
<td>Goods receipt (general)</td>
<td>Sup process</td>
</tr>
<tr>
<td>2.4</td>
<td><strong>Goods output (ITAR)</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Goods output of AN/PVS31 or other L3 devices for loan.</td>
<td></td>
</tr>
</tbody>
</table>

**General (services)**

<table>
<thead>
<tr>
<th>3.1</th>
<th><strong>Repairs L3 devices</strong></th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Repair process of all L3 devices for European customers.</td>
<td></td>
</tr>
<tr>
<td>3.1.1</td>
<td>Goods receipt (general)</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.1.2</td>
<td>Evaluation</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.1.3</td>
<td><strong>Quote and material procurement</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td>3.1.4</td>
<td><strong>Goods receipt (L3 spare parts)</strong></td>
<td>Sub process</td>
</tr>
<tr>
<td></td>
<td>Goods receiving of any L3 spare parts for repair.</td>
<td></td>
</tr>
<tr>
<td>3.1.5</td>
<td>Repair pass</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.1.6</td>
<td>Order fulfilment</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.1.7</td>
<td>Goods output (general)</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.2</td>
<td><strong>Repair NT devices</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Repair process of all NT devices.</td>
<td></td>
</tr>
<tr>
<td>3.2.1</td>
<td>Goods receipt (general)</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.2.2</td>
<td>Order fulfilment</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.2.3</td>
<td>Goods output (general)</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.3</td>
<td><strong>Loaned devices</strong></td>
<td>Process</td>
</tr>
<tr>
<td></td>
<td>Loaned process for all NT devices.</td>
<td></td>
</tr>
<tr>
<td>3.3.1</td>
<td>Order fulfilment</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Goods output (general)</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Goods receipt (general)</td>
<td>Sub process</td>
</tr>
<tr>
<td>3.3.4</td>
<td>Repair NT devices</td>
<td>Sub process</td>
</tr>
</tbody>
</table>

Table 5.2 - Identified processes of the company

Source: Prepared by the author
5.2. Specification of Entities

There are multiple organizational entities in a business process which can interact with each other. Swimlanes are used to graphically assign processes or parts of processes to organizational entities involved in business processes. Pools represent specific process participants, which are often companies, business entity roles, such as suppliers or customers. Lanes represent organizational entities within participants. The main purpose of data object artifacts is the documentation of the process which are simply represented by a name (Weske, 2007). Data objects can represent for example paper documents, electronic documents and information on any type of medium. A empty cylinder represent a data store, a place containing data objects that need to persisted beyond the duration of a process instance, such as database for electronic artifacts or a filing cabinet for physical ones (Dumas et al., 2012). In this work project, there are several entities, which can be actors, systems and documentation. The activities in a process are performed by actors who are people or groups of people. Systems are the software in which actors interact to perform their functions e.g. passing documents, data, or information, and communication of various stakeholders. The documentation includes a series of digital and non-digital documents, corresponding to the forms and requirements used by actors to share information between them. In this work project, actors are represented by lanes or pools and systems and documentation are represented by the artifacts of the data object type (systems = database; documentation = sheet).

5.2.1. Actors

Table 5.3 presents the actors and the tasks with the related processes in which it arises.

<table>
<thead>
<tr>
<th>Actor</th>
<th>Description</th>
<th>Process where it arises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier</td>
<td>These are all those who deliver components for the various products.</td>
<td>1.2, 1.3, 1.4, 2.3, 3.1, 3.1.3, 3.1.5, 3.2</td>
</tr>
<tr>
<td>Customer</td>
<td>These are all those who buy products or services or borrow devices.</td>
<td>1.1, 1.3, 1.4, 1.5, 2.2, 2.4, 3.1, 3.2, 3.3</td>
</tr>
<tr>
<td>Consigner</td>
<td>These can be customers and suppliers.</td>
<td>1.1, 2.1</td>
</tr>
<tr>
<td>Parcel service</td>
<td>These can be various parcel services specialized in the transport of goods.</td>
<td>1.1, 1.5, 2.1, 2.4, 3.1.4</td>
</tr>
<tr>
<td>Custom</td>
<td>Goods imported or exported from third countries must be treated as customs.</td>
<td>1.3, 2.1, 3.1.4</td>
</tr>
<tr>
<td>Parcel post insurance</td>
<td>Parcel are generally to be insured by a general transport insurance from a</td>
<td>1.5, 2.4</td>
</tr>
<tr>
<td></td>
<td>value of 500 euros.</td>
<td></td>
</tr>
<tr>
<td>L3-Warrior Systems Division</td>
<td>These are the company that deliver various devices.</td>
<td>2.3, 3.1, 3.1.3, 3.1.4</td>
</tr>
<tr>
<td>Insight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General company</td>
<td>These can be any employee of the entire company.</td>
<td>1.1, 2.1</td>
</tr>
</tbody>
</table>
Manager
Person who is responsible for the coordination of all employees in P&L, M&D, and D&P, and project transactions.
1.3, 1.5, 2.2, 2.3, 2.4

Product manager
Person responsible for signing of outgoing goods, sales (civil/authority) of all optical devices, maintenance of all optical devices (L3), advertising journal.
1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3, 3.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.2, 3.3

Sales clerk
Person responsible for signing of outgoing goods (weapons), sales of weapons and optical devices (civil), external production parts, assembly processing and weapons editing.
1.2, 1.3, 1.4, 1.5, 3.3

Administrative staff
Person responsible for signing of outgoing goods (general) and goods receiving, order fulfilment support, licenses, clearance, shipping, personnel administration, general organization and exhibition.
1.3, 1.4, 1.5, 2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 3.3

Workshop manager
Person responsible for signing of outgoing goods and goods receiving, final assembly, maintenance and loan of NT devices as well as the repair of L3 devices.
1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3, 2.4, 3.1, 3.1.2, 3.1.4, 3.1.5, 3.2

Part-time assistance 1
Person responsible for preparing, performing and signing of all outgoing goods and all goods receiving, warehouse, assembly semi-finished products, facility engineering, and outdoor facilities.
1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3, 2.4, 3.1, 3.1.4, 3.1.5, 3.2, 3.3

<table>
<thead>
<tr>
<th>Type</th>
<th>System</th>
<th>Description</th>
<th>Process where it arises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printed</td>
<td>Goods receipt list</td>
<td>It is a printed list that is used to document all incoming products which contain a serial number.</td>
<td>1.1, 2.1, 3.1.4</td>
</tr>
<tr>
<td></td>
<td>Delivery note folder</td>
<td>In this folder, delivery notes are archived in paper form.</td>
<td>1.1, 2.1, 3.1.4</td>
</tr>
<tr>
<td></td>
<td>Parcel service list</td>
<td>The list contains the different parcel services with the prices and the delivery conditions.</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Goods outgoing list</td>
<td>It is a printed list that is used to document all outgoing products which contain a serial number.</td>
<td>1.5, 2.4, 3.2, 3.3</td>
</tr>
<tr>
<td></td>
<td>Reclamation folder</td>
<td>In cases of damaged delivery goods, these are photographed and archived in the reclamation folder in paper form.</td>
<td>1.1, 2.2, 3.1.4</td>
</tr>
</tbody>
</table>

Table 5.3 - Actors of the company
Source: Prepared by the author

5.2.2. Systems

Table 5.4 presents the systems and the respective processes in which they occur. Due to some confidential and sensitive data, only a few documents have been added to the appendix.
<table>
<thead>
<tr>
<th>Folder/Document Type</th>
<th>Description</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invoice copy folder</td>
<td>A copy of all invoices is archived in the invoice copy folder in paper form. All documents of the order are attached to the invoice copy.</td>
<td>1.5</td>
</tr>
<tr>
<td>ITAR Demo folder</td>
<td>Collection of all documents in paper form of the demo devices.</td>
<td>2.1, 2.2, 2.4</td>
</tr>
<tr>
<td>Microsoft Excel Invoice list</td>
<td>Overview of all short-term receivables. This list contains information such as invoice number, customer, good, invoice amount. An exemplary excerpt from this list can be found in Annex B.1.</td>
<td>1.3</td>
</tr>
<tr>
<td>Repair overview ITAR</td>
<td>The repair overview ITAR list contains information of all the incoming L3 devices which needs to be repaired such as RMA (Return material authorization) / ITAR number (is created), customer, warranty, description, date. Partial request at L3 with date, evaluation date, quote date. An exemplary excerpt from this list can be found in Annex B.2.</td>
<td>3.1, 3.1.5</td>
</tr>
<tr>
<td>Device PVS folder No.xxx</td>
<td>The folder contains the following template documents (excel): - Repair and Parts - RMA general information - Unit history sheet An exemplary excerpt from this folder can be found in Annex B.3.</td>
<td>3.1</td>
</tr>
<tr>
<td>Overview spare and parts list PVS No.xxx</td>
<td>There is a list for each type of device, in which the current inventory with all parts of the replacement and the respective prices is documented. The list contains all spare parts needed for repair and available in the warehouse. An exemplary excerpt from this list can be found in Annex B.4.</td>
<td>3.1.3, 3.1.4</td>
</tr>
<tr>
<td>ITAR demo material list</td>
<td>Overview of all demo devices and their current location (customer, warehouse, manufacturer). An exemplary excerpt from this list can be found in Annex B.5.</td>
<td>2.1, 2.2, 2.4</td>
</tr>
<tr>
<td>NT list</td>
<td>In the NT list, all delivered tubes are documented as well as the tubes which are used to produce NT devices and the finished NT devices with the serial number and the corresponding tube number. An exemplary excerpt from this list can be found in Annex B.6.</td>
<td>1.2, 1.4, 3.3</td>
</tr>
<tr>
<td>Repair NT list</td>
<td>Repair NT list, include all devices to be repaired with the RMA / c (commercial) number. An exemplary excerpt from this list can be found in Annex B.7.</td>
<td>3.2</td>
</tr>
<tr>
<td>Goods output list (will collect)</td>
<td>In the list, all devices that contain a serial number and are personally collected by the customer are documented.</td>
<td>3.1</td>
</tr>
<tr>
<td>Price list (general)</td>
<td>The price list includes several products in which</td>
<td>1.3</td>
</tr>
</tbody>
</table>
Table 5.4 - Systems of the company
Source: Prepared by the author

5.2.3. Documentation

Table 5.5 presents all the documentation used for the above processes, along with the associated processes in which they occur. Due to some confidential and sensitive data, only a few documents have been added to the appendix.

<table>
<thead>
<tr>
<th>Type</th>
<th>Documentation</th>
<th>Description</th>
<th>Process where it arises</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printed</td>
<td>Repair accompanying card</td>
<td>It is a card in which the RMA number is written down and attached to the associated device. To distinguish the repair order, the card for ITAR devices is red and the one for commercial devices is green.</td>
<td>3.1, 3.2</td>
</tr>
<tr>
<td></td>
<td>Replacement delivery note</td>
<td>Upon delivery of goods without a delivery note, a replacement delivery note will be used to document the receipt of the goods. An exemplary excerpt from this document can be found in Annex C.3.</td>
<td>1.1, 2.2, 3.1.4</td>
</tr>
<tr>
<td></td>
<td>Valid eligibility</td>
<td>It is the document which is necessary for the customer to purchase or loan an NT device.</td>
<td>2.2, 3.3</td>
</tr>
<tr>
<td>Digital/printed</td>
<td>Purchase order</td>
<td>For orders, there is no template, these are mainly carried out individually by email or by phone.</td>
<td>1.2, 1.4, 2.2, 2.3, 3.1.4</td>
</tr>
<tr>
<td></td>
<td>Order</td>
<td>It is the customer’s or companies order document, which is either sent by e-mail or hand-written in paper form.</td>
<td>1.3, 2.2</td>
</tr>
<tr>
<td></td>
<td>Data sheet</td>
<td>Each tube contains an associated data sheet in which the respective tube number is documented. The datasheet is provided on a supplied CD and the file is stored and archived on the corporate drive. The printed document is achieved in the “Invoice copy folder” with the respective invoice. An exemplary excerpt from this document can be found in Annex C.1.</td>
<td>1.2, 1.4, 2.2, 2.3, 3.2, 3.3</td>
</tr>
<tr>
<td></td>
<td>Repair order</td>
<td>It is the repair order document for invoicing.</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>Delivery note</td>
<td>This document can be either a delivery note from customers or suppliers or it can be an accompanying document from the company for goods such as for test delivery, sight shipment, additional delivery, replacement and repairs. An</td>
<td>1.1, 1.2, 1.3, 1.4, 1.5, 2.2, 2.4, 3.1, 3.1.4, 3.2, 3.3</td>
</tr>
<tr>
<td>Tool</td>
<td>Document Type</td>
<td>Description</td>
<td>Reference(s)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Microsoft Word / printed</td>
<td>Invoice</td>
<td>New invoices are taken from the previous invoices, modified and saved under the consecutive invoice number. An exemplary excerpt from this document can be found in Annex C.4.</td>
<td>1.3, 1.4, 1.5, 2.3, 2.4, 3.1</td>
</tr>
<tr>
<td></td>
<td>Pre-invoice</td>
<td>The document is used for orders containing technical devices with serial numbers. The invoice pre-document does not contain the serial number of the devices, this is entered only after selection of the device and then create as an invoice.</td>
<td>1.3, 1.4, 1.5, 2.3, 2.4</td>
</tr>
<tr>
<td></td>
<td>Quote</td>
<td>It is the offer for the repair service.</td>
<td>3.1, 3.1.3</td>
</tr>
<tr>
<td>Microsoft Excel</td>
<td>Unit history sheet</td>
<td>The unit history sheet includes information of the device such as serial number, type, RMA number, unit history, employee and date. An exemplary excerpt from this document can be found in Annex C.5.</td>
<td>3.1</td>
</tr>
</tbody>
</table>
|                             | RMA general information                            | The RMA general information list contains several sheets as following:  
- Overview: information such as customer, device, serial-/ model-/ and RMA numbers.  
- Quote: pre-quote.  
- Inventory sheet: information of device type, RMA number, customer and check list for device and components.  
- Visual inspection: information of device type, RMA number, customer and with default steps to check the device/ components.  
- Operational checkout: information of device type, RMA number, customer and general instruction for test steps.  
- Group A data sheet 1/2: information of device type, RMA number, customer and instruction for special test steps.  
An exemplary excerpt from this document can be found in Annex C.6 a), b), c) and d).                                                                 | 3.1, 3.1.2, 3.1.3, 3.1.5 |
|                             | Repair and parts                                   | The repair and parts list contains all defect parts that need to be replaced for repair. It also contains information of the working hours. An exemplary excerpt from this document can be found in Annex C.7.                                           | 3.1, 3.1.2, 3.1.3, 3.1.5 |
|                             | Project management folder no.xxx                    | The PM folder contains several documents such as invoice, quote, order / invoices for suppliers, (timetable), quality assurance folder. The documents differ from order to order.                                           | 2.3          |
|                             | Other                                              | Photos For documentation of goods in goods receipts and outputs.                                                                                                                                              | 2.1, 2.4      |

Table 5.5 - Documents of the company  
Source: Prepared by the author
6. PROCESS MODELING

There are many reasons for modeling processes such as simply understand the process and to share the understanding with people who are involved with the process. Furthermore, its helps to better understand the process and to identify and prevent issues. Therefore, process modeling is inevitable towards a thorough understanding, which is the prerequisite to conduct process analysis, redesign or automation (Dumas et al., 2012). The following chapter presents the primary processes of the company with one self-produced device and one which is sold directly as well as several services. The studied process can be divided into the following 3 groups (detailed processes see table 5.3):

- NT 940
- AN/PVS31
- General (services)

6.1. PROCESS “NT 940”

The process “NT 940” along the value chain from goods receipt, goods assembling, order fulfilment, goods complement, and goods output is one of the main frequency processes of the company. Goods receipt (general) concerns all components that consist of an NT 940 device with the device itself as well as other complementary goods. All L3 devices from USA, which are subject to the ITAR regulations are executed in a separate process.
6.1.1. Process “Goods receipt (general)”

The process “Goods receipt (general)” contains the general receiving of parcels from suppliers or customers which is presented by the pool “Consigner”. Parcels can be accepted by any employee which is presented by the lane “General company employees”. If the parcel contains a seal, one of the “General company employees” must go to the custom for clearance.

Figure 6.1 - Process “Goods receipt [general]”
Source: Prepared by the author
6.1.2. Process "Assembling of goods (NT 940)"

The process "Assembling of goods (NT 940)" is performed by the employee's workshop manager, product manager or sales clerk. Furthermore, this process contains the following sub-process which have already been listed or presented in the following chapter: "Goods receipt (general) (see 6.1.1) and "Goods output" (see 6.1.5). The sub-process "Tube and housing assembling" is presented in the next process.

Figure 6.2 - Process „Assembling of goods (NT 940)"
Source: Prepared by the author
6.1.3. Sub-Process “Tube and housing assembling”

The sub-process “Tube and housing assembling” is performed by the employee’s workshop manager, product manager or sales clerk.

Figure 6.3 - Sup-process “Tube and housing assembling”

Source: Prepared by the author
6.1.4. Process “Order fulfilment”

In the process “Order fulfilment” an offer can only be accepted by the manager, sales clerk, product manager or workshop manager. The invoicing is done by the manager or administrative staff. The further procedure for customs clearance for certain goods is not described. After invoicing, the invoice is set up in the goods output. There, the compilation of the ordered goods takes place, for which the respective employee (product-specialized) is responsible. In this case, the process “NT940”, NT 940 device/s, is/are assembled in the following process “Goods complement”. A further sub-process which has already been listed is “Goods receipt (general)” (see 6.1.1).

Figure 6.4 - Process „Order fulfilment”

Source: Prepared by the author
6.1.5. Process “Goods complement”

The process “Goods complement” is performed according to the customer’s order. The responsible employee can be the workshop manager, product manager or sales clerk. They process the order from the documents “Pre-invoice” or “Delivery note”. The documents “Pre-invoice” or “Delivery note” is done by the administrative staff in the sub-process “Order fulfilment” (see 6.1.3). If the desired device is not available, the device must be assembled according to the customer requirements. This is done in the sub-process “Assembling of goods (NT 940)” (see 6.1.2). A further sub-process which has already been listed is “Goods receipt (general)” (see 6.1.1).

Figure 6.5 - Process “Goods complement”
Source: Prepared by the author
6.1.6. Process “Goods output (general)"

The process “Goods output (general)” contains the general output of goods which is mostly done by the employee part-time assistance 1. If there is a defect of any goods, the employee must inform a “Responsible employee” which can be the manager, sales clerk, product manager, workshop manager or administrative staff (limited).

Figure 6.6 - Process "Goods output (general)"
Source: Prepared by the author
6.2. Process “AN/PVS31”

As mentioned in the previous chapter, all L3 devices are governed by the ITAR regulations. Some of these processes require additional steps. The process of the device “AN/PVS31” along the value chain from goods receipt, loaned devices, goods complement, and goods output is another main process of the company. For this work project, it was decided to model the processes for loaned devices under ITAR regulations. For the loaned devices, there are separate processes for goods receipt and output which are “Goods receipt (ITAR)” and “Goods output (ITAR)”. Regardless of the landed goods, authorities buy one or more such devices with or without a complete set solution or equipment. In this case the goods receipt and output are the “general” ones. In the following chapter, the processes are presented.
6.2.1. Process “Goods receipt (ITAR)”

The process “Goods receipt (ITAR)” contains the receiving of parcels from the supplier L3-Warrior Systems, other companies from the USA or authority customers for loaned L3 devices, which is presented by the pool “Consigner”. Parcels can be accepted by any employee which is presented by the lane “General company employees”.

Figure 6.7 - Process “Goods receipt (ITAR)”

Source: Prepared by the author
6.2.2. Process "Loaned PVS31"

The process “Loaned PVS31” is performed by the product manager, workshop manager, manger or administrative staff. If the desired device is not available, the device must be ordered from the company L3 Warrior-Systems. Further sub-process which have already been listed are “Order fulfilment (NT 940)” (see 6.1.3), “Goods receipt (ITAR)” (see 6.2.1). The sup-processes “Goods output (ITAR)” (see 6.2.1) and “Repair L3 devices” (see 6.3.1) will be presented in the following chapter. In case that the customer intends to buy the device, the order confirmation is passed to the manager or administrative staff for invoicing. The complement of the devices takes place after invoicing, which is present in 6.2.3.

![Diagram of the process "Loaned PVS31"](image)

*Figure 6.8 - Process „Loaned PVS31“*

*Source: Prepared by the author*
6.2.3. Process “PVS31 complement”

The process “PVS31 complement” is performed by the manager, product manager or workshop manager. Further sub-process which have already been listed are “Goods receipt (ITAR) (see 6.2.1)” and “Goods receipt (general)” (see 6.1.1).

Figure 6.9 - Process “PVS31 Complement”

Source: Prepared by the author
6.2.4. Process “Goods output (ITAR)”

The process “Goods output (ITAR)” contains the output of parcels to the supplier L3-Warrior Systems, other companies from the USA or authority customers for loaned L3 devices, which is done by the manager, administrative staff, workshop manager, product manager and part-time assistance.

Figure 6.10 - Process „Goods output (ITAR)“

Source: Prepared by the author
6.3. Process “General (Services)"

In this work project, an investigation of the offered services of the company is conducted as well. The company offers a variety of services, such as repairs of different types of devices as well as seminars. It was decided to model the processes that are most frequently used from customers and which are the most value-added for the company.

For all L3 devices in Europe, IEA takes over the services and maintenance as the representative company for L3-Warrior Systems. For this purpose, the employees of the company were specially trained by L3-Warrior Systems. The rooms have been specially provided according to the ITAR requirements. Sub-processes which occur repeatedly such as “Goods receipt (general) or order fulfilment” are not listed again. The sup-processes of “Repair NT devices” and “Loaned devices” are handled in the same way.
6.3.1. Process “Repair L3 devices”

The process “Repair L3 devices” is performed according to the customer’s order. They are two main responsible employees, which are the product manager and the workshop manager. This process requires a lot of documentation due to the cooperation with the company L3-Warrior Systems and the ITAR regulations. The sub-process “Evaluation” is presented in 6.3.2, “Quote and material procurement” in 6.3.3, “Goods receipt (Spare parts)” in 6.3.4 and “Repair pass” in 6.3.5. Furthermore, this process contains the following sub-process which have already been listed: “Goods receipt (general) (see 6.1.1), “Order fulfilment” (see 6.1.3) and “Goods output (general)” (see 6.1.5).

![Diagram of the Repair L3 devices process](image)

**Figure 6.11 - Process „Repair L3 devices“**

Source: Prepared by the author
6.3.2. Sub-Process “Evaluation”

The sub-process “Evaluation” is performed by the product manager or workshop manager. This sub-process requires also a lot of documentation. For a better overview of the structure of the excel spreadsheet, a note has been included in the diagram.

Figure 6.12 - Sub-process „Evaluation”
Source: Prepared by the author
6.3.3. Sub-Process “Quote and material procurement”

The sub-process “Quote and material procurement” is performed according to the customer’s order. There are two main responsible employees, which are the product manager and the workshop manager.

Figure 6.13 - Sub-process „Quote and material procurement”

Source: Prepared by the author
6.3.4. Sub-Process “Goods receipt (L3 spare parts)”

The sub-process “Goods receipt (L3 spare parts)” contains the receiving of any spare parts from L3 Warrior-Systems. The parcels can be accepted by any employee which is presented by the lane “General company employees”. The process is subject to the special conditions under the ITAR regulations, but it differs from the process of “Goods receipt (ITAR)”. Due this fact, it was decided to model this process separately.
6.3.5. Sub-Process “Repair pass”

The sub-process “Repair pass” is performed according to the customer’s order. There are two main responsible employees, which are the product manager and the workshop manager. This sub-process contains also a further sub-process which has already been listed, the “Goods receipt (general) (see 6.1.1).

Figure 6.15 - Sub-process „Repair pass“
Source: Prepared by the author
6.3.6. Process “Repair NT devices”

The process “Repair NT devices” is performed according to the customer’s order. There are two main responsible employees, which are the product manager and the workshop manager. This process contains the following sub-process which have already been listed: “Goods receipt (general) (see 6.1.1), “Order fulfilment” (see 6.1.3) and “Goods output (general)” (see 6.1.5). The quality technician is either the workshop manager or the product manager. Depending on which of the two carried out the repair process, the other then must perform the final operational checkout, to ensure the correct repair of the devices.

Figure 6.16 - Process „Repair NT devices“
Source: Prepared by the author
6.3.7. Process “Loaned devices”

The process “Loaned devices” is performed according to the customer’s order. The responsible employees are the manager, product manager, and sales clerk. This process contains the following sub-processes which have already been listed: “Goods receipt (general)” (see 6.1.1), “Order fulfilment” (see 6.1.3) and “Goods output (general)” (see 6.1.5).

Figure 6.17 - Process „Loaned devices“

Source: Prepared by the author
7. CRITICAL REVIEW OF PROCESSES AND IMPROVEMENTS

The first step in implementing a new process or updating an existing process is to gain a common understanding of the current state of the process and its consistency with business goals (ABPMP, 2009). Creating this common understanding is process analysis. Furthermore, it is a commitment that allows companies to continuously improve their processes by monitoring process performance and thereby improving the performance of the company (ABPMP, 2013).

The company under study performs their daily work with the help of easy spreadsheet systems (Excel) for various processes such as the inventories of certain goods, overview of invoices as well as monitoring of several service performances. The systems used in the company are no longer up-to-date and insufficient for the number of processes. One of the biggest problem of the company is the manual nature of processes (minimal IT use), some of which were not reviewed in the last years due the non-existent process diagrams. There are different types of documentation for the various processes and there is no uniform data management in the company. In some processes, there is no data entry and for other processes there is a double collection effort. One of the company’s main problems is the lack of transparency and uniformity of process flows for employees. Also, the manual nature of the processes makes it difficult for the employees to track the status of the process at a given time and slowed down the response to both internal and external stakeholders.

Furthermore, when creating reports, these must always be created manually, which are time-consuming and often can cause many errors when creating excel reports. Data must always be recorded manually and there is always the risk of transmission errors and inconsistencies. Furthermore, there is a high administrative overhead in the company, since resources cannot be used optimally due the only partially existing inventory management. There is a non-optimal delivery quality of the company, because due the only partially managed warehouse stocks often late orders are made to suppliers. General insist inefficiencies especially in the areas of material management, production, and assessment of demand.

To improve many of the above-mentioned problems, the company primarily requires a central system such as an ERP, which enables a better planning and controllability of all processes. Whether the use of RFID or barcode is worthwhile for the company depends on the processes and the potential for optimization. Both technologies offer many advantages for different applications. Due to the high acquisition cost of RFID, an exact process analysis should be carried out in advance to ensure economic use. In the following chapter a critical analysis and review is carried out on each previously modeled process, as well as opportunities for process improvement are identified.
### 7.1. Process “NT 940”

<table>
<thead>
<tr>
<th>Number and process name</th>
<th>Critical analysis</th>
<th>Improvement proposals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NT 940</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Goods receipt (general)</td>
<td>1. All goods in the goods receipt are not electronically recorded and there is no inventory control, although all devices that contain a serial number are documented in paper form in the goods receipt list. Only certain devices such as NT devices or thermal imaging devices are recorded in different excel lists.</td>
<td>1. All goods and semi-finished products should be electronically recorded in a central stock system to provide a current inventory level and to manage detailed warehouse data. Furthermore, it should be possible to monitor cost and price changes, as well as a function to track and record stock movements.</td>
</tr>
<tr>
<td></td>
<td>2. As specific devices are documented in the goods receipt list and in various excel lists, employees must look for them individually when tracing business transactions. These search terms can cause high processing expense.</td>
<td>2. It should be possible to track and record stock movements automatically to obtain real-time access and accurate information on inventory levels and production orders from the desktop or even mobile devices, whether in the office, at the warehouse, or at a remote location.</td>
</tr>
<tr>
<td></td>
<td>3. For orders from suppliers, the order is partially processed by phone or e-mail. Orders are not electronically recorded or documented and thus cannot be monitored and controlled.</td>
<td>3. The purchase planning needs to be supported, as well as vendor selection and purchase order management. There is a detailed and a centralized vendor data (including all possible vendors) repository necessary, to make the best decisions, identify opportunities and save costs, as well as to manage supplier relationships. Thereby orders should be created electronically and connected to the central stock. It should be possible to set reminders to inform the employees when orders are expected to be received. That allows better monitoring and adherence to delivery times.</td>
</tr>
<tr>
<td>Number and process name</td>
<td>Critical analysis</td>
<td>Improvement proposals</td>
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<tr>
<td>-------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1.1 Goods receipt (general)</td>
<td>4. Employees do not check the goods receipt every day. Some of the goods are sometimes left in the warehouse for several days without being processed by the employees. Thus, the processing times are sometimes considerably longer. The division of tasks is not well defined and not transparent for every employee.</td>
<td>4. It is necessary to implement a process to monitor incoming goods on daily basis, assigned to a responsible employee. Furthermore, this process should be connected to the stock system.</td>
</tr>
<tr>
<td>1.2 Assembling of goods</td>
<td>1. When assembling NT devices, not all semi-finished products are always available in the warehouse. There is no inventory management for all products and employees always must look in the warehouse. This is due the lack of proper maintenance of inventories. A further problem is, that mostly all employees are responsible for the warehouse and the components are not always ordered promptly when they reach the minimum of stock level. Some of the employees do not have an overview, as the unit number of the components are not recorded in an electronic manner. Delays in delivery can be poorly monitored and if delivery times are exceeded, they are often forgotten. 2. The company logo, the warnings signs and the serial numbers are attached to the devices with a sticker by hand.</td>
<td>1. In general, all components should be automatically recorded into a central stock. This keeps inventories up-to-date, accelerates the processes and avoids delivery problems, as well as productions problems due to missing parts. Errors when entering the goods are also avoided by the automatic entry, see also improvement proposal 1.1. (3). 2. For add the logo and other labels to the devices, a laser could be used to apply them. This can increase the readability of the labels after a few years of use and it could be detected electronically in the central stock. There should be also the option to generate an automatic serial number. Due the laser, the devices would have a higher quality look. In addition, transmission problems of serial numbers in the electronic documents could be avoided, such as e.g. key in errors as well as the process could be accelerated.</td>
</tr>
<tr>
<td>Number and process name</td>
<td>Critical analysis</td>
<td>Improvement proposals</td>
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<tr>
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</tr>
<tr>
<td>1.2 Assembling of goods</td>
<td>3. There is no supplier catalog where all suppliers of the company are listed. The employees must choose suppliers individually.</td>
<td>3. The same improvement proposal as in point 1.1. (3).</td>
</tr>
<tr>
<td>1.3 Order fulfilment</td>
<td>1. Customers usually order by e-mail or in person. When ordering by phone, customers are asked to write an e-mail. There is currently no way to order products via an online system.</td>
<td>1. There should be the option to process the order for customers via an online shop. In this way, many products can be processed automatically in the online shop, without the hassle of manual intervention. Process steps such as printing emails, manual creation of invoices or checking stock availability can be automated. This would mean that the ordered goods would have to be prepared, packed and shipped by an employee only. In addition, ordering via the online shop is easier for many customers, as well as for the company, especially when ordering equipment or even complete device sets. This would also increase sales and speed up the ordering process without forgetting orders.</td>
</tr>
<tr>
<td></td>
<td>2. Orders placed by customers via e-mail must be printed out and will be forwarded to the responsible employee who is accountable for the creation of the invoice. In addition, orders by e-mail are sometimes not processed immediately and in some cases, they are forgotten.</td>
<td>2. Order which was given via e-mail should be automatically forwarded to a central system. There should be the option that the system checks the availability of the order and the relevant information should be adopted from the e-mail order for invoicing. In this way orders by e-mail will not be forgotten anymore.</td>
</tr>
<tr>
<td>Number and process name</td>
<td>Critical analysis</td>
<td>Improvement proposals</td>
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<tr>
<td>1.3 Order fulfilment</td>
<td>3. There are big problems with the article descriptions, as customer often use different names when accepting orders, what is misleading for some employees. Although there is a default of uniform description in the inventory, in practice different descriptions are used. In such cases, time is wasted looking for the right item in the warehouse and it needs to be communicated with other employees to ensure the correct order. Even on the invoice partly different descriptions appear, which can be also misleading for the customer.</td>
<td>3. A uniform description for all products must be made available for all employees.</td>
</tr>
<tr>
<td></td>
<td>4. When invoicing, the prices are looked up in a separate document.</td>
<td>4. The products should be electronically managed with their respective prices, which should be transferred automatically to the invoice document.</td>
</tr>
<tr>
<td></td>
<td>5. The complete order process of a customer with invoice and if available the order by e-mail will be archived in the invoice copy folder. Therefore, there is a very high number of archiving documents. Only the invoices and some invoice details are recorded electronically in the invoice list. To track the order processing processes of individual customers, the invoice copy folder must always be consulted.</td>
<td>5. An electronic documentation system should be made available in which all copies of an order are documented. This would eliminate a large portion of archiving documents and more storage space would be available. Thus, time can be saved as well as storage costs could be reduced.</td>
</tr>
<tr>
<td></td>
<td>6. All incoming and outgoing invoices are submitted monthly to the accounting firm and are not yet recorded electronically. The accounting firm must insert each invoice manually in their software to perform the required work. Incoming invoices are not recorded electronically and archived in folders in form of paper.</td>
<td>6. There should be the option to transmit the data electronically to the accounting firm. This would save time and costs. For this it would be necessary to scan all incoming invoices, to have them electronically. Furthermore, the transmission of data could be also done automatically each month.</td>
</tr>
</tbody>
</table>
**Number and process name** | **Critical analysis** | **Improvement proposals**
--- | --- | ---
1.4 Goods complement | 1. Several orders cannot be sent immediately because the assembling of a set of devices due to the missing components in the warehouse is not possible (see point 1.2 (1)).

2. When employees assembling devices and equipment, they often must search for the components, since stock keeping is not always maintained and as well as the problem with different article descriptions (see point 1.3 (3)).

3. Invoices must always be printed in advance to assemble the goods for the customers. For orders of devices containing serial numbers, the numbers must be written by hand after compilation the order in the invoice. Then the serial number must be inserted in the invoice document and then printed out again.

4. When customers make a larger order for devices and equipment, there is often a problem with time management, as milestones are not made transparent for the responsible employees and tasks are not handled well. The information flow is sometimes inefficient, as employees are not properly informed. This often leads to delivery problems because orders are not timely instructed. In addition, there are delays in order processing and sometimes a double workload for certain processes. | 1. The same improvement proposal as in point 1.2 (1).

2. The same improvement proposal as in point 1.3 (3).

3. There should be the option to select a device with the respective serial number automatically, which inserts the number in the invoice without the hassle and manual intervention.

4. There should be a module, which allows to plan for expenditures and resources, to centrally control and monitor quotations, for preparation and order processing. Thus, orders for suppliers can be better monitored and placed at the right time (see point 1.1 (3), 1.2 (1)). Furthermore, a responsible person is needed to handle large projects, to coordinate and control all partial tasks for the involved employees. This allows for a consistent information flow between all involved employees.
<table>
<thead>
<tr>
<th>Number and process name</th>
<th>Critical analysis</th>
<th>Improvement proposals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4 Goods complement</td>
<td>5. The devices are assembled according to the customer’s order. The employees assemble the devices, and if necessary additional equipment based on the invoice. Often the manual instruction is forgotten because it is not listed on the invoice.</td>
<td>5. For this, a checklist should be provided to the employees, to consider all necessary parts in the assembling of any order.</td>
</tr>
<tr>
<td>1.5 Goods output (general)</td>
<td>1. If customers pick up devices by their own and the devices contain a serial number, the entry in the goods output list (will collect) is usually forgotten. Furthermore, the book-off in the various inventory lists is often forgotten as well, and it can only be checked based on the output invoices, where the device is located. 2. In cases if the part-time assistance 1 is also responsible for assembling some equipment for an order, the employee must search components, since stock keeping is not always maintained and components are often stowed away on other shelves as well as the problem with different article descriptions (see point 1.3 (3), 1.4 (2)). 3. Orders, in which the goods should be assembled are partly unprocessed for days in the warehouse.</td>
<td>1. The sold devices should be automatically listed in a central inventory with the respective customer. 2. An optimal inventory should be kept electronically, with information about the location and with uniform article designations. This would give all employees a better overview of the existing products in the warehouse (see point 1.3 (3), 1.4(2)). 3. The same improvement proposal as in point 1.1(5)</td>
</tr>
</tbody>
</table>

Table 7.1 - Critical review and improvement proposals of the company “NT 940”

Source: Prepared by the author
### 7.2. Process “AN/PVS31”

<table>
<thead>
<tr>
<th>Number and process name</th>
<th>Critical analysis</th>
<th>Improvement proposals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AN/PVS31</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Goods receipt (ITAR)</td>
<td>1. The same critical analysis as in point 1.1 (2).</td>
<td>1. The same improvement proposal as in point 1.1 (2).</td>
</tr>
<tr>
<td></td>
<td>2. The same critical analysis as in point 1.1 (3).</td>
<td>2. The same improvement proposal as in point 1.1 (3).</td>
</tr>
<tr>
<td></td>
<td>3. The same critical analysis as in point 1.1 (4).</td>
<td>3. The same improvement proposal as in point 1.1 (4).</td>
</tr>
<tr>
<td></td>
<td>4. For the delivery of loan devices, these must always be photographed to ensure the completeness of the loan devices and its equipment for the next loan. The pictures are compared at the goods output with the pictures from the goods receipt and thus checked whether the delivery is complete.</td>
<td>4. For this purpose, each part of a delivery could be provided with a number so that all delivered parts are recorded in a central system at the goods output and can then be compared and checked with each other at the goods receipt. Furthermore, a checklist could be created for each device type, which contains all parts.</td>
</tr>
<tr>
<td>2.2 Loaned PVS31</td>
<td>1. A simple delivery note is sent along with the loan of devices. This contain only the device and possibly equipment. Additional information on how to handle the device (as it is not in the property of the customer) to avoid damage does not exist. The customer receives only the user manual with the test devices. Furthermore, the devices may not be given to third parties as these devices are covered by the ITAR regulations.</td>
<td>1. A additional information sheet on the use of loaned devices and how to handle them is necessary. Furthermore, clear guidelines must be defined in the event of damage.</td>
</tr>
</tbody>
</table>
## Critical analysis

2.3 PVS31 complement

1. The same critical analysis as in point 1.4 (1).

2. The same critical analysis as in point 1.4 (2).

3. The same critical analysis as in point 1.4 (3).

4. There is no overview of the sale of all devices. The devices sold for large projects is not recorded in an inventory management list. To track business transactions, the respective invoices must be consulted since they contain all the devices with the serial numbers (see also critical analysis 1.4 (4)).

2.4 Goods output (ITAR)

1. The same critical analysis as in point 2.1 (4).

### Improvement proposals

1. The same improvement proposal as in point 1.4 (1).

2. The same improvement proposal as in point 1.4 (2).

3. The same improvement proposal as in point 1.4 (3).

4. The same improvement proposal as in point 1.4 (4).

### Table 7.2 - Critical review and improvement proposals of the company “AN/PVS31”

Source: Prepared by the author
# 7.3. Process “General (Services)"

<table>
<thead>
<tr>
<th>Number and process name</th>
<th>Critical analysis</th>
<th>Improvement proposals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.1. Repairs L3 devices</strong></td>
<td>1. There are many different excel documents available which are required for the repair process. Data entry is partly done twice in the various lists.</td>
<td>1. An overview of all repair orders should be provided electronically in a central system. The goods receipt and output of repair and replacement parts can be accelerated and simplified. It would not take many different excel documents, and mistakes in data entry would be avoided. It would be also possible to automatically apply the same data to different tables without having to enter them twice.</td>
</tr>
<tr>
<td>3.1.2 Evaluation</td>
<td>2. One of the main problems in the repair process is the high processing time which can be up to 220 days. Often the customer sends a device to be repaired without equipment parts. At the goods receipt, it is checked which parts were supplied, but if the customer has not sent equipment this will be added to the quote for missing parts. For this, the employee must check the stock inventory whether the parts are in stock and if not when they can be delivered. The information is then recorded in the quote and handed over to the customer. In the case that the customer does not want any equipment, since he did not send it or no longer needed, the effort would have been in vain by the employee.</td>
<td>2. To avoid unnecessary work step of the employees, it would be necessary to send a document in advance to the customer, that all relevant information for the repair can be made available. Furthermore, the customer can specify on this document which device it is and which equipment parts are send or needed in the future.</td>
</tr>
<tr>
<td>3.1.3 Quote and material procurement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.4 Goods receipt (L3 spare parts)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.5 Repair pass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and process name</td>
<td>Critical analysis</td>
<td>Improvement proposals</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>3.1. Repairs L3 devices</td>
<td>3. The RMA number will only be issued when the goods are received for repair. A planning of possible order for spare parts or equipment can only be made after the goods have been received. In addition, the RMA number is handwritten on the repair accompanying card and attached to the device.</td>
<td>3. Here it would be advantageous for better planning and monitoring of the spare parts, if the customer is assigned the RMA number for his defective device when registering. With a central system, an RMA number could be immediately assigned to the information document for repairs. Furthermore, the information document can then be sent via e-mail automatically to the respective customer, so that he would only have to fill in or complete the required information and send it to the company together with the device.</td>
</tr>
<tr>
<td>3.1.2 Evaluation</td>
<td>4. There is no inventory management for equipment parts. In some cases, repaired devise could not be sent to the customer because of the missing equipment parts as in point 1.1. (1), 1.2 (1), 1.2. (3).</td>
<td>4. The same improvement proposal as in point 1.1 (1), 1.2 (1), 1.2. (3).</td>
</tr>
<tr>
<td>3.1.3 Quote and material procurement</td>
<td>5. After the quote is created, it will be forwarded to another employee for invoicing. For this, the data must be manually transferred from the quote to the invoice document.</td>
<td>5. The invoice could be automatically created from the quote. For this, the data from the quote is automatically transferred to the invoice document.</td>
</tr>
<tr>
<td>3.1.4 Goods receipt (L3 spare parts)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.5 Repair pass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and process name</td>
<td>Critical analysis</td>
<td>Improvement proposals</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>3.2 Repair NT devices</td>
<td>1. If customer has a defective device e.g. NT 940 and does not report to the product manager or workshop manager, inefficiencies occurs because missing information about the devices to be repaired are not noted in advance.</td>
<td>1. An additional document for registration of defective devices would be necessary. If the workshop manager or representative are not available, all employees can complete the recording of the relevant data for the registration of the defective devices with the document.</td>
</tr>
<tr>
<td></td>
<td>2. There is also the problem in this repair process which is the high processing time, sometimes up to 150 days (see point 3.1. (2)).</td>
<td>2. The same improvement proposal as in point 3.1. (2).</td>
</tr>
<tr>
<td></td>
<td>3. The same critical analysis as in point 3.1. (3).</td>
<td>3. The same improvement proposal as in point 3.1. (3).</td>
</tr>
<tr>
<td></td>
<td>4. The same critical analysis as in point 3.1. (4).</td>
<td>4. The same improvement proposal as in point 3.1. (4).</td>
</tr>
<tr>
<td></td>
<td>5. There are some problems with the delivery times of the suppliers of spare parts or equipment parts. The delivery times are not controlled and there is no uniform overview of all suppliers (see point 1.1 (3), 1.2. (1), 1.2. (3)).</td>
<td>5. The same improvement proposal as in point 1.1 (3), 1.2. (1), 1.2. (3).</td>
</tr>
<tr>
<td></td>
<td>6. After finishing the repair of the devices, the repair order is written by hand on a paper which is handed over to the administrative staff for invoicing. There is no special repair invoice document available. The data entry is done twice (see 3.1 (5)).</td>
<td>6. The same improvement proposal as in point 3.1 (5).</td>
</tr>
<tr>
<td>Number and process name</td>
<td>Critical analysis</td>
<td>Improvement proposals</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3.3 Loaned devices</td>
<td>1. One of the biggest problems is that the loaned devices (e.g. NT940) are forgotten by the employees. These will only be listed in the general NT list and a reminder date is set in the e-mail. For monitoring, the NT list is not sufficient because often not even a date on loaned devices is registered. Nevertheless, the devices are often sent back much too late.</td>
<td>1. All loaned devices should be recorded and reported to the responsible employee automatically if the loan period is exceeded. Furthermore, a reminder e-mail can be automatically created and send to the customer as soon as the loan period is exceeded. It could be checked automatically whether the device has arrived after the customer has been informed and after a further period has elapsed. If the device has not arrived after the expiry of the second deadline, the employee can be notified automatically, so that he can ask the customer himself.</td>
</tr>
<tr>
<td></td>
<td>2. There are no special test devices in the company available. Devices that are loaned to customers are often send back late, since the employees do not have a good overview of the test period. Accordingly, the devices lose their value if they are used over the duration of the test period and many devices cannot be sold if they are in the loan.</td>
<td>2. There is a need for better monitoring, as well as the overshoot times should be reduced, which in turn would allow more devices to be sold. Furthermore, the company should offer special devices only for test use to reduce the often-lost value of many devices.</td>
</tr>
<tr>
<td></td>
<td>3. A simple delivery note with the user manual is sent along with the loan of devices. This contain only the device and possibly equipment. Additional information on how to handle the device (as it is not in the property of the customer) to avoid damage does not exist. Therefore, partly defective devices come back. In cases if the devices come back defective, it is discussed individually whether the customer must buy the defective device or should pay for the repair. This will not be clarified in advance with the customer.</td>
<td>3. A additional information sheet on the use of loaned devices and how to handle them would reduce the repair rate of loaned devices. Furthermore, clear guidelines must be defined in the event of damage.</td>
</tr>
</tbody>
</table>
### 7.4. DISCUSSION OF IMPROVEMENTS

Table 7.4 presents the technologies for the proposed improvement options.

<table>
<thead>
<tr>
<th>Process number</th>
<th>Technology</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>- It allows a complete overview of all orders which can be assigned to the employees.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Automatic serial number generation of different products.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Through the introduction of an online shop and the integration with the ERP system, many products can be processed automatically in the online shop.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- For all employees, a uniform article description would be provided for invoicing and the warehouse, as well as for the customer.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- All available products would be deposited with the respective prices and when an invoice is created, these are automatically transferred.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- It provides a document system in which all the processes of the orders from the order to the outgoing goods are documented.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- All data could be transmitted electronically to the accounting firm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- It selects a device from stock when creating the invoice and insert the corresponding serial number into the invoice.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- It provide an overview of all orders and the necessary equipment with the respective suppliers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- A sold device is automatically posted in the inventory with the respective customer.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- An optimal inventory can be kept, with information about the location.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- It provides a complete overview of all repair orders.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The RMA number could be immediately assigned to the information document for repairs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- It could record all loaned devices and report it to the responsible employee automatically if the loan period is exceeded.</td>
</tr>
</tbody>
</table>
| 1.1 (1), 1.2 (1), 1.2 (2), 1.4 (1), 1.4 (2), 1.4 (4), 1.5 (2), 2.1 (4), 2.3 (1), 2.3 (2), 2.4 (1), 3.1 (3), 3.1 (4), 3.2 (4), 3.2 (5) | Barcode or RFID | - A barcode or RFID system could be used to detect automatically all goods in an ERP system.  
- The serial number can be engraved with a barcode on the device by a laser. This allows the barcode to be electronically recorded in the central warehouse.  
- Smartphones can be equipped with an app so that they can scan the QR code and show the employee which products are on the shelf. This can significantly accelerate the search for the components.  
- Any RMA number could be attached to the accompanying card with a barcode or RFID. |
| 1.2 (1), 1.3 (2), 1.3 (6), 1.4 (1), 1.4 (4), 2.3 (1), 3.1 (1), 3.1 (3), 3.1 (4), 3.1 (5), 3.2 (3), 3.2 (5), 3.2 (6), 3.3 (1) | RPA | - RPA can be used to order automatically as soon as the minimum stock is reached. For this purpose, the respective supplier must be deposited for the components and goods.  
- A reminder e-mail can be automatically created and sent as soon as the delivery times is exceeded.  
- It can be used to check whether the goods have arrived after the supplier has been informed and after a further period has elapsed. If the goods have not arrived after the expiry of the second deadline, the employee can be notified automatically by RPA, so that he can ask the customer himself.  
- Orders which were given by e-mails could be automatically forwarded to the ERP system. There, the ERP system checks the availability of the order and the RPA software adopts the relevant information from the e-mail order for invoicing. For this purpose, a specific structure should be present in the e-mail so that RPA can process the order. The information which structure should be used for ordering by email should be provided for example on the homepage of the company. In case that RPA cannot process an order due missing information, a message would appear so that an employee checks it and, if necessary handles it by himself.  
- Scans such as incoming invoices can be automatically transferred to the ERP system. Furthermore, it can compile monthly all incoming and outgoing invoices and automatically forwarded to the accounting firm.  
- It can be used to automatically apply the same data to different tables without having to enter them twice.  
- Any information document can be sent via e-mail automatically |
to the respective customer, so that the customer only has to complete the required information and send it back to the company.

- The invoice could be automatically created from the quote, by using an ERP system and RPA.

- A reminder e-mail can be automatically created and sent as soon as the loan period is exceeded. Furthermore, it could be used to check whether the device has arrived after the customer has been informed and after a further period has elapsed. If the device has not arrived after the expiry of the second deadline, the employee can be notified automatically by RPA, so that he can ask the customer himself.

Table 7.4 - Technologies for proposed improvements

Source: Prepared by the author

Furthermore, the requirements for an ERP system are proposed for the company under study. An ERP system must be able to map the requirements and needs of the company through functional modules. Accordingly, this must support all corporate division and their data collected, presented clearly and consistently. Thus, data can be easily recreated or changed. One of the most important requirements of a modern ERP system is the modular construction. This allows the company to flexible extend or reduce the functional scope, as needed.

The following modules should be therefore taken into consideration:

- Merchandise management (Inventory management, order tracking, mobile inventory control, sales, sales controlling, and purchasing)

- Customer relationship management (CRM) (Campaign management, sales forecasts, management information system, and integrated document management)

- Financial and accounting (Payments transactions, dunning, liquid planning, budget planning, and DATEV-export)

- Integrated management system (Process documentation and risk management)

- Project organization (Multi-project management and graphical resource planning)

- E-business (Online-shop)

- Service management (Service and repair orders and e-mail integration)
8. CONCLUSION

8.1. ANALYSIS OF THE RESULTS

This work project starts with the intention of modeling several value-adding processes of the company. It is a high-tech company and one of the leading companies in the optoelectronic sector. Some of the modeled processes were already documented in several documents, but it was necessary to conduct a new study to complete the processes. The objective of this work project, was to model the value-adding processes of the company, and through its analysis, propose improvements. Literature research was a prerequisite for modeling and analyzing the processes to understand both the BPM approach and the current technologies to apply the best practices. After the study and analysis, it was possible to create process models. The modeling of the current processes was done with BPMN 2.0 with the Bizagi Process Modeler tool. The modeling phase was of particular importance, which was possible with the help of the company’s employees. This was also interesting for the employees, as the diagrams presented a different view of the processes based on the descriptive presentation of the diagrams.

Helping to analyze the strengths and the potential for improvements also made employees aware of the importance of a clear presentation of the processes. The processes become more transparent for all involved. Process modeling is a useful tool for the company, it allows a clear understanding of the processes that are performed daily by the employees. In this way, it was possible to reach the proposed objectives and propose several possible improvements in the processes. The modeling and analysis of processes are two of the main important aspects for any process improvement activity. During the modeling, it came out that there were many different documentations for the various processes needed. Due the fact, that also some important processes are not recorded electronically there is a huge amount of printed archived documents. There is no inventory management which causes inefficiencies and decreased labor productivity. Therefore, one of the main suggestion was to introduce an ERP system, which allows a centralized and consistent data, as well as encouraging collaborative, interdepartmental efforts. Furthermore, it greatly reduces the need to manually enter information and allows to proactively manage operations, prevents disruptions and delays, breaks up information logjams and helps users make decisions more quickly. In this way, it improves the efficiency and productivity, used to make realistic estimates and more effective forecasts. In addition, helping user navigate complex processes, preventing data re-entry, and improving functions such as production, order completion and delivery.

8.2. LIMITATIONS

The main areas of difficulty were identified as, that there was no graphical documentation available, it was an ongoing task to capture information for modeling processes from the employees. In addition, the project also requires the time effort by the various employees involved in each modeled process, which was not easy because the employees in their work are busy and could not always be available. In overall, it can be said that with the literature review and the critical inquires of the employees regarding the processes, deficits and possibilities for improvement could be analyzed. To increase productivity and efficiency in the future, it is indispensable for the company to integrate a centralizes system that will considerably improve the interaction of all processes.
8.3. Future work

Finally, in all projects there are always ways to improve them, as this work project shows that much can be done to achieve better results. The company under study can only improve if they don’t take BPM as one-off project, but as a continuous activity that is a part of their business strategy. If activities and their relationships are identified and represented, stakeholders are able to communicate these processes in an efficient and effective manner and potentials for improving them can be developed (Weske, 2007).

For the future work, the modeling of the “TO-BE” models are necessary after the modeling and analysis of the most important value-adding processes of the company, which was done in this work project. The “TO-BE” models must be adapted and created, considering all the suggestions for improvement as well as the needs of the company. Thereafter, the implementation of the new diagrams should be carried out to be able to show the performance difference by further modeling and analyzing the processes. Thus, the BPM lifecycle is reintroduced, with the intension always on the way to discovering new needs and finding innovations.
BIBLIOGRAFY


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ANNEX

A.

1. Goods receipt (general)

The employee commissioned for the goods receipt basically carries out the following activities at the packing station:

- Check if goods are for IEA (address)
- Check the outer packaging for visible damage
- Check if package is containing a seal of customs - if yes definitely not open it
- Carefully open the box with the knife so that the goods are not damaged
- Dispose of packaging and packaging materials properly (waste separation or reuse)
- Check the packaging for visible damage
- Check the condition of the goods for visible defects
- Check if delivery note is available on the parcel, therefor they are two variants A and B

Variant A: Delivery note is not included in the package:

- Take a replacement delivery note from the gray box on the packaging table
- The following fields are added to the replacement delivery note:
  Message for ___, from company, Mr/Ms, Street/Nr., ZIP/City, Email, Telephone, Mobile, Fax,
  Goods: pcs, goods, N/S, subject, Goods receipt stamp with abbreviation

Variant B. Delivery note is included in the package:

- Check if the description of the goods agrees with the delivery note
- Check if quantity agrees with delivery note
- Check if the serial number of the goods matches the data on the delivery note
- Documentation of the serial number of the goods on the delivery note, if there is no information available
- If serial number is present on the goods, then enter in white folder (on the packaging table): date of receipt, zip code, description of goods, serial number and sender
- Stamp delivery note with goods receipt stamp and sign off with name shortcut
- Copy the delivery note/replacement delivery note and place it in the "Copy delivery note" folder after the goods receipt date. (Delivery rail are collected in the folder "delivery notes for one year")
- Store goods in blue display box
- Place delivery note in the blue display box
- If an invoice is included, also put in the blue display box
- Store goods at the incoming goods store
## 2. Goods receipt (ITAR)

### Workflow for goods receipt / goods issue of ITAR goods Demo material

The employees responsible for the work process basically carry out the following activities:

### 1. Incoming inspection for parcels of ITAR goods demo material

The employee responsible for the incoming goods generally carries out the following activities at the packing station (part-time assistance / workshop manager / administrative staff):

- Check if goods are for IEA (address)
- Check the outer packaging for visible damage
- Check if package is provided with seal of customs - if yes open in any case
- Carefully open the box with the knife so that the goods are not damaged
- Dispose of packaging and packaging materials properly (waste separation or reuse)
- Check the packaging for visible damage (part-time assistance / workshop manager / administrative staff)
- Check if the battery compartment is facing upwards if the battery compartment is not visible, carefully close the packaging again and immediately inform the laser safety officer
- Check if delivery note is present on the parcel, there are two variants A and B for this
- Check the condition of the goods for visible defects check that the description of the goods agrees with the delivery note
- Check if quantity agrees with delivery note
- Check whether the serial number of the goods matches the data on the delivery note
- Documentation of the serial number of the goods on the delivery note, if there is no information available
- If serial number is available on the goods, then enter them in the folder (on the packaging table): date of receipt, zip code, description of goods, serial number and sender
- Stamp delivery note with goods receipt stamp and sign off with name shortcut

### Variant A: Delivery note is not included in the package:

- Take a replacement delivery note from the gray box on the packaging table
- The following fields are added to the replacement delivery note:
  - Message for ____, from company, Mr / Ms, Street / Nr., ZIP / City, Email, Telephone, Mobile, Fax,
  - Goods: pcs, goods, N / S, subject
- If serial number is present on the goods, then enter in folder "Serial numbers WE" (on the packaging table): date of receipt, zip code, description of goods, serial number and sender
- Stamp delivery note with goods receipt stamp and sign off with name shortcut

### Variant B: Delivery note is included in the package:

- Check whether the description of the goods agrees with the delivery note
- Check if quantity agrees with delivery note
- Check if the serial number of the goods matches the data on the delivery note
- Documentation of the serial number of the goods on the delivery note, if there is no information available
- If serial number is present on the goods, then enter in folder "Serial numbers WE" (on the packaging table): date of receipt, zip code, description of goods, serial number and sender
- Stamp delivery note with goods receipt stamp and sign off with name shortcut
3. Goods output (general)

A. Goods output at parcel delivery
The employee commissioned for goods output basically carries out the following inspection activities after provision of the goods:

- Check if the goods correspond to the description in the delivery note/invoice
- Check if the quantity of the goods agrees with the delivery note (check the position on the order)
- Check the condition of the goods for visible defects
- Check if the serial number of the goods matches the data on the delivery note
- Documentation of the serial number of the goods on the delivery note, if there is no information available (Documentation of all serial numbers in the blue folder on the packaging table)

Basic control on goods issue
Basically, no goods leave the house without a second employee checking the following criteria again:

- Control is to be carried out by 2 employees
- Matched goods with description in the delivery note
- Coordinated quantity with delivery note
- Match serial number of the goods with data on the delivery note if available

Packing

- Lay out the goods with the order and photograph them (print out the L3 product documentation and attach it to the process)
- 2 invoices (invoice original and a copy) / (exception of delivery note only one copy) stamp with goods output stamp and signed by two employees (2 bills or 1 delivery note remains in the house)
- An invoice/delivery note in red mailer (DPD shipping) and stick to the package
- When shipping with Fedex, use Fedex shipping bag; when shipping with UPS, use UPS shipping bag
- Pack the goods
- For optics and fragile goods affix tape “Caution glass”
- Weigh the package, note the weight on the invoice/delivery note (below)
- Place invoices/delivery notes in storage compartment GO

B. Goods output by employee (by supply)

- Display goods with order
- If serial number is present on the goods and no serial number is entered on the invoice/delivery note: Note serial number on invoice/delivery note
- If serial number is on invoice/delivery note: chop off serial number
- Enclose an invoice/delivery note in an IEA envelope and to the goods
- 2 bills (invoice original and a copy) / (exception for delivery note only one copy) stamp with GO stamp and signed by two employees (2 bills or 1 delivery note remains in the house)
- Lay out the goods with the order and take pictures
- Enter the serial number in the list “Goods output by customer”
- For invoices order slide to accounting (exception: weapons, ITAR products to Management/Administrative clerk)
- Delivery notes in box “Delivery notes” (in the office Management)
- When delivering the goods, have a delivery note/invoice acknowledged by the customer

C. Outgoing goods at pickup

- If serial number is present on the goods and no serial number is entered on the invoice/delivery note: Note serial number on invoice/delivery note
- If serial number is on invoice/delivery note: chop off serial number
- 2 invoices (invoice original and one copy)/(Exception for copies only one copy) remains in the house. Sign an invoice/delivery note as a receipt from customer
- Pass goods to customers
- Hand over an invoice/delivery note to the customer
- Customer acknowledges receipt of the goods on our invoice copy
- When paying in cash, the employee confirms receipt of the purchase price on the customer invoice
- Enter goods with serial number in the list Goods issue by customer
- For invoices order slide to accounting (exception: weapons, ITAR products to Management/Administrative clerk)
- Delivery notes in box "Delivery notes"

D. Outgoing goods transport (by employees for example trade fair, presentation, demonstration ...)
- Enter the name, address, date and reason in the goods transport list
- Enter the number of goods, description of goods, serial number, accessories and value of goods in the list goods transport
- Lay out goods with list of goods transport and take photos
- Pack the goods safely

Control at goods issue Goods transport
- Control is to be carried out by 2 employees
- Coordinate prepared amount with the goods transportation document
- Matched goods with designation on the goods transport list
- Match serial number of the goods with data on the delivery note
- Matching accessories with list goods transport
- Agreement of goods value with list of goods transport
- Stamp with GO stamp and sign by two employees
- Copy the goods issue list (copy with copy stamp)
- A list is to be carried along with the goods
- A list appears in box "Delivery notes"
### 4. Goods output ITAR

**Note:** Delivery notes are created exclusively by workshop manager or administrative staff. The employee commissioned for the goods issue (commissioned) basically carries out the following inspection activities after provision of the goods (part-time assistance / workshop manager / administrative staff)

- Check whether the battery compartment is facing upwards in the case of a laser, if the battery compartment is not visible, carefully move the goods back and immediately inform the laser safety officer
- Check whether the goods correspond to the description in the delivery note / invoice
- Check if the quantity of the goods agrees with the delivery note (check the position on the order)
- Check the condition of the goods for visible defects
- Check whether the serial number of the goods matches the data on the delivery note
- Documentation of the serial number of the goods on the delivery note, if there is no information available
- Documentation of all serial numbers in the "Outgoing goods folder" on the packaging table

Basically, no goods leave the house, without the following test criteria being checked again by a 2nd employee (part-time assistance / head of workshop / administrative staff)

- Control is to be carried out by 2 employees
- Check whether the battery compartment is facing upwards in the case of a laser, if the battery compartment is not visible, carefully move the goods back and immediately inform the laser safety officer
- Matched goods with description in the delivery note
- Coordinated quantity with delivery note
- Match serial number of the goods with data on the delivery note if available

**Packing:**

- Lay out the goods with the order and take pictures
- Print out the photo and place it on the delivery note
- Stamp a delivery note with goods output stamp and have it signed by the second employee - a delivery note remains in the house
- Stick a delivery note in red mailer (for ELB shipping) and to the package
- When shipping with Fedex, Fedex shipping bag use us to stick to the package
- When shipping with UPS, use UPS shipping bag and stick to the package
- Pack the goods
- For optics and fragile goods affix a sticker "Caution glass"
- Weigh the package, note the weight on the delivery note (below)
- Delivery notes go to the administrative staff

**B. Goods issue by employee (by supply)**

The employee commissioned for the goods issue (commissioned) basically carries out the following inspection activities after provision of the goods (part-time assistance / head of workshop / administrative staff)

- Check whether the battery compartment is facing upwards in the case of a laser, if the battery compartment is not visible, carefully move the goods back and immediately inform the laser safety officer
- Design goods with order
- Chop off serial number on delivery note
- Enclose a delivery note in IEA envelope & to the goods
- Stamp delivery note with WA stamp and have it signed by two MA, a delivery note remains in the house
- Lay out the goods with a job and take pictures
- Print out the photo and place it on the delivery note
- Enter the serial number in the list Goods issue by customer
- Have the delivery note acknowledged by the customer
- Delivery note / documents to the administrative staff
C. Outgoing goods at pickup
The employee commissioned for the goods issue (commissioned) basically carries out the following inspection activities after provision of the goods (part-time assistance / head of workshop / administrative staff)

- Check whether the battery compartment is facing upwards in the case of a laser, if the battery compartment is not visible, carefully move the goods back and immediately inform the laser safety officer
- Chop off serial number on delivery note
- Lay out the goods with a job and take pictures
- Print out the photo and place it on the delivery note
- A delivery note remains in the house to have a delivery note signed by customers as a confirmation of receipt
- Transfer goods to customers
- Hand over an invoice / delivery note to the customer
- Customer acknowledges receipt of the goods on the delivery note
- Enter goods with serial number in the list Goods issue by customer
- Delivery note / documents to the administrative staff

D. Outgoing goods transport (by employees for example trade fair, presentation, demonstration ...)
The employee commissioned for the goods issue (commissioned) basically carries out the following inspection activities after provision of the goods (part-time assistance / head of workshop / administrative staff)

- Enter the name, address, date and reason in the goods transport list
- Check whether the battery compartment is facing upwards in the case of a laser, if the battery compartment is not visible, carefully move the goods back and immediately inform the laser safety officer
- Enter the number of goods, description of goods, serial number, accessories and value of goods in the list goods transport
- Lay out goods with list goods transport
- Photographing goods
- Print out the photo and place it on the delivery note
- Pack the goods safely
- List of goods transport / documents to the administrative staff

Basic control at goods issue goods transport
The employee commissioned for the goods issue (commissioned) basically carries out the following inspection activities after provision of the goods (part-time assistance / head of workshop / administrative staff)

- Control is to be carried out by 2 employees
- Check whether the battery compartment is facing upwards in the case of a laser, if the battery compartment is not visible, carefully move the goods back and immediately inform the laser safety officer
- Coordinate targeted amount with the goods transportation document
- Matched goods with designation on the goods transport list
- Match serial number of the goods with data on the delivery note
- Matching accessories with list goods transport
- Agreement of goods value with list of goods transport
- Stamp with WA stamp and sign by two MAs
- copy the goods issue list (copy with copy stamp)
- A list is to be carried along with the goods
- A list goes to the administrative staff
## 5. NT devices assembling

### Completion of Night vision devices

1. Selection of a tube data sheet according to customer requirements
2. Provide the appropriate tube based on the data sheet
3. Selection of a housing according to the customer requirements
4. Apply rating plates & lens protection stickers
5. Mounting the tube
   - Screw on and clean housing
   - Remove the tube and clean both lenses carefully and thoroughly. Pay attention to the smallest black dots and streaks.
   - Grease the tube at the front.
   - Insert the tube into housing. Pay attention to exact fitting. Note groove guide.
   - Insert the plastic clamping ring behind the tube. (Must be inserted without effort)
   - Grease the tube on the rear.
   - Screw on eyepiece and lens. (Attention threads are sensitive to tipping)
   - Put on the lens cap and insert the batteries.
   - Switch on the device for the function test.
   - Look at a white wall with the device switched on and check for any interfering particles in the field of vision. If defective, disassemble the device and repeat the last six steps
   - Documentation, on picture tube test sheet are recorded:
     - Type / IEA Ser. / Housing no.
     - Record a circle and draw in points on the image area
     - Colored marking on device by sticker green / yellow / blue
   
   Green = XX1441AH, XX1451V
   Yellow = XX1441CB
   Blue = XW1441A, XW1451V

   Caption with luminance sensitivity/resolution/signal noise
   - Assembling the accessories (Light Kit/Heavy Kit)
     - Light Kit: case with 2 lenses, cleaning cloth, line
     - Heavy Kit: bag with 2 lenses, cleaning cloth, cord headset, adapter, strap

6. Enter the device data (type & IEA Ser. No.) in the list tube and change the color code if necessary (green = present / black = absent / yellow = rented)
6. Repair L3 devices

Customer accepts quotation:
- Enter date in repair overview ITAR
- Abandon parts from stock (as specified) and place to device.
- If parts are not in stock order at L3 (by product manager), specify RMA number on order. Order under TAA. Parts must already be market in red in the excel folder "Repair Parts "! Inventory may change, so update.
- Enter in Repairing overview ITAR under Short-Parts if part is missing

If all device-specific (not kit content / inventory sheet) parts exist, perform repair as specified:

Operator

Perform work stages according quotation with:
- Operational checkout
  - Purge (Mark with a pen the norm box “N2”)
  - Group A Data Sheet 2 (Res. And Col.) Process digitally fill out and print out.
  - Final Clean (Mark with a pen the norm box (FC))
  - Compare visual inspection/supplement parts, check off/replaced

Complete sentence contents with missing parts or damaged parts. In suitcase (Stores on the shelf "empty container customer")
- Tally in repair overview/received date. If all parts are there, prepare the device for final inspection at the test station.
- If parts are missing for sentence content, keep red marking in the overview. Consult with customer if he wants to return the device "incompletely".
- If the customer wants the device "incompletely", mark red parts in the repair overview. Enter date in repair overview ITAR by operator.

Operation checkout inspector device includes:

Inspector needs to check:
- Operational checkout after maintenance manual
- Group A Datasheet 2 verification. Comparison no. 1 to 2, if necessary follow-up check for large deviations. Then enter digitally under datasheet 2 (Inspector / Date).
  - Purge whether held on norm box.
  - Final clean if FC on norm box is held.
  - Enter in repair overview ITAR Operational Checkout Inspector

Complete Inspection (with sentence content) includes:

Inspector must check test place "incoming/outgoing goods":

Operator must prepare:
- Visual Inspection in paper form - with old parts
- Quotation adjust for deviations
- Inventory Sheet (misspelled sentence added?), if ok, then register in rep. overview ITAR "Complete Inspection Inspector"
- Dissolve norm box and finish set
- Inspector is only 2nd employee of the briefing according to Excel book in Operational Checkout this device type has
- Invoice can be created by the administrative clerk or workshop manager according to quotation (possibly minus missing parts that are forwarded, marked in red)!
- Operation with all documentation back at administrative clerk. "Invoice creation goods output L3”.

Administrative staff: If invoice created in repair summary enter in ITAR.
- Finished invoice comes from administrative staff back in tray. "Invoice goods output L3” At administrative staff office.
- Form for invoice has yet to be made.
Fill in in case of the first time (already stored in folder PVS-31 with series): Ser. no., grade.
- At every return material automation (RMA), RMA no., Unit history, Prod, MA, Date

Goods output:
- Finished equipment set stored on the shelf
- When the device is picked up, have the customer sign the invoice or for parcel shipment, goods will be placed and signed by workshop L3 in goods issue.
- In repair summary enter ITAR as "shipped".

7. Order fulfilment

The following procedure describes the procedure for the EDV technical creation of an order after receipt of order by the customer.

1. Reroute the collected correspondence with the customer from a yellow slide (OFFER) to a green folder (JOB).
2. Open the following lists: Seller.RE..xls, sellers.invoice.table.xls, ordertemplate.doc
3. Enter the corresponding billing address in the order template.
4. Create a new invoice line in the SKUAR list according to the following criteria.
   - Column Document Type: Number is as follows: R = FIX / 5050. = consecutive number / 0110. = date in month and year / i = inland (e = EU and d = third country)
   - Date column: Enter date of creation
   - Customer column: Enter the name of the customer
   - Article column: Enter a short description of the article
   - Column net: Enter the net price incl. Shipping costs
   - Column VAT: Computes automatically if the line has been copied
   - Column gross: Computes automatically if line was copied
   - Column Comments: Add if available
   - Columns After: Serve the rough overview of still open debtors
5. Select the current, consecutive invoice number from the SKUAR list and enter it in the order template
6. Enter the delivery method and delivery address according to the agreements with the customer
7. Create an invoice in the Invoice List according to the offer and calculate it with the applicable prices.
8. Copy the invoice from the Invoice table list to the order template. (See example table below)
9. Define the terms of payment in writing (if required by agreement).
10. The standard instructions (see red marked sample) remain the same, unless otherwise agreed.
    The goods remain our property until full payment.
    For this order applies for both sides exclusively German law according to HGB or BGB as well as jurisdiction Böblingen as agreed.
We thank you for your order and wish you much success with our products.
11. Instructions for return and invoice date are also standard (see red marked pattern)
    • Returns only to our house address, carriage paid and insured!
    • Invoice date is delivery date unless otherwise stated.
12. Optional for item 11: For export probability of goods subject to export license following
    Add note:
    • In case of export from the EU, observe the export license requirement (BAFA).
13. Invoice Save in list RE.LS under the COD and invoice number
14. Print the invoice 3 times (4 times billing address and delivery address different) and place it in Green Folder for correspondence.
Edit order after VA_order processing
8. Repair NT devices

The staff responsible for the repairs carry out the following activities

The employee responsible for the initial test must perform the following tasks:
- Check if display boxes with repairs on the shelf "goods receipt" are available
- The initial inspection must be carried out daily within 24 hours after receipt of the goods
- If the initial test cannot be processed by the responsible employee, his representative is responsible for this, the responsible employee must inform his representative in before
- The following data is entered manually in the paper repair list (folder is in the shelf repairs):
  Serial no., Customer, input data, model designation, serial number, findings, previous repair period
- The identical data entered manually in the repair list must be entered in the repair list in the PC
  IEA - Night Vision - Repair List 2016
- Blank repair accompanying card is removed from the repairs folder
- The following data is entered in the repair accompanying card:
  - Serial number, customer, date of receipt, model name, serial number, findings, estimated repair time
- - Lfd.Nr. on visual box with red round sticker
- Visual box is placed in the shelf Repairs in the workshop Dessert after the Ifd. No sorted

Repair: there are two variants:
A. Device can be repaired immediately
B. Device can not be repaired immediately (for example, parts must be ordered ...)

A. Device can be repaired immediately
- Device is being repaired
- The following fields are filled in the repair accompanying card:
  - Repair completed on, actual repair time, loan tube, done on, engineer, control of 2nd MA, costs
  - The following data are entered in the paper repair list by hand (repair completed on, actual repair time, lead tube, done on, engineer, control of 2nd MA, costs)
  - The identical data entered manually in the repair list must be entered in the repair list in the PC - IEA
  - Night Vision - Repair List 2016
  (Repair completed on, actual repair time, loan tube, done on, engineer, control of 2nd MA, costs)
  - Display box with the repair accompanying card is parked in the "interim storage goods issue"
  - Pass the protective cover with repair accompanying card to the administrative staff

B. Device cannot be repaired immediately
- The device is stored on the shelf "repairs in progress"
- After all parts are available for repair:
- Device is being repaired
- The following data are entered in the paper repair list by hand (repair completed on, actual repair time, lead tube, done on, engineer, control of 2nd employee, costs)
- The identical data entered manually in the repair list must be entered in the repair list in the PC
  (repair completed on, actual repair time, lead tube, completed on, engineer, control of 2nd MA, cost)
- Display box with the device is parked in the "interim storage goods issue"
- Pass the protective cover with repair accompanying card to administrative staff
9. Loaned devices

Expiry of loaned goods to end customers

- Customer orders night vision device for test
- Customer must prove a valid purchase authorization as security
- Sales clerk, workshop manager, product manager, manager, administrative staff creates delivery note
- Tube is taken from the tube list by the clerk
- Goods will be sent
- Order goes to the administrative staff - Shipping note is created
- After shipping the loan devices, the administrative staff notes on the delivery note in the upper right corner, that she has entered the customer in the list of end user loan items "Loaned"
- The delivery note is forwarded to the responsible clerk for monitoring
- The monitoring is done by Outlook by the responsible clerk - Loan period must be kept
- If the customer has not returned the device within the deadline, the clerk will call the customer to ask if everything is OK with the device is.
- After returning the device, the clerk carries the tube out of the tube list and stores the goods after receiving the goods again
- When buying the delivery note must be back to the administrative staff, the purchase is added to the list of loaned goods and noted on the delivery note
- Once the note has been made, the process is done
B.

1. Invoice list

2. Repair overview ITAR
3. Device PVS folder No.xxx

4. Overview spare and parts list PVS No.xxx
5. Goods demo material list (ITAR)

6. NT list
## 7. Repair NT List

![Excel Sheet](image-url)

The table above shows a list of repairs for NT (Network Time Protocol) systems. Each row represents a repair request with details such as the date, description, and status. The columns include identifiers for easy reference and tracking. The table is well-organized, allowing for efficient management of repair requests.

### Key Columns:
- **Date**: Date of the repair request.
- **Description**: Detailed description of the repair issue.
- **Status**: Current status of the repair request.
- **Requestor**: Person who requested the repair.
- **Date Requested**: Date when the repair request was made.
- **Due Date**: Deadline for completing the repair.
- **Assigned**: Person assigned to handle the repair.
- **Completed**: Status indicating whether the repair is completed.

This system ensures that all repair requests are tracked and managed effectively, allowing for prompt resolution of issues.
### 8. Price list (general) a)

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Model</th>
<th>Price (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT 910,</td>
<td>Gen 2 Ultra HP</td>
<td></td>
</tr>
<tr>
<td>NT 910,</td>
<td>Gen 2 Ultra HP Select</td>
<td></td>
</tr>
<tr>
<td>NT 910, Full Kit,</td>
<td>XD4</td>
<td></td>
</tr>
<tr>
<td>NT 910, Full Kit,</td>
<td>XRS</td>
<td></td>
</tr>
<tr>
<td>NT 910, Full Kit,</td>
<td>XRS AG</td>
<td></td>
</tr>
<tr>
<td>NT 910-4</td>
<td>Gen. 2 Ultra HP</td>
<td></td>
</tr>
<tr>
<td>NT 910-4</td>
<td>Gen. 2 Ultra HP Select</td>
<td></td>
</tr>
<tr>
<td>NT 910-4</td>
<td>XD4</td>
<td></td>
</tr>
<tr>
<td>NT 910-4</td>
<td>XRS</td>
<td></td>
</tr>
<tr>
<td>NT 910-4</td>
<td>XRS AG</td>
<td></td>
</tr>
<tr>
<td>NT 910-6</td>
<td>Gen. 2 Ultra HP</td>
<td></td>
</tr>
<tr>
<td>NT 910-6</td>
<td>Gen. 2 Ultra HP Select</td>
<td></td>
</tr>
<tr>
<td>NT 910-6</td>
<td>XD4</td>
<td></td>
</tr>
<tr>
<td>NT 910-6</td>
<td>XRS</td>
<td></td>
</tr>
<tr>
<td>NT 910-6</td>
<td>XRS AG</td>
<td></td>
</tr>
<tr>
<td>NT 930/PVS14</td>
<td>Gen. 25 CG (B)</td>
<td></td>
</tr>
<tr>
<td>NT 940</td>
<td>Gen. 25 CG (A)</td>
<td></td>
</tr>
<tr>
<td>NT 940</td>
<td>Gen. 2 Ultra HP</td>
<td></td>
</tr>
<tr>
<td>NT 940</td>
<td>Gen. 2 Ultra HP Select</td>
<td></td>
</tr>
<tr>
<td>NT 940 Full Kit,</td>
<td>XD4 (inkl. Kopfhalterung)</td>
<td></td>
</tr>
<tr>
<td>NT 940 Full Kit,</td>
<td>XRS (inkl. Kopfhalterung)</td>
<td></td>
</tr>
<tr>
<td>NT 940 Full Kit,</td>
<td>XRS AG (inkl. Kopfhalterung)</td>
<td></td>
</tr>
<tr>
<td>NT 940</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

*Aufpreis Röhre schwarz/weiß (Onyx)*
8. Price list (general) b

<table>
<thead>
<tr>
<th>Produktgruppe</th>
<th>Preise (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hellblaues Oszilloskop Ohne/Aufnahme</td>
<td>€ 3.250</td>
</tr>
<tr>
<td>Polarisator</td>
<td>€ 2.500</td>
</tr>
<tr>
<td>Glühbirnenfrequenzmessgeräte</td>
<td>€ 1.250</td>
</tr>
<tr>
<td>Goniometer</td>
<td>€ 950</td>
</tr>
<tr>
<td>Spezialgeräte für NT 940/941</td>
<td>€ 1.350</td>
</tr>
</tbody>
</table>

Die Preise sind auf den ersten Blick sehr hoch, was auf die Qualität und die spezielle Auslegung des Geräts zurückzuführen ist. Die Geräte sind für spezielle Anwendungen gedacht und bieten einen sehr hohen Funktionsumfang. Es ist zu empfehlen, das entsprechende Geräteequipment sorgfältig zu prüfen und eventuelle Zulassungen und Genehmigungen zu überprüfen, bevor man sich für ein Einkaufsentscheid macht.
### 1. Data sheet example

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Measured</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminance sensitivity 2850 K</td>
<td>270</td>
<td>659</td>
<td>/</td>
<td>μA/lnm</td>
</tr>
<tr>
<td>Radiant sensitivity 830 nm</td>
<td>18</td>
<td>62</td>
<td>/</td>
<td>mA/W</td>
</tr>
<tr>
<td>Max. output brightness</td>
<td>4.0</td>
<td>6.0</td>
<td>8.0</td>
<td>cd/m²</td>
</tr>
<tr>
<td>Luminance gain (at 20 μlx)</td>
<td>5000</td>
<td>9830</td>
<td>12000</td>
<td>cd/lm/μlx</td>
</tr>
<tr>
<td>Resolution center</td>
<td>30</td>
<td>55</td>
<td>/</td>
<td>lp/mm</td>
</tr>
<tr>
<td>Equiv. Background illumin.</td>
<td>/</td>
<td>0.15</td>
<td>0.40</td>
<td>μlx</td>
</tr>
<tr>
<td>Signal to noise ratio</td>
<td>12.00</td>
<td>24.10</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>/</td>
<td>19.6</td>
<td>N/A</td>
<td>mA</td>
</tr>
<tr>
<td>Image alignment</td>
<td>/</td>
<td>0.07</td>
<td>0.35</td>
<td>mm</td>
</tr>
<tr>
<td>Useful cathode diameter</td>
<td>17.0</td>
<td>&gt; 17.9</td>
<td>/</td>
<td>mm</td>
</tr>
<tr>
<td>Burn in</td>
<td>OK</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Image quality</td>
<td>OK</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**

```
NT940 18A2
```

![Signature](signature.png)
2. Delivery note (IEA) example

Lieferschein
RMA-C-062

Wir liefern per DPD

<table>
<thead>
<tr>
<th>Menge</th>
<th>Artikel</th>
<th>EP</th>
<th>Gesamt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Röhre, Ser. 3050153 (Kundeneigentum)</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td>1</td>
<td>Röhre instandgesetzt zurück</td>
<td>€</td>
<td>€</td>
</tr>
<tr>
<td></td>
<td>Gesamt netto</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MwSt. 19 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gesamt brutto</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Zahlungsbedingungen: kostenfrei

Die Ware bleibt bis zur vollständigen Bezahlung unser Eigentum.

Für diesen Auftrag gilt für beide Seiten ausschließlich Deutsches Recht nach HGB bzw. BGB sowie Gerichtsstand Böblingen als vereinbart.

Wir danken für Ihren Auftrag und wünschen Ihnen viel Erfolg mit unseren Produkten.

- Rücksendungen nur an unsere Hausanschrift, frachtfrei und versichert!
- Rechnungsdatum entspricht Lieferdatum, soweit nichts anderes angegeben ist.
- Im Falle eines Exports ggf. Ausfuhrbehördengenehmigungspflicht beachten (BAFA).
3. Replacement delivery note

Nachricht für ____________________

Von Firma ____________________________________________
Herr / Frau __________________________________________
Straße / Nr. __________________________________________
PLZ / Ort ____________________________________________
Email _________________________________________________
Telefon _______________________________________________
Mobil ________________________________________________
Fax ___________________________________________________

<table>
<thead>
<tr>
<th>Stk.</th>
<th>Ware</th>
<th>S/N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Betreff

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Stempel
4. Invoice example

<table>
<thead>
<tr>
<th>Menge</th>
<th>Artikel</th>
<th>EP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nachtsichtgerät NIGHT-TRONIC 940 Gen 2 Ultra HP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Geräte-Nr. AA2935/04127/3320291</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Laserluchs 850-50 Pro II</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zubehör: Tasche, Streulichtblende, Ringmontage, Doppelflämmchen, Bedienungsanleitung, Datenblatt</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gesamt netto</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MwSt. 19%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gesamt brutto</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Zahlungsbedingungen: innerhalb von 8 Tagen auf unser Konto der Commerzbank.

Die Ware bleibt bis zur vollständigen Bezahlung unser Eigentum.

Für diesen Auftrag gilt für beide Seiten ausschließlich Deutsches Recht nach HGB bzw. BGB sowie Gerichtsstand Böblingen als vereinbart.

Wir danken für Ihren Auftrag und wünschen Ihnen viel Erfolg mit unseren Produkten.

- Rücksendungen nur an unsere Hausanschrift, frachtfrei und versichert!
- Rechnungsdatum entspricht Lieferdatum, soweit nichts anderes angegeben ist.
- Im Falle eines Exports nationale Ausfuhrgenehmigungspflicht (BAFA) beachten.
5. Unit history sheet

<table>
<thead>
<tr>
<th>Serial Number</th>
<th>Type</th>
<th>Prod.</th>
<th>MA</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>12464</td>
<td>PVS-31</td>
<td>2015</td>
<td>LK</td>
<td>24.10.2017</td>
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<tr>
<td>RMA-1-021</td>
<td>monocular left defect</td>
<td>2015</td>
<td>AE</td>
<td>21.05.2019</td>
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<tr>
<td>RMA-1-172</td>
<td>Objective left defect</td>
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</table>

6. RMA general information

a) Inventory sheet

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>QTY</th>
<th>Description</th>
<th>QTY</th>
<th>Description</th>
<th>QTY</th>
<th>Description</th>
<th>QTY</th>
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</thead>
<tbody>
<tr>
<td>E01</td>
<td>Battery Pack</td>
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<td>Battery Pack</td>
<td>4</td>
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<tr>
<td>E02</td>
<td>Battery Holder</td>
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<td>Battery Holder</td>
<td>4</td>
<td>Battery Holder</td>
<td>4</td>
<td>Battery Holder</td>
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<tr>
<td>E03</td>
<td>Case</td>
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<td>Case</td>
<td>4</td>
<td>Case</td>
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<td>Case</td>
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<tr>
<td>E04</td>
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<td>Charger</td>
<td>4</td>
<td>Charger</td>
<td>4</td>
</tr>
</tbody>
</table>
b) Visual inspection

c) Operational checkout
d) Group A data sheet

7. Repair and parts