# Process performance indicators for measuring Order to Cash process

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Abstract:

Processes are at the center of competition. They form a significant portion of organizational costs and managing them offers significant opportunities for improving managerial decision making, performance, customer satisfaction, and ultimately improving market share. One of the key dimensions facilitating a company's transformation into a process-oriented is process performance indicators. Despite the fact that business processes have been the subject of formal study for a long time, existing performance measurement models tend to give little guidance on how business process performance indicators can be chosen and operationalized. This study enhances the literature which is focused on the design and development of process performance measurement systems but lacking attention to the actual measures. This Master thesis is executed as a case study with focus on the OTC process of a manufacturing company. The research questions are what process performance indicators of OTC process can be used to measure the as-is end-to-end process, and how these indicators could be applied for process performance benchmarking. After a literature review on existing process performance measurement frameworks, the Devil's quadrangle is selected as research framework. The study results in a list of concrete process performance indicators covering four performance dimensions: time, quality, cost, and flexibility. Recommendations on how the process performance can be benchmarked based on the Devil's quadrangle framework are also provided. One of the limitations of this research is related to significant process performance indicators. It was not proven mathematically that the selected indictors can significantly predict the OTC process performance, therefore it is challenging to evaluate whether there would have been other significant predictors. Another limitation is that the process performance indicators are OTC process specific and cannot be applied to evaluate performance of other process types.


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# 1 INTRODUCTION

Over the past decade organizations' interest in business processes has increased dramatically, and today many companies set up for a journey to transform their operations to be process driven. For example, CISCO, Dell, and Amazon are among many who already changed their strategies and business models towards process-oriented thinking.

Processes are at the center of today's and tomorrow's competition (Willaert et al. 2007, p. 1). They constitute a significant portion of organizational costs and managing them offers significant opportunities for improving market share, managerial decision making, performance (Seethamraju 2012, p. 532) and customer satisfaction (Zairi 1997). According to the investigation conducted by McCormak and Johnson (2001), business process orientation also leads to reduction of cross-functional conflicts inside an organization, increases interdepartmental connectedness and integration, both of which impact long and short-term performance.

According to McCormak and Johnson (2001) the transformation into a process-oriented organization is facilitated by three dimensions:

1. Process management and measurement which means that there are measures in place that cover such process aspects as output quality, cycle time, process cost and variability.
2. Process jobs meaning that a company has clearly defined process related roles and tasks.
3. Process view which is achieved by creating thorough process documentation and process understanding.

Measuring a business process seems to be more challenging than a company might anticipate. Firstly, despite business processes have been the subject of formal study for a long time, since the start of industrial age, processes still are not well understood (Seethamraju 2012, p. 532). Secondly, while different performance measurement models, systems and frameworks have been developed by academia and practitioners (van Looy & Shafagatova 2016, p. 1), performance measurement models tend to give little guidance on how business process performance indicators can be chosen and operationalized (Shah et al. 2012). One of the reasons for this is that performance indicators are considered organization-dependent because many measurement models require their strategic alignment (van Looy & Shafagatova 2016, p. 2).

The gap that this research is aiming to fill is to create a concrete set of ready-to-use process performance indicators for a specific end-to-end business process. This study enhances the literature which is focused on the design and development of process performance measurement systems but lacking attention to the actual measures. The process for which the measures are created is chosen to be Order to Cash being a customer-facing process existing in any organization and directly impacting business profitability, operating cash flow and customer relationships. If not well-optimized, it may lead to negative consequences for a company. The choice to focus on Order to Cash is also motivated by it consisting of same key steps shared by many organizations, therefore allowing the process performance benchmarking between companies within and across industries. Accordingly, this thesis addresses the following research questions:

1. What process performance indicators of Order to Cash process can be used to measure the as-is end-to-end process?
2. How these indicators can be applied for process performance benchmarking?

The objective of the research question (1) is to create a list of process performance indicators, whereas the research question (2) mainly intends to provide recommendations for how Order to Cash process performance can be benchmarked. At this stage it is also important to add, that terms “measures” and “indicators” are used interchangeably throughout this thesis.

# 2 THEORETICAL FRAMEWORK

## 2.1 Previous research

In the performance related literature numerous performance measurement models exist. Some of the most cited are the Balance Scorecard (Kaplan & Norton 1996), self-assessment excellence model EFQM (2010), also the models by Cross and Lynch (1988), Kueng (2000) and Neely et al. (2000). Some of them focus on the entire business and organizational performance, and others on a single business process. This thesis is solely focused on measuring a process performance, therefore organizational performance measurement models are not discussed.

The approach taken in business process performance measurement is generally less holistic than in organizational performance measurement (van Looy & Shafagatova 2016, p. 4). Although the importance of process measurement is emphasized by many (Ljungberg 2002, Willaert et al. 2007, Gonzales et al. 2010, Dumas et al. 2013), there is no such thing as traditional measurement in terms of processes (Ljungberg 2002, p. 256). This can be explained by the fact that many authors strongly agree on the process performance indicators being organization specific because they should be derived from a company's strategy (Brand & Van der Kolk 1995, Kueng 2000, Ljungberg 2002). Developing process measurement is also rather demanding task in terms of the number of steps involved, the amount of information needed, and the competences and skills required (Ljungberg 2002, p. 256).

Most of the reviewed research is concerned with developing and implementing process performance measurement frameworks on a general level (Brown 1996, Kueng 2000). It was also noticed that there is not enough attention given to how the measurement approach can differ depending on the type of a business process. One research found in relation to measuring a concrete process was published in 2016 by L. O. van den Ingh. The study focused on how to measure and evaluate overall performance of Purchase to Pay process based on process mining and by using the Devil's quadrangle concept (van den Ingh 2016). The focus on Purchase to Pay process makes it unsuited to measure performance of other types of processes (van den Ingh 2016, p. 43), however the research resulted in a new conceptual framework that supports multidimensional assessment of performance and can be applied to another specific business process.

Another observation made in the literature is that many authors describe how the process measures can be derived on conceptual level, however only few propose a list of concrete measures. The most recent research paper aiming at creating an exhaustive list of process performance indicators was published in 2016 by van Looy & Shafagatova. Even though the list can be a starting point for companies to find appropriate indicators (van Looy & Shafagatova 2016, p. 13), it doesn't make a distinction between which indicators could be applicable to which process.

Numerous process related studies in IT field and recent advances in technology made it possible to measure processes by applying process mining tools. Process mining has been an area of academic research for more than a decade but is a fairly new technique for businesses to analyze their processes (van den Ingh 2016, p. 1). Modern process mining tools such as Celonis include already a number of predefined process specific measures, however they are only available for companies who actually purchase and implement the software.

This thesis describes research that was executed to answer the question what process performance indicators can be used to measure a specific process. Since existing literature doesn't provide enough guidance how to measure a given process while the business need for process measurement has become increasingly important, this research contributes to both business and academic research. The second research question of this thesis is concerned with process benchmarking. This is seen especially relevant because while benchmarking organizational performance is a rather common practice and seen as a "powerful tool for helping companies ensure that they are not falling behind key competitors in important functional capabilities" (Wise 2011, p. 5), this topic is not addressed in most of the reviewed research papers concerned with process performance. It was observed that benchmarking was briefly mentioned only in the research papers by van Looy and Shafagatova (2016) and van den Ingh (2016) more as a side note, rather than an important aspect.

## 2.2 Understanding a business process

A process can be anything, whether it being a process of learning, a process of coding, a legal process, a chemical process, or a manufacturing process, to name a few. All processes are different in nature, yet they have several things in common:

- a definite starting point;
- a definite ending point; and
- measurable result.

When looking at a business process, different views and definitions exist. Perhaps one of the most complete definitions was provided by Striening (1988), who described a business process as “a succession of tasks, activities, and performances for the creation of products or services, which are directly connected with one another and in their sum determines the business management, technical production, technical administration, and financial success of the enterprise”. Almost 10 years later Oberweis (1997) added automation and customer value creation perspectives defining a business process as “a manual, partly automated, or fully automatic business activity, which is performed following definite rules and leads to a particular goal. A business process creates, in this way, a valuable result for the client”. Dumas et al. (2013) in their book “Fundamentals of Business Process Management” define a business process as “a collection of interrelated events, activities and decision points that involve a number of actors and objects, and that collectively lead to an outcome that is of value to at least one customer”. Typical examples of processes that can be found in most organizations include Order to Cash, Quote to Order, Procure to Pay, Issue to Resolution, Application to Approval (Dumas et al. 2013, p. 1).

The process approach for managing an organization is promoted by ISO 9001 standard for quality management systems that examines more than 20 processes in its scope. The standard is based on several quality management principles including a strong customer focus, the motivation and implication of top management and continual improvement (ISO 2020). ISO 9001 was first published in 1987 by the International Organization for Standardization (ISO) and the current version was released in September 2015. The standard may be of interest to companies of all types and sized who aims at organizing their processes and continuously improving process efficiency. There are over one million companies and organizations in over 170 countries that are certified to ISO 9001 (ISO 2020).

The standard underlines that understanding and managing interrelated processes as a system contributes to the organization’s effectiveness and efficiency in achieving its intended results (ISO 9001:2015). The process approach enables the organization to control the interrelations and interdependencies among the processes of the systems, so that the overall performance of the organization can be enhanced (ISO 9001:2015).

ISO 9001:2015 defines five elements of a process: sources of inputs, inputs, activities, outputs and receivers of outputs (Figure 1), where sources of inputs are usually predecessor processes which can be internal and external; inputs include resources, materials, information and efforts both human and system; activities that transform inputs to outputs; outputs as results of a process, either tangible or intangible; receivers of outputs such as customers, internal and external stakeholders, interested parties.

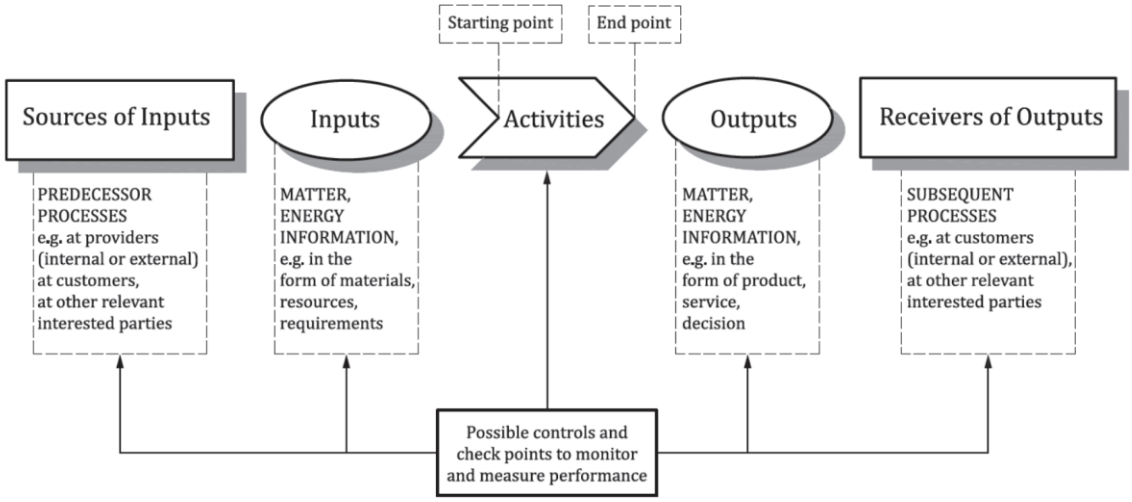


*Figure 1. Schematic representation of the elements of a single process (ISO 9001:2015).*

**Business process orientation**

As a response to fierce competition, challenging market situation and shifting customer demands, many authors have been suggesting organizations to decrease emphasis on hierarchical structures and increase focus on whole chains of business operations. Davenport and Short (1990) were among the early ones who examined this concept and discussed the process orientation as important management practice. In many articles and publications, a process-oriented company is often called “horizontal organization” (Ostroff 1999), “process-centered organization” (Hammer 1997), “process enterprise” (Hammer & Stanton, 1999), “process-focused organization” (Gardner 2004) or simply “process organization” (Osterloh & Frost 2006; Gaitanides 2007).

Based on extensive literature review, Kohlbacher and Gruenwald (2011) summarized the main attributes required for an organization to become a process oriented:

- design and documentation of business processes: a prerequisite for managing an organization based on its processes is to know which business processes are performed within the organization and how they are related to each other (Hinterhuber 1995);
- management commitment towards process orientation: without the support of senior executives, the process idea cannot unfold to its full potential (Hinterhuber 1995);
- the process owner role: according to Hammer and Stanton (1999), the existence of process owners is the most visible difference between a process enterprise and a traditional organization;
- process performance measurement: by focusing measurement on processes rather than functions, alignment and common focus across separate organizational units can be achieved (Hammer 2007b);
- a corporate culture in line with the process approach: only a culture based on teamwork, willingness to change, customer orientation, personal accountability, and a cooperative leadership style goes hand in hand with the process approach (Hammer 2007a)
- application of continuous process improvement methodologies, like KAIZEN, Six Sigma, etc.; and
- process-oriented organizational structure: a process-oriented organization has adapted its structure to the process view, following the principle "structure follows process" (Gaitanides 2007).

**Business process management**

A process-oriented company follows the principles of the Business Process Management (BPM) discipline, which is "used to manage process improvement, and includes the use of process discovery, mapping and modeling, metrics, key performance indicators (KPI), collaboration, decision-making and process monitoring" (Rock & Dwyer 2015). According to the BPMInstitute.org, in order to apply the BPM discipline strategically, a company is required to exercise the following nine areas:

- Aligning processes with business strategy
- Discovering and modelling processes
- Measuring processes
- Analyzing and benchmarking processes

- Harvesting policies and rules
- Improving processes
- Managing the changing culture
- Governance – decision making
- Deploying technology (Rock & Dwyer 2015)

The four disciplines related to BPM are Total Quality Management (TQM), Operations Management, Lean and Six Sigma.

Business value provided by BPM is achieved by:

- Using process-enabled achievement of strategic objectives
- Accelerating time to market
- Delivering improvements in cost, productivity, timeliness and quality
- Improving customer service levels and increasing customer satisfaction
- Transferring knowledge to ensure that customer teams achieve the necessary competence and autonomy to maintain and develop future capabilities
- Simplifying business processes to drive effectiveness, efficiencies, and agility
- Managing risks and meeting compliance regulations
- Providing greater visibility into your organizational performance
- Introducing new process designs faster
- Reducing costs and improving revenue streams (Rock & Dwyer 2015)

Dumas et al. (2013) in the book "Fundamentals of Business Process Management" present BPM as a continuous cycle containing six well-defined phases (Figure 2).

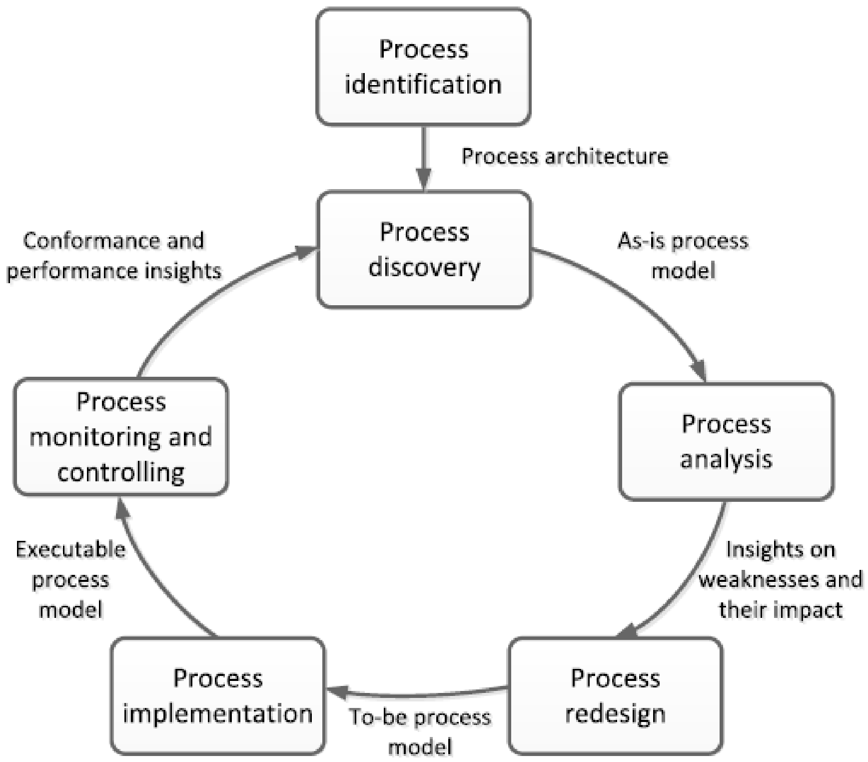


*Figure 2. BPM lifecycle (Dumas et al. 2013, p. 21).*

Process identification phase is a starting point in in the BPM lifecycle model. At this stage a business problem is posed, processes relevant to the problem are identified, delimited and related to each other (Dumas et al. 2013, p. 21). The result of process identification is a new or updated process architecture that provides an overall view of the processes in an organization and their relationship (Dumas et al. 2013, p. 21).

During process discovery, or as-is process modeling, the current state of the relevant process is documented, typically in the form of a process model (Dumas et al. 2013, p. 22). Sometimes this phase can be called process mapping. Process analysis phase includes identification of issues associated with the as-is process, documentation of these issues and quantification when possible by using performance measures (Dumas et al. 2013, p. 22).

Process redesign, or process improvement, phase is concerned with identification of changes to the process that would help to address the issues identified in the previous phase and allow the organization to meet its performance objectives (Dumas et al. 2013, p. 22). To this end, multiple change options are analyzed and compared in terms of the chosen performance measures (Dumas et al. 2013, p. 22). This entails that process redesign and process analysis go hand-in-hand: as new change options are proposed, they are analyzed using process analysis techniques (Dumas et al. 2013, p. 22). Eventually, the most promising change options are combined, leading to a redesigned process (Dumas et al. 2013, p. 22).

During process implementation phase the changes required to move from the as-is process to the to-be process are prepared and performed (Dumas et al. 2013, p. 22). Once the redesigned process is running, relevant data are collected and analyzed to determine how well is the process performing with respect to its performance measures and performance objectives (Dumas et al. 2013, p. 22). Such activities take place in process monitoring and controlling phase (Dumas et al. 2013, p. 22). Bottlenecks, recurrent errors or deviations with respect to the intended behavior are identified and corrective actions are undertaken (Dumas et al. 2013, p. 22). New issues may then arise, in the same or in other processes, requiring the cycle to be repeated on a continuous basis (Dumas et al. 2013, p. 22).

To summarize, a company can gain a competitive advantage by transforming its ways of working to process oriented. Principles of BPM discipline for designing, analyzing, executing, and monitoring business processes serve as a good tool to support an organization who chooses to become process oriented. Process performance measurement is seen as one of the foundational attributes required for process orientation.

## 2.3 Process performance measurement frameworks and concepts

This chapter introduces four of the most known process performance measurement frameworks. They share similarities concerning focus on strategy, use of leading indicators and several dimensions for measuring process performance. As the aim of this thesis is to define process indicators for a specific process, the performance measurement framework selected from this chapter is applied to the rest of this research.

### 2.3.1 The Devil's quadrangle

The Devil's quadrangle (Figure 3) is one of the well-known frameworks for process performance evaluation introduced by Brand and Van der Kolk in 1995. It incorporates the tradeoff that has to be made between different performance dimensions (van den Ingh 2016, p. 11). According to the framework, the process performance should be measured on four axes: time, cost, quality, and flexibility. A high value on these axes indicates high performance on that dimension, so concerning time and cost, a high value indicates respectively a highly time-efficient and cost-efficient process, while for flexibility and quality, a high value means that the process is highly flexible and has high quality (van den Ingh 2016, p. 11).

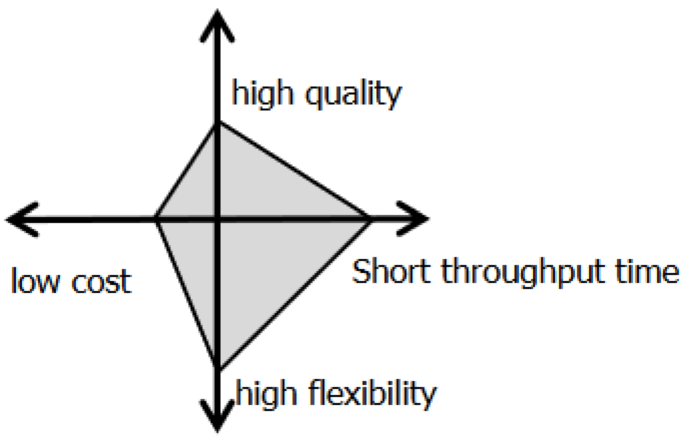


*Figure 3. The Devil's quadrangle (Brand & Van der Kolk in 1995).*

The challenge in the quadrangle framework comes from the fact, that it is impossible to maximize all four performance dimensions simultaneously, therefore a company needs to make a choice which dimension should be maximized and what can be decreased. Improving all dimensions is only possible when the total surface is increased (Brand & Van der Kolk, 1995).

Based on the research conducted by Jansen-Vullers et al. (2008) the following definitions of the Devil's quadrangle dimensions were given:

- Time is seen as a source of competitive advantage and as a fundamental performance measure. Process performance analysis on this dimension can be done by measuring lead time and throughput time, which in turn also consists of service time, queue time, wait time, move time and setup time.

- Cost has a relation to time because time spent on executing activities within and outside of a process costs money, for example manual labor has an hourly rate, machine labor has costs from machine depreciation and power consumed. Costs are also linked to quality as bad quality causes time-consuming and costly error corrections. And finally, costs are related to process flexibility because inflexible process leads to a costly process execution. In the research by Jansen-Vullers et al. (2008), a difference is also made between running costs, inventory costs, transport costs, administrative costs and resource utilization costs.
- Quality can be looked at from external or internal perspective. External quality is defined by the customer's perception of quality, and internal quality is viewed from within the company. In relation to external quality, customer satisfaction is the most important measure. In case of internal quality, it is the quality of the workflow.
- Flexibility is concerned with the process ability to react to changes, and it can be connected to individual resources, individual tasks or processes. Jansen-Vullers et al. (2008) defines five types of flexibility: mix flexibility, labor flexibility, routing flexibility, volume flexibility and process modification flexibility.

The quality dimensions, either internal or external, are the most difficult to operationalize because the large number of factors influence the quality perception and it is more subject to opinion than fact-based measures (van den Ingh 2016, p. 79).

### 2.3.2 Inputs, processes, outputs, outcomes

Another notable process performance measurement framework was proposed by Mark G. Brown in 1996. In his framework performance indicators are determined by splitting the process into four stages: input, process (throughput), output and outcome. As a result of this categorization, process performance measures evolve from performance measures for input, throughput, output and outcome measures (Figure 4).

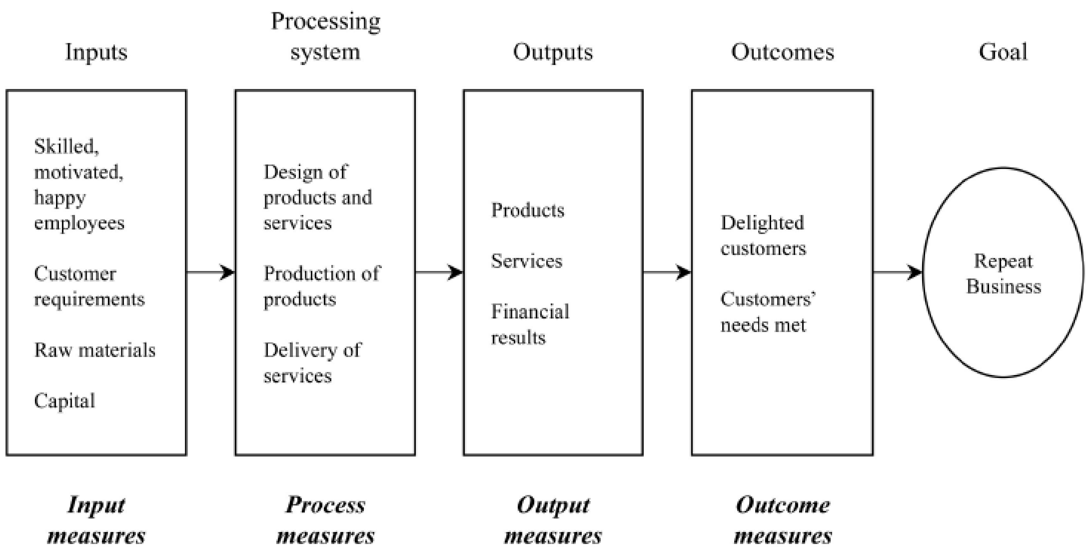


*Figure 4. Inputs, processes, outputs, outcomes (Brown 1996).*

To explain his framework better, Brown (1996) uses the analogy of baking a cake. Input measures would be concerned with volume of flour, quality of eggs, etc.; process or throughput measures – with oven temperature and length of baking time; output measures would be concerned with the quality of the cake; and outcome measures – with the satisfaction of the cake eaters, e.g. was the cake enjoyable.

### 2.3.3 Stakeholder-driven measurement model

Kueng (2000) suggests that process performance measurement system should have a focus on satisfaction of people who have an interest in a process. Therefore, the process-relevant goals should be defined based on the stakeholder groups. In his stakeholder-driven measurement model, Kueng (2000) substitutes the term of process performance with the degree of stakeholder satisfaction.

Kueng (2000) defines the four groups of process stakeholders: Investors, Employees, Customers and Society. As in this case process performance is measured based on the degree of stakeholder satisfaction, four aspects of performance are formulated: Financial aspect, Employee aspect, Customer aspect and Societal aspect. In order to satisfy the four stakeholder groups in the long term, Kueng (2000) adds Innovation as the fifth aspect to facilitate business processes' continuous improvement. Having these five aspects in mind, the relevant process performance measures can be identified.

When creating measures, Kueng (2000) recommends starting from scratch deriving them either from business process goals or from the means of achieving these goals. With the focus on process goals, they can be gathered from the enterprise-wide objectives, the business competitors, and the stakeholders. Kueng (2000) noted that these goals and performance measures themselves are influenced by the economic, technological, social and legal environment (Figure 5).

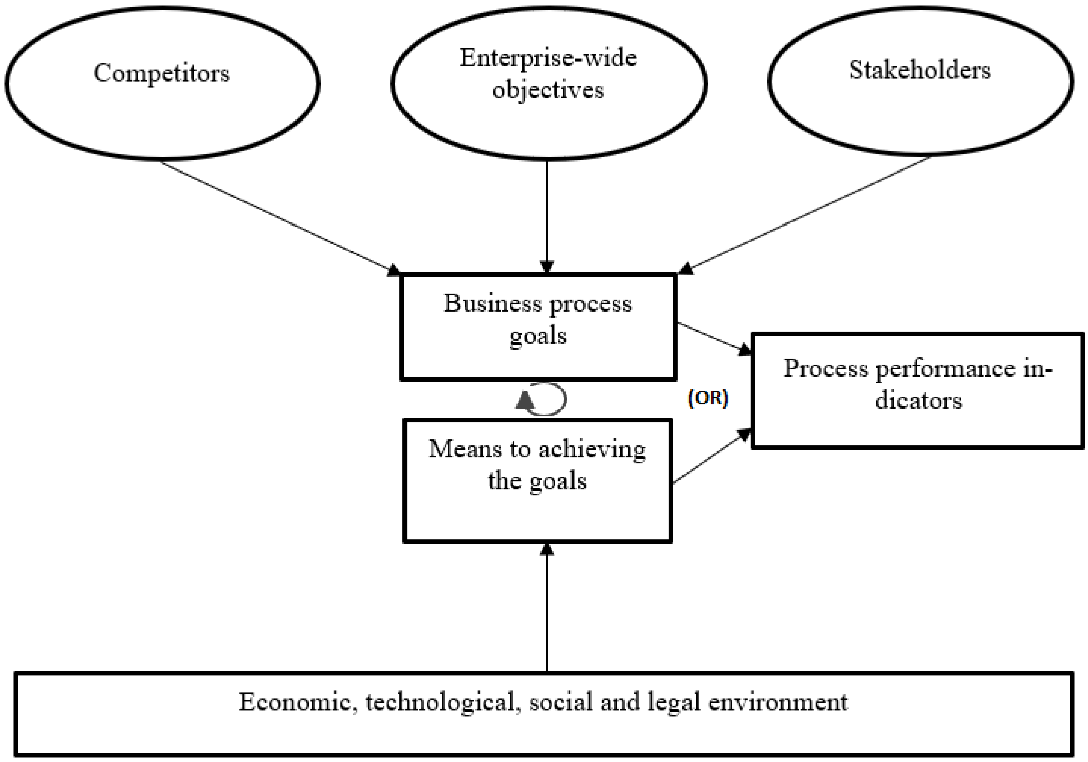


*Figure 5. The driving forces of process performance indicators (Kueng 2000, p. 76).*

In his framework, Kueng (2000) also formulated the few-step approach to how performance indicators can be elicited. The work begins with defining high-level business process goals for each of the five aspects (financial, customer, employee, societal, innovation). Once this is accomplished, performance measures are derived by answering the question “what is measurable and reflects the extent to which a certain goal has been fulfilled” (Kueng 2000, p. 76). High-level goals are then decomposed to sub-goals based on the means and actions that need to be taken by the organization to fulfill a certain goal. The result of this process is the goal tree, which will need to be refined and modified to ensure that the created measures do not undermine the unstated goals. If this is the case, additional indicators should be added.

Kueng (2000) adds that acceptability of process performance indicators is crucial as the process teams who are measured by these indicators must perceive the selected indicators as a fair and accurate assessment instrument. Kueng (2000) recommends using a questionnaire to check whether the process participants consider the defined performance indicators useful or not.

### 2.3.4 Ljungberg's process measure classification model

Another framework for measuring a process was introduced by Anders Ljungberg in 2002. He emphasized that measures should not be randomly selected, and they should reflect important characteristics and performance aspects of the process studied. Similar to Brown (1996), Ljungberg listed the core components which a process consists of: input, activity, resources, transformation, information, and output. Figure 6 illustrates how these components are linked together:

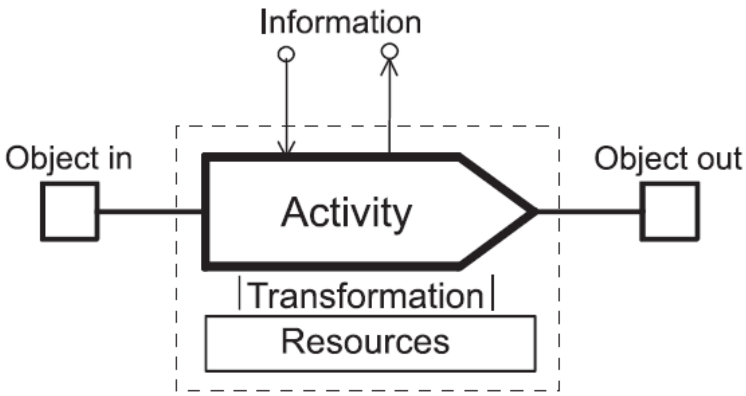


*Figure 6. The core characteristics of a process (Ljungberg 2002, p. 258).*

Object in, or input, triggers the process, and without this component a process cannot start. Activity is a sequence of tasks. Resources necessary for performing the activity are given their own dimension because Ljungberg (2002) believed that resources, most importantly people, are the most overlooked element when considering processes. Transformation is the meeting of activity and resources required to produce the object out. Object out is the result of transformation, which in turns triggers the next subprocess. Quality of object out highly depends on a quality of object in, activity, resources and transformation (Ljungberg 2002, p. 259).

Information supports and controls the process. It can be created by an activity performed in the process to control and support other activities. According to Ljungberg (2002), information is often used for coordination purposes and can be seen as a link connecting all processes together in an organization.

Ljungberg (2002) suggested the several-step approach to creating a process measurement system:

1. Developing of competences to enable people equally understand the basics of processes, measurement, quality, and service quality.
2. Creating a detailed description of a process and mapping all sub-processes, activities, information flows, inputs and outputs, and their interconnection between each other.
3. Understanding customer needs as they are the foundation of business success. Based on the customers' requirements, quality dimensions of a process output can be developed and translated into specific measurable characteristics.
4. Connecting process measures to strategy by breaking down organization's goals to clarify their relations to the processes. According to Ljungberg (2002), this is a critical step because it ensures that the strategy is made a part of day-to-day operations.
5. Selecting process measures and creating a proper documentation to ensure that they will be calculated and used in the same manner each time.

During his research, Ljungberg (2002) created a process measure classification model where measures were divided into two big groups as illustrated on Figure 7:

- the actual process measures concerned with the activity part of the process, and
- the resource measures concerned with resource part of the process.

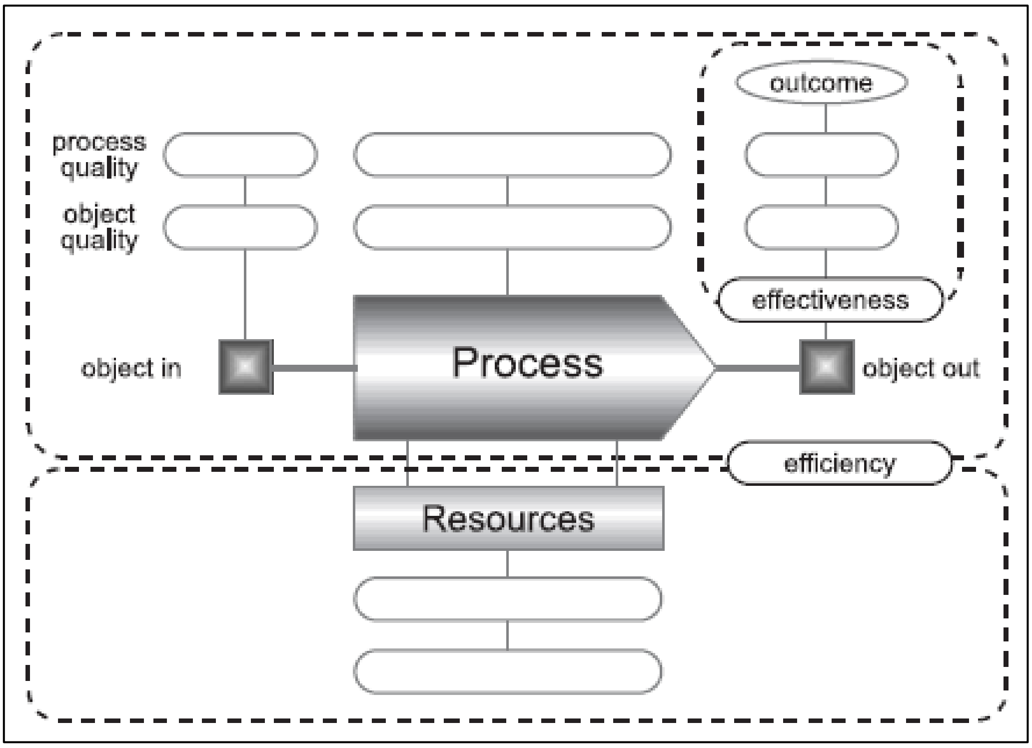


*Figure 7. The process measure classification model (Ljungberg 2002, p. 267).*

**The process measures**, according to Ljungberg (2002), have a two-dimensional principle of classification:

- dimension 1: object in, the activity, object out, and
- dimension 2: quality of object (measures related to the characteristics of the object) and quality of process (measures describing how the object is received, processed, and delivered).

Ljungberg (2002) describes these two dimensions of the actual process, or the activities, measures as performance drivers. He believes that “the most interesting activity-related measures are those that guarantee or facilitate fulfilment of the demands placed on object out”. According to Ljungberg (2002), “all measures related to object out – process quality, object quality, and outcome – reflect effectiveness of the process and represent a clear customer focus”.

**The resource measures** typically would cover resource consumption and utilization, but their classification was not developed in Ljungberg’s research.

### 2.3.5 Comparison of the measurement frameworks and conclusion

An overview of the key attributes of the process performance measurement frameworks described in the previous sections is shown in the Table 1. The selection of the attributes was influenced by the research questions which are related to process performance indicators of a specific business process and process performance benchmarking. The "v" mark indicates that the attribute is true for the framework, the "-" mark indicates that the attribute is not true for the framework.

*Table 1. Comparison of the process measurement frameworks (Muurinen 2020).*

| **Author of the framework** | **Low complexity** | **Step by step model** | **Strategy driven** | **Multiple dimensions** | **Financial and non-financial** | **Allow benchmarking** |
|---|---|---|---|---|---|---|
| Brand and Van der Kolk, 1995 | v | - | v | v | v | v |
| Brown, 1996 | - | - | v | v | v | - |
| Kueng, 2000 | - | v | v | v | v | - |
| Ljungberg, 2002 | - | v | v | v | v | - |

Many of the attributes are equally true for all four frameworks. All of them are strategy driven, include multidimensional performance assessment and suggest using financial and non-financial measurements. However, the Devil's quadrangle framework by Brand and Van der Kolk (1995) has the advantage in terms of being less complex when comparing to Brown (1996), Kueng (2000) and Ljungberg (2002). The quadrangle approach for visualizing the process performance is also seen to be suitable to perform process benchmarking. Therefore, the framework of Brand and Van der Kolk (1995) is chosen as the performance measurement framework to create process performance indicators within the scope of this thesis.

## 2.4 Process benchmarking

According to definitions provided by the literature, benchmarking is:

- A process of continuous evaluation and comparison of the organization with the worldwide leading companies to obtain information that will help the organization to take action to improve its performance (APQC 2006);
- A process of continuous comparison of the organization performance with the best practices in industry, given the significant customer needs and determine what needs to be improved (Vaziri 1992);
- A tool for continuous improvement of competitive performance of the company in its core business processes; the implementation of continuous evaluation of the effectiveness of business process (Watson 1992).

Among different types of benchmarking that exist in the modern science, process benchmarking is distinguished as a separate type. It is used when a company focuses on improving specific critical processes and operations (Goncharuk et al. 2015, p. 31). It searches for the most successful enterprises that perform similar work or provide similar services (Goncharuk et al. 2015, p. 31).

Benchmarking is a fairly universal method (Goncharuk et al. 2015, p. 31) that consists of five basic stages (Zairi 2004):

- Planning: selecting area for benchmarking, key performance indicators which will be compared, defining data collection methodology for the analysis.
- Data collection: selecting the group of companies for comparison (industry, geographic location), collecting data about these companies and their processes, collecting data about own processes, defining methodology for data analysis.
- Comparative analysis: estimating the efficiency of own and comparable companies, identifying the gap in performance of the analyzed process, analyzing the cause factors of the performance gap, finding the ways and making recommendations for bridging the gap in the level of efficiency.
- Realization: implementing changes in the company’s processes to improve performance.

- Control and Estimation: monitoring a progress in the implementation of benchmarking plan and its impact on the processes by measuring the relevant performance indicators (Goncharuk 2014, p. 30).

According to Wise (2011), benchmarking delivers four critical benefits for organizations:

1. current state assessment of a function;
2. identification and prioritization of opportunities for transformation programs;
3. creation or renewal of managing culture that enables continuous improvement, and
4. setting standard terms and definitions for key aspects of a company's business processes that enable all employees to share the same understanding about the state of the company's operations.

## 2.5 Research methodology

### 2.5.1 Choice of methodology

This thesis project was carried out as a qualitative study. This type of research explores and provides deeper insights into real-world problems (Moser & Korstjens 2017). It helps generate hypotheses and further investigate and understand quantitative data. (Moser & Korstjens 2017). Qualitative research gathers participants' experiences, perceptions, and behaviors, and it allows participants themselves to explain how, why, or what they were thinking, feeling, and experiencing at a certain time or during an event of interest (Tenny et al. 2020).

In qualitative business research the business-related phenomenon is studied in its context and this way new knowledge on how things work in real-life can be produced (Eriksson & Kovalainen 2008). The empirical materials used for this thesis consist of company documentation collected from projects, meetings and various workshops. The context of the collected data justifies the use of qualitative method, as it would have been difficult to transform this data into mathematically and statistically measurable values.

The analysis of the empirical data was based on a single case study. This choice was motivated by the fact, that the research question required a close and in-depth study of a single phenomenon (process performance measurement) related to the particular subject (OTC business process) in the pre-defined context (a manufacturing company). According to Yin (2009), a case study is the preferred method for research when it seeks to explain some present circumstance and the case is a contemporary phenomenon within real-life context.

One of the weaknesses of case studies is that their results are difficult to apply to other environments. However, according to Kasanen et al. (1993) it would be difficult to imagine a situation and a solution which would suit well the case company but no other companies in approximately similar context. For that reason, the aim of this thesis was to explore the particular case in its context, create new knowledge and provide practical solution.

### 2.5.2 Research approach

The activities performed to answer the research questions were following the principles of BPM discipline and the Devil’s quadrangle framework. The first phase of this project was dedicated to developing necessary competences to understand the basics of processes, measurement, and quality. This phase included extensive literature review covering research papers on Business Process Management, Process Measurement, studying process approach through ISO 9001:2015 standard and familiarizing with different technologies that enable automatic process discovery.

The empirical work begins with mapping the OTC process of the case company. At this point it is important to clarify that the process map presented in the chapter 4.2. is a summary of a lengthy project carried out in the case company outside of this research. As a subject matter expert, I was involved in creating the OTC process model and performing the as-is process analysis. Mapping the OTC process was a demanding task that took more than six months to complete. It required contribution from managers, experts and specialists involved in the OTC process on several levels. Such tools as SIPOC diagram, Input-Process-Output (IPO) model, 5 Whys and Value-stream mapping were applied at different stages to enable accurate as-is process mapping. Celonis Process Mining software was also in use to facilitate automatic process discovery and help to complete the process map. A fairly detailed process taxonomy was created at the same time as well.

The original taxonomy is a subject to a commercial confidentiality and therefore not disclosed in this research. Yet the process hierarchy is explained because the scope for OTC process measures in this thesis is defined based on and limited to certain process levels. The process map is presented on four levels as a vertical flowchart diagram and other process details are omitted.

The next phase was dealing with describing the OTC process goals. First, the case company's business strategy and strategic business objectives were empirically collected from the openly available documents. OTC problem statement and OTC process goals were defined along with the process mapping project and aligned with the company strategy.

The work for defining the process performance indicators started in the chapter 4.4. The first step was to assign the process goals to four performance dimensions: time, cost, quality and flexibility, according to the Devil's quadrangle framework. In the next step, process performance indicators were selected from the analyzed empirical evidence, which included the outcome of the two process mining projects conducted for the end-to-end OTC process in the case company prior to this thesis; findings from the Master thesis "Evaluating business process performance based on process mining" by L. O. van den Ingh completed in 2016; and result of the structured literature review of indicators, measures and metrics for business process performance measurement conducted by A. van Looy and A. Shafagatova in 2016.

The chosen performance indicators relevant for the OTC process were grouped based on the Devil's quadrangle dimensions in the same way as the process goals. After that each performance indicator was assigned to one of the four process levels described on the figure 12, given definition for calculation and linked to the process goals (tables 6 – 9). This was a critical step that helped to ensure that the selected performance indicators can influence the future performance.

In the next step, by following the conceptual framework described by van den Ingh (2016) in order to visualize the Devil's quadrangle, significant process performance indicators were chosen from the tables 6 – 9 and again segmented per performance dimension (table 10). The significance of these indicators for the OTC process was not proven mathematically as this was not the aim of this study. The evaluation of significance was made based on recommendations found in the literature and also based on the case company's choices. Many companies offering technology solutions for OTC process discovery and analysis highlighted the same indicators as key metrics.

Once the lists of process performance indicators have been finalized, the topic of the process performance benchmarking was researched. The significant process performance indicators (table 10) and the shape of the Devil's quadrangle have a great potential to be used for benchmarking purposes because there are only eight indicators, but they capture process performance from all the four different dimensions; the indicators were already operationalized; and the shape of the Devil's quadrangle enables clear visual comparison of the process performance. Then by following the several-stages benchmarking approach described by Zairi (2004), the step-by-step benchmarking plan was created. To provide an example, several shapes of the Devil's quadrangle were simulated in a separate Excel file based on assumption that a high performing OTC process (target performance) would have lower process cost, higher quality, shorter cycle time and more flexibility comparing to as-is performance.

One of the limitations in this research is related to significant process performance indicators. It was not proven mathematically that these indictors can significantly predict the OTC process performance, therefore it is hard to tell whether there would have been other significant predictors among listed in the tables 6 – 9. Another limitation is that the process performance indicators provided in this research are OTC process specific, and therefore cannot be applied to evaluate performance of other process types. Also, since the case company A is a manufacturing company, its OTC process is not comparable to OTC process of a service company, for example. This means that some of the performance indicators cannot be directly applied to measure any OTC process, and business specific adjustment is required.

As this research was carried out as a case study, its results provide little basis for generalization to the wider scope of business processes. The Devil's quadrangle framework, however, could be applied to evaluate performance of other types of processes. The case study is also a subject to the researcher's bias. I analyzed only qualitative data and made conclusions based on own experience and interpretations. My subjective opinion might have influenced the assessment of the data I dealt with throughout the research, therefore hopefully the findings will be researched further in quantitative studies.

# 3 CASE COMPANY

This thesis is focused on the Order to Cash process of a typical large international manufacturing company – the case company A. It has several production facilities in few geographic locations, goods are produced from the converted raw materials and components, and finished products are sold mainly to other manufacturers. The case company has several different business areas, and the business model is primarily B2B.

# 4 ORDER TO CASH PROCESS PERFORMANCE INDICATORS

## 4.1 OTC process

Order to Cash (OTC) refers to a business process for receiving and processing customer orders for goods and services and their payments (Dvorak 2020). This type of process is performed by a vendor, starts when a customer submits an order to purchase a product or a service and ends when the product or service in question has been delivered to the customer and the customer made the corresponding payment (Dumas et al. 2013, p. 1). In an international manufacturing company, it is also one of the longest and complex processes, which is often spread over many geographic locations.

The typical OTC process consists of multiple steps (Dvorak 2020):

1. Customer places an order
2. Order is fulfilled (processed and shipped)
3. Order is delivered
4. Invoice is created
5. Invoice is paid by the customer

## 4.2 OTC process map

OTC process map of the company A was created outside of this thesis project, and this chapter includes the description of the outcome. Detailed process activities are omitted as the research scope does not require a drill down to a single task level.

Building the OTC as-is process taxonomy for the company A was a many-months project of its own. It brought together process managers, internal and external experts from all the teams involved in the OTC process. After numerous interviews, discussions and studies of the company's internal work instructions and process descriptions in the form of Word documents, the graphical representation of the as-is process was drawn using process and deployment flowcharts, as well as BPMN (Business Process Model and Notation) software.

The Order to Cash actual process map of the company A was created on several levels. This was done in order to gain an in-depth understanding of all the process activities, create transparency to the process experts on the sequence of events and open up cross-organizational dependencies. The original taxonomy is a subject to a commercial confidentiality and therefore not disclosed in this research. Yet the process hierarchy is explained because the scope for Order to Cash process measures in this thesis is defined based on and limited to certain process levels.

**Order to cash process hierarchy**

According to Business Process Glossary, a process hierarchy is a hierarchical decomposition from core business processes to the task level (BPM Glossary 2020). The number of levels in a hierarchy is determined by the breadth and side of the organization (BPM Glossary 2020). Figure 8 illustrates the company A's Order to Cash process hierarchy, where five process levels are identified. The levels of this hierarchy differ from the company's original hierarchy by a small degree, because the deviation was necessary for the process measurement purposes.

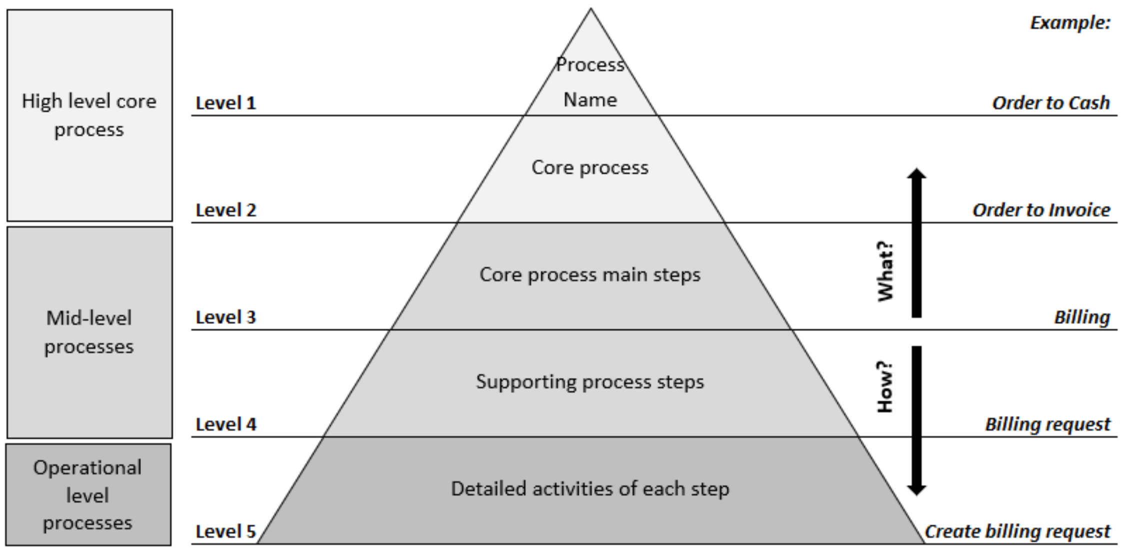


*Figure 8. Order to Cash process hierarchy (Muurinen 2020).*

The Order to Cash process hierarchy for the purpose of this thesis was divided into three parts: high level core process, mid-level processes and operational level processes. Such general approach was proposed by Paul Harmon in his book Business Process Change (2019). This allows to "associate analysis techniques with specific levels" (Harmon 2019).

High level core process includes high level process name (Level 1) and the core process (Level 2) that belong to the same area. Mid-level processes aggregate the key steps of the core process in a sequential order (Level 3) and supporting process steps (Level 4). Operational level processes (Level 5) combine detailed activities/number of single tasks performed by individual participants of the Order to Cash process. Figures 9, 10 and 11 show the core process decomposition from level 1 to level 3.

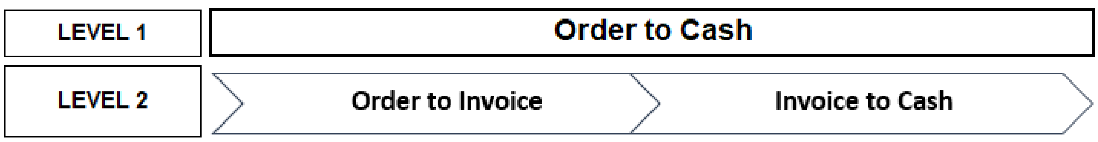


*Figure 9. Order to Cash process decomposition (Muurinen 2020).*

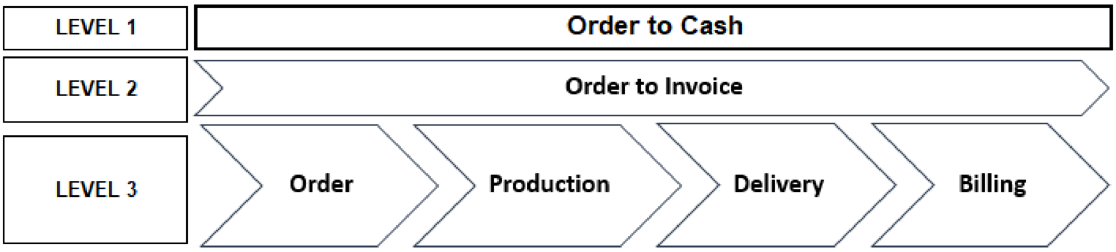


*Figure 10. Order to Invoice process decomposition (Muurinen 2020).*

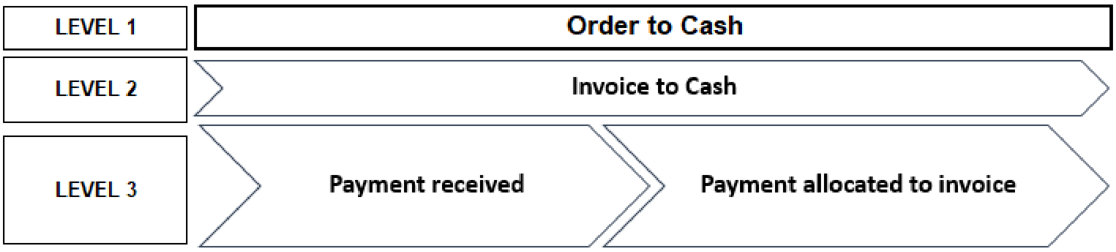


*Figure 11. Invoice to Cash process decomposition (Muurinen 2020).*

Order to Cash process is a rather standard process, and up to a certain level the process steps are same or very similar in large manufacturing companies. The aim of this thesis is to identify a number of as-is process performance measures which can support a company towards process orientation. Therefore, the Order to Cash process decomposition to the level 4 (Figure 12) is seen to be enough. Operational level of the process (level 5) – unique to each company and a subject to operational secrecy and confidentiality – requires own measuring approach and a separate research.

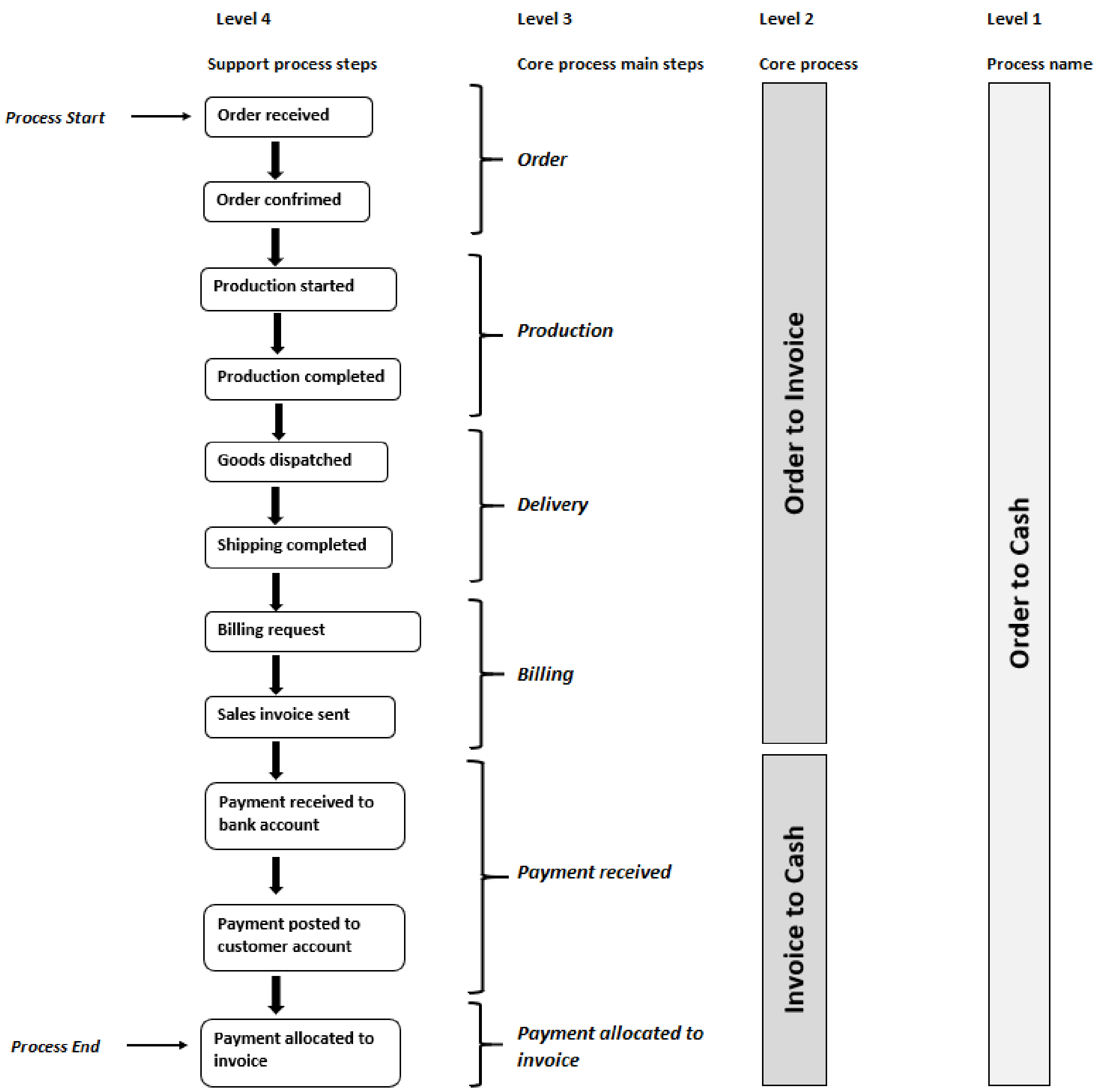


*Figure 12. Order to Cash process decomposition to level 4 (Muurinen 2020).*

## 4.3 OTC process goals

OTC process goals are formulated by connecting the company A's strategic business objectives and process problem areas. The reason for doing so is that flaws in as-is process execution are obstacles to achieving the business strategic targets. Once process goals are defined, they serve as a foundation for choosing OTC process performance indicators.

The company A's business strategy and strategic business objectives presented in the table 2 were empirically obtained from the company's material. This information is also available for the company's external stakeholders through open sources, and therefore is included in this research without reference to confidentiality.

*Table 2. Company A's strategic business objectives (Muurinen 2020).*

| Business strategy | Strategic business objectives |
|---|---|
| **Top performance** | • Commercial excellence<br>• Cost efficiency<br>• Efficient use of assets and capital<br>• Strong cash flow<br>• Continuous improvement programmes |
| **Long-term growth** | • Competitive operating environment<br>• Investments in business expansion<br>• Earnings growth over top-line growth |
| **Innovations** | • Investments in innovation and R&D programmes<br>• Exploring new technologies, applications, and robotics<br>• New digital tools implementation<br>• Utilizing advanced data analytics, robotics, and automation |
| **Responsible operations** | • Compliance<br>• Value chain creation<br>• Credible and transparent reporting |

OTC problem statement was created during process mapping stage. It was done through multiple interviews and open discussions with sub-process participants. The final problem statement containing over 100 items for the end-to-end OTC process was then validated by the process experts and used as a tool to define process goals. The problem statement presented in the table 3 is a high-level summary on the process level 3. The detailed problem statement is not disclosed in this research as it contains business sensitive information.

*Table 3. OTC problem statement, process level 3 (Muurinen 2020).*

| Process name | Problem area | Impact |
|---|---|---|
| **Order** | Order changes | Extra manual work for handling additional customer requests, increased order handling time and cost, longer OTC cycle time |
| ***Production*** | *Out of scope* | *Out of scope* |
| **Delivery** | IT system errors in dispatching process | Extra manual work for fixing system errors result in extra cost, delay in delivery, negative customer experience, longer OTC cycle time |
| **Billing** | Billing blocks handling | Late billing, negative customer experience |
| | Late billing | Negative customer experience, longer time to revenue, longer OTC cycle time |
| | Full invoice cancellation | Extra manual work, additional cost for rework, longer OTC cycle time |
| | Credit notes process | Negative customer experience, extra process costs, longer OTC cycle time |
| **Payment received** | No payment | Credit loss, revenue leakage, poor cash flow |
| | Late payment | Poor cash flow, requires collection activities which increase process cost, longer OTC cycle time |
| | Unearned and incorrectly deducted cash discounts | Unearned revenue, revenue leakage, requires collection activities which increase process cost |
| | Dispute handling process | Negative customer experience, extra manual work, extra costs for dispute handling, longer OTC cycle time |
| **Payment allocated to invoice** | Remittance advice availability | Extra time spent on clarifying with customer which invoices were paid, payment cannot be automatically allocated to invoices without remittance advice, extra manual work, delay in payment clearing, longer OTC cycle time |
| | Invoices paid partially | Unearned revenue, revenue leakage, requires additional collection activities which increase process cost, longer OTC cycle time |

*Table 4. OTC process goals (Muurinen 2020).*

| **Strategic business objectives** | **Process problem areas** | **OTC process goals** |
|---|---|---|
| • Commercial excellence<br>• Cost efficiency<br>• Efficient use of assets and capital<br>• Strong cash flow<br>• Continuous improvement programmes | • Order changes<br>• IT system errors in dispatching process<br>• Billing blocks handling<br>• Late billing<br>• Full invoice cancellation<br>• Credit note process<br>• No payment<br>• Late payment<br>• Unearned and incorrectly deducted cash discounts<br>• Dispute handling process<br>• Remittance advice availability<br>• Invoices paid partially | • Doing things right the first time<br>• Prevent revenue leakage at different points<br>• Process cost reduction<br>• Accelerate sales velocity and time to revenue<br>• Better customer experience<br>• Waste-free process execution<br>• Improving process consistency |
| • Competitive operating environment<br>• Investments in business expansion<br>• Earnings growth over top-line growth | | • Increase overall agility<br>• On time delivery<br>• Keeping customer promise<br>• Improving process capacity<br>• Reducing DSO |
| • Investments in innovation and R&D programmes<br>• Exploring new technologies, applications and robotics<br>• New digital tools implementation<br>• Utilizing advanced data analytics, robotics and automation | | • Reduce process complexity<br>• Increase process automation |
| • Compliance<br>• Value chain creation<br>• Credible and transparent reporting | | • Product and service delivery according to contractual terms<br>• Effective claim handling process<br>• Invoicing accuracy<br>• Accurate payment allocation |

## 4.4 OTC process performance indicators

The Devil's quadrangle framework applied in this research requires process performance analysis on four dimensions: time, cost, quality, and flexibility. In order to ensure that process performance indicators support OTC process goals, these goals are first mapped to the performance dimensions (table 5).

*Table 5. OTC process goals and process performance dimensions (Muurinen 2020).*

| No | OTC process goal | Time | Cost | Quality | Flexibility |
|---|---|---|---|---|---|
| 1 | Doing things right the first time | v | v | v | |
| 2 | Prevent revenue leakage at different points | | v | v | |
| 3 | Process cost reduction | | v | | |
| 4 | Accelerate sales velocity and time to revenue | v | | | |
| 5 | Better customer experience | v | | v | v |
| 6 | Waste-free process execution | v | | v | v |
| 7 | Improving process consistency | | | | |
| 8 | Increase overall agility | v | v | v | |
| 9 | On time delivery | | | v | |
| 10 | Keeping customer promise | | | | v |
| 11 | Improving process capacity | | | v | v |
| 12 | Reducing DSO | | | | |
| 13 | Reduce process complexity | | v | v | v |
| 14 | Increase process automation | | | v | |
| 15 | Product and service delivery according to contractual terms | | | v | |
| 16 | Effective claim handling process | | v | v | |
| 17 | Invoicing accuracy | | | | v |
| 18 | Accurate payment allocation | | v | v | |

In the next steps, process performance indicators are selected from the analyzed empirical evidence and grouped based the Devil's quadrangle dimensions. Each process indicator is assigned to one of the four process levels described on the figure 12, is given definition for calculation and linked to process goals from the table 5.

Empirical evidence used for choosing process performance indicators includes:

- Outcome of the two process mining projects conducted for the end-to-end OTC process in the company A prior to this thesis.
- Findings from the Master thesis "Evaluating business process performance based on process mining" by L. O. van den Ingh completed in 2016.
- Result of the structured literature review of indicators, measures and metrics for business process performance measurement conducted by A. V. Looy and A. Shafagatova in 2016.

OTC process mining project documentation of the company A is not disclosed due to confidentiality, but other two studies and their findings can be found in the open sources. The selection of the process performance indicators presented in the tables 8 - 11 was made based on my evaluation of their relevance given my knowledge and experience obtained when working as a subject matter expert of OTC process in both above mentioned process mining projects.

*Table 6. OTC process performance indicators, time dimension (Muurinen 2020).*

| **Process performance indicator** | **Process level** | **Definition** | **Process goals** |
|---|---|---|---|
| OTC cycle time, days | 1 | Number of days from the order received date to the date when received payment is allocated to the sales invoice (end to end cycle time) | 1<br>4<br>5<br>6<br>8 |
| Internal lead time, days | 1 | The cumulative time between all internally executed activities (without e.g. waiting for an order to be delivered) | |
| Process waiting time | 4 | Average time lag between sub-processes, when a process instance is waiting for further processing | |
| Processing time | 4 | Cumulative time that actual work is performed on a request at each sub-process | |

*Table 7. OTC process performance indicators, cost dimension (Muurinen 2020).*

| Process performance indicator | Process level | Definition | Process goals |
|---|---|---|---|
| OTC process cost | 1 | OTC total end to end process cost as a percentage of revenue | 1<br>2<br>3<br>8<br>13<br>16<br>18 |
| OTC process cost per FTE | 1 | OTC total process cost per OTC FTE | |
| % of personnel cost | 1 | Percentage of personnel cost in the total OTC process cost | |
| Late cash discounts | 3 | Percentage of cash discounts accepted when customer payment is received late compared to all accepted cash discounts | |
| % of cash discounts | 2 | Percentage of all cash discounts accepted in relation to all sales invoices value | |
| Lost interest on late payment, € | 3 | The interest amount (€) that is not earned by not charging customers for late payments | |
| % of unpaid invoices | 2 | Percentage of created invoices that were never paid compared to total number of invoices | |
| # of users per € billion revenue | 1 | Number of different resources that is used to generate € 1 billion revenue | |

*Table 8. OTC process performance indicators, quality dimension (Muurinen 2020).*

| Process performance indicator | Process level | Definition | Process goals |
|---|---|---|---|
| Avg # of orders per customer | 2 | The average number of orders per customer | 1<br>2<br>5<br>6<br>8<br>9<br>11<br>13<br>14<br>15<br>16<br>18 |
| Avg revenue per customer | 1 | The average sales order value per customer | |
| DSO | 1 | Days sales outstanding | |
| Revenue per OTC FTE | 1 | Amount of revenue (€) pear each FTE participating on OTC end to end process | |
| % of cash received late | 3 | Percentage of revenue received after invoice due date | |
| # of customers per | 1 | Number of customers per billion € received | |

| | | | |
|---|---|---|---|
| billion € revenue | | revenue | |
| % of first time right | 1 | Percentage of orders executed end to end without changes and payment delays compared to total number of executed orders | |
| Dispute resolution time | 3 | Time between dispute raised by customer and resolution offered to customer which customer accepted | |
| % of claim credit notes | 4 | Percentage of credit notes (total €) raised to customers due to product/service quality claims compared to total revenue received | |
| % of full invoice cancellations | 4 | Percentage of invoices cancelled in full compared to total number of created invoices | |
| % of late invoicing | 4 | Percentage of invoices sent late to the customer compared to total number of created invoices | |
| % of interface errors | 4 | Percentage of interface errors between IT systems used in the OTC end to end process compared to total number of orders executed | |
| Process automation rate | 1 | Percentage of activities executed automatically compared to the total amount of activities of end to end process | |

*Table 9. OTC process performance indicators, flexibility dimension (Muurinen 2020).*

| **Process performance indicator** | **Process level** | **Definition** | **Process goals** |
|---|---|---|---|
| % of executed orders | 1 | Percentage of orders executed compared to total number of orders received | 5<br>6<br>10<br>11<br>13<br>17 |
| % of customers invoiced | 3 | Percentage of customers invoiced compared to total number of customers in the master data | |
| % of special requests | 4 | Percentage of special customer requests compared to total customer requests | |
| % of changes | 4 | Percentage of orders that were changed during Order-to-Invoice process compared to tola number of executed orders | |

| | | | |
|---|---|---|---|
| # of OTC FTEs | 1 | Number of FTEs tied in the end to end OTC process | |
| # of IT systems | 4 | The number of IT systems or IT services required to fulfil OTC end to end process | |

## 4.5 The Devil's quadrangle for OTC process

### 4.5.1 Significant process performance indicators

According to the conceptual framework described by van den Ingh (2016) in order to visualize the Devil's quadrangle, significant process performance indicators were chosen from the tables 8 – 11 of the chapter 5.3. and segmented per performance dimension (table 10). The significance of these indicators for the OTC process was not proven mathematically as this was not the aim of this study. The evaluation of significance was made based on recommendations found in the literature, own evaluation based on previous studies and experience in performance analysis, and also based on the case company's choices. Many companies offering technology solutions for OTC process discovery and analysis highlight these indicators as key metrics. The company A's managers also saw them as the main OTC key performance indicators.

*Table 10. OTC significant process performance indicators (Muurinen 2020).*

| **Dimensions** | **Process performance indicator** |
|---|---|
| Time | OTC cycle time, days |
| Cost | OTC process cost |
| | % of unpaid invoices |
| Quality | DSO |
| | Process automation rate |
| | % of cash received late |
| Flexibility | % of executed orders |
| | % of changes |

### 4.5.2 Shape of the Devil's quadrangle for OTC

Building the actual shape of the Devils's quadrangle for the OTC process was not in the scope of this research. Nevertheless, several points are important to mention. The significant process performance indicators for each performance dimension can be calculated by using almost any suitable tools available in a company. Visualizing the shape of the quadrangle can be achieved by using Excel spreadsheet.

As the significant process performance indicators have different units of measure such as number of days for time, monetary value for cost, percentage for quality and flexibility, they need to undergo a mathematical transformation so that each performance dimension can be expressed as a single value at the end of the calculation. This mathematical transformation and calculation process should be carefully documented to ensure that the same logic is applied consistency. Otherwise, creating the shape of the Devil's quadrangle and process performance benchmarking will not be possible.

# 5 PROCESS PERFORMANCE BENCHMARKING

The second research question of this thesis was "How the process performance indicators can be applied for process performance benchmarking?". During open interview with one of the senior process experts of the OTC process in the company A, process performance benchmarking was seen as a valuable tool to enable comparison of the OTC processes between regions with the aim to analyze differences in the performance, plan needed improvement activities and share best practices.

Significant process performance indicators (table 10) and the shape of the Devil's quadrangle have a great potential to be used for benchmarking purposes for the following reasons:

1. There are only eight indicators, but they capture process performance from the four different dimensions;
2. The indicators were already operationalized;
3. The shape of the Devil's quadrangle enables clear visual comparison of the process performance.

The objective of the second research question was to provide recommendations for how OTC process performance can be benchmarked, therefore the following step-by-step benchmarking plan was proposed (table 11).

*Table 11. Proposed benchmarking plan of OTC process performance (Muurinen 2020).*

| Phase | Key steps | Outcome |
|---|---|---|
| **Planning** | 1. Selecting area for benchmarking | OTC process (figure 12) |
| | 2. Selecting process performance indicators for comparison | Significant process performance indicators (table 10) |
| | 3. Defining data collection methodology | Ensure that the indicators are calculated in the same manner for each compared OTC process |
| **Data collection** | 4. Selecting industry | Manufacturing |
| | 5. Selecting companies (for cross-company benchmarking) | Word class manufacturers vs company A |
| | 6. Selecting OTC process type (internal benchmarking) | As-is OTC process vs Ideal OTC process based on strategic targets |
| | 7. Selecting geographic location | Based on continents, countries, regions within one country |
| | 8. Defining methodology for data analysis | The Devil's quadrangle framework |
| **Comparative analysis** | 9. Identifying gaps in process performance | By comparing shapes of the Devil's quadrangle (figure 13 and 14 as examples) |
| | 10. Identifying root causes for the gaps in the process performance | Company A's own analysis |
| | 11. Finding ways and making recommendations | Company A's own analysis |

| | | |
|---|---|---|
| | for bridging the gap in the level of efficiency | |
| **Realization** | 12. Implementing changes to improve performance | Company A's own improvement actions |
| **Repeat steps 4 to 12 to enable continuous process improvement** | | |

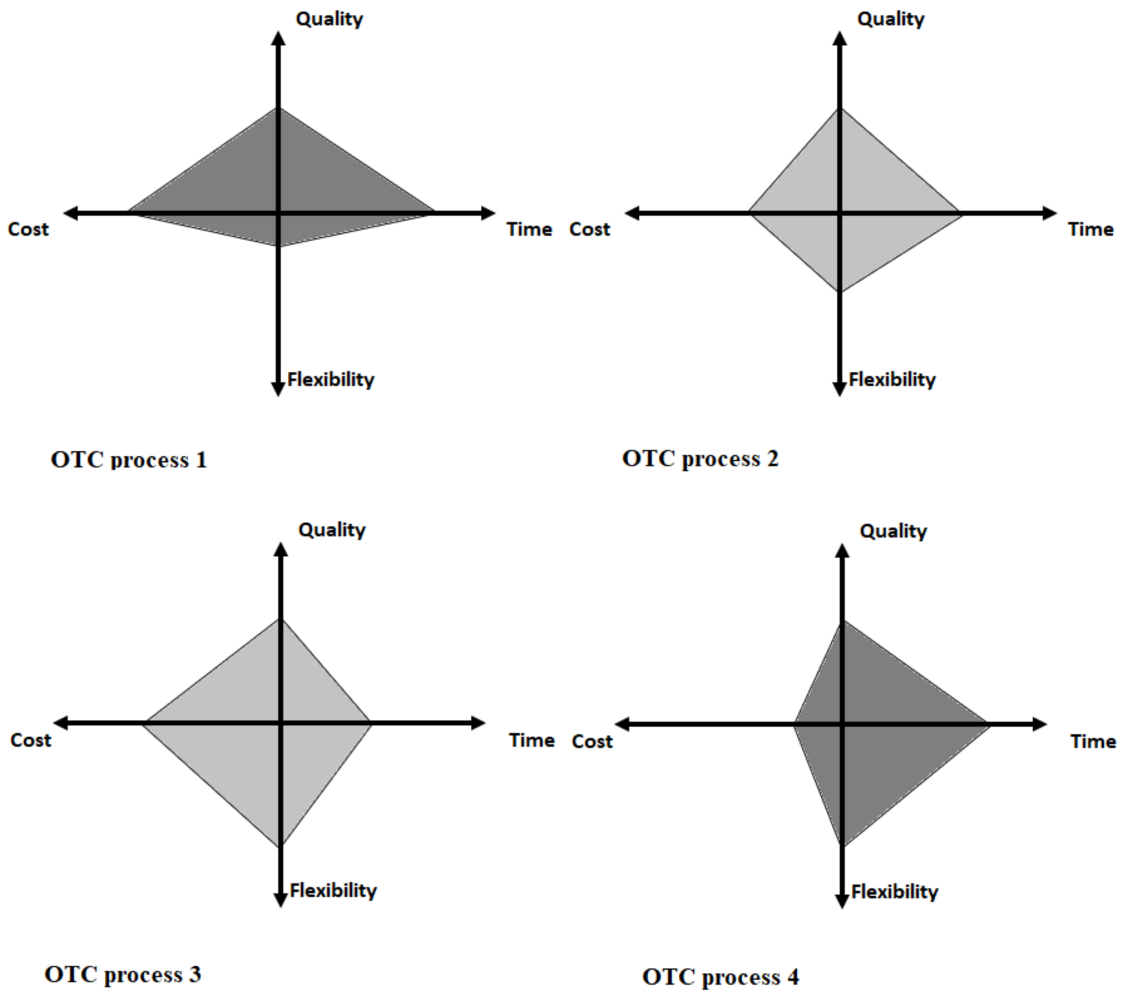


*Figure 13. OTC processes performance benchmark example (Muurinen 2020).*

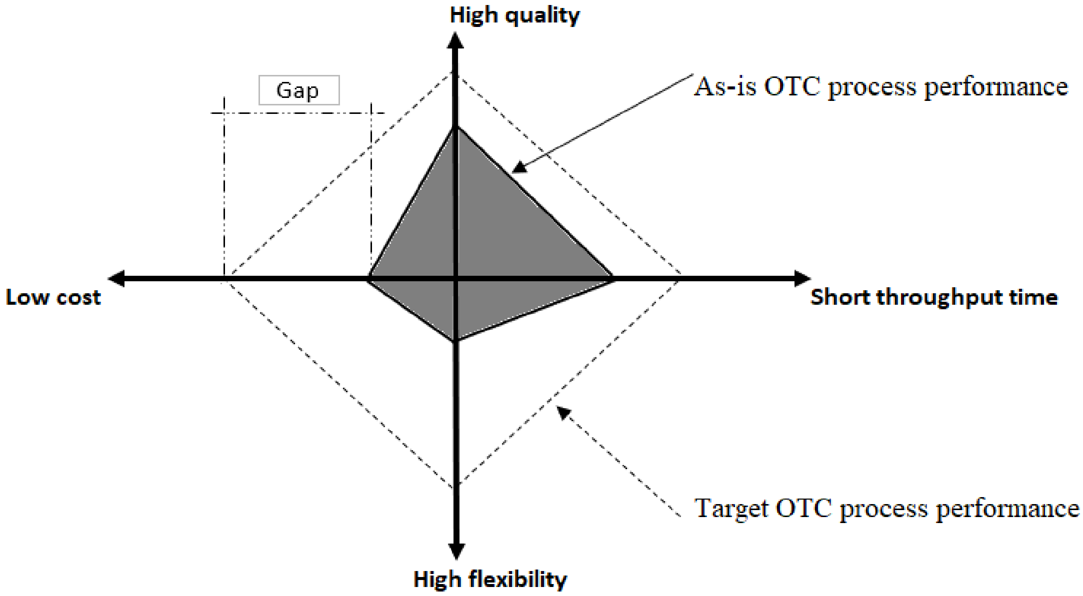


*Figure 14. Gaps in OTC process performance: as-is vs target (Muurinen 2020).*

The shapes of the Devil's quadrangle presented in the figures 13 and 14 were simulated in an Excel file based on assumption that a high performing OTC process (target performance) would have lower process cost, higher quality, shorter cycle time and more flexibility comparing to as-is performance. This assumption took into consideration only one particular product type manufactured by the company A. In order for the benchmarking results to provide real value for companies, careful selection of OTC processes is critical. For example, the case company A has several business areas where different product types are manufactured. Product 1 requires more resources and time to be produced than product 2 due to their nature. Therefore, benchmarking of the OTC process performance based on the business areas (product 1 vs product 2) is irrelevant. For the company A OTC process performance benchmarking should be done based on the geographic locations within one business area instead (for example, product 1: OTC process in China vs Spain).

During extensive literature review no established practices for OTC process performance benchmarking were found. Technology companies providing process mining and automatic process discovery solutions, such as Celonis, have integrated process benchmarking functionality in their tools. This functionality was tested in the company A as part of the proof of concept project for a given business area, but it is applicable only for internal process benchmarking. In order to enable cross-company performance benchmarking, certain information from other companies need to be available as well. Such performance indicators, as EBITDA or ROCE are often available in the open sources and are used by companies to compare performance. It would be interesting to find, whether the shape of the Devil's quadrangle could potentially be used as "EBITDA" of the process performance.

# 6 CONCLUSION AND DISCUSSION

This thesis addressed two research questions: what process performance indicators of the OTC process can be used to measure the as-is end-to-end process and how these indicators could be applied for process performance benchmarking. The research questions were answered in the chapters 4 and 5 by applying the Devil's quadrangle framework. This last chapter concludes the research results and includes discussion on the limitations and opportunities for further research.

## 6.1 Summary

This report describes the topic of process performance indicators for measuring OTC process and process performance benchmarking. In the chapter 2 I looked at the four different process performance measurement frameworks: by Brand and Van der Kolk (1995), by Brown (1996), by Kueng (2000) and by Ljungberg (2002). Based on my analysis, I concluded that all of them are strategy driven, include multidimensional performance assessment and suggest using financial and non-financial measurements. The Devil's quadrangle framework by Brand and Van der Kolk (1995) however has the advantage in terms of being less complex and more suitable to perform process benchmarking. This motivated my choice to select the Devil's quadrangle framework for this thesis.

The first research question was "*What process performance indicators of the OTC process can be used to measure the as-is end-to-end process*?". This question was answered by creating the list of process performance indicators presented in the tables 6 – 9. According to the Devil's quadrangle framework, the indicators cover the four performance dimensions: time, quality, cost, and flexibility. In order to build the shape of the Devil's quadrangle the significant performance indicators were selected. The selection was performed based on recommendations from the literature and also based on the case company's own selection. The actual shape of the Devil's quadrangle for the OTC process was not visualized as it was not in the scope of this research.

The second research question, "*How these indicators can be applied for process performance benchmarking?"*, was answered in the form of recommendations. The benchmarking plan was proposed, and some examples were given how shape of the Devil's quadrangle could be used for this purpose. A careful attention should be given to which OTC process a company intends to benchmark. In order for the benchmarking results to provide real value, comparison should be made within the same line of business and same or similar product types.

## 6.2 Discussion

The goal of this thesis was to study the Order to Cash end-to-end process in a large manufacturing company and create new knowledge on process performance measurement. This qualitative research was conducted as a case study, and due to the research nature, it is a subject to some limitations. As I was working with the qualitative data, my own interpretations of the collected information, as well as the research outcome are biased. The case studies are arguably difficult to generalize because of the large degree of subjectivity involved. However, I made an attempt to produce an outcome, that could be helpful to at least some companies, similar to the case company A.

When working on my research, part of the empirical material I collected was confidential. For this reason, I was not able to include it in this report. I was not able to disclose the company's name nor provide more details on the business, what narrows down the number of companies which could directly apply the proposed process performance indicators in their work. One might also argue that these indicators are relevant to the single case company only.

The background literature for this thesis provided practical process performance measurement frameworks and offered step by step guidance how to approach the subject in a constructive way. This was especially useful when I was creating the research plan that resulted in a concreate list of ready to use process performance indicators for the case process. The academic journals were used to study what process performance measurement models exit.

While working on the case, I have observed how far the company A has progressed in terms of transformation into a process oriented. OTC organization was the front runner in adopting the process-oriented ways of working, and the gained experience started to spread further within the company, affecting larger scope of business processes. This was a positive change showing the increased interest in the processes among employees outside of the OTC.

During the research process it was quickly noticed how challenging it was for the case company to design process performance indicators for the OTC. This didn't come as a surprise because the literature already had a warning, that process measures design in fact is much more challenging than a company can anticipate. A problem seemed to be that in a large organization where OTC process is spread over many geographical locations and includes large number of participants, managers from different departments looked at the process performance only from own department's perspective. It was also visible in the type of process performance indicators that were proposed. With my thesis I tried to solve this problem by creating such indicators, that wouldn't have a departmental bias, but would rather measure OTC end-to-ed process performance as a whole.

As a researcher, there were two main problems I tried to address. First was the lack of ready performance indicators for specific business processes. When it comes to measuring financial performance of an organization, there are certain standard performance indicators, that are widely used. For example, EBITDA, Working Capital, ROE, ROI. I hope to see similar practice to evolve in the future in terms of business processes. The processes have been formally studied for many years, and the importance of performance measurement has been emphasized. Yet, only very few process related measures have been standardized.

The second problem was related to process performance benchmarking. The literature claims, that process performance indicators are company specific as they should be derived from the company's strategy. Due to this fact I believe there was no attempt nor research made on how process performance can be benchmarked across companies. Or at least I have not found any such information during my research. The practice of benchmarking organizational performance has existed for many decades, and I think the companies will benefit if process performance benchmarking becomes possible as well. In order to enable this to happen, one condition needs to be met – development of standard process performance indicators that can be used for benchmarking.

## 6.3 Limitations

One of the limitations is related to significant process performance indicators. It was not proven mathematically that these indictors can significantly predict the OTC process performance, therefore it is hard to tell whether there would have been other significant predictors among listed in the tables 6 – 9. Some of the dropped performance indicators could make the shape of the Devil's quadrangle more accurate, but it is hard to say which indicators, and how without further research.

Another limitation is that the process performance indicators provided in this research are OTC process specific, and therefore cannot be applied to evaluate performance of other process types. Also, since the case company A is a manufacturing company, its OTC process is not comparable to OTC process of a service company, for example. This means that some of the performance indicators cannot be directly applied to measure any OTC process, and business specific adjustment is required.

## 6.4 Further research

The research was performed with the focus on providing a ready to use list of performance indicators to support companies on their process-oriented journey. More research could be executed to find the ideal shape of the Devil's quadrangle for OTC, for example based on the world class performing companies. The proposed list of significant performance indicators could be also mathematically validated and further developed.

Once the significant performance indicators are calculated and the results are transformed, the shape of the Devil's quadrangle can be visualized in an Excel. Considering a large number of advance data analytics tools available on the market today, a new research for selecting the best suitable tool for visualizing the Devil's quadrangle could be of a great value. Future research could also look into a possibility to integrate the Devil's quadrangle in the automatic process discovery software, such as process mining.

The process performance benchmarking plan proposed in the chapter 5 has a theoretical nature. An interesting next step would be to perform an actual benchmarking and test how it could be applied in practice. A series of case studies could be a good approach here, with some focusing on the world class performers. Such findings are needed to enrich existing literature on the process performance analysis, and to motivate process performance benchmarking becoming a more regular practice.

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