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Developing the Purchasing Department's KPIs for Performance Follow-up

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The moment when you have only one page left to write your thesis feels pretty good. One year ago, when I was walking to the entrance exam of in this program, this feeling felt quite distant. I wasn't even sure if I'll pass the exams. But I did, and I have to say, this has been an instructive year. I have met awesome people and learned a lot, also from myself.

I was really lucky that the organization that I am working in was in a phase that the research this thesis is about had to be done in any case. This thesis enabled me and the organization to take a step forward and progress. I would like to thank my colleagues, subordinates, and my employer for giving me the opportunity to educate myself and allowing me to be absent from the workplace. Also, I'm really grateful to all the stakeholder representatives who supported me and collaborated to the research for making this thesis possible.

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<p>This study was carried out for Sako Ltd, a metal manufacturing company. This thesis focuses on finding suitable performance measurement indicators for three different stakeholder groups in the case company from the purchasing department's viewpoint. At the moment, the Key Performance Indicators for purchasing used in the case company are not strategically derived, so the performance of the purchasing department is not visible.</p> <p>The purchasing department needs indicators to measure its performance. The assembly unit as an internal customer needs KPIs to be able to follow-up on its internal suppliers' (purchasing) performance and the management needs KPIs to know whether purchasing is strategically on track.</p> <p>The needs, strengths and weaknesses of the current state of performance measurement in the case company are approached through the current state analysis. The proposed set of KPIs is carried out by collecting best practices from relevant literature and appreciating the needs of the stakeholder groups through discussions, interviews and workshops to form the conceptual framework of purchasing performance measurement and to support the KPI proposal. The research tackles the weaknesses in performance measurement from three different perspectives, i.e. daily management, strategic and financial. Based on the findings of the current state analysis, the study focus is on financial performance measurement, which is the main weakness in the case company.</p> <p>The outcome of this thesis is a proposal of a grounded set of KPIs with recommendations on how to finalize the proposal. The proposal serves all three stakeholder groups from three perspectives. Also, the identified needs are taken into account by enhancing the strengths of the current state and tackling the weaknesses of performance measurement with new KPIs. In addition to the new KPIs, the proposal also includes tools and introduces a new concept on how to measure and handle raw ERP data to support the overall performance assessment.</p> <p>The outcome of this thesis also increases the efficiency of the assembly and purchasing department's daily work by removing manual work regarding the interpretation and combining of different listings and tables.</p>	
Keywords	Key performance Indicator, measurement, purchasing

Contents

Preface	
Abstract	
Table of Contents	
List of Tables	
1 Introduction	1
1.1 Key Concepts	1
1.2 Case Company Background	2
1.3 Business Challenge, Objective, and Outcome	2
2 Method and Material	4
2.1 Research Approach	4
2.2 Research Design	5
2.3 Data Collection and Analysis	7
2.4 Validity and Reliability Plan	12
3 Current State Analysis of Purchasing Performance Measurement in the Case Company	15
3.1 Overview of the Case Company Performance Measurement Practises	15
3.2 Overview of The Owner's KPI Requirements	17
3.3 Identifying User Needs (Assembly + Purchasing + Management)	19
3.4 Comparing User Needs to Current Status	24
3.5 Strengths of Identified Key Performance Indicator's	25
3.6 Weaknesses of Identified KPIs	26
3.7 Summary of Identified Strengths & Weaknesses	28
4 Existing Knowledge on Performance Measurement	31
4.1 Basics of Financial Performance Measurement in Manufacturing Industry	31
4.2 Requirements of Performance Measurement System	34
4.3 Establishing Financial Performance Measurement for Purchasing	37
4.4 Beretta Practises of Purchasing Performance Measurement	43
4.5 Conceptual Framework of This Thesis	45
5 Building a Grounded Set of KPIs	48
5.1 Steps of Building the Proposal	48
5.2 Preliminary Proposal for Assembly KPIs	48
5.3 Preliminary Proposal for Purchasing KPIs	50

5.4	Preliminary Proposal for Management KPIs	51
5.5	Summary of the Preliminary KPI Proposals	53
6	Simulation Pilot, Feedback, and Validation of Proposal	56
6.1	Findings of Data Collection 3	56
6.2	Final Proposal	57
6.3	Feedback and Validation	59
6.4	Recommendations for Future Actions	59
7	Discussion and Conclusions	62
7.1	Summary	62
7.2	Evaluation of the Thesis	63
7.3	Outcome vs. Objective	64
7.4	Reliability and Validity	64
7.5	Closing Words	65

Appendices

Appendix 1. Financial methods, models and systems for performance measurement

Appendix 2. Results of studies on the information content of shareholder value performance measures, 1991-2011

Appendix 3. Most useful inventory performance indicators

Appendix 4. An example of a Balanced Scorecard

Appendix 5. Summary of Data 1 interviews and workshops

Appendix 6. Summary of Data 2 interviews and workshops

Appendix 7. Summary of Data 3 interviews and workshops

Appendix 8. Validation and Feedback, summary

List of Tables

Table 1. Data 1 Stakeholder interviews.....	8
Table 2. Data 2 Stakeholder interviews.....	9
Table 3. Data 3 Stakeholder interviews.....	11
Table 4. Four types of validation and their relation to this study.....	13
Table 5. Overview of identified purchasing KPIs divided into perspectives.....	16
Table 6. The owner's identified purchasing KPIs	18
Table 7. Assembly department needs for indicators.....	20
Table 8. The purchasing department needs for indicators.....	22
Table 9. Management's needs for indicators.....	23
Table 10. Comparison of user needs to current status.....	24
Table 11. Strengths of identified KPIs	25
Table 12. Weaknesses of identified KPIs.....	27
Table 13. Summary from strengths and weaknesses.....	29
Table 14. Popular financial indicators divided into economic-based and accounting-based measures.....	32
Table 15. Performance management system requirements.....	36
Table 16. Evaluating a performance measurement system for purchasing	40
Table 17. Ways of improving economic value added	41
Table 18. Cost of stockouts	42
Table 19. The owner's identified purchasing KPIs.....	43
Table 20. A proposal for shopping baskets by product category breakout	52
Table 21. Summary of the preliminary proposal set of performance indicators	53
Table 22. The timetable for planned simulations with features to review.....	55
Table 23. A listing from KPIs to initial proposal	57
Table 24. Task list for finalizing the research	58

1 Introduction

Successful companies usually have a clear and well-defined strategy. Companies measure their performance by using different kinds of metrics or indicators to be able to monitor whether the company is strategically on track. If performance is not measured, it is challenging to interpret whether development actions have been correct or if there has been any progress. For successful companies, it is a common feature that they continuously develop their functions and seek progress. Also, their performance measurement is up-to-date and they develop and update their measuring practices to withstand the continuous change of the business world. When defining new performance indicators, the groundwork should be done properly to get the best benefits out from performance measurement. Performance should not be measured for the joy of measuring, it should be measured for keeping the stakeholders on track of things.

The performance of different departments in a company can be measured using performance indicators. However, there is no one principle for how the measuring is carried out; rather it could be, for example, done by measuring time, value, currency, or unit per unit. There are several possible indicators available, and the most useful of them is called Key Performance Indicators (KPIs). With a well-defined KPI set, it is possible to measure the current performance against goals and to understand strengths and weaknesses and to improve and develop processes. The most important specification is that the chosen indicator provides useful information and it is easily interpretable.

1.1 Key Concepts

Two central concepts are necessary to understand when performance is measured through specific metrics for achieving strategic goals. The first one is Purchasing as a function. Purchasing can be divided into two different categories, namely traditional purchasing and contemporary purchasing. To clarify, in traditional purchasing a buyer sends a request for quotation to selected suppliers and based on the lowest quoted cost, places a purchase order and assures the delivery. In contemporary purchasing, the responsibilities of a buyer are expanded to tactical and strategic decisions with other stakeholder groups of an organization. Instead of the lowest possible purchase price, the goal is to build and maintain long-term relationships with suppliers and ensure the collaboration with the supply chain participants to achieve cost, quality and delivery targets.

The second key concept is Key Performance Indicators (KPIs). Performance can be measured in many ways, and there are several different indicators to do that. Using too many or too complicated indicators can make things difficult, and it is challenging to screen the most important information from the raw data. That is why companies identify their most important metrics as Key Performance Indicators and use them to measure and interpret whether functions are strategically on track.

Indicators could be shown in the form of a chart, percentage, a dial or even a histogram. There are no rules as to what the indicator should look like visually. The purpose of the indicator or group of indicators is to show valid, coherent and relevant information to its reader and to support the interpreter's decision-making process. This study focuses on measuring purchasing performance from the viewpoint of three different stakeholder groups which are assembly department, purchasing department, and management.

1.2 Case Company Background

The case company in this study is Sako Ltd and it is located in Riihimäki, Finland. The company is owned by Beretta Ltd, which is the oldest family owned company in the metal manufacturing industry in the world. In addition to rifle cartridges, the case company is producing bolt action rifles for sporting, recreational and military use. Currently, there are 310 employees in the Riihimäki plant.

The case company has long traditions in the metal manufacturing industry and assembly. The production has evolved from craftsmanship to high-efficiency industry. Currently, three main components are manufactured in-house in addition to assembly and testing, all other parts and sub-assemblies are subcontracted. The Author is working in the rifle business unit as a Purchasing Manager.

1.3 Business Challenge, Objective, and Outcome

Currently, the Key Performance Indicators used in the case company are not strategically derived, so the performance of the purchasing department is not factually visible. There is a need for three different sets of KPIs for the stakeholder groups. The purchasing department needs indicators to measure its performance, the assembly unit as an internal customer needs KPIs to be able to follow-up on its internal suppliers' (purchasing) performance and management needs KPIs to know whether purchasing is strategically on track.

Unfortunately, strategy derived KPIs for the case context are missing on all three levels, which **forms the business challenge of this thesis**. The purchasing performance measurement is in a very significant role when the majority of end product's parts are outsourced. Therefore, all three stakeholder groups are part of purchasing performance.

What this in effect means is that the purchasing department's true performance cannot be objectively measured nor rewarded. Fixing this issue is also a part of the production development program approved by the owner, Beretta Group.

This study focuses on finding suitable indicators for three different stakeholders in the case company and, in particular, **the objective of this study is to propose** a grounded set of KPIs for the case company that meets the requirements of the three stakeholder groups. This study is carried out by collecting best practices from existing literature and knowledge and researching the needs of the stakeholder groups through open discussions, interviews and workshops in the Current State Analysis.

The outcome is a proposal of a set of indicators based on the findings of the Current State Analysis and Conceptual Framework from the existing knowledge and literature. In addition to the proposed set of KPIs, recommendations on how to put them into practical use are given.

Section 2 describes the research methods and approach and how the data is collected and analyzed. Also the plan to ensure validity and reliability is described with a few references to literature. Section 3 provides an overview to the current state analysis and clarifies the strengths and weaknesses of the identified KPIs at the case company. Section 4 introduces the existing knowledge and the case company owner's best practices relating to the topic of this thesis, thus forming the Conceptual Framework of this thesis. The proposals for the KPI set is presented in section 5 and the simulation pilot in section 6 with feedback, validation and recommendations for future. The last section 7, contains the final discussion and conclusions with a summary of the thesis.

2 Method and Material

This section presents the research method and material that was utilized in this study. Firstly, the research approach is described. Secondly, the research design is shown visually with a flowchart which shows the goal, contents, and outcomes of the different data collection phases. In the third sub-section, data collection and analysis are overviewed, and it is explained how the data of this study is collected. Finally, the reliability and validity plan of this study is explained.

2.1 Research Approach

When choosing the research approach, it is important to seek if the selected approach gives answers to the question at hand. This study is carried out by using the qualitative action research approach because it aims to solve current practical problems while expanding scientific knowledge of the matter. In action research, the practitioners (in this case, the stakeholders) are enabled to investigate and evaluate their work and seek answers to questions like “what am I doing? Do I need to improve anything? If so, what? How do I improve it? Why should it be improved?” With the help of existing knowledge and practice, new ideas are generated, and the work is improved. (McNiff & Whitehead, 2011)

In this case, the problem is practical and scientific knowledge is needed to provide a valid proposal. Also, the researcher is closely involved in the process and seeks to have an organizational change to improve and study the problem (Baburoglu & Rawn, 1992).

Action research is defined in numerous different ways. One of the most cited is (Rapoport, 1970) who defines action research in the following way:

Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and the goals of social science by collaboration within a mutually acceptable ethical framework. (p.499)

The above quote is also applicable to this study since this study focuses on solving an immediate problematic situation for the three different stakeholder groups. The action research process used in this study is visually described in Figure 1. It is based on Sullivan, Hegney & Francis (2013) and Susman & Evered (1978).

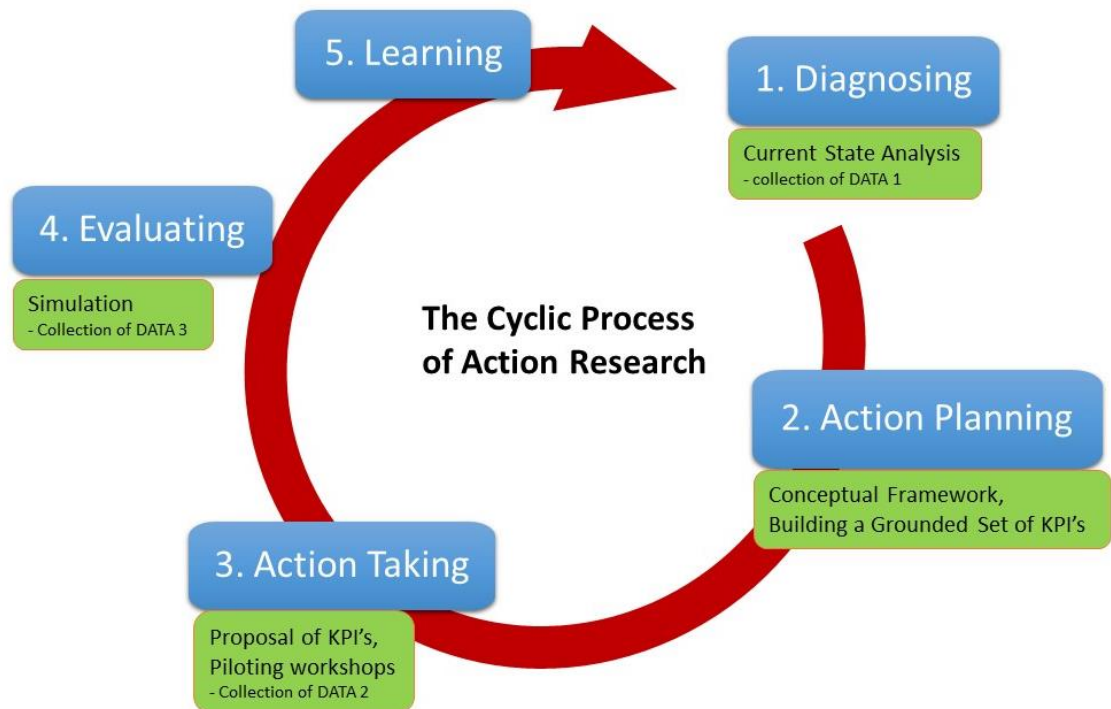


Figure 1. The cyclic process of action research approach

As seen in Figure 1, the action research process of this study is visualized as a cyclical process. All starts from the diagnosing phase where the Current State Analysis (CSA) is carried out and Data 1 is collected. The actions are planned based on the results of the CSA and the building of the Conceptual Framework, which in turn, provide tools for building a grounded set of KPIs to each stakeholder group.

The action is taken with the proposed set of KPIs by using them in the piloting workshops, thus forming Data 2. After the phases of the action taking and piloting workshops, the actions are evaluated through a simulation which will then form Data 3. After possible corrections and re-simulation, the final phase is the lessons learned phase.

2.2 Research Design

The research design of this study is illustrated in Figure 2. It has been divided into stages, data sources, and goals. As mentioned in section 1.3, the business challenge in this thesis is that strategy derived KPIs are missing. Therefore, **the objective** is to propose a grounded set of KPIs that meets the requirements of the three stakeholder groups.

After defining the business challenge and the objective, **the Current State Analysis** is conducted with the three different stakeholder groups; purchasing, assembly and management using open-style discussions, group interviews and workshops. Interviews are performed without a pre-defined questionnaire but the topic frame and the target of the discussions are pre-planned as seen in appendices 5-7. The goal is to clarify what the strengths and weaknesses of the KPIs thus identified are. The company has a massive data storage from several years, so there is a significant number of different KPIs that have been or are currently being used. The CSA forms the first data collection point, Data 1.

After conducting the CSA, the goal is to form a **Conceptual Framework** with the help of existing knowledge and benchmarking to the mother company. To achieve a solid set of KPIs, possible similarities of performance measuring with the group owner, Beretta Ltd, should be taken into notice to add reliability to this study.

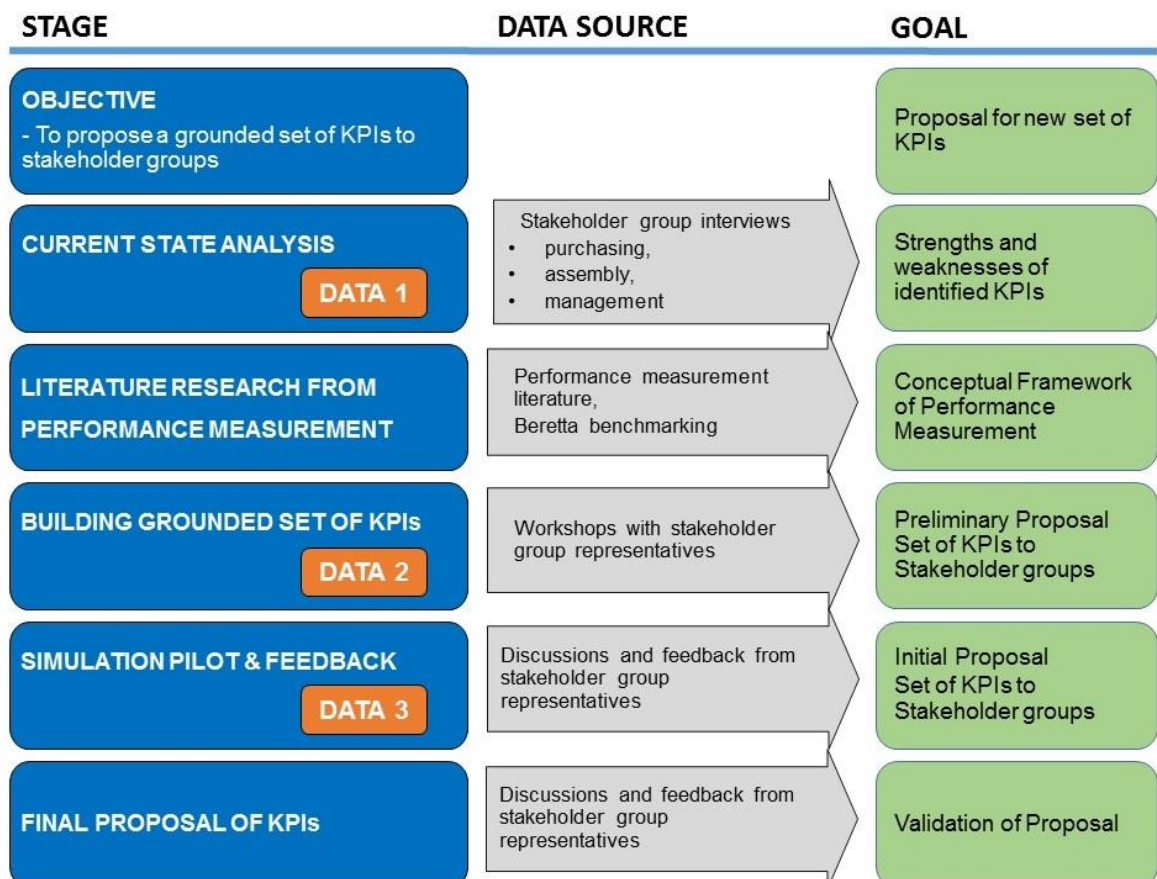


Figure 2. The research design of this study

As seen in Figure 2, the different stages, data sources, and goals of the research design of this thesis are emphasized with distinctive coloring; blue, grey and green. The data collection points 1, 2 and 3 are highlighted with an orange frame to stages. After data 1, the CSA, data collection point number 2 consists of workshops with stakeholder representatives. The Conceptual Framework is used to build a proposal of a grounded set of KPIs, and they are fine tuned in the workshops with the stakeholder representatives. After the workshops, the KPIs are simulated with data from previous years, found in the company's ERP system, and feedback is collected from the same stakeholder representatives as in the previous stage. Finally, it is the task of the stakeholder groups to validate the proposed set of KPIs.

2.3 Data Collection and Analysis

This study used data collection in three different points, i.e. Data 1, 2, and 3 marked with an orange frame in Figure 2. The first data collection (Data 1) was carried out with the CSA, with three different stakeholder groups involved, i.e. purchasing, assembly and management. The goal of this data collection was to obtain an accurate view of how current KPIs are used and what the weaknesses and strengths of them are. The data was collected through personal and group interviews and discussions, and they were conducted as many times as necessary to achieve robust and reliable information. The discussions and agendas are shown in Table 1 on the next page. The results from data collection 1 are described in Section 3, Current State Analysis.

The workshops, interviews and discussions in this study were analyzed with thematic analysis, identifying the most important themes and issues and refining them for further research with the conceptual framework.

Stakeholder group & Representatives	Data collection point	Date and duration	Documented as	Topics discussed
Management Financial Director, Production Controller, IT-specialist	Data 1	Discussion 21.1.2016, 60min	Memo	<ol style="list-style-type: none"> Purchasing KPIs from Management's view Identified KPIs <ul style="list-style-type: none"> - Relevancy - Interpretability - Access - Usability Need for new KPIs
Assembly Supervisor, Production Manager, Production Controller, Production Planner Assistant	Data 1	Discussion 27.1. 2016 60min	Memo	<ol style="list-style-type: none"> Purchasing KPIs from production's view Identified KPIs <ul style="list-style-type: none"> - Strengths - Weaknesses - Relevancy - Usability
Purchasing Purchasing Manager, Production Controller, Purchasing Coordinator	Data 1	Workshop 4.2.2016 60min	Memo	<ol style="list-style-type: none"> Identified KPIs <ul style="list-style-type: none"> - Strengths - Weaknesses - Relevancy - Usability Financial KPIs <ul style="list-style-type: none"> - Existence - Future needs
Assembly Supervisor, Production Planner Assistant	Data 1	face-to-face meeting 10.2.2016	Memo	Distortion caused by the surface treatment

Table 1. Data 1 Stakeholder interviews

As seen in Table 1, Data 1 collection was performed through discussions, workshops, and a face-to-face meeting following the open discussion method. Discussions started with mapping and identifying the stakeholder needs and indicators in contrast to purchasing performance measurement to clarify what the KPIs in use are, how they are working and what the requirements for a performance measurement are.

After identifying the needs and indicators, the common features such as interpretability, relevance, accessibility and usability, were recognized to form an understanding of the strengths and weaknesses of an indicator and to clarify the current and identified KPIs as thoroughly as possible. The summary of data collection 1 is displayed in Appendix 5, and the results are seen in Section 3, Current State Analysis.

The second data collection point (Data 2) was built with the stakeholder groups with the help of the Conceptual Framework and mother company's references. The goal was to

have a preliminary proposal set of KPIs. The results from Data 2 are described in section 5 where they were used to form the preliminary proposal of KPIs. Also, the interviews and discussed topics are shown in Table 2.

Stakeholder group & representatives	Data collection point	Date and duration	Docu-mented as	Topics discussed
Benchmarking Purchasing and Supply Chain Director, Fabbrica D'Armi Beretta	Data 2	Meeting 5.3.2016 60min	Memo	<ol style="list-style-type: none"> 1. Focus point of purchasing <ul style="list-style-type: none"> - quality vs. price 2. Identified KPIs in the Mother Company <ul style="list-style-type: none"> - reliability - interpretability 3. Needs for new KPIs 4. Supplier performance evaluation
Purchasing/ Management IT specialist 1, IT specialist 2, Production Controller, Financial Director	Data 2	Workshop 8.3.2016 60min	Memo	<ol style="list-style-type: none"> 1. Delivery accuracy calculation 2. ERP data storage <ul style="list-style-type: none"> - cost savings - spend - Inventory value
Assembly IT Specialist Production Manager	Data 2	Meeting 31.3.2016 60min	Memo	<ol style="list-style-type: none"> 1. Indicator for surface treatment 2. Enhancing identified indicators
Purchasing/ Management Purchasing Manager, Purchasing Coordinator, IT Specialist, Production Controller	Data 2	Workshop 31.3.2016 120min	Memo	<ol style="list-style-type: none"> 1. PPV indicator for cost savings <ul style="list-style-type: none"> - standard cost reliability - where to start cost savings 2. Inventory value <ul style="list-style-type: none"> - value measurement by product categories 3. Shopping basket concept 4. Service level and delivery accuracy formulas 5. Costs of stockout 6. ERP-listing to OBI

Table 2. Data 2 Stakeholder interviews

As seen in Table 2, Data 2 collection started from interviewing the author's colleague from the case company owner's organization to have a benchmarking perspective from their way of purchasing performance measurement. The interview started from a general level to identify the owner's key criteria for purchasing, whether price or quality. The interview progressed similarly as Data 1 discussions, to clarify the current state and to identify the needs, strengths and weaknesses of the case company owner's purchasing performance measurement practices.

Data 2 collection continued with internal workshops in the case company with the stakeholder representatives. In internal workshops, firstly, the owner's performance measurement practices were introduced to participants following a brief presentation of the Conceptual Framework key points. After presenting the interface of the frame to the stakeholder representatives, an open-format discussion was carried out to have a mutual understanding of the goals to include in the proposal set of KPIs. The workshops (carried out on 8 March, 31 March) included, in addition to the delivery accuracy formula improvements, suggestions on how to utilize the massive data storage to arrive at reliable financial performance such as cost savings, spend, inventory value and which would be the most valuable items or products to follow.

An indicator for surface treatment was seen an important indicator as the daily management indicator to the assembly department. It also reduces the uncertainty factor from other daily management indicators in use.

In the last workshop (31 March), utilizing the data storage took a bigger leap, and there was a consensus to use the PPV indicator to allocate the cost savings. Also, the challenge to filter the massive data was solved. A product breakout by main categories was suggested including the shopping basket concept where the most important items from product categories form a shopping basket which includes the items to follow financially. In the same workshop, service level and delivery accuracy formulas were again inspected and decided to propose them as according to the case company owner (service level in Table 6, p. 15) and identified user need of delivery accuracy (Table 10, p. 21). Costs of stockout calculation were also proposed as a new indicator to support the quality department's claims, and IT is investigating whether it is possible to build. Finally, a need identified by the purchasing department was the ERP past due orders listing to be moved and automatically sorted to Oracle Business Intelligence (OBI) system which is used as a platform for KPIs.

The summary of data 2 workshops is displayed in Appendix 6, and the outcome of data 2 is a preliminary proposal for a grounded set of KPIs that is listed in Section 5, p. 46.

The third data collection point (Data 3) consisted of the process of Data 2's simulation and feedback. The goal was to have an initial set of KPIs with the help of stakeholder group representatives. The results from Data 3 are shown in Section 6. The topics discussed are presented in the following Table 3 and summarized in Appendix 7.

Stakeholder group & representatives	Data collection point	Date and duration	Docu-mented as	Topics discussed
Assembly IT specialist, Product Manager	Data 3	Workshop 6.4.2016 60min	Memo	1. Surface treatment indicator - simulation - implementation
Purchasing/ Management Purchasing Coordinator, IT Specialist, Production Con- troller	Data 3	Workshop 6.4.2016 120min	Memo	1. Timetable for simulations - service level - delivery accuracy - product spend - inventory turnover rate 2. Challenges in the shopping basket proposal 3. Challenges in costs of stock- out
Management Rifle Business Unit Director	Data 3	face-to- face meeting 7.4.2016 20min	Memo	1. Daily management indicators for purchasing - assembly missing parts - pre-assembly missing parts
Management CEO	Data 3	Discussion 8.4.2016 15min	Memo	1. Service level formula 2. Presentation of proposals
Management, Purchasing, Production Representatives	Data 3	Meeting 20.4.2016 60 min	Memo	Presentation of initial proposal - discussion - feedback - validation

Table 3. Data 3 Stakeholder interviews

As seen in Table 3, the simulation and feedback phase started from the surface treatment indicator to establish whether it is possible to implement and what it takes. Luckily, IT found a solution how to use and implement a check-in/check-out function to have a reliable indicator for parts in surface treatment. In the next workshop, a timetable was agreed to simulate the proposed updated stakeholder KPIs with old ERP data, such as the delivery accuracy and service level for the purchasing, the inventory value by product breakout, and the product spend and the inventory turnover rate utilizing the shopping basket concept. Also, the issues regarding the shopping basket concept and the cost of stockouts were taken into notice. There are some challenges to be solved before the reliability to implement is achieved.

In the next two meetings (7.-8 April) new suggestions were made to include in the initial proposal daily management indicators for purchasing related to assembly missing parts

and pre-assembly missing parts. The CEO of the company prefers that the supplier service level formula should not be similar to the mother company. These were taken under investigation before formulating the final proposal.

In the last meeting, the initial proposal was presented to the representatives of the stakeholder groups and the director of the business unit for feedback, discussion, and validation. The proposal was already accepted on behalf of the stakeholders participating in the workshops. Therefore, the final validation took place on the 20 April 2016. The summary of the validation is presented in Appendix 8.

2.4 Validity and Reliability Plan

In research, validity and reliability are used to measure the quality of the work. It could be said that they are the two foundation pillars of the study in qualitative research that ensure *credibility*. In this study, firstly, validity and reliability are taken into account during the planning phase of the work, and it is carried out throughout the thesis. Evidence trail is kept visible by conducting interviews and discussions comprehensively and providing comprehensive tables, summaries and appendices what has discussed.

The problem is examined from three different angles from each stakeholder's view to ensure validity. Also, four interviews from various levels of organizational hierarchy are carried out, and similar questions are presented for *rigorosity*. Also, the stakeholder groups are involved in the last three stages of the research design, whereas preliminary, initial and validation of KPIs are completed. According to Quinton and Smallbone (2006), an important point about validity is to make the design approach rigorous enough to whoever is assessing your work. In addition to that, the researcher's thinking should be transparent throughout the work and honestly discuss the threats of validity. In this paper, it is done in section 7.5.

Lather (1991), wrote about the reconceptualization of validation and identified four types of validation, the relevancy of which to this study is described in Table 4.

Type of Validation	Validation Relation to this Thesis
1. Triangulation (multiple data sources, methods, theoretical schemes)	Benchmarking, more than one stakeholder group, informants from different organizational level, multiple theory sources
2. Construct Validation (recognizing the constructs that exist than imposing theories on informants or the context)	Comprehensive interviews, identifying strengths and weaknesses of existing metrics, engaging the stakeholders
3. Face Validation (when an assessment or test appears to do what it claims to do)	The researcher himself is involved through his position; simulation is used in “real life.”
4. Catalytic Validation (engages participants toward knowing reality to transform it)	Stakeholders are engaged and agitated through Current State Analysis

Table 4. Four types of validation and their relation to this study. Conducted from (Lather, 1991)

As seen in Table 4, the four types of validation are all related to this study and the common factor of all types is engaging others in the process and making the research transparent. It also obliges the researcher to triangulate his view from different perspectives, which increases the validity of the study.

Reliability is the second pillar of credibility. One assessment of reliability, according to Quinton and Smallbone (2006), is if the research would be repeated by someone else, the same findings and outcome are obtained. In this case, it is seen as a threat, because the outcome and the findings could be different if this research is conducted in a different time or different surroundings. In fact, Quinton & Smallbone (2006) came up with the same conclusion in their paper if the definition is used in business and management research.

Finally, this study is a part of a bigger production development program required by the owner so that the outcome will also be reviewed by the top management. To sum up, the objective and the research question is clear, research approach is appropriate for the question, the expected outcome is well defined and the process is conducted with systematic data collection and analyzing. Therefore, the research meets the requirements of *trustworthiness* (Baxter, 2008).

This section presented the chosen research approach and the reasons it is applicable in this thesis. The research design was visualized with a flowchart to give details of the

stages, data sources, and goals of the research design and data collection points. In the third subsection, the data collection and analysis was explained with the help of tables 1, 2 and 3. Finally, the reliability and validity plan of this study was described.

In the next section, the current state of purchasing performance measurement and identified KPIs in the case company are analyzed with a presentation of the strengths, weaknesses and identified user needs.

3 Current State Analysis of Purchasing Performance Measurement in the Case Company

This section analyzes the current state of the identified Key Performance Indicators in purchasing from the view of three case company stakeholder groups. First, the focus is on how the case company measures its performance currently, what the perspectives in purchasing performance measurement and the identified KPIs in each stakeholder group are. Second, the analysis concentrates on determining how the mother company measures its purchasing performance and how it is influencing the case company.

After the background sub-sections, user needs are identified from all stakeholder groups through interviews and the identified user needs are then compared to the current status. Finally, the strengths and weaknesses of the KPIs identified are listed, and a summary is presented, which is shown in Table 10.

3.1 Overview of the Case Company Performance Measurement Practises

Performance measurement began to take a bigger role in the case company after the Beretta acquisition in the year 2000. The mother company has been constantly following numbers from the financial side (profit, costs, cash flow, and personnel) in addition to production volumes and productivity, on a monthly basis. Since only three main components are manufactured in-house and the sales are rapidly increasing, the outsourced quantities and amounts are increasing yearly. Consequently, purchasing performance measuring is now in a bigger role due to increased spending. At the moment, purchasing performance is measured, but strategically defined Key Performance Indicators are missing in all three stakeholder levels.

Currently, purchasing performance measurement is divided into three different perspectives: financial, daily management and strategic. There is plenty of data from all these perspectives in the company's *ERP, OBI and IT databases. This thesis is tackling all of those perspectives from the viewpoint of the key stakeholder groups to find out how they are measuring purchasing performance in their operations at the moment. The overview of the identified Key Performance Indicators is listed in the following Table 5.

**ERP stands for Enterprise Resource Planning*

**OBI stands for Oracle Business Intelligence system*

**WO stands for Work Order*

Identified purchasing KPI perspectives			
Stakeholder	Financial	Daily management	Strategical
Assembly	No need for an indicator	<ol style="list-style-type: none"> 1. *WOs that are missing parts, 2. WOs than can be assembled, 3. Products missing parts, 4. Assembly missing parts 	No defined indicator
Purchasing	No defined indicator	<ol style="list-style-type: none"> 1. Past due orders 2. Assembly missing parts 	<ol style="list-style-type: none"> 3. TOP10 supplier delivery accuracy, 4. Total supplier delivery accuracy
Management	No defined indicator	No need for an indicator	<ol style="list-style-type: none"> 1. TOP10 supplier delivery accuracy, 2. Total supplier delivery accuracy

Table 5. Overview of identified purchasing KPIs divided into perspectives

As seen in Table 5, the identified purchasing KPIs are divided into three different perspectives that are highlighted with blue coloring. The stakeholders are on the left side, in grey.

As seen, the stakeholder groups follow many indicators. The Table also shows some performance measuring perspectives have not had a defined indicator. However, it should be highlighted that a stakeholder does not have to measure performance from every perspective if it is not providing extra value to its function. For example, a financial performance indicator does not provide any essential information to the assembly department supervisor. His job is to secure daily assembly, and the financial information is hardly helpful there. Similarly, the management does not need daily management tools for purchasing. The daily management indicator from purchasing actions does not give any valuable information on how to run the company.

To summarize, the assembly department is a function with an objective to achieve the daily production volume target. That is why the financial indicator is not important. In daily management, three important indicators are available from the Oracle Business Intelligence (OBI) system. The listings update automatically and show the Work Orders (WOs) that are missing parts and WOs that can be assembled. The indicator is a numerical quantity. Also, a summary of product categories that are missing parts is provided.

The purchasing department has no financial indicator defined, although the data is available from the case company database. Daily management indicators are in use, to help

the department's internal customer, i.e. assembly. Strategic indicators are supplier delivery accuracies divided in TOP 10 supplier delivery accuracy and total delivery accuracy of suppliers.

Obviously, the management is currently following purchasing financial numbers but not with explicitly defined indicators. The data for financial purchasing indicators would be available, but it is scattered in different IT systems and raw data. As said earlier, there is no need for a daily management purchasing indicator for management. Strategic indicators that the management is following are the same supplier delivery accuracy indicators that the purchasing department is using.

3.2 Overview of The Owner's KPI Requirements

The Purchasing and Supply Chain Director of Fabbrica D'armi Beretta were interviewed to clarify how they measure their purchasing performance and to add a benchmarking point of view to this study. Regarding the field of industry, the quality of the parts is playing a very significant role in the owner's factory. If parts are out of tolerance, the end product could be hazardous to its user. Additionally, the mother company is measuring purchasing performance with six different metrics, which are overviewed below in Table 6 and explained more thoroughly in section 4.1.

The owner's identified KPIs	
Performance Indicator	Explanation
1. Supplier Quality trend [PPM], monthly. (quantity & value)	A histogram where the difference between non-conform quantity and incoming quantity is calculated and displayed as PPM indicator. Measured also by value.
2. Non-conformances allocation, [%]	A table where non-conformances are displayed from incoming inspection and assembly lines.
3. Supplier service level [%], weekly	A percentage histogram where the back order quantity is divided by required quantity. Followed on weekly basis
4. Supplier cost analysis, trend	A table which indicates the trend and the variance (Δ) from average annual purchase price with item and product category Breakout to forecasted price
5. Cost savings, parts	The variance (Δ) of purchased part total cost multiplied by the quantity accepted.
6. Cost savings, products	A. The variance (Δ) of internal cost of the product. B. The variance (Δ) of external cost of the product.

Table 6. The owner's identified purchasing KPIs

As seen in Table 6, where the identified purchasing KPIs are listed with an explanation, the supplier quality is measured with two different indicators. Parts per Million (PPM) indicator from incoming parts by the quantity and by value, displayed to two different histograms which are followed on a monthly basis. In addition to supplier quality indicator, the non-conformant parts are allocated and followed from two separate locations, in reception inspection, and in the manufacturing area.

The service level of a supplier is followed on a weekly basis by the following formula:

$$1 - \frac{\text{back order at the end of the period}}{\text{back order at the beginning of the period} + \text{required qty in the period}}$$

The supplier is given a timeframe of one week to deliver the parts and the service level percentage is calculated from the back order quantity at the end of the week divided by the back order quantity at the end of the week + required quantity in the period.

Financial performance is followed with three different indicators; supplier costs analysis and two different cost savings calculations. In supplier cost analysis, the variance (Δ) of part prices is collected throughout the year to the ERP system and compared to the

forecasted price. All the collected data is possible to group by item or by product category with the annual trend.

Cost savings are collected with two different calculations. Firstly from the parts, the variance (Δ) is calculated from min/max purchase price and then multiplied by the accepted quantity. Secondly from the products, cost savings variance is divided by internal and external variance, whereas internal cost is activities happening in-house and external costs are purchase price and logistics. This indicator was said to have some reliability issues because the ERP system is calculating the average price of products. Hence, it requires manual work from the purchasing and controller personnel to have reliability at an acceptable level.

All things considered, the owner has similar challenges as the case company with purchasing performance measurement; there is an enormous amount of data in several different IT systems, and KPIs have to be defined to conform to the company strategy, and it just has to be done. At the moment, the owner has focused on quality perspective when measuring purchasing performance, because increasing supplier quality has at the moment their focus of interest. The Owner's Purchasing and Supply Chain Director encapsulated the challenge fittingly in a Data 2 interview:

You just have to make the decision what indicator or feature you are following. The huge amount of raw data does not give you answers.

Data 2: Interviewee, Beretta Purchasing & Supply Chain Director

In the case company, the level of supplier quality and the quality of parts are already at the required level. Therefore, they are not the focus when measuring performance.

3.3 Identifying User Needs (Assembly + Purchasing + Management)

According to Data 1 interviews as seen in Table 5, acknowledged clarifications and simplifications are necessary regarding stakeholders' indicators, and some user needs do not have an equivalent indicator. The identified user needs are put in Tables by one stakeholder group at a time, starting from Assembly user needs in Table 7.

Identified assembly user needs	
Performance Indicator	Identified user need
1. WOs that are missing parts	What is the week that a WO is planned for assembly? No indicator for parts that are in surface treatment!
2. WOs that can be assembled	No indicator for parts that are in surface treatment!
3. Products that are missing parts	Good summary with similar information than in indicator n:o 1
4. Assembly missing parts	A comprehensive listing of parts that are late.

Table 7. Assembly department needs for indicators

As seen in the above Table 7, where the identified KPIs are listed in grey followed by the identified user need, there are two additional user needs (indicator number 1 and number 2) for the identified assembly purchasing indicators. The listing “*work orders that are missing parts*” is not showing the assembly week. The production planner assistant describes what this does to her daily work:

Sometimes it is really frustrating to cross-examine work orders that are missing the parts with another listing from another system just to find out what is the week when the work order is planned to assemble

Data 1: Interviewee, Production planning assistant

In addition, there is no indicator available if the outsourced parts are in surface treatment, although they seem to be available in the listing “*work orders that can be assembled*”. The material flow regarding the surface treatment is clarified in Figure 3.

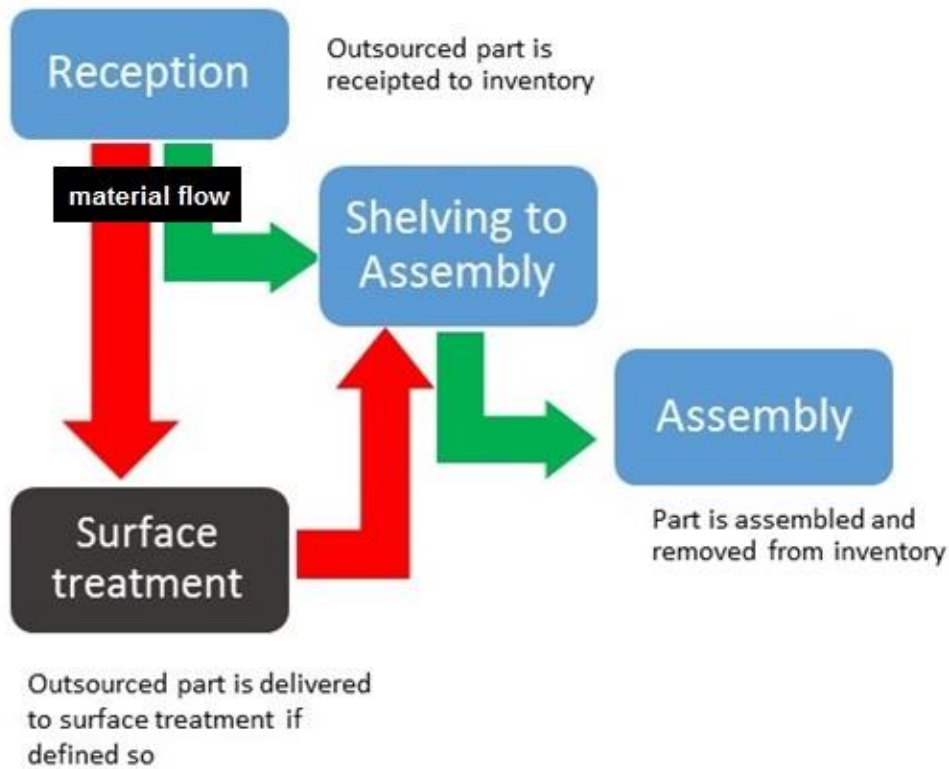


Figure 3. Material flows from reception to assembly

As seen in Figure 3, where the surface treatment material flow is highlighted in red, a detour is formed when parts are routed to surface treatment. The problem is that nothing indicates how many parts are in surface treatment, whether they are in process or if they have been delivered to be processed. The parts are in the inventory. Hence, ERP indicates that they have arrived and have been received, and they are available in the listing “*WOs that can be assembled*”. The assembly supervisor describes the “black hole” as follows:

Sometimes parts are just missing and after checking the late status, reception status and manually search for the parts, it clears out that they are in the “to surface treatment” shelf. The surface treatment is a kind of a black hole what eats the parts.

Data 1: Interviewee, Assembly Supervisor

Secondly, the identified user needs from the purchasing stakeholder’s view are described in Table 8.

*OBI stands for Oracle Business Intelligence system

Identified purchasing user needs	
Performance Indicator	Identified user need
1. Past due orders	Indicator is not available from OBI, retrieved from ERP to excel. Another Business unit's parts and spare parts in the same listing
2. Assembly missing parts	No need for improvement
3. TOP 10 supplier delivery accuracy	Calculation is done by purchase order line, does not take into account partially delivered orders deliveries
4. Total supplier delivery accuracy	Calculation is done by purchase order line, does not take into account partially delivered orders deliveries
	All financial indicators are missing. Occasional need for inventory value, total spend, inventory turnover time with product split and cost savings

Table 8. The purchasing department needs for indicators.

As seen in Table 8, where the identified KPIs are listed in grey followed by the user needs, *Past due orders* are available from ERP, but they are not in the OBI system that is used to present and visualize indicators. Also, there are other business units' parts in the listing in addition to spare parts.

Supplier delivery accuracies are calculated by PO line which distorts the actual delivery accuracy. For example, if 9,900 parts are received from one 10,000pcs PO line, then the delivery accuracy is 0% for that delivery even though the exact delivery accuracy was 99%. Data 1 interviews revealed two critical user needs, i.e. missing indicators from the financial perspective. The data is available but not in an easily retrievable format. These needs are occasionally needed by the owner or by an auditor, and they have to be collected manually. Importantly, there is not an indicator to show how much cost savings the purchasing department has achieved.

The third and final stakeholder user needs are listed on the next page in Table 9.

Identified management user needs	
Performance Indicator	Identified user need
1. TOP 10 supplier delivery accuracy	No identified user needs
2. Total supplier delivery accuracy	No identified user needs
	Supplier service level would be an excellent addition to supplier delivery accuracy
	All financial indicators are missing. Occasional need for inventory value, total spend, inventory turnover time with product split and cost savings

Table 9. Management's needs for indicators

As seen in Table 9, where the identified KPIs are listed in grey followed by the identified user needs, the same *delivery accuracy* indicators as in Table 8 were seen informative enough, though the purchasing stakeholder group had additional needs regarding them. Additionally, the management stakeholder group saw the service level as an indicator to measure supplier performance from another angle, as the Production Controller expressed in Data 1 interview.

Service level would tell more from a supplier's performance in addition to delivery accuracy. To have a good comparison, the formula should be the same that the sales is using.

Data 1: Interviewee, Production Controller

Regarding the non-existent financial indicators, there were similar user needs compared to those in Table 8, Purchasing user needs, as the Financial Director describes.

"It is rather funny that we do not measure the inventory value or total spend, even if data is available in the system."

Data 1: Interviewee, Financial Director

3.4 Comparing User Needs to Current Status

Several unmet user needs exist when looking at the current status. Some of them are causing excess work from using several indicators to sort the important information out, especially since some of the needs have no indicator of any kind. A comparison between user needs and the current status is found in Table 10.

Stakeholder	User needs	Current status
Assembly	1. Assembly week to “WOs that are missing parts.”	“WOs that are missing parts” has to be combined with another listing where the WO week is visible
Assembly	2. Parts in surface treatment	The surface treatment is a “black hole.”
Purchasing	3. Past due orders from ERP to OBI. Spare parts and another business unit’s parts off the list	Past due orders are manually retrieved and sorted from ERP
Purchasing	4. Delivery accuracy formulas by: $\frac{\text{Parts (qty) received}}{\text{Parts (qty) ordered}}$	Delivery accuracy formulas by: $\frac{\text{PO's received completely}}{\text{PO's ordered}}$
Purchasing	5. Financial indicators with product split <ul style="list-style-type: none"> - inventory value, - total spend, - inventory turnover time, - trends - cost savings 	No strategically defined financial indicator although data is available
Management	6. Financial indicators with product split <ul style="list-style-type: none"> - inventory value, - total spend, - inventory turnover time, - trends - cost savings 	No strategically defined financial indicator although data is available
Management	7. “parts in” service level as in “products out”	Supplier service level is not measured

Table 10. Comparison of user needs to current status

As seen in Table 10, where the identified user needs are compared to current status by stakeholders, there are several user needs in addition to the indicators identified. Some of them are easily changeable from the current status to respecting user needs, like

number 1 for instance. “*Assembly week*” and number 3. “*Past due orders.*” Regarding the missing indicators, further examination is provided in section 5.

3.5 Strengths of Identified Key Performance Indicator’s

The strengths of the identified KPIs are listed in Table 11, grouped by stakeholders. Also, the perspective that each one refers to is shown in the Table. The indicators are numbered similarly than in Tables 6, 7 and 8.

Strengths of identified KPIs			
	Indicator n:o	Strengths	Perspective
ASSEMBLY	3. Products that are missing parts	Good summary with product split, easy to read, used daily.	Daily management
	4. Assembly missing parts	A comprehensive listing of parts that prevent assembly.	Daily management
PURCHASING	1. Past due orders	The useful listing, used daily. Shows what parts are late against PO’s	Daily management
	2. Assembly missing parts	Comprehensive listing of parts that prevent assembly	Daily management
	3. TOP 10 supplier delivery accuracy	Indicates the TOP 10 supplier delivery accuracy, good overview.	Strategic
	4. Total supplier delivery accuracy	Indicates the total delivery accuracy from all suppliers.	Strategic
MANAGEMENT	1. TOP 10 supplier delivery accuracy	Shows the TOP 10 supplier delivery accuracy, good overview.	Strategic
	2. Total supplier delivery accuracy	Indicates the total delivery accuracy from all suppliers.	Strategic

Table 11. Strengths of identified KPIs

As seen in Table 11, where the identified strengths are organized by stakeholders and performance measuring perspectives, every stakeholder group has strengths in perspectives that are important to their daily operation. The assembly department’s priority is not to follow whether purchasing is financially on track. The department’s most important task is to secure the daily assembly target. Indicator number 3 shows the information through product groups. In other words, the missing parts are divided and summed under

a product group they belong to. Indicator number 4 shows all the missing parts without a product group breakout. In other words, a listing that shows the quantity of parts that are missing and preventing assembly with the item number and the name. The Production Planning Assistant describes how the indicator number 3 is used in the following quote.

Sometimes it is easier just to look what is the sum of missing parts per product; it gives more information than a single work order missing parts. Usually, it's the same part that every product is missing so that you can postpone all the products, and when the part arrives, all are ready to assemble.

Data 1: Interviewee Production Planning Assistant

Purchasing is supporting its internal customer for the daily target and is using similar KPIs to follow whether they are succeeding or not. Orders that are past the due date are indicating that the part is late but not yet missing from the assembly and consumption is relying on the inventory buffer. Strategic KPIs are concentrated mostly on delivery accuracies, which indicate the performance of a supplier but only from the accuracy point of view. Still, it is seen useful as in the quote below by a Data 1 interviewee.

Suppliers are happy to receive the monthly report of their delivery accuracy, so they can compare if their indicator is in sync with customer's measurements.

Data 1: Interviewee, Purchasing Coordinator

As pointed out in the first paragraph, the importance of an indicator relies on the department's operating priority. A daily management indicator from purchasing is not helping the management how to run the company. The management sees the same delivery accuracy indicators than purchasing as a good overview of how suppliers and purchasing are performing.

3.6 Weaknesses of Identified KPIs

The weaknesses of the identified KPIs are listed in Table 12, grouped by stakeholders. The numbers used for the indicators are the same than in Tables 6, 7 and 8.

Weaknesses of identified KPIs			
	Indicator n:o	Weaknesses	Perspective
ASSEMBLY	1. WO's that are missing parts	Listing does not show planned assembly week. No indicator for parts that are in surface treatment!	Daily management
	2. WO's that can be assembled	No indicator for parts that are in surface treatment!	Daily management
PURCHASING	1. Past due orders	Indicator not available from OBI, retrieved from ERP to excel. Another Business unit's parts in the same listing	Daily management
	2. Assembly missing parts	Surface treatment causes distortion to indicator	Daily management
	3. TOP 10 supplier delivery accuracy	Calculation is done by purchase order line does not take into account part deliveries	Strategical
	4. Total supplier delivery accuracy	Calculation is done by purchase order line does not take into account part deliveries	Strategical
MANAGEMENT	1. TOP 10 supplier delivery accuracy	Gives only one angle from supplier performance	Strategical
	2. Total supplier delivery accuracy	Gives only one angle from supplier performance	Strategical

Table 12. Weaknesses of identified KPIs

As seen in Table 12, where the identified weaknesses are organized by stakeholders and performance measuring perspectives, there are similarities between weaknesses and user needs when comparing Table 12 and user needs from Table 10. The identified indicators have strengths but they also have some weaknesses, or they need little fine-tuning. From the assembly point of view, the missing indicator for the parts in surface treatment is causing distortion to indicator number 1, “*WOs that are missing parts*”, number 2, “*WOs that can be assembled*”, as well as to purchasing department’s indicator number 2, “*Assembly missing parts*”. The distortion implies that the indicators mentioned are not showing true information because the parts are in the surface treatment instead of being delayed or available.

In purchasing, indicator number 1, “*Past due orders*” causes extra work every time it is asked. The listing has to be retrieved manually from ERP to Excel and then do some sorting out; remove other business unit’s past due parts and also take spare parts off the list. The Purchasing Coordinator described the excess work in Data 1 interview as follows:

It is frustrating to sort the past due list whenever it is asked in a production meeting. You have to remove the lines that do not concern this business unit or assembly just to make the list shorter and more readable.

Data 1: Interviewee, Purchasing Coordinator

The delivery accuracy calculation is seen to be inaccurate as it does not take into account part deliveries, as shown in Table 8. According to management, the angle of supplier performance measurement is too narrow when relying only on delivery accuracy. It gives only one angle, and as mentioned earlier in Table 9, a similar *service level* measurement than Sales is using, could provide good additional information.

3.7 Summary of Identified Strengths & Weaknesses

The data concerning the strengths and weaknesses was collected by interviewing stakeholder groups, thus forming Data 1 for the Current State Analysis. Firstly, the identified Performance Indicators were collected in Table 5 to have a clear overview of the three types of indicators by perspectives, and the overview was compared to the owner’s identified KPIs. Secondly, the user needs were identified, again, relying on the interviews and workshops with the stakeholder group representatives and compared to the current status in Table 10.

Thirdly, with the help of the overview and by comparing it to the current status, the strengths and weaknesses were identified and divided into perspectives, as seen in Tables 11 and 12. Finally, the findings from the previous subsections are listed in Table 13 below.

Summary of identified strengths & weaknesses		
	Strengths	Weaknesses
ASSEMBLY	Comprehensive the sum of missing parts indicator by product categories. Well available in user-friendly format	Efficient use requires manual sorting, or combining with another listing.
	Comprehensive missing parts indicator by Work orders. Well available in user-friendly format	Parts in surface treatment causes distortion and reliability issues to indicator
PURCHASING	Comprehensive daily management indicators from past due orders and assembly missing parts	Listings require sorting, and manual work, surface treatment causes distortion and reliability issues to indicators.
	Comprehensive listings for delivery accuracy measurement	Delivery accuracy is not accurate enough
		No defined indicators in financial perspective, even though user needs are acknowledged
MANAGEMENT	Comprehensive listings for delivery accuracy measurement	Supplier performance measurement is too narrow
	Comprehensive ERP data storage from several years	No defined indicators in financial perspective, even though user needs are acknowledged

Table 13. Summary from strengths and weaknesses

As seen in Table 13, where the identified strengths and weaknesses are summarized by stakeholders, there are comprehensive indicators from a daily management perspective, but they need fine-tuning or additional indicators to make performance measurement more accurate and more efficient. What is seen as rather alarming, is that all the financial indicators are missing even though the data is available in the company IT systems.

Based on the findings from the CSA, the goal of the further KPI proposal is scoped to financial performance measurement in management and purchasing stakeholder groups which are currently missing completely, as highlighted in the following Figure 4. In addition, the identified daily management indicators from assembly and purchasing are scoped to be fine-tuned, to show more accurate information and to remove the distortion caused by the surface treatment process. Also acknowledged user needs are taken into consideration. The scope of strategic indicators is for purchasing and management

stakeholder groups. The potential scope of study by issues from the perspectives of a stakeholder are summarized in Figure 4.

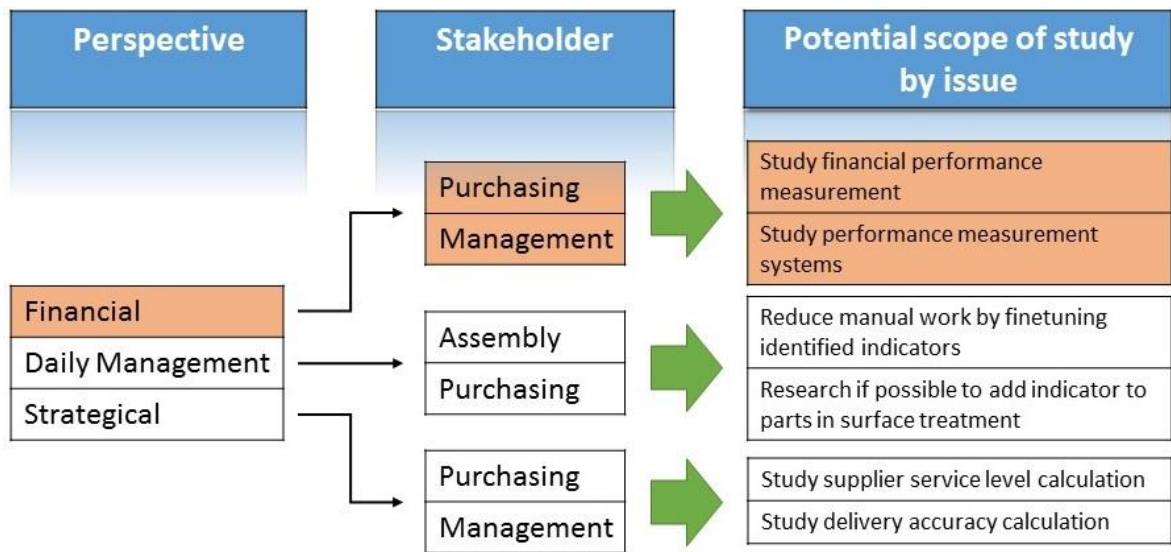


Figure 4. Performance measuring perspectives to potential scope by issue

As seen in Figure 4, the identified purchasing performance measuring is divided into three different perspectives and furthermore by stakeholder groups. Finally, the results of the CSA are divided by potential issues to help narrow down the scope of the next section's theory research and also formulating the Conceptual Framework of this thesis.

To summarize, the current state of purchasing performance measurement in the case company was assessed in this section. The identified strengths (Table 11, p.25), weaknesses (Table 12, p.27) and user needs (table 10, p. 24) were mapped through the CSA for each stakeholder. The analysis was divided to three different perspectives to inspect; daily management, strategical and financial. The findings of the CSA indicated that the financial perspective is the main weakness in the case company purchasing performance measurement.

The following sections provide assistance in tackling the weaknesses of the current state and to accomplish the objective of this thesis. The existing knowledge and the owner's best practices of financial performance measurement and its establishment to purchasing is presented in section 4, to form the Conceptual Framework of this work.

4 Existing Knowledge on Performance Measurement

This section overviews the fundamentals of financial and economic performance measurement, general requirements of performance measurement and management systems and how financial measures are established in purchasing performance measurement in order to create a clearly stated proposal of KPIs. The KPI proposal is scoped to financial performance measurement in management and purchasing stakeholder groups which are currently missing completely, as revealed by the CSA in section 3.7 (p.28).

Furthermore, based on the theory and the owner's purchasing performance measurement practices, the Conceptual Framework of this thesis is introduced. An overview and identified KPIs from the owner's side were also introduced in section 3.2.

4.1 Basics of Financial Performance Measurement in Manufacturing Industry

The recent pressure for technological and competitive changes in the manufacturing sector has created demands to performance measures and measurement towards tracking, management and improvement of organizations. The importance of understanding the scope, frequency and relevance of different performance measures is relevant, especially to executives who are interpreting the indicators (Gomes, et al., 2011). To clarify, this section is not listing accounting measures from the income statement; it is how accounting and economic based indicators are used in performance measurement in different operations inside a manufacturing organization.

Organizations seldom rely solely on pure financial quantitative indicators in performance measurement due to their nature of showing business performance data on a monthly or quarterly basis, which is historical data compared to the present. To assess overall performance, financial indicators are mixed with qualitative, non-financial indicators, such as level of customer satisfaction, services or work performed, motivating employees (Caruntu, et al., 2012). Nevertheless, pure financial indicators are still in frequent use in the evaluation of company performance, based on a survey by Gomes (2011) where 500 organizations were interviewed from a database of 1,111 manufacturing organizations with 50 employees or more. One aspect of the survey was to inquire the ease of acquisition of information, and the result indicated that nine financial indicators out of 65 of performance indicators were in use with performance measurement. The

result may be attributed to the fact that information on these measures is the most readily available (Gomes, et al., 2011).

From quantitative indicators, *Return on Investment* (ROI) is one that is focused on measuring the performance of business units or to evaluate the efficiency of an investment or to compare the efficiency of some investments. ROI is calculated by the following the formula and, like said, by quantitative aspects. The result is shown as a percentage of a ratio (Glavan, 2011).

$$\frac{\text{the benefit of the investment (return)}}{\text{the cost of the investment}} = \text{Return on Investment, (ROI)}$$

Glavan has listed performance measuring models, systems and methods in his paper with referencing to numerous authors. The listing is put together in a chronological order, and it is shown that purely financial measures were more often used before the 1990s, than a mix of financial and non-financial models. The listing is shown in Appendix 1 with financial models highlighted in red.

According to Hall (2013), financial indicators can be divided into economic and accounting based indicators to help the financial decision making process; the division is shown in the following Table 14 with abbreviations of a measure.

Economic-based measures	Accounting-based measures
EVA , Economic Value Added	NOPAT , Net Operating Profit After Tax
REVA , Refined Economic Value Added	OCF , Cash Flow from Operations
CVA , Cash Value Added	EPS , Earnings per Share
RCE , Return of Capital Employed	ROA , Return of Assets
RI , Residual Income	

Table 14. Popular financial indicators divided into economic-based and accounting-based measures

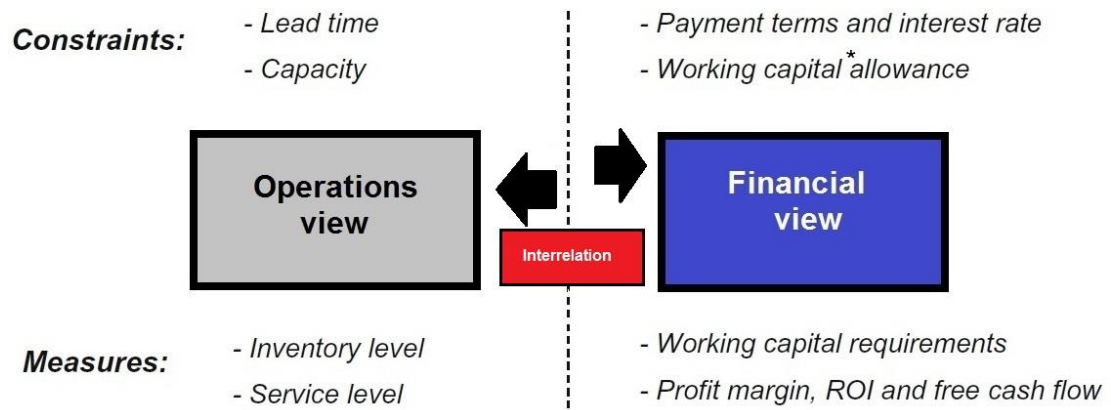
Measures seen in Table 14 are used, according to Hall, to explain, express and measure shareholder value creation. From the above measures, the relevant question is “which measure provides the best information on shareholder value created? Which measure should be used? Hall provides an answer to the above questions in his paper relying on 18 prior studies from different authors. The results from the prior studies are shown in

Appendix 2 with the formulas of abbreviations shown in the results. To summarize answers to the above questions, the internal variables with the highest information content of shareholder value creation can be classified into the following economic-based measures; EVA, REVA, discounted EVA and RI and accounting-based measures as EBEI, OI, NI, EPS, NOPAT and OCF (Hall, 2013).

One of the most well-known overall performance measurement system, which combines both qualitative and quantitative measures, is *The Balanced Scorecard* (BSC) which was developed in the early 1990s by economists Robert Kaplan and David Norton of the Harvard Business School (see an example of BCS in Appendix 4). As a framework, BSC approach suggests organizations to view the performance from four different perspectives; customer, financial, internal business processes and learning. All of the mentioned elements are visible from the single report (Crandall, 2009). According to Lardenoije (2005), the BSC is undoubtedly the best-known performance measurement system, and he describes it as follows:

The balanced scorecard provides an enterprise view of an organization's overall performance: it complements the traditional financial performance measures with key performance indicators (KPIs) in three non-financial areas (Lardenoije, et al., 2005)

Balancing between financial and operational performance measures is tricky, for example, efforts to improve the company's *working capital** by decreasing accounts payable can lead to increased supplier prices and thus, having a counterproductive outcome with increasing working capital. It means that there is a paradox between financial and operational views, too much attention to the other may cause failing in both. That is why it is suggested to have constraints and measures to how much weight is possible to put on one or another view's measures as visualized in Figure 5 (Protopappa-Sieke & Seifert, 2010).



*working capital = [(accounts receivable + value of inventories) - accounts payable]

Figure 5. Common operational and financial performance measures and constraints. (Protopappa-Sieke & Seifert, 2010)

According to a study by Protopappa-Sieke & Seifert (2010), the interrelation between operational and financial performance measures exists such as inventory level, service level, and return on investment, cash outflows and working capital requirements. The main findings suggested to consider the operational and financial cost together to have a more holistic approach. Moreover, the higher the working capital allowance, the lower the total operational cost, and the higher the total financial cost, the lower the return on working capital investment.

To summarize, this subsection introduced how financial indicators are mixed with qualitative, non-financial indicators to assess overall performance. Specifically, it pointed out the importance of considering a joint cooperation between both sides when building a performance measurement system. The requirements of a performance measurement system are introduced in the next section.

4.2 Requirements of Performance Measurement System

As stated earlier in this thesis, performance measurement is moving towards balanced or multi-dimensional frameworks. In this section, the requirements of a performance measurement system are introduced to clarify what, why and when performance is measured.

As Lardenoije states, total operational performance measurement is not accurate enough if relying only on the financial view or operational view. It has to have financial and non-financial metrics to increase reliability and avoid short-termism.

The performance measures on which the system is based should be relevant, balanced, and related to the company strategy. Performance measurement should be based on financial as well as non-financial performance indicators because the quality or other non-financial goals are often part of a company strategy.

(Lardenoije, et al., 2005, p. 3).

According to Folan (2007), performance may be said to be governed by the following three priorities:

1. It is always made as per the deemed relevance of an entity to a particular environment (thus, we commonly assess a company on its impact, for example, in a particular market, and not on its impact, in a place that is unlikely to be relevant to its operation).
2. It is always made with a relevant objective in mind (thus, we commonly assess a company as per some set future vision on what the company wants to achieve, not on the objectives of some other body that is not the company).
3. It is always reduced to relevant, recognisable characteristics (thus, we commonly assess a company on competitive parameters, such as cost, quality, time, etc.), and more harder-to-measure competitive priorities, such as flexibility, or sustainability, because they are relevant and recognisable; but we do not assess on irrelevant, unrecognisable characteristics (thus, we do not assess a company on its performance in terms of its "ability to use office stationery").

(Folan, et al., 2007, p. 613)

To summarize the three priorities quoted above; first, choose a specific environment in which to operate. Second, choose an objective respecting the company strategy. Third, choose a relevant, measurable characteristic from the objective.

The study by Nita (2008), proposes a comprehensive set of ten requirements for modern *performance management system* (PS) taking into account different perspectives of performance evaluation. The set of requirements and key objectives of a requirement is listed in the following Table 15.

Performance management system requirements	Key objectives of a requirement
Linkage to organizational strategy	Performance should be derived from strategy and allow its execution and support management efforts toward future strategic goals.
Focus on stakeholders	The demands and requirements of the groups interested in the company's activities should be taken into account
Multidimensional and balanced performance measurement	Implement financial and non-financial measures, long-term and short-term measures, internal and external measures, objective and subjective metric, lagging and leading indicators
Allowing for critical success factors	Identify success factors from the company's special areas and take them into account
Stimulation of organizational learning and continuous improvement	Take into account the flexibility and adaptability issues from the external and internal environment when designing the system
Performance reporting	Managerial reports from the system is an essential part of performance measurement
Performance cascading	Both vertical and horizontal cascading of objectives and measures
Orientation on future and planning	Performance measurement assessment should be oriented toward future, not of past performance.
Serving as control tool	Include feed-back and feed-forward loops, to provide past performance information for comparison against targets and feed-forward loop to involve the anticipation of unfavorable deviations are likely to happen
Taking into account the motivational aspects	Evaluation of performance of individual employees should be a basis for compensation programs.

Table 15. Performance management system requirements (Nita, 2008)

As seen in Table 15, performance management systems (PS) should fulfil a lot of requirements from various functions and different parts of an organization. Similarly, being multidimensional and respecting the company strategy is important by taking into account if the company has specialized in the particular process area. Moreover, performance reports have to be easily available from the system to provide past performance information for target achieving evaluation in addition to future forecasts to anticipate

unfavorable deviations, if possible. The system should also have flexibility and adaptability in the ever-changing external and internal environment without forgetting to take into account motivational aspects (Pohl & Förstl, 2011).

To summarize the requirements of a performance measurement system and this subsection, it is important to have a balanced measuring system, where there are financial and non-financial aspects. A specific operating environment and an objective respecting the company strategy have to be chosen with a relevant, measurable characteristic from the objective. Establishing summarized requirements to purchasing is explained in the next subsection.

4.3 Establishing Financial Performance Measurement for Purchasing

Purchasing has been a challenging function due to the breadth of activities and responsibilities, and also the controllable monetary resources they have to control. According to Dumond, the expenditure can account as much as 63 percent of the total revenues of a company, when calculating the purchase of raw materials, components, and sub-assemblies (Dumond, 1994). That is why financial indicators play a significant role also in purchasing actions.

Purchasing activities have been shown to contribute to and critically influence the financial performance of firms. (Pohl & Förstl, 2011, p. 1)

When implementing a performance measurement system to purchasing, according to Pohl & Förstl (2011), the roles of a *purchasing performance measurement system* (PPMS) could be categorized as visualized in the following Figure 6.



Figure 6. The categorization of purchasing performance measurement system roles. (Pohl & Förstl, 2011)

As seen from figure 6, there are five categories of roles that a PPMS should fulfill. Pohl & Förstl explained the roles in their paper as follows.

The first one is the strategy management which defines the measures that are followed in performance measurement. Different business environments have different competitive priorities, and they lead to different strategic purchasing choices. Hence, a different set of financial and non-financial measures is needed to support the strategic choices and decisions in purchasing actions (Pohl & Förstl, 2011).

Secondly, a PPMS should measure internal and external performance from activities that lead to performance, to achieve purchasing competence. Furthermore, It should be taken into account that purchasing practices may vary according to purchased items, based on the mix of produced products (Pohl & Förstl, 2011).

Thirdly, concerning purchase practices, the behavioral component of a PPMS affects the purchasing personnel in choosing appropriate practices to achieve their targets. The influence of a relevant PPMS also improves managerial performance through the role clarity and psychological empowerment (Pohl & Förstl, 2011).

Fourthly, a PPMS has to adapt to environmental changes and shifts in strategies without losing the assurance of a stable measurement of performance over time. PPMS should also question used purchasing practices and corporate strategy through feedback cycles, thus leading to continuous improvement and learning process which supports development in performance (Pohl & Förstl, 2011).

Finally, to have purchasing being perceived as a strategic contributor to business performance, the purchasing performance has to be integrated into the corporate reporting system to have the visibility, and the accountability contributed to corporate performance (Pohl & Förstl, 2011).

In Table 16 on the next page, five different *performance measurement systems* (PMS) are introduced, and their suitability for purchasing is assessed according to an investigation by Lardenoije (2005). In his paper, the connection of developing a purchasing performance measurement system with the help of the above mentioned five performance measurement systems is explained through the strategic and operational definition of

purchasing performance. Importantly, all of those systems have such a feature that they are definable by the user to include financial metrics to assist in the financial decision-making process (Pohl & Förstl, 2011).

On a strategic level, purchasing performance is determined by the extent to which purchasing can contribute to the organization's desired levels of innovation, quality, flexibility, and cost. On an operational level, purchasing performance is determined by the extent to which purchasing achieves to secure the supply of goods according to the requirements of the internal customer against the best conditions (Lardenoije, et al., 2005, p. 7).

An overview of an each measuring system perspectives and their evaluation for purchasing is described in Table 16. The same evaluation criteria are used in every perspective.

Performance measurement system and their perspectives	Evaluation for Purchasing	+/-
1. The Balanced Scorecard [BSC] <ul style="list-style-type: none"> - financial perspective - customer perspective - internal processes - learning and growth 	<ul style="list-style-type: none"> - Strategic and operational measures - Stakeholder coverage (internal, suppliers, top management) - Lead and lag indicators - Individual-level performance measured - Effectiveness and efficiency measures 	+ - ++ +/- +
2. The Tableau de Bord [TdB] <ul style="list-style-type: none"> - a dashboard with several indicators - indicators are defined by the user - undefined structure 	<ul style="list-style-type: none"> - Strategic and operational measures - Stakeholder coverage (internal, suppliers, top management) - Lead and lag indicators - Individual-level performance measured - Effectiveness and efficiency measures 	+ - ++ +/- +
3. The Performance Prism [PPR] <ul style="list-style-type: none"> - stakeholder satisfaction - strategies - processes - capabilities - stakeholder contributions - perspectives visualized by a three dimensional prism-shaped model 	<ul style="list-style-type: none"> - Strategic and operational measures - Stakeholder coverage (internal, suppliers, top management) - Lead and lag indicators - Individual-level performance measured - Effectiveness and efficiency measures 	+ - ++ +/- +
4. The Performance Pyramid System [PPS] <ul style="list-style-type: none"> - the interrelated system of different performance variables - controlled at different organizational levels - links the organization's strategy to its operations 	<ul style="list-style-type: none"> - Strategic and operational measures - Stakeholder coverage (internal, suppliers, top management) - Lead and lag indicators - Individual-level performance measured - Effectiveness and efficiency measures 	+ - ++ +/- +
5. Productivity Measurement and Enhancement System [ProMES] <ul style="list-style-type: none"> - a practical method of measuring organisational productivity - step-by-step process - identifies organizational objectives - develops a feedback system 	<ul style="list-style-type: none"> - Strategic and operational measures - Stakeholder coverage (internal, suppliers, top management) - Lead and lag indicators - Individual-level performance measured - Effectiveness and efficiency measures 	+ - ++ +/- +

Table 16. Evaluating a performance measurement system for purchasing (Lardenoije, et al., 2005).

When assessing the evaluation from Table 16, according to Lardenoije, the **Performance Pyramid System (PPS)** offers all levels of measures from strategic to operational and is well suitable for a purchasing manager's tool.

The Performance Prism (PPR) recognizes more the stakeholder's side than customers and shareholders, hence, concentrating more on the supply side of the business. Also, the lead and lag indicators are well-represented in the PPR as well as in **The Balanced**

Scorecard (BSC). PPS and **the Tableau de Board (TdB)** do not specify lead and lag indicators explicitly, but they can be included in the system.

The Productivity Measurement and Enhancement System (ProMES) is seen as the most advanced system when using performance measurement as a tool for motivation and learning. Lardenoije concludes in his paper that the BSC, TdB, and PPS fit best as a performance measurement system when the purchasing function is seen as a strategic function (Lardenoije, et al., 2005).

Companies typically calculate, and the case company is no exception here, standard costs for the items and they usually become the official price of the part. A widely used metric from the standard cost is *the purchase price variance* (PPV), which is used to measure the difference between the actual purchase costs and planned, or standard, costs. PPV is used in companies engaged in the repetitive production and assumes standardized use of materials and components as specified in the bill of materials (Lysons, 2012).

The PPV indicator is seen as important if the organization puts a high importance on the purchase price, especially if purchase prices are worth 50-80 percent of the goods sold. The PPV metric has also downsides; it could cause the quality and delivery to be seen as less important if the cost reduction has a big role in the purchasing organization and the metric is also easily manipulated to show better outcome (Emiliani, et al., 2005). Also, to achieve a better unit price and lower PPV, an excess inventory or the wrong mix of inventory is often the result due to large volumes of purchasing (Crandall, 2009).

Nevertheless, without a PPV indicator, reduced inventory, cost savings or increased ROI remain uncovered. Emiliani (2005) describes the importance of PPV as well as combining it to other operational supplier performance measures as follows:

The trend in actual costs compared to target costs provides purchasing with better information for understanding cost reduction challenges. Used in concert with operational measures of supplier performance in critical dimensions that affect costs throughout the value stream, the alternative measure will direct buying organizations to reduce costs in collaboration with suppliers using well-established problem-solving methods and tools (Emiliani, et al., 2005, p. 155).

In addition to standard costing, there are also other accounting approaches used in purchasing performance measurements such as activity-based costing and economic value

added (EVA), which was already introduced in the previous section and its calculating formula in Appendix 2. In the activity-based costing model (ABC) organization's activities are identified, and each activity's resource costs are assigned to all products and services according to the actual consumption by each. With the help of ABC, an organization can estimate the cost of individual products and services and identify and eliminate unprofitable ones and decrease overpriced ones (Glavan, 2011). The calculation of economic value added was introduced but how it is used and improved? According to Lysons (2012), the ways of improvement are listed below in Table 17.

Ways of improving the Economic Value Added (EVA)
improve returns with little or minimal capital investment
invest new capital only in processes or equipment that will, at least, recover their capital cost
avoid investments with lower than capital cost returns
identify and eliminate processes or operations where the return is below capital cost
identify and eliminate processes or operations where there is no possibility of improving returns

Table 17. Ways of improving economic value added, (Lysons, 2012)

As seen in Table 17, an organization should have well defined and calculated investment plans, because they have a big impact on economic value added. As seen in Figure 5, financial performance measures are linked to operational measures, such as inventory performance indicators which include cost as a financial measure. According to Lysons (2012), it can measure *the cost of stockout*, which means being out of inventory. A cost of stockout includes the following costs, listed in Table 18.

Cost of stockouts
costs of production output loss
costs of idle time and fixed overheads spread over the reduced level of output
costs of any action taken to deal with the stockout, such as buying from another supplier at an enhanced price
costs of switching production
costs of obtaining substitute materials
costs of customer goodwill due to inability to supply or late delivery

Table 18. Cost of stockouts (Lysons, 2012)

As Table 18 shows most stockout costs are hidden in overhead costs and usually there are not any indicators to follow them, or they are difficult to define. For stockouts, there are several KPIs related to inventory management, to prevent stockout from happening. The common factor with inventory management KPIs is to have the right quantity of inventory in the right place at the right time respecting the pre-defined minimum and maximum levels of inventory from the aspects of quantity and cost. The most useful inventory KPIs are listed in Appendix 3.

Inventory management is closely related to ordering policies, how to know the correct quantity to order so that the inventory's value does not increase too much. To investigate the correct economic order quantity for an item to minimize the cost, an *Economic Order Quantity* (EOQ) is possible to calculate by following the basic formula below (Lysons, 2012):

$$EOQ = \sqrt{\frac{2(\text{annual anticipated demand} \times \text{order cost per order})}{\text{cost of the item} \times \text{annual carryin cost of the item}}}$$

To summarize this subsection, financial performance measurement is possible to establish in purchasing, and there is existing knowledge pointing to what to acknowledge. According to Pohl & Förstl (2011), the roles of a *purchasing performance measurement system* (PPMS) could be categorized into five roles (Fig. 6, p.37). After explanations of the five roles, five different *performance measurement systems* (PMS) were introduced, and their suitability for purchasing was assessed according to an investigation by Larde-noije (Table 16, p.38). Finally, after different measurement systems, few economic-based indicators were presented, such as *the purchase price variance (PPV)*, *the economic value added (EVA)*, *the cost of stockouts* and *the economic order quantity (EOQ)*.

4.4 Beretta Practises of Purchasing Performance Measurement

Even though there are no ground rules for how to measure performance, every organization should define their measuring indicators which support their goals and strategy. In this case, similarities between the owner's and the case company's strategy, vision and markets are commonly recognized. Hence, the purchasing performance measurement practices should be in parallel to one another with respecting the identified user needs from the CSA and the Conceptual Framework, which is introduced in the next subsection 4.4.

To highlight the importance of individual parameterization of performance metrics, a quote from Lebas (1995) where he describes manufacturing facility's performance is helpful:

The performance of a manufacturing facility can, therefore, be defined by different parameters by each firm, defining it to match its strategy and vision, subject to external constraints of the market (Lebas, 1995).

Beretta has parameterized their purchasing performance metrics towards three different categories: quality, outcome and financial as seen in the following Table 19.

Performance parameterization	Performance Indicator
Quality	<ol style="list-style-type: none"> 1. Supplier Quality trend [PPM, quantity], monthly 2. Non-conformances allocation, [%]
Outcome	<ol style="list-style-type: none"> 3. Supplier service level, [%], weekly
Financial	<ol style="list-style-type: none"> 4. Supplier cost analysis, trend 5. The variance (Δ) of purchased part total cost 6. The variance (Δ) of internal cost of the product. 7. The variance (Δ) of external cost of the product. 8. Supplier Quality trend [PPM, value], monthly

Table 19. The purchasing KPIs identified by the owner

As seen in Table 19, where the KPIs identified by the owner are categorized with performance parametrization, *the quality* performance is from supplier's quality to deliver items that fulfill quality requirements and it is followed by the Parts per Million (PPM) indicator. The PPM result is recorded monthly to a trend to show the supplier quality performance visually. In addition to PPM, non-conformant parts are allocated from incoming inspection, manufacturing and assembly lines to show the percentage of parts that fulfill the requirements of quality.

The second category is *the outcome* of a supplier's performance, and it is measured weekly with a supplier service level indicator (formula explained in section 3.2, p.15). It is the only performance indicator for a supplier's performance outcome.

The third and last category is the *financial* category which has five different cost-related indicators. In supplier cost analysis, the variance (Δ) of part prices are collected and

compared to the forecasted price, thus forming the purchase price variance (PPV) with the possibility to group by item or by product category with an annual trend. It is used to target cost saving actions to a certain product or item group.

Cost savings are collected using two different calculations. Firstly from the parts, with applying the PPV method and multiplied by the accepted quantity. Secondly from the products, total cost variance is divided into internal and external costs, whereas internal cost is activities happening in-house and external costs are purchase price and logistics. Finally, a financial indicator which is using the PPM results by value, it is showing the value parts that are not fulfilling the quality requirement.

4.5 Conceptual Framework of This Thesis

The findings from the relevant existing literature and the case company owner's best practices are summarized into the Conceptual Framework for building a proposal of a grounded set of purchasing KPIs. The CF consists of three elements: the basics of financial performance measurement in the manufacturing industry, the requirements of a performance measurement system and the financial performance measurement for purchasing.

The elements of the CF are systematically built from the identified needs, strengths and weaknesses from the CSA and are linked to each other to scoping down towards the objective of this thesis. The CF is visualized on the next page as Figure 6.

The key points in the Conceptual Framework are that KPIs should be balanced with financial and non-financial metrics to assess overall performance, the objective of performance measurement should respect the company strategy with relevant, measurable characteristics, and the organization should measure only the features that are relevant to their functions.

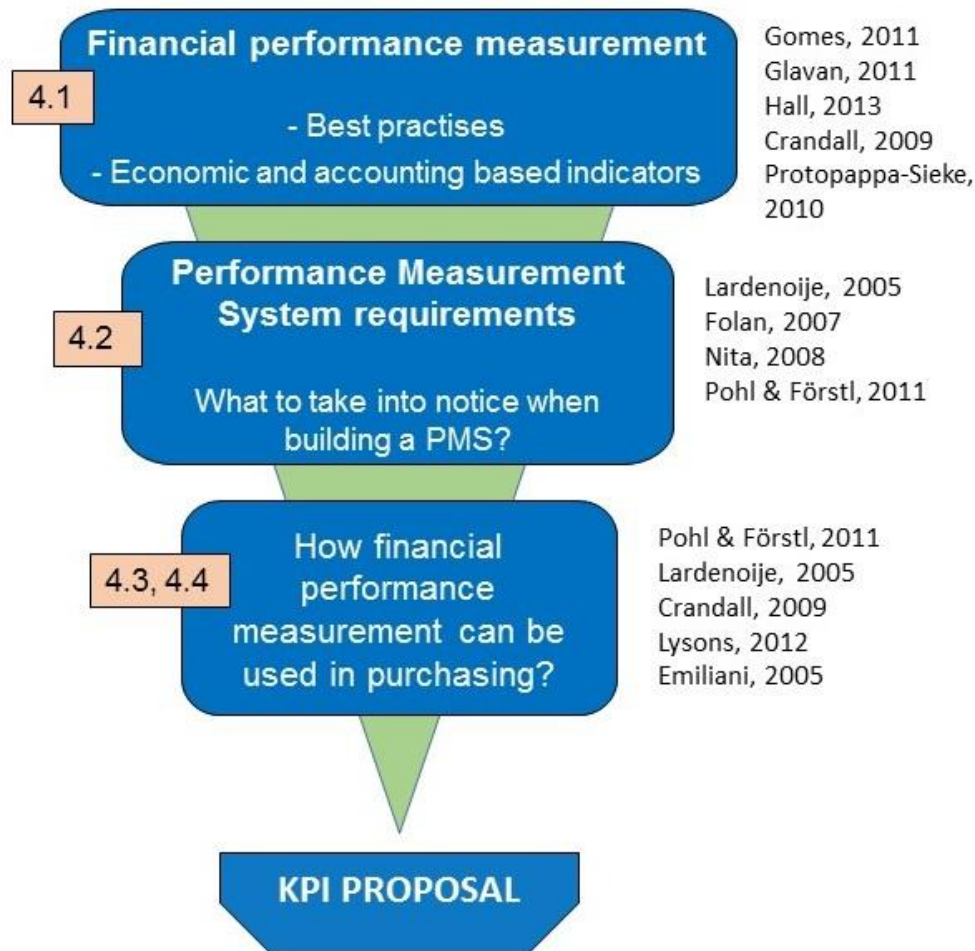


Figure 7. The conceptual framework of purchasing KPI proposal

As seen in Figure 7, **the first element (section 4.1)** overviews the basics of financial performance measurement in the manufacturing industry and its common measures, such as *Return on Investment* (ROI). Financial measures are divided to economic and accounting-based indicators and they are introduced and listed in Table 14 also, the information which are the best measures to provide information on *created shareholder value* (Hall, 2013). To assess the importance of overall performance, financial measures should be mixed with qualitative non-financial measures. Hence, *The Balanced Scorecard* is introduced (Crandall, 2009; Lardenoije, et al., 2005). The complexity balancing between financial and operational measures is emphasized with an example with the help of *working capital* explained (Protopappa-Sieke & Seifert, 2010).

The basics of financial performance measurement introduced terminology from the requirements of a *performance measurement system* (PMS), which is **the second element (section 4.2)** of the CF. The section overviews how a comprehensive performance

measuring system should be designed to take into account all relevant aspects of performance measuring, and they are summarized to three priorities by Folan (2007). The performance evaluation is introduced with a set of ten requirements from modern *performance management system* (PS) with key objectives explained (Nita, 2008).

The last element of the CF is establishing financial performance measurement (Section 4.3) to purchasing by starting with the categorization of roles to take into notice when building a *purchasing performance measurement system* (PPMS) (Pohl & Förstl, 2011), visualized in Figure 6. After the PPMS categorization, the suitability of five different *performance measurement systems* (PMS) for purchasing is evaluated with the investigation of Lardenoije (2005). Also, commonly used financial measures that are suitable in purchasing are introduced, such as *purchase price variance* (PPV), *economic value added* (EVA), *activity-based costing* (ABC), the *cost of stockouts* and *economic order quantity* (EOQ) (Lysons, 2012; Emiliani, 2005). Finally, the best practices of the case company owner's purchasing practices are introduced (sections 4.4, 3.2)

To summarize, the CF covers all the relevant elements needed for building a proposal of a grounded set of KPIs to the case company purchasing department including theory, requirements, establishment and the owner's best practices. The proposal of a grounded set of KPIs is introduced in the next section 5.

5 Building a Grounded Set of KPIs

In this section, the workshops and meetings from Data 2 are analyzed and put together as a preliminary proposal of a grounded set of KPIs.

5.1 Steps of Building the Proposal

The conceptual framework was used as a guideline to build the proposal since it covers the existing knowledge (4.1), requirements (4.2), establishment (4.3) and the owner's best practices (4.4) of performance measurement to purchasing. The focus of the proposal is to enhance the identified strengths and create new KPIs to tackle the weaknesses to achieve the objective and the expected outcome of this thesis.

In the data 2 workshops, firstly, the owner's performance measurement practices were introduced to the stakeholder participants following the presentation of the conceptual framework. After introducing the framework to the stakeholder representatives, a free-format discussion was carried out to have a mutual understanding of the contents to include in the proposal.

The performance indicator proposals for the assembly, purchasing and management are introduced in the following subsections and visually listed and summarized in the last subsection 5.4.

5.2 Preliminary Proposal for Assembly KPIs

Nevertheless, the scope of the proposal was narrowed down to the financial perspective; the assembly department identified user needs are taken into account in this section, to respect the objective of this thesis. As seen from the comparison table (Table 10, p.24) where the identified user needs were compared to the current state, assembly department has two user needs that need to be corrected.

Idea from the framework:

- ✓ Measure features that are important to the organization

Introducing parts in surface treatment proposal

Challenge

As visualized in Figure 3 (p.18), the material flow concerning the surface treatment is not in control. The assembly supervisor insinuates the surface treatment as a “black hole” in the material flow because ERP indicates that parts have arrived and they have been received, and they are available in the listing “WOs that can be assembled”. Yet, that is not the case.

Proposal

As discussed in Data 2 meeting, it would be possible to have a listing for parts in surface treatment. There are two possibilities to proceed and they are listed below.

1. A new level in the item structure is to be established and purchasing department orders the “un-surface treated” part, which produces needs to the top level of the structure (=the surface treated part). The material resource planning calculates the needs and initiates necessary quantity of work orders.
 - Every part needed to be surface treated has its work order. Thus, the process is visible in the ERP.
 - Downside:** the item structure is essential to keep as simple as possible, and there are hundreds of items

2. ERP has an item check-in and a check-out feature for items that resides in designated projects. It is possible to read the status of the item, whether is either available or held by the project in which the object currently resides.
 - Items held in the project is the listing currently in the surface treatment.
 - Upside:** no need for creating new levels in the item structure

It was agreed, that the second choice is the correct way to proceed.

Introducing the updated “Work orders that are missing parts” proposal

Challenge

As seen in Table 10 (p.21), there is an identified user need to the listing that visualizes work orders that are missing parts. The listing has to be manually combined with another listing to resolve the week the WO is planned to be assembled.

Solution

According to Data 2 meeting and the statement from the IT department, it is a simple task to add the WO week to the listing. It was agreed to be done.

5.3 Preliminary Proposal for Purchasing KPIs

According to the Current State Analysis, the identified indicators in purchasing's perspective are seen adequate, but there are plenty of sharpening and identified user needs (Table 8, p.19) to be taken into account to eliminate weaknesses and make the performance measurement more accurate.

Ideas from the framework:

- ✓ Measure features that are important to the organization
- ✓ Measure internal and external performance from activities that lead to performance
- ✓ Use balanced measuring: financial + non-financial
- ✓ Keep the importance of an individual parametrization in mind when designing KPIs

Introducing proposal for enhancement procedures to the identified indicators

Challenge

The listing "Past due orders" is manually retrieved from the ERP and there are also another business unit's parts and spare parts in the same listing which reduces readability and causes excess manual sorting operations.

Delivery accuracy (from total and TOP10 suppliers) and supplier service level are calculated from PO's received completely per PO's ordered, therefore, the calculation does not take into account part deliveries, and the measurement is seen to be too narrow.

Proposal

The listing from "Past due orders" is sorted automatically and moved to the Business Intelligence system.

The delivery accuracy formula is updated as identified user need (Table 10, p. 21). The supplier service level formula is updated according to the case company owner's measuring principal (Table 6, p.15, the formula in p.16).

Introducing the cost of stockouts proposal

Challenge

Occasionally, a stockout occurs, and it causes re-arrangement to the assembly work orders and reduces the daily assembly volume target. Usually, a stockout originates from insufficient or incomplete actions of a supplier. At the moment, the costs of stockouts

(listed in Table 18, p.38) are not recorded or calculated, so it is impossible to invoice the costs from a supplier, and it causes strain to the case company overhead costs.

Proposal

The cost of stockouts was introduced in the Data 2 workshop, and it was seen an essential financial indicator to assist and support claiming a supplier due to incomplete or insufficient actions. The cost of stockouts indicator, as presented in Table 18, p.38, is proposed to be investigated by the IT department because it has to be built from nothing and it involves several other stakeholders outside this thesis.

5.4 Preliminary Proposal for Management KPIs

The current state analysis revealed that in the case company, the financial perspective is the area where performance measurement is lacking. Additionally, the potential purchasing performance is not emerged nor rewarded because there are not any indicators to support the performance. The idea of setting the focus purely on the financial perspective was confirmed due to benchmarking interview (data 2) since the owner has focused on the quality perspective where they have issues, the case company is allowed to focus on the financial perspectives where there are identified issues, i.e. no indicators.

Ideas from the framework:

- ✓ Measure features that are important to the organization
- ✓ Use balanced measuring: financial + non-financial
- ✓ Keep the importance of an individual parametrization in mind when designing KPIs
- ✓ Keep the quantity of KPIs in a reasonable level (~10pcs)

Introducing the inventory value proposal

Challenge

As mentioned in the strengths and weaknesses summary in the Current State Analysis (Table 13, p.26), there is a massive ERP data storage in the case company where all the items are divided into hundreds of different product categories and sub-categories. Unfortunately, there are so many categories that it is impossible to sort out the important information effectively.

Proposal

In the Data 2 workshop, an idea was put forward to sort out the massive data according to product categories. Hence, the inventory value could be followed by the product category breakout. There are only eight main categories in the case company, which all the products fall into. The proposal for category breakout is displayed in Figure 8 with

fictional numbers. There is also a possibility to break out the product categories to sub-categories, but they have to be defined distinctly because there is a risk that the indicator will saturate from the excessive information.

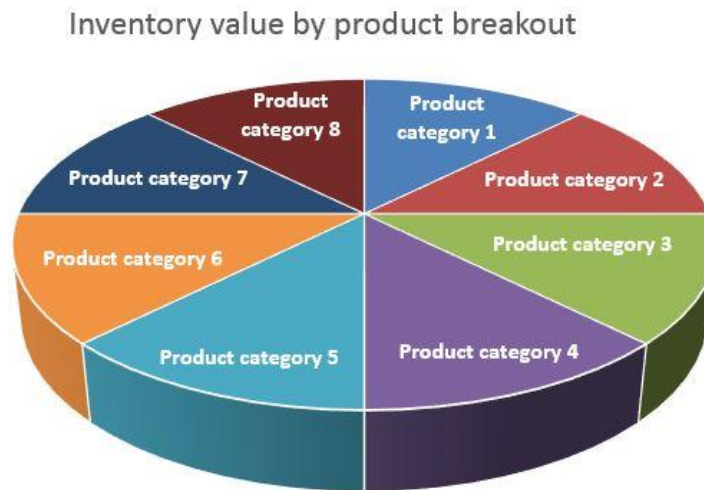


Figure 8. Inventory value by product breakout

As seen in Figure 8, there are only eight product categories which all the case company products fall into and the inventory values are not followed by category breakout even though there is an identified need to do that.

Introducing the shopping basket concept to allocate key item cost savings and spend
Challenge

The case company is calculating standard costs for the items. Hence, the cost savings from purchased products can be allocated by using the purchase price variance (PPV). The problem is that there are thousands of purchased items in the case company, and the Purchasing department consists of only five people including the manager. There are not enough resources to select the suitable target where to place the cost-saving efforts.

Proposal

In the Data 2 workshops, an innovation of the shopping basket concept emerged. Utilizing the product category breakout, it would be possible to establish eight different “shopping baskets” that include vital parts from the end product at every level from the bill of materials (BOM). To make the cost savings beneficial, there should not be any cheap parts in the shopping baskets, i.e. springs, pins or tiny screws. Parts should be rather collected from a price category that represents a substantial percentage of the

total purchased costs from the BOM. Additionally, with the help of the data storage, a variance price trend could be reconstructed from historical data to show a cost savings trend from each item followed in the basket. Moreover, the spend of shopping basket items would be additional important information to allocate how much money the company has spent on the items in the basket.

A preliminary decision of shopping basket contents was already made in Data 2 workshop, but they should be re-designed with a more thorough investigation. An illustration of shopping baskets by category breakout is shown in the following Table 20.

BASKET	1	2	3	4	5	6	7	8
n:o	category 1	category 2	category 3	category 4	category 5	category 6	category 7	category 8
item 1	raw material barr	raw material barr	raw material barr	raw material barr	raw material barr	raw material barr	raw material barr	raw material barr
item 2	raw material rcv	raw material rcv	raw material rcv	raw material rcv	raw material rcv	raw material rcv	raw material rcv	raw material rcv
item 3	stock	stock	stock	stock	stock	stock	stock	stock
item 4	magazine	magazine	magazine	magazine	magazine	magazine	magazine	magazine
item 5	firing pin	firing pin	firing pin	firing pin	firing pin	firing pin	firing pin	firing pin
item 6	bolt assy	bolt assy	bolt assy	bolt assy	bolt assy	bolt assy	bolt assy	bolt assy
item 7	trigger assy	trigger assy	trigger assy	trigger assy	trigger assy	trigger assy	trigger assy	trigger assy
item 8								
item 9								

Table 20. A proposal for shopping baskets by product category breakout

As seen in Table 20, eight different shopping baskets are set up to follow and allocate cost savings through purchase price variance (PPV). Each shopping basket is established to characterize a product category and inside the basket, there are items whose purchase price represents a substantial percentage of the total purchase price from the category's product. It was suggested that a hyperlink is built to the item row, which would show a historical trend from the standard cost and item spend development.

It should be noted that with utilizing the product breakout shopping basket for key items, there is an option to calculate also the *inventory turnover rate* and *days in hand* indicators for selected items as they apply to both management and purchasing stakeholder groups. Both formulas are introduced in Appendix 3. However, the decision what to measure should be considered carefully, because adding too many indicators will threaten the usability and readability of the KPI set.

5.5 Summary of the Preliminary KPI Proposals

The introduced proposals were based on the user needs, strengths and weaknesses identified in the CSA with acknowledging the existing knowledge from literature and the owner's perspective from purchasing performance measurement. The proposed indica-

tors were decided with mutual understanding through stakeholder interviews and workshops to benefit all parties and perspectives engaged in the matter. The introduced stakeholder proposals are visualized in Table 21.

Stakeholder	Proposed indicator	Explanation	Daily Management	Strategical	Financial	Improved
ASSEMBLY	Parts in surface treatment	A listing that shows the parts in surface treatment, to increase the reliability of other listings	X			
	Work orders that are missing parts	The week number of work order is added to listing to remove manual sorting	X			X
PURCHASING	Improvement procedures to the identified indicators	Past due orders listing automation to remove manual work	X			X
		Updated formula to increase the reliability of supplier delivery accuracy		X		X
		Updated formula to increase the reliability of supplier service level		X		X
	The cost of stockouts	A tool to assist and support when claiming a supplier			X	
	Days in hand	An indicator that calculates the number of days to stockout		X		
MANAGEMENT	The inventory value by product breakout	A tool to measure inventory value from eight product categories			X	
	The shopping basket concept with purchase price variance (PPV)	A tool to target cost saving actions and measure spend from key items		X	X	
	The inventory turnover rate	An indicator to show the number of times inventory item has been sold and replaced			X	

Table 21. Summary of the preliminary proposal set of performance indicators

As seen in Table 21, proposed performance measurement indicators are divided into stakeholder groups as labeled on the left side of the table followed by the name of the indicator with a short explanation. The perspective from what view the indicator is measuring is tagged on the right side of the table with an “X”. Furthermore, if there is an “X” in the furthest right column in the “updated” column, it indicates that the indicator is updated

from the identified one by taking into account identified user needs. The next step is to simulate the proposed indicators with historical ERP data, if available, and the feedback from the simulation is collected, thus forming the Data 3 and the initial proposal of KPIs.

To summarize, this section introduced the preliminary KPI proposals for three different stakeholder groups. The proposals are visualized in Table 21. Next, the preliminary proposal is tested with a simulation pilot and feedback to form the initial proposal to be validated and finalized.

6 Simulation Pilot, Feedback, and Validation of Proposal

This section reviews the simulation pilot timetable and feedback from the preliminary proposal, which forms the data collection point number 3 and the initial proposal of the KPI set to be presented for validation.

Findings from the data collection 3 and the timetable of the simulation are overviewed in the next section following the feedback and alterations made to have an initial proposal which to validate. Finally, recommendations for future actions concerning the purchasing performance measurement in the case company are suggested.

6.1 Findings of Data Collection 3

Since the case company has a reliable and extensive ERP data storage, it was seen reasonable to run the indicators, which have old stored data available, through a simulation to identify the issues and make another adjustment cycle. The timetable for the simulations was agreed in Data 3 workshop (6 April 2016). Unfortunately, it was not possible to simulate all the proposed indicators within the timeframe of this research due to extensive groundwork to be done when building new indicators. Therefore, the simulation began from the identified and updated KPIs. The timetable for all the planned simulations is presented in Table 22.

Simulated indicator	Feature to review	Timetable
[updated] <i>supplier delivery accuracy</i>	Does the delivery accuracy increase or decrease?	W16
[updated] <i>supplier service level</i>	Does the service level increase or decrease?	W16
[new] <i>parts days in hand</i>	Are all the variables taken into notice?	W20
[new] <i>inventory value by product breakout</i>	Products in different categories are using same parts. In which product category the value is put?	W20
[new] <i>the shopping basket concept</i>	Is the standard cost calculation reliable and will the cost savings and the spend able to be allocated?	W20
[new] <i>the inventory turnover rate</i>	Are all the variables taken into notice?	W20

Table 22. The timetable for planned simulations with features to review

As seen in Table 22, the simulation is planned to start from **supplier delivery accuracy and service level**; the updated formula will be compared to the currently identified indicator. **The days in hand indicator** is also simulated and checked whether all the variables affecting the indicator are taken into notice. From the **Inventory value by product breakout**, there are overlapping items in different categories, i.e., the same item is in the product BOM that is representing a different product category. It was seen an important issue to simulate and to solve what the effect is when the same item is under different product categories, and the inventory value of a category is under evaluation. **The shopping basket** concept is based on the standard cost calculation from where the purchase price variance (PPV) is derived. It is necessary to check and simulate whether the indicator is working, i.e. whether the standard cost calculation is correct and reliable. Finally, **the inventory turnover** rate is simulated in the case of unexpected variables.

In the next workshop, possible challenges from the shopping basket concept were inspected. To this indicator, background work for choosing the items to the basket is in a crucial role as they are the basis of the measurement in addition to the issues with standard cost calculation. **The cost of stockouts** was rejected from the initial proposal because of too many variables that are not controllable with the systems in use at the moment. Primarily, root causes are supposed to be eliminated, measuring the problem itself moves the attention to the wrong direction.

In the April 7, 2016 meeting, the Director of Rifle Business Unit proposed to add two more daily management indicators to the purchasing department, a combination of two listings to increase the measurement accuracy of assembly missing parts. It was a worthy addition and will be taken into account in the final proposal which is introduced in the next subsection.

6.2 Final Proposal

When taking into consideration the research method used in this thesis (action research), the process is cyclic and continuous as visualized in Figure 1, p. 5. Obviously, after the simulations have been accomplished and the feedback reviewed, the final proposal will be updated and KPIs re-simulated to achieve the best possible outcome. Unfortunately, due to the long timeframe of simulating and reviewing, the final proposal is excluded from this thesis. **The cost of stockouts** is excluded from the initial proposal and also **the**

assembly missing parts will be combined to another listing to increase the accuracy and reliability of the indicator. The initial proposal is visualized in Table 23 below.

Performance indicator, [unit]	How is it measured?
Parts in surface treatment, [item code & quantity]	A listing that shows the parts in surface treatment
Work orders that are missing parts, [work order number & assembly week]	A listing from assembly WOs that are missing parts
Assembly missing parts, [item code & quantity]	A listing that shows the parts which assembly is missing, combination of two listings
Past due orders, [PO number, item code, delivery date]	A listing that shows POs that are late
Supplier delivery accuracy, [%]	$\frac{\text{Parts (qty) received in the delivery period (1w)}}{\text{Parts (qty) ordered to the delivery period (1w)}}$
Supplier service level, [%]	$1 - \frac{\text{back order at the end of the period}}{\text{back order} + \text{required qty in the period}}$
Parts days in hand, [number of days]	$\frac{\text{current quantity at inventory}}{\text{anticipated future daily rate of usage}}$
The inventory value, [EUR]	An indicator that shows the value of selected items in the inventory
Cost savings, [EUR]	An indicator that shows the cost variance from selected purchased parts
Total spend, [EUR]	An indicator which shows the amount of currency used in purchasing chosen part in period
The inventory turnover rate, [number of days]	$\frac{\text{sales or issues}}{\text{average inventory with standard cost}}$

Table 23. A listing from KPIs to initial proposal

As seen in Table 23, where all the initial proposed KPIs are listed, there are also clarifications how the outcome of an indicator is measured, as well as the unit of the indicator.

6.3 Feedback and Validation

The initial proposal was presented to the Director of the Business Unit and the representatives of the stakeholder groups for feedback and validation (Appendix 8). The event was very positive, and there was a good open discussion how to finalize the research with suggestions on what to take into account before implementing the proposed KPIs.

There was a discussion how the indicator “parts days in hand” could be applied as a supportive tool to material resource planning, for example, to reveal oversized inventory if the days in hand is exceptionally large.

The days in hand could also be used as a supportive tool to material resource planning.

Production Manager

Finally, the proposed indicators were validated with positive feedback and recognition of profound work.

The proposal is providing a nice overview of performance measurement, particularly the additional supportive tools. There are not just indicators to measure the outcome but also helpful tools how to achieve it.

The Director of Business Unit

The meaning of the groundwork was emphasized several times in the discussion. In order to make this study beneficial to all the stakeholders, it has to be taken care that every indicator is thoroughly built, inspected and simulated to obtain as accurate measurements as possible.

6.4 Recommendations for Future Actions

To finalize the study according to the research design, all the proposed KPIs are simulated and reviewed to achieve the best possible outcome. Importantly, the groundwork for characterizing indicators should be completed before continuing with simulations in addition to some other issues. The task list for all the issues is listed in Table 24.

Task list for finalizing the research	
1. Decide what items to include in <i>the shopping basket</i>	Workshop with management and purchasing
2. Decide in which product category <i>inventory value</i> falls into when same parts are used in different products	Workshop with IT and purchasing
3. Simulate, review and re-simulate all KPIs	Workshop with IT
4. Inspect the KPI recording and trending possibilities	Workshop with IT
5. Decide the reporting interval of KPIs	Workshop with management and purchasing
6. Decide the inspection and update interval of KPIs	Workshop with stakeholders
7. Inspect the possibilities of overall purchasing performance presentation platform	Workshop with IT and purchasing
8. Discuss the role of purchasing in the case company	Discussion with the management

Table 24. Task list for finalizing the research

As seen from the Table 24, there are several important issues to do before it could be said that this research is completed, ready and working.

The groundwork for *the shopping basket* and product breakout should be completed for reliable measurement of *purchasing spend*, *inventory value* and *cost savings allocation* (**task 1, 2**). After the groundwork and specifications, all the KPIs should be simulated, reviewed and re-simulated to have all the issues removed and to make measuring as reliable as possible (**task 3.**) Past performance is seen almost as important as the present one. Hence, a trend from a performance metric would be very useful in the decision-making process and particularly in cost savings (**task 4**).

To have visible and transparent measurement throughout the organization, the reporting interval of KPIs should be decided with the timeframe and the format of which the results are internally presented (**task 5**).

Furthermore, when the organization is developing and expanding, performance measurement should follow the requirements and evolve. It would be beneficial to all stakeholders that the KPI inspection interval is decided beforehand to ensure that the indicators are up-to-date and on track (**task 6**).

According to overall performance and internal communication, a suitable platform for presenting the current situation to stakeholders and other functions of an organization would provide a clearer view. This could be, for example, a balanced scorecard –type of layout **(task 7)**.

As this study indicates, the proposed indicators are making the purchasing performance visible. When taking into notice the percentage of accountable expenditure of the total revenues of the purchasing the company participates in, the author recommends further work to be done to establish purchasing as being perceived as a strategic contributor to business performance in the organization **(task 8)**.

To summarize, this section introduced the initial proposal of KPIs with a timetable for simulations. Also, the validation of the research with feedback was presented in addition to an 8-step task list to achieve the final validation. The next section summarizes this thesis and discusses whether the outcome fulfills the business problem and the objective set at the beginning. Also, the reliability and validity, as well as the credibility of research methods, are assessed.

7 Discussion and Conclusions

This section summarizes and evaluates this thesis and discusses whether the outcome is corresponding to the objective and whether the applied research method fulfills the reliability and validity requirements.

7.1 Summary

The purchasing performance is in a very significant role in the case company because the majority of end product's parts are outsourced. Unfortunately, strategy derived KPIs for three stakeholder groups that are engaged to purchasing, are missing, which forms the business challenge of this thesis.

The objective of this study was to propose a grounded set of Key Performance Indicators that meet the requirements of the three stakeholder groups; assembly department, purchasing department and the management. The purchasing department needs indicators to measure its performance, the assembly unit as an internal customer needs KPIs to be able to follow-up on its internal suppliers' (purchasing) performance and management needs KPIs to know whether purchasing is strategically on track. Building a KPI set for purchasing is also a part of the production development program approved by the owner, Beretta Group.

The outcome of this study is a proposal of a set of indicators based on the findings of the data collection phases 1-3 and furthermore Current State Analysis and Conceptual Framework from the existing knowledge, literature and benchmarking. Furthermore, also, recommendations how to proceed and finalize the research are presented.

The study is completed from three perspectives of purchasing performance measurement with every stakeholder group, and the proposed KPIs are taking every perspective into notice to support the case company's quest after overall improved performance. The strengths of the current state are improved, and the weaknesses removed with new ways of performance measurement. Moreover, this study is not providing purely new indicators, but also tools to handle and filter massive data to support the control of purchasing expenditure.

7.2 Evaluation of the Thesis

This thesis was carried out to solve a real life problem in a real organization where the Author is in the middle of the action. When composing this thesis, a distinct interest was in mind to maintain readability and consistency throughout the work. That is why this study contains many tables and figures, to keep the readability on a high level and the author's line of thinking transparent to the reader.

This study was carried out utilizing the qualitative action research approach since it aims to solve current practical problems while expanding the scientific knowledge of the matter. The practitioners (in this case, the stakeholder representatives) were involved in investigating and evaluating their work and further on, developing it. In this case, the problem was practical and scientific knowledge was needed to ground the proposal. As said in the beginning of the chapter, the researcher is highly involved in the process and seeks to have an organizational change to improve and study the problem.

In the data collection phases, all the stakeholders were engaged in the decision-making process and building the proposal to make it as tangible and beneficial as possible. The focus of the work was divided to three different perspectives in an early stage of the study to explain the current state, the literature research, and the Conceptual Framework as clearly as possible. The group owner's view from purchasing performance measurement was also taken into account to support the reliability of the research.

Discussions and workshops were carried out in open discussion style, to have the best ideas emerged from the stakeholder representatives. It is proven that to get the best ideas out of creative people, we must remove the boundaries, sharpen the objective and give space. In other words, pre-defined questionnaires would have suffocated the creativity of the representatives. Naturally, the frame and the target of the discussions were pre-defined.

The literature review turned out challenging due to the nature of the topic which had an effect on building the Conceptual Framework. In other words, the literature did not give any straight answers on what would be the suitable KPIs for the case company, so it made the CF a bit more intangible than what the author had in mind. However, the literature provided valuable aspects to what should be taken into account when building a KPI set and how to implement financial performance measurement to purchasing.

Importantly, this study increased the functional transparency inside the organization during the research, the true needs of a stakeholder became visible, and the understanding and root causes of issues became more evident to co-workers and managers. There were also other significant findings along the research, for example, new ways to filter and follow the purchasing expenditure from key items and indicators that can be used as a tool to support material resource planning. Also, removing manual work with enhancing the reliability of identified indicators increases internal efficiency and the daily decision-making process in the stakeholders' departments.

Moreover, there is still plenty to do to finalize the project. As said, this thesis is merely a proposal, and the testing, implementation and updating the KPI set is still to be done.

7.3 Outcome vs. Objective

The objective of this study was to propose a grounded set of Key Performance Indicators that meet the requirements of the three stakeholder groups. The outcome of this study was a proposal of a set of indicators with recommendations how to proceed and finalize the research. When comparing the outcome and the objective, according to the feedback when presenting the proposal for final validation, the outcome fulfills the requirements of the objective.

7.4 Reliability and Validity

Reliability and validity are used to measure the quality of the work and to ensure the credibility. In this study, reliability and validity are kept in mind all the way through the research; the evidence trail is kept visible by conducting interviews and discussions comprehensively and providing accurate summaries and tables for maintaining the researcher's thinking transparent. To increase the validity, the research was triangulated from different perspectives with engaging others in the process, as seen in the Lather's (1991) four types of validation (Table 4, p.4). According to Quinton & Smallbone (2006), the researcher's thinking should be transparent throughout the work and honestly discuss the threats of validity. In this case, the repeatability of the research is seen as a threat, because the outcome could be different if this research would be conducted in a different time or different surroundings. Also, there could have been more workshops and discussions in the data collection phases, but due to the short timeframe and the availability of the stakeholder representatives, only 4-5 meetings per round were performed.

Finally, this study is part of a bigger production development program required by the owner so the outcome will also be reviewed by the top management. That provides face value to the researcher and increases the reliability of the thesis.

7.5 Closing Words

Performance measurement is one of the most important cornerstones of a successful organization and it also should be defined in the company strategy what is measured and why. With a systematically built performance measurement system and key performance indicators the organization is able to monitor whether the company is strategically on track in the continuously changing environment.

For an organization, it is important to decide what characteristics to measure. This thesis concentrated on performance measurement of purchasing activities and more closely on its financial side. As this study has shown, there is always room for improvement even if it may seem that the organization is measuring appropriate features for performance follow-up and the indicators are accurate.

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Financial methods, models and systems for performance measurement

<i>Period of introduction</i>	<i>Name of the model/framework</i>	<i>References</i>
<i>Before 1980s</i>	The ROI, ROE and derivatives	Simons (2003)
<i>1980</i>	The Economic Value Added Model, EVA	Stewart (2007)
<i>1988</i>	The Activity Based Costing, ABC	Cooper and Kaplan (1998)
<i>1989</i>	The Supportive Performance Measures, SPA	Keegan (1989)
<i>1990</i>	The Customer Value Analysis, CVA	Customer Value Inc. (2007)
<i>1990</i>	The Performance Measurement Questionnaire, PMQ	Dixon (1990)
<i>1991</i>	The Results and Determinate Frameworks, RDF	Fitzgerald (1991)
<i>1992</i>	The Balance Scorecard, BSC	Kaplan and Norton (1992)
<i>1994</i>	The Service Profit Chain, SPC	Heskett (1994)
<i>1995</i>	The Return on Quality Approach, ROQ	Rush (1995)
<i>1996</i>	The Cambridge Performance Measurement Framework, CPMF	Neely (1996)
<i>1996</i>	The Consistent Performance Measurement System, CPMS	Flapper (1996)
<i>1997</i>	The Integrated Performance Measurement System, IPMS	Bittici (1997)
<i>1998</i>	The Comparative Business Scorecard, CBS	Kanji (1998)
<i>1998</i>	The Integrated Performance Measurement Framework, IPMF	Medori (2000)
<i>1999</i>	The Business Excellence Model, BEM	EFQM (2007)
<i>2000</i>	The Dynamic Performance Measurement System, DPMS	Bittici (2000)
<i>2001</i>	The Action Profit Linkage Model, APL	Eppstein (2001)
<i>2001</i>	The Manufacturing System Design Decomposition, MSDD	Cochran (2001)
<i>2001</i>	The Performance Prism, PP	Neely (2001)
<i>2004</i>	The Performance Planning Value Chain, PPVC	Neely (2004)
<i>2004</i>	The Capability Economic Value of Intangible and Tangible Assets, CEVITA	Ratnatunga (2004)
<i>2006</i>	The performance, Development, Growth Benchmarking System, PDGBS	St-Pierre (2006)
<i>2007</i>	The Unused Capacity Decomposition Framework, UCDF	Balachandran (2007)

(Glavan, 2011, p. 31)

Results of studies on the information content of shareholder value performance measures, 1991-2011

Authors	Internal independent variable(s)	External dependent variable(s)	Result	Country; statistical technique
Stewart (1991)	EVA, EPS, ROE and others	MVA	EVA	US; LS regression
Stern (1993)	EVA, ROE, cash flow growth, EPS growth, asset growth	MVA	EVA	US; LS regression
Milunovich and Tsuei (1996)	EVA, EVA growth, ROE, FCF	MVA	EVA	US; LS regression
O'Byrne (1996)	EVA, NOPAT, FCF	Market value+ IC	EVA	US
Bacidore, Boquist, Millbourn, and Thakor (1997)	REVA, EVA	Stock returns	REVA	US; LS regression
Biddle, Bowen, and Wallace (1997)	EVA, EBEL, RI, OCF	Market-adjusted stock returns	EBEL	US; LS regression
Chen and Dodd (1997)	EVA, change in EVA, ROC, SPREAD, capital GROWTH, EPS, ROA, ROE	Stock return	ROA, EVA	US; Regression
Bao and Bao (1998)	NI, EVA, Value added	Equity value; share price	Value added (accounting)	US; LS regression
De Villiers and Auret (1998)	EPS, EVA per share	Share price	EPS	South Africa; Regression
Hall (1999)	EVA, discounted EVA, ROA, ROE, ROCE, EPS, DPS, and others	MVA	EVA (same result as discounted EVA)	South Africa; LS regression
Worthington and West (2004)	EVA, RI, NCF, EBEL	Stock returns	EVA	Australia; Regression
De Wet (2005)	EVA, CFO + IC, ROA	MVA	CFO + IC	South Africa; LS regression
Ismail (2006)	EVA, RI, NI, NOPAT, OCF	Stock returns	NI, NOPAT	UK; Panel data regression
Kyriazis and Anastassis (2007)	EVA, NI, OI	Stock returns; MVA	NI, OI	Greece; Regression
Erasmus (2008)	CVA, EVA, RI, EBEL, CFO	Market adjusted returns	RI	South Africa; LS regression
Chmelikova (2008)	EVA, ROA, ROE	Market value of equity + equity	EVA	Czech republic; Regression
Lee and Kim (2009)	EVA, REVA, MVA, CFO, ROA, ROE	Market adjusted returns	REVA, MVA	US; Pooled regression
Kumar and Sharma (2011)	EVA, NOPAT, OCF, ROE, ROCE	MVA	NOPAT, OCF	India; LS regression

(Hall, 2013, p. 1177)

$$EVA = \left(\frac{\text{net operating profit}}{\text{capital employed}} - WACC \right) \times \text{capital employed}$$

WACC = the cost of company funds (debt & equity)

EBEL = net income before extraordinary items and tax

NOPAT = net operating profit after tax (= EBEL + aftertax interest adjustment)

NI = net income attributable to shareholders

ROA = the return on average total assets

EPS = the headline earnings per share

ROE = the return on average equity

$$ROCE = \left(\frac{\text{net operating profit}}{\text{capital employed}} \right)$$

SPREAD = ROCE – WACC

(Hall, 2013, p. 1178)

Most useful inventory performance indicators

Lead times

The length of time taken to obtain or supply a requirement from the time a need is ascertained to the time the need is satisfied

Service levels

The actual service level attained in a given period, which can be ascertained from the formula:

$$\frac{\text{number of times the item is provided on demand}}{\text{number of times the item has been demanded}}$$

Rate of inventory turn

Indicates the number of times that inventory item has been sold and replaced in a given period and is calculated by the formula:

$$\frac{\text{sales or issues}}{\text{average inventory (at selling price)}}$$

Stockouts in a given period

Expressed as a percentage of the total inventory population during a given period

Inventory days in hand

Opposite of inventory turn and indicates the number of days the current inventory of a stock keeping unit (SKU) will last if sales or usage continues at the anticipated rate. For a simple SKU, it can be calculated as:

$$\text{Inventory days in hand} = \frac{\text{current quantity at inventory}}{\text{anticipated future daily rate of usage or sales}}$$

Adopted from (Lysons, 2012, p. 319)

An example of a Balanced Scorecard

Perspective	Outcome/driver	Formulation
Customer	Percentage of line items on backorder to total line items	$\frac{\text{Average number of items on back order per month}}{\text{Total number of line items}}$
	Cost per order by customer	$\frac{\text{Total expenditure of the department}}{\text{Total IRF received}}$
	Effectiveness of ordering time	$\frac{\text{Actual average cycle time}}{\text{Targeted average cycle time}}$
Supplier	Quality of delivery	$\frac{\text{Number of rejects/early/late shipments}}{\text{Total number of items received}}$
	Cost per order to suppliers	$\frac{\text{Total expenditure of the department}}{\text{Total number of purchase orders}}$
	Effectiveness of delivery time	$\frac{\text{Actual average cycle time}}{\text{Targeted average cycle time}}$
	Supplier evaluation	$\frac{\text{Number of supplier evaluations that meet objectives}}{\text{Total number of supplier evaluations}}$
Process	Solvability rate	$\frac{\text{Number of cases solved within 60 days}}{\text{Number of cases reported}}$
	Stock take discrepancy	$\frac{\text{Total variance}}{\text{Total stock value}}$
	Supply chain costs	$\frac{\text{Total expenditure of department}}{\text{Total purchase value}}$
	Effectiveness of processing time	$\frac{\text{Actual average cycle time}}{\text{Targeted average cycle time}}$
	GPO participation rate	$\frac{\text{Number of items under GPO}}{\text{Total number of items}}$
	Requisition completion rate	$\frac{\text{Number of IRFs completed}}{\text{Number of IRFs received}}$
IT system	Efficiency of IT system	$\frac{\text{Number of EIRFs}}{\text{Number of employees handling the system}}$
	Effectiveness of IT system	$\frac{\text{System down-time}}{\text{Total number of hours in operation}}$
Learning and growth	Training utilization rate	$\frac{\text{Number of training places utilized}}{\text{Number of planned training}}$
	Employee engagement index	$\frac{\text{Number of participants in engagement survey}}{\text{Total number of employees in department}}$
Overall	Effectiveness of department	$\frac{\text{Total expenditure of the department}}{\text{Budget of the department}}$
	Effectiveness of policies/projects/procedures	$\frac{\text{Total number of policies/projects/procedures that meet objectives}}{\text{Total number of policies/projects/procedures}}$
	Efficiency of policies/projects/procedures	$\frac{\text{Total savings from policies/projects/procedures}}{\text{Total number of policies/projects/procedures}}$

Adopted from (Kumar, et al., 2005, p. 159)

Summary of Data 1 interviews and workshops

Issues where to seek answers by a stakeholder

Management

1. What are the purchasing KPIs that are in use at the moment?
2. Are they relevant?
3. Is it difficult to understand what the KPI is measuring?
4. What is the outcome or numeral value of a KPI?
5. Who has access to the KPI, is it easy to be found from the system?
6. Is the KPI useful, who reads it?
7. What are the identified needs to current status?

Assembly

1. What are the purchasing KPIs that are in use at the moment?
2. Are they relevant from assembly's view?
3. Good and bad features from the KPIs?
4. Strengths and weaknesses of KPIs?
5. Is the listing or indicator relevant to assembly?
6. What is the usability of an indicator?
7. What are the identified needs to current status?

Purchasing

1. What are the identified KPIs?
2. Strengths and weaknesses of KPIs?
3. Is the listing or indicator relevant to purchasing's daily work?
4. What is the usability of an indicator?
5. How does the purchasing follow monetary indicators?
6. What are the identified needs to current status?

Summary of Data 2 interviews and workshops

Building a preliminary proposal with stakeholders, issues to solve and discuss.

Owner's performance measurement practices (benchmarking)

- What is the focus point of performance measurement in Beretta? Price, quality, ..?
- How is purchasing performance measured in Beretta?
- Is it difficult to understand what the KPI is measuring?
- What is the outcome or numeral value of a KPI?
- Is the outcome reliable?
- Who has access to the KPI, is it easy to be found from the system?
- Is the KPI useful, who reads it?
- What is the usability of an indicator?
- How does the purchasing follow monetary indicators?
- What are the identified needs to current status?
- How suppliers' are evaluated?

Purchasing/Management (8.3.2016)

- Is the delivery accuracy calculation reliable? How is it calculated?
- How is ERP data saved?
- What data is saved?
- What financial data is saved? Is the data reliable?
- Is there data available for spend or inventory value measurement?
- Can ERP data be used for cost savings?
- How can we filter the ERP data?

Assembly

- Pros/cons for measuring parts in surface treatment
- Is it possible to measure?
- What does it take from the IT?
- Would it possible to implement identified needs to identified KPIs?
 - o Is it internally doable or should the IT work be outsourced?

Purchasing/Management (31.3.2016)

- How is the standard cost allocated in the case company?
 - o Is the data reliable?
- How to target cost savings actions? To what items?
- From what item the inventory value should be measured? All items or groups of items?
- Is the delivery accuracy and service level formulas up-to-date? What is the formula?
- When a stockout happens, should we measure it? Does it provide any additional value?
- How to remove all the manual work from purchasing daily management?

Summary of Data 3 interviews and workshops

The process of data 2 simulations and feedback for initial proposal

Assembly

- The timetable for surface treatment indicator simulation and implementation
- What to take into notice when implementing the system

Purchasing/Management

- Timetable for simulations
- The KPIs from where simulations should start?
- What are the most plausible pitfalls and what should take into account when building a shopping basket concept?
- Is the cost of stockouts usable, challenges?

Management/Purchasing

- Additional tools to improve the accuracy of assembly missing parts
- Service level formula, recap

Management/Purchasing/Assembly

- Presentation of the initial proposal
- Discussion and feedback
- Validation (look appendix 8)

Validation and feedback, summary

Topics to discuss after the presentation (suggestions)

- The timetable for implementing the proposed KPIs should be followed and obeyed
- The groundwork of the proposed KPIs should be done properly before final implementation
- The selection of items to shopping basket should be made thoroughly
- The formula of all KPIs should be visible, for transparency
- The proposal does not include the quantity of supplier claims
- The proposed KPIs could be used as the basis of a supplier evaluation
- Assembly missing parts, a combination of two listings should be used
 - o the sum of different items missing (how many rows, in total)
 - o the sum of total missing parts (how many parts, in total)
- Parts days in hand-indicator, divided to two different KPIs
 - o What was the days in hand from selected item when measuring past 6 months?
 - o What is the days in hand from selected item when comparing to forecast
 - o Days in hand could be a supportive tool in addition to material resource planning