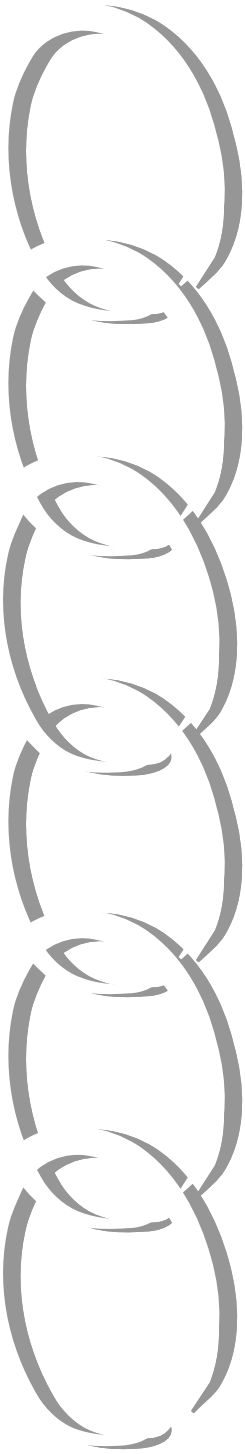
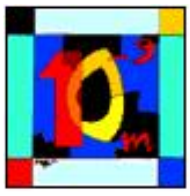


InCoCo-S

Innovation, Coordination and Collaboration
in Service Driven Manufacturing Supply Chains

Deliverable Nr. DL 4.2

Development of Methodology for Measuring the Performance Metrics



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Executive Summary

Increasing customer requirements, ever faster changing environments, and increased competition are often mentioned as important, general business trends. The plant and machinery industry is one example where these trends, which pressure companies into a continuous improvement cycle, can be observed. One challenge is to improve the level of satisfaction and quality of co-operation at the service interface by integrating service providers in the customers` processes. Within the context of InCoCo-S, one of the key aims is to standardise integrative industrial service processes in order to facilitate transparency on service operation performance and the resulting customer benefit. Focusing on this area, deliverable (DL) 4.2 presents a new standard performance framework for the measurement of operational PIs in the domain of industrial service operations (chapter 3). Furthermore, a comprehensive set of performance indicators (PIs) facilitating the measurement of industrial service operations is linked to standardised reference service processes developed in DL2.6 (chapter 4). Based on intensive literature research (DL4.1) and the results of the InCoCo-S survey (DL2.1), the assumption was validated that there exists no standard performance system so far, but that there is an unsatisfied business need to quantify both the efficiency and effectiveness of industrial service operations and to make their impact on the customers` overall performance transparent.

Based on the analysis of requirements in theory and practice by means of literature review and industrial workshops, a concept for performance measurement in the domain of industrial service operations was developed. The developed Service Performance Measurement System (SPMS) addresses the integrative character of industrial service operations by highlighting the interaction between customers and service providers. The SPMS provides both, service providers and customers with a structured set of comprehensive PIs, which are qualified for measuring service operations performance and are applicable to a wide range of industrial services. The SPMS as an outcome of DL 4.2 can be taken as an essential part of the InCoCo-S Reference Model (IRM) as the designed PIs will be assigned to the cluster specific reference service processes over three levels. In order to show the impact of service activity processes (level 3) on the service object, the interdependencies and correlations between PIs will be investigated by using a simulation tool within further research activities (DL4.3). As DL4.2 focuses on the design of the SPMS, the validation phase will be centred in DL4.4.

Please note that the original title of the Deliverable “Methodology to Measure the Performance of Systems and Development of Tools to quantify added value and to determine market pricing” has been changed to the task 4.2 headline “Development of Methodology for Measuring the Performance Metrics” in order to better reflect the outcome of the task.

1 Introduction

1.1 The development of a Service Performance Measurement System (SPMS)

In DL 4.2 the main objective in InCoCo-S is the development of a practical standardised description for the measurement and management of industrial service operation performance of service providing enterprises on a generic level, which will be adapted to the industrial service clusters. The major outcome will be a standard performance framework for the measurement of operational performance indicators (PIs) in the domain of services. The SPMS constitutes these PIs in a structured way.

Based on intensive literature research in DL 4.1 and the results of the survey in DL 2.1 the assumption was validated that there exists no standard system so far but there is an unsatisfied business need to quantify both the efficiency and effectiveness of service operation activities and to make the impact of industrial service activities on the customers overall performance transparent. Besides the description of the elemental PIs with measurement points, the SPMS provides the different service clusters with a specific set of PIs. Based on developed standard reference service processes (DL2.6) a set of PIs for service activities are structured in a hierarchical way. The target hierarchy with several target areas like quality, costs and flexibility presumes that the maximisation of the service effectiveness, respectively the customer benefit, is the principal goal that needs to be achieved. The associated PIs are defined in such a way that their contribution to the respective target area can be reproduced.

Figure 1-1 illustrates the procedure in WP4 and shows how Task 4.2 is connected to the InCoCo-S Reference Model (IRM) including the belonging service clusters the project is focusing on. The input has been worked out with the help of the industrial partners in the project.

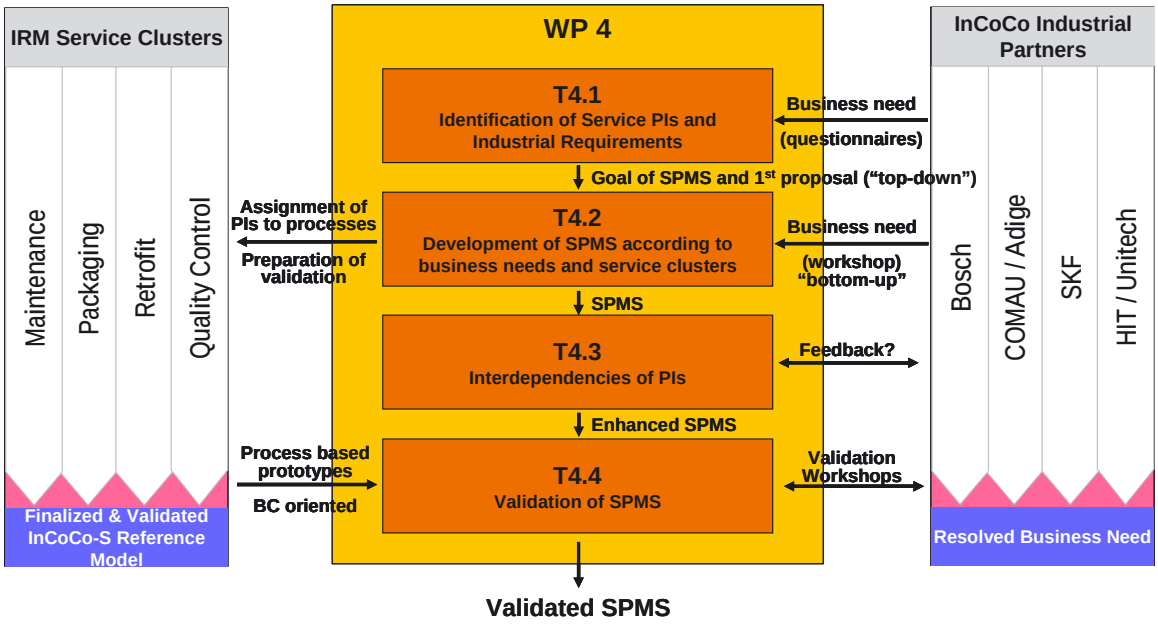

Figure 1-1: Interactions in Workpackage 4

One of the key aims in Task 4.2 is to assign the single Performance Indicators (PIs) -coming

as an output of DL 4.1- to the basic service reference processes developed in DL 2.6.

The research process comprises first an analysis of requirements in theory and practice by means of a literature review (desk research) and industrial workshops at the partners of the InCoCo-S project. Based on these results, a concept for performance measurement in the domain of industrial service operations was developed. In close cooperation with industrial partners, relevant performance indicators (PIs) as an essential part of the SPMS have been identified.

1.2 The connection between SPMS and the InCoCo-S Reference Model

The standardised SPMS is one of the essential parts building up the InCoCo-S Reference Framework (IRM). Figure 1-2 is showing the stepwise development of the IRM consisting of the defined service specific processes (Task 2.6), the coordination mechanisms (WP3) and the SPMS (WP4).

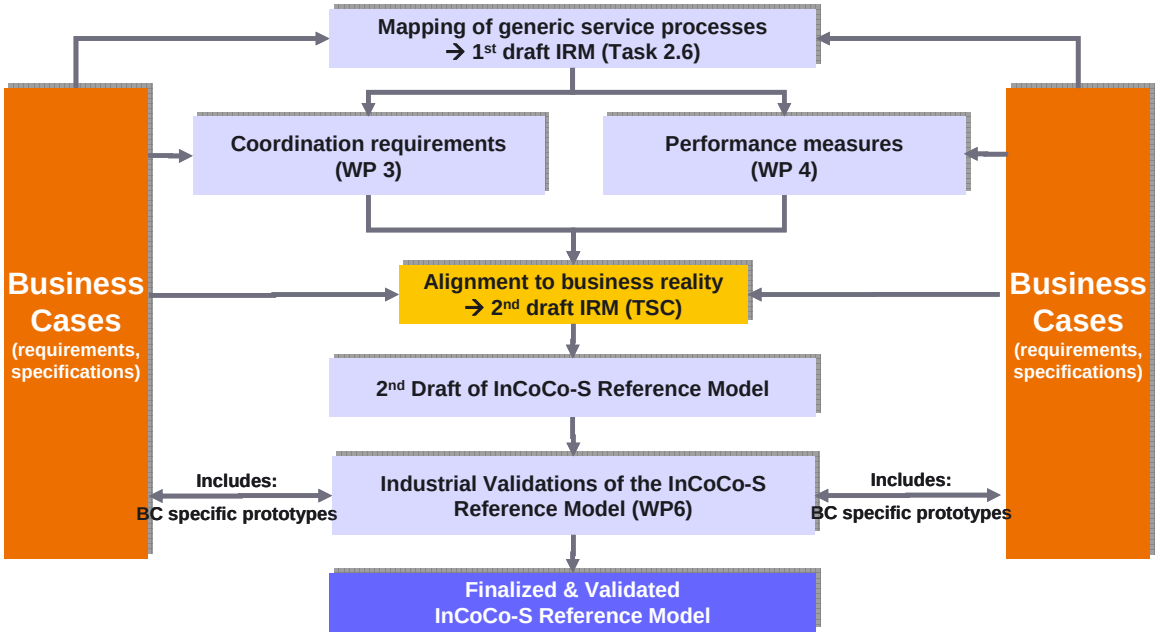

Figure 1-2: Connection between WP4 and the IRM

The sole objective of applying or developing any standard reference model is to be able to measure and benchmark the performance of the organisation in contrast to the existing competitors. Performance measurements are clubbed together into distinct performance attributes which help organisations to focus on core themes of their measurement. Hence, the performance metrics are used in conjunction with performance attributes.

The Performance Attributes are characteristics of the organisation that permit it to be analyzed and evaluated against other competitors with competing strategies. Just as one would describe a physical object like a piece of lumber using standard characteristics (e.g., height, width, depth), an organisation, service or supply chain requires standard characteristics to be described. Without these characteristics it is extremely difficult to compare an organisation that chooses to be the low-cost provider against an organisation that chooses to compete on reliability and performance.

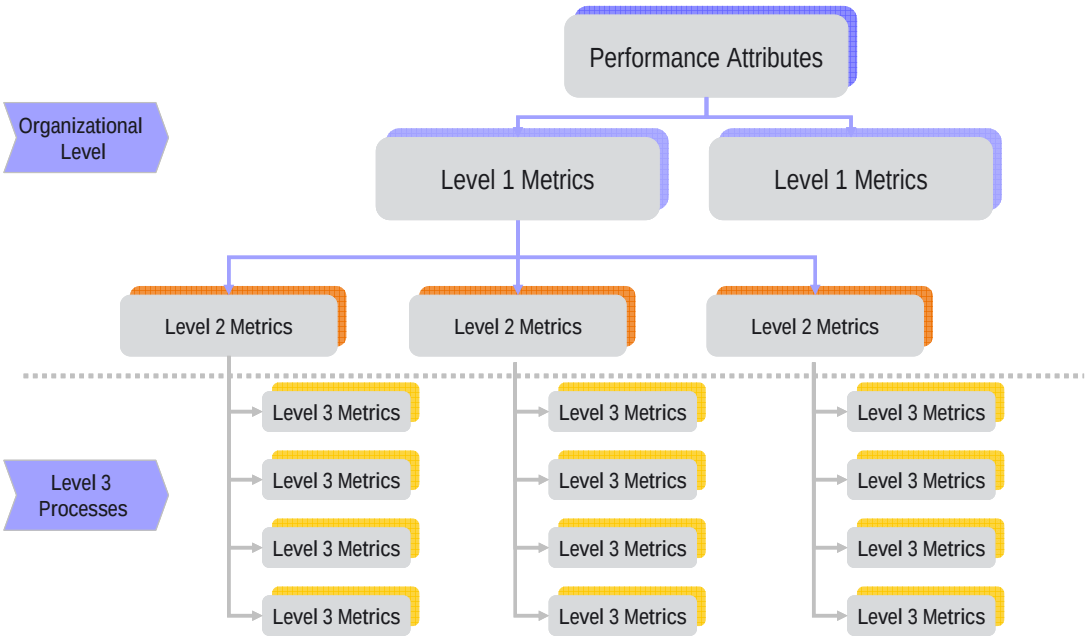

Figure 1-3: Inter-relationship between InCoCo-S Reference Model & SPMS

Associated with the Performance Attributes are the Level 1 metrics. These Level 1 metrics are the calculations by which an implementing organisation can measure how successful they are in achieving their desired positioning within the competitive market space. Lower level calculations (Level 2 metrics) are generally associated with a narrower subset of processes and sometimes can be mapped to the actual flow of processes at Level 2 of the reference model. Finally, there are level 3 metrics which are directly attributed to the individual process elements.

2 Methodology to develop a Service Performance Measurement System (SPMS)

2.1 Structure and approach for the development of the SPMS

For the development of the SPMS theoretical and practical research methods were used. The theoretical approach is based on intensive literature research. This approach is called top-down approach as it reflects a general approach. On the other side the requirements and needs of the industrial partners have been elaborated in several workshops and were taken as a mature input for the development of the SPMS. As this research activity is highlighting the specific needs of companies this approach is consecutively named as bottom-up approach.

2.1.1 Goals and objectives

Goals

DL 4.2 is giving the platform to develop a structure for various performance indicators to measure services generally and to adapt the PIs individually to our service clusters. A special focus will be on the description of necessary interactions between service providers and their customers highlighting the interdependencies in the service supply chain. At the end, a practical standardised description, measurement and assessment for the service performance will be provided. The basic idea is to get a hierarchical target structure of PIs which presumes that the maximisation of the service efficiency and effectiveness is the principal goal to be achieved. The SPMS also allows measuring the service performance from a customer perspective through securing the implementation of the measurement of the value-added provided by the service provider at the customer's site in the implementation methodology. Section 3.1 provides a detailed goal catalogue structured by general, technical and functional goals.

Objectives

From these generic goals two main objectives for the domain of InCoCo-S can be derived:

- Develop a hierarchical framework on a general level for the performance measurement of any industrial service
- Adaptation of the general SPMS to the defined service clusters and specific industrial conditions

2.1.2 Research Questions

The following research questions have been followed during the development of the SPMS (questions marked with * were kept in mind for the development, but are not covered by this deliverable):

- How can interactions at the interface between service provider and their customers be measured?
- Which factors are influencing service performance?
- What are challenging aspects associated with the development of an SPMS?
- How can industrial partners make use of the framework?

Another important part of the development of the SPMS is a first description of the identified and defined performance indicators. Following some basic questions are presented, which need to be considered for the description in a first rough way, but need to be further detailed

during the implementation phase, which is not part of this deliverable. However, the questions needed to be kept in mind are:

- What is the reason for this PI?
- Why do we want to measure it?
- Who is going to act on the measure once the data becomes available?
- What do they then do with the benefit of this knowledge?
- Where are we going to get the data from?
- Who is going to collect the data?
- How often are they going to collect the data?
- How often will the data be reviewed?
- Is our general measurement framework adaptable to different business goals and strategies?
- How are the measures being communicated?
- How can these measures be used for a performance *management*?

These questions went into consideration while designing the SPMS. Following some more aspects coming from literature for the design of performance measurement systems are presented.

2.2 Literature research

There is a vast amount of literature discussing the process for developing a performance measurement system (PMS) in general. A characteristic of many of these development methods is that the development of a PMS may conceptually be separated into phases of

1. Design,
2. Implementation and
3. Use.

The design phase is about identifying key objectives and designing measures. In the implementation phase, systems and procedures are put in place to collect and process the data that enables the measurements to be made regularly. In the use phase, managers review the measurement results to assess whether operations are efficient and effective, and the strategy is successfully implemented. This may also lead to the situation that the strategic assumptions are reviewed. The design, implementation, and the use of a set of performance measures are not a one-time effort: a company should install processes that ensure continuous reviews of the system. Review processes imply that a measure may be deleted or replaced, the target may change, and the definition of measures may change (Lohman et al. 2004).

In the following, a theoretic guideline for the development of each phase of a PMS (design, implementation and use) is provided based on literature research.

2.2.1 Design phase

The design phase of the PMS is the identification and definition of targets. It includes the performance planning and shall define the magnitude and the range of excellence the company has to preserve to maintain its competitiveness. Consequently these targets are broken down to operational measures by assigning performance indicators (PI) to them, allowing an assessment of the level of achievement of the targets (Sennheiser, p.11; Sinclair, Zairi 1995):

Goal definition: Develop a goal definition for the SPMS based on recognizing the needs of all organisational stakeholders (industrial customers, employees, shareholders etc.). This may include mission statement, vision statement, quality policy, and corporate values.

Value Creation Area (VCA): Based on this goal definition, identify VCAs, a set of processes that adds value to industrial services (e.g. Service Provider internal view, Service Encounter Interaction between Service provider and Customer, Service quality area). VCA should represent all groups involved in producing, providing and consuming industrial services.

Critical Success Factors (CSF): Based on VCA identify CSFs which are the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation or VCA.

Key Performance Indicators (KPI) / PI: Define performance measures for each CSF – i.e. key performance indicators. There may be one or several KPIs for each CSF. Definition of KPIs and PIs should include (Lohman et al. 2004):

- Title of KPI, PI: use exact names to avoid ambiguity
- Objective/purpose: the relation of the metric with the organisational objectives must be clear

- Scope: states the areas of business or parts of the organisation that are included
- Target: Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
- Data used in calculation of KPI
- Equation: Method of calculation of KPI
- Units of measure: what is/are the unit(s) used
- Source of data used in calculation
- Proposed measurement frequency
- Responsibility for the measurement process
- Drivers: Factors that influence the performance, i.e. organisational units, events, etc.
- Comments: outstanding issues regarding the metric.

In reference to Lohman et al. (2004), one of the possible structure of metrics and the outcome of the design phase of the PMS is shown in the following Figure 2-1.

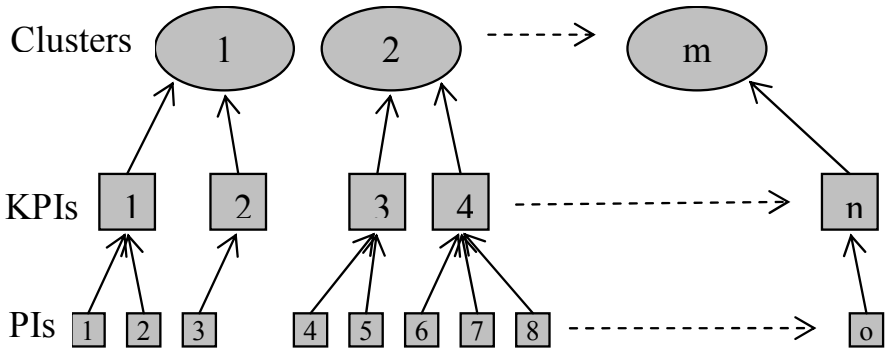

Figure 2-1: Structure of performance indicators

However, it is important to understand, that the PMS to be developed in InCoCo-S should be a very basic and universal framework, providing a complete set of PIs relevant for industrial service operations. This comprehensive system is then adapted to individual organisations, leading also to an individual structure of KPIs and PIs, dependent on the characteristics of the industries and environment it belongs to. Appropriate value creation areas and critical success factors as well as the right key performance indicators are those which enable organisations to direct their actions towards achieving their own particular strategic objectives. Thus the appropriate information should be gathered by using documents, interviews, and executive workshops. Kaplan and Norton (1993) provide various approaches that can be used during the design phase of the PMS:

- Asking: Techniques to find out the requirements of managers, such as interviews, group discussions, planning meeting, and surveys.
- Prototyping: Instead of focusing primarily on a thorough analysis of the information needed, an initial set of requirements is specified and a prototype system is built. Through interaction with users of the system, e.g. managers, requirements are added or changed until the user is satisfied.

- Planning methods: Methods that design appropriate measures based on the characteristics of the firm, such as strategy, processes, and customers. For example, a method could be followed to determine a few areas (critical success factors) that dictate the success of the firm. For such areas critical success factors are described, which lead to the definition of measures that capture these factors.
- Existing reports: Often existing reports build a useful source of the information to be used to design the PMS.

2.2.2 Implementation phase

The implementation phase of PMS deals with the collection of data, in-line measurement of production processes and the aggregation of data in statistical evaluation of historical data (regression, linear smoothing, extrapolation etc.) (Sennheiser, 2004). Furthermore, the information system for the PMS should be set up.

For the successful implementation of PMS, the management must be convinced of the need to change. The users should be educated so that they understand the information available from the SPMS system and how that information should be used in decision making.

In order to implement the SPMS successfully, the following steps are recommended (Sinclair, Zairi 1995):

1. Implement the information system, reporting system for the PMS (IT infrastructure etc.)
2. Develop plans to achieve the target performance. This includes short-term action plans and longer-term strategic plans
3. Assign responsibility for achievement of desired performance against KPI targets: Identify and document job descriptions based on process requirements and personal characteristics. This information should include the identification of:
    - Activities to be undertaken in performing the job
    - Activities and responsibilities to be undertaken for measuring the KPI / PI
    - Requirements of the individual with respect to the identified activities, in terms of experience, skills and training
    - Requirements for development of the individual, in terms of personal training and development
4. Operate processes
5. Measure performance against KPIs, and compare to target performance
6. Based on this comparison, identify areas with high leverage for improvement, and update action plans
7. Communicate performance and proposed actions throughout the organisations giving feedback to individuals of their performance in carrying out tasks
8. Reward and recognise superior organisational performance

2.2.3 Use phase

The use phase of PMS includes performance assessment, performance improvement and performance rewarding. Performance assessment provides gap analysis which shows deviations from previously defined goals, as well as an analysis and interpretation of reasons

for inferior performance, while performance improvement deals with the application of countermeasures to improve performance ratios back into the desirable range. Performance reward asserts fair distribution of benefits and a balanced compensation of trade-offs.

The main assignments of the use phase of PMS are to:

- Implement continuous improvement activities
- Identify areas for improvement
- Update action plans
- Update performance targets
- Redesign processes (where appropriate)
- Manage the performance of teams, individuals and suppliers

In order to use the SPMS properly, the following steps are recommended (Sinclair, Zairi 1995):

1. Identify the need for assessment. The identification of the need for assessment will come from:
    - Poor performance at the organisational or process levels against KPIs
    - Identified superior performance of competitors
    - Customer inputs
    - The desire to direct improvement efforts
    - The desire to concentrate attention on the need for performance improvement
2. Identify mode and technique of assessment: This involves determining whether the assessment should be carried out internally within the organisation, or externally, and the type of assessment that should be carried out. Some techniques are purely internal (e.g. self-assessment, cost of quality, activity based costing, business process reengineering), while others (e.g. external benchmarking, competitor analysis, customer surveys, quality function deployment) involve obtaining information from sources external to the organisation. The choice depends on:
    - How the need for assessment was identified
    - The aim of the assessment. If the aim is to improve performance relative to competitors, external benchmarking may be a better option than internally measuring the cost of quality
    - The relative costs and expected benefits for each technique
3. Carry out the assessment
4. Feed results into the planning process at the organisational or process level
5. Determine whether to repeat the exercise. If it is decided to repeat the exercise, the following points should be considered:
    - Frequency of assessment
    - At what levels to carry out future assessment (organisation –wide or process-by–process)

- Decide whether the assessment technique should be incorporated into regular performance measurement processes, and if so how this will be managed.

2.3 Workshops with industrial partners

Following the approach for designing a PMS as presented in section 2.2.1, a Task 4.2 workshop was conducted within the frame of a full consortium meeting in Budapest on 10/11th of October, in order to work out the business needs towards a SPMS (i.e., "Service PMS"). The bottom up research approach was followed by splitting up the participating partners into four groups representing each service clusters. In every group there was at least one person representing the industrial and one representing the academic point of view. The following questions and tasks were used as a guideline through the meeting of several hours.

Starting basis were the Business Cases and 5 Service Clusters (outcome of Tasks 2.3 and 2.6)

1. Prioritise the benefits of your service from your customer perspective **30' min**
2. Identify the two high level PIs which are most important for your customer (e.g. costs, machine availability, etc.
    - **Example:** For packaging we found that output of the packaging system and maintenance costs are most relevant from customer perspective
3. Identify 1-3 more high-level PIs important for your service operation
4. Filter the relevant PIs from the pool given to you through all different levels
5. Go step by step through the process of your service cluster and identify the potential of essential process steps concerning the identified high level PIs **45'**
    - **Example:** The implementation of a so called „Embedded Engineer" avoids error diagnostics in remote and facilitates process monitoring and optimisation
6. Identify influencing factors for the selected performance indicators / potentials **30'**
7. Define performance indicators for the essential steps (PIs) **30'**
8. Restructure PI hierarchy according to the needs of your service cluster **20'**
    - Basis is the initially proposed structure
9. Work out (critical) influence factors which may have a positive or negative impact on the identified PIs
    - **Example:** Customers Top Management involvement (is missing); Packaging machine operator; worker at the machine is not cooperating, could be afraid of loosing his job

Input for the workshop was the PMS in the form as presented in DL 4.1, which was the result of the top-down academic approach (literature research). A major contribution of these workshops was the deduction of two to three main performance areas, which are considered as most important for the customer. So these areas can be defined as the cluster-specific Value Creation Areas (VCAs). These VCAs are presented in Table 1.

Service Cluster	VCA 1	VCA 2	VCA 3
Maintenance	Maintenance costs	Productivity of the machine(s)	
Retrofit	Machine output quality	Productivity of machine	Time taken to perform retrofit
Packaging	Machine(s) output quantity	Cost per product	
Quality	Product quality	Product delivery lead time	

Table 1: Identified Value Creation Areas per Cluster

Coming from these VCAs the workshop participants were identifying the relevant critical success factors, which from their experience influence the performance of these VCAs. Major outcome of this phase was that the interaction with the customer in every cluster was crucial, whether this was the provided environmental conditions in the production facility in the packaging case or the collaboration when it comes to scheduling maintenance activities against the customer's production schedule.

A detailed overview of the results of the workshops, including the defined critical success factors (CSFs) for the VCAs, can be found in the annex. These CSFs were then used for the final step of the workshop, which was a first collection and definition of specific performance indicators (PIs), which could be assigned to the actual process repositories. These results can also be found in the table in the annex. However, in the weeks after the workshop further activities in these domains were undertaken, which resulted in the generic SPMS, so that the results from these workshops are intermediate steps which were further elaborated and improved. Finally the developed PIs of the SPMS were reassigned to the service clusters, which are presented in chapter 4. These results cover the aspects as developed in the initial workshops.

2.4 Measurement of industrial services from a customer benefit perspective

A major goal for the SPMS to be developed is the possibility to measure the value added generated through the service provision from a customer perspective. This need arose directly from the industry partners, who are not in the position to give a transparent picture on the impact of their services, because of the human factors playing a big role in such activities.

In operations and also from a manufacturer's perspective, the term "value-added" classically is simply defined as the full cost of goods manufactured minus the variable material costs, the variable external production costs, and a part of the general fixed manufacturing costs (Schönsleben, 2003). This is a pure cost perspective. But this approach does not necessarily reflect the customer's point of view, because there might be processes during the production, which he considers as unnecessary and do not "add value". Additionally, the value the customer assigns to a product, i.e. the price he is willing to pay, might completely differ from the pure production perspective. Especially in the area of services, this approach obviously is not feasible. So approaches from the areas of finance and marketing need to be taken into consideration.

2.4.1 Description of current approaches to quantify the value-added

In literature, there can be found several approaches for the representation of the value added:

- Lifecycle cost model
- Business value approach
- Value equations approach
- Economic Value Added
- Point of Value approach

In the following, these approaches will be described.

The Lifecycle Cost model

The lifecycle cost (LCC) model (e.g. by Lay, Radermacher, 2004; Nagle, Holden, 2002; Thompson, Cow, 1997; Thompson, et al., 1994) tries to provide a basis for evaluating different options of investments in fixed production assets. It recognises that a capital good leads to several kinds of expenses through its lifecycle, namely the selling price, plus costs for handover, quality, operation (e.g. energy consumption, wear, and tear parts), maintenance, and disposal. By taking values from experience and/or from the supplier of the machine, a customer can calculate the expected total lifecycle costs and therefore compare different alternatives.

This model is also used in the environment of industrial services, but only when the supplier of a machine wants to communicate to the potential customer why he should buy the machine in combination with additional services. This can be for instance a preventive maintenance service, which on the one hand increases the investment costs, but lowers the costs in the areas of quality and reactive maintenance, leading to lower LCC. Using this approach, the perceived value of the product, here the machine and the corresponding service, can be increased.

However, this approach focuses on the decision-support before investing in capital goods and simplifies dynamic aspects during the lifecycle. Furthermore, it only applies to capital goods

providers, but not to pure service providers.

The Business Value (BV) approach

The business value approach is a discounted cash flow model, calculating the net present value (NPV) of not only tangible, but also intangible factors. It focuses on the whole organisation and evaluates the value of the company trying to quantify its present and future cash flows. For this, it calculates the NPV of the company's assets, the chances for growth and the likely (future) profits, as well as of the possible increases of efficiency in processes and organisation. Detailed descriptions of this concept can be found in Walters, et al., (2004).

The BV approach is used for management and investment decisions. Although it would be possible to integrate the impact of industrial services on for instance efficiency improvements, it would be hard to quantify the value-added. This is because it is hardly possible to define the right future potentials, especially when compared to the situation in which the customer does the provided service activities on his own. Additionally, the NPV concepts always have the strong weakness that it is hard to define correct discount rates and estimate the right future cash flows.

The Value Equation (VE) approach

The traditional exchange theory states that an organisation will only enter into an exchange, when it anticipates that, by so doing, its needs will be satisfied. This anticipation of satisfaction is a necessary condition for an exchange to occur (Blois 2003). Day (1999) further developed this understanding and defined the customer value equation, which is Vc = Bc – Cc, with the perceived value (Vc) of making the exchange, the perceived benefit (Bc) and the perceived life time costs (Cc) arising from making the exchange. A customer only realises an exchange when his perceived benefit is greater than the perceived costs for doing the exchange, meaning the exchange provides a positive value. A product is the object of the exchange, being a bundle of attributes. Perceived benefits are for example reduced operating costs or reduced working capital. Perceived life time costs comprise ordering costs, purchase price, set-up costs, operating and maintenance costs, financing costs, and disposal costs.

Blois (2003) extends this understanding in renaming the term "costs" to "sacrifices", in order to enlarge the focus from an only monetary perspective to also intangible elements like a performance improvement. This enlargement makes it feasible for the domain of industrial services, which focus exactly on performance improvements, and would also be found in the sacrifice element of the customer, because services are collaborative, i.e. contain strong intangible elements.

The suggestion of Blois (2003) even goes a step further. He argues that a supplier should also be clear about the customers' value equations, in order to obtain insights into how it might create increased value for its customers, and to understand how customers perceive their value equation.

Additionally, the supplier should build its own value equation, which would be Vs = Bs – SAs, with Vs being the perceived value of making the exchange, Bs being the perceived benefits of supplying a specific customer and SAs being the perceived life cycle sacrifices of supplying the product or service. Examples of perceived benefits are the purchase price, reputational effects of being associated with the customer, and access to a market. Perceived life cycle costs comprise costs of "production" and delivery, service and servicing costs, financing costs, disposal costs, or restraints on the choice of customers resulting from the contract.

The VE approach implies that the values of benefits and costs are known and already

quantified. Blois (2003) comments on this by saying, "to the supplier how the customer interprets value does not matter as long as the supplier has an understanding of what that interpretation is", meaning that the supplier must define this value in "the customer's terms". But he does not provide an idea on how to do this.

The Economic Value-added (EVA)

Coming from investment theory, the "economic value-added" (EVA) approach wants to quantify the value of a company or a project from the perspective of the shareholders (e.g. Ehrbar, 1999, and Biddle, et al., 1998). The approach is based on common numbers used in financial reporting and is widely accepted in practice. It defines the value basically as the net operating profit after taxes (NOPAT) minus the weighted average costs of capital (WACC) times the net operating assets (NOA), i.e. EVA = NOPAT - (WACC * NOA). The value therefore is the earned cash, which can be distributed to the shareholders or be reinvested in their sense. Although this approach enlarges the pure cost perspective to the profit gained with the produced goods, current literature does not provide valuable insights on how to quantify operational performance into the EVA. It takes only the high level, static numbers from the financial reports. When it comes to the evaluation of an offered industrial service like the maintenance of a fixed production asset, it is again hard to come to a valuable result.

A way to transform supply chain performance data into the EVA was presented in the concept of the supply chain design decomposition (SCDD) by Sennheiser (2004) and Schnetzler, et al., (2007). This approach develops a hierarchical set of performance indicators according to different strategic target areas and on the basis of the processes of the Supply Chain Operations Reference (SCOR) model, with the top hierarchical element of the EVA. The SCDD aims at collaborative environments with the possibility to measure inter-company wide processes and gives hints on means to improve the performance and, because of the hierarchical structure, finally increasing the EVA. However, it provides no quantification of the change in the EVA, for it only allows a qualitative hint on the effect on the EVA.

The advantage of the SCDD is the very comprehensive approach. When it comes to industrial services, it would be possible to define the areas of where the service would improve the supply chain performance, but the direct link of its impact to the EVA is difficult to show, since the interdependencies are decomposed. Additionally, it allows only for qualitative hints on the impact on the EVA.

The Point of Value (POV) approach

A further cash flow oriented approach is presented in the "point of value (POV)" approach as described in (Groth, et al., 1996a; Groth, et al., 1996b; Byers, et al., 1997a; Byers, et al., 1997b). This approach introduces the separation of the capital cycle from the operating cycle, where the capital cycle represents the transformation of cash flow to fixed assets. Therefore, the cash cycle is the enabler of the operating cycle and produces no value-added. This is done only during the operating cycle, where the production takes place and the product is sold. The cycle starts with an investment of cash in work and labour. The product is produced, represented by work in process and the finished goods inventory. The point in time the customer buys the product is the point of value (POV). Cash comes in via the accounts receivables, which might be delayed from the POV. At this stage, the value is transformed back to cash. The operating cycle time defines the speed of the transformation process. The understanding of the generated value is that, from the selling company's perspective, value is only created when all of the following occurs (Groth, et al., 1996a):

- Customers buy the products/services and realise fulfilment.

- Customers pay for the product/service.
- After covering all costs, the return remaining for the providers of capital is greater than the required rates of return or, greater than the "cost of capital".

Every time the operating cycle is run through fully, a value is generated. It is now easy to understand that, the shorter the operating cycle, the more value is generated in a given period of time. This indicates that improved performance of production assets, which results in shorter lead times, provide value-added to the shareholders of the company via the operating cycle. Imagine also a reduction of fixed costs during production because of a better performance of a fixed asset, e.g. through preventive maintenance, which results in eliminating down times and decreases idle capital invested in the operating cycle. The costs of labour are decreased, which increases the contribution margin of every product sold, and therefore increases the value generated. The following figure displays the operating cycle according to Groth, et al., (1996) and lists effects of industrial services on it.

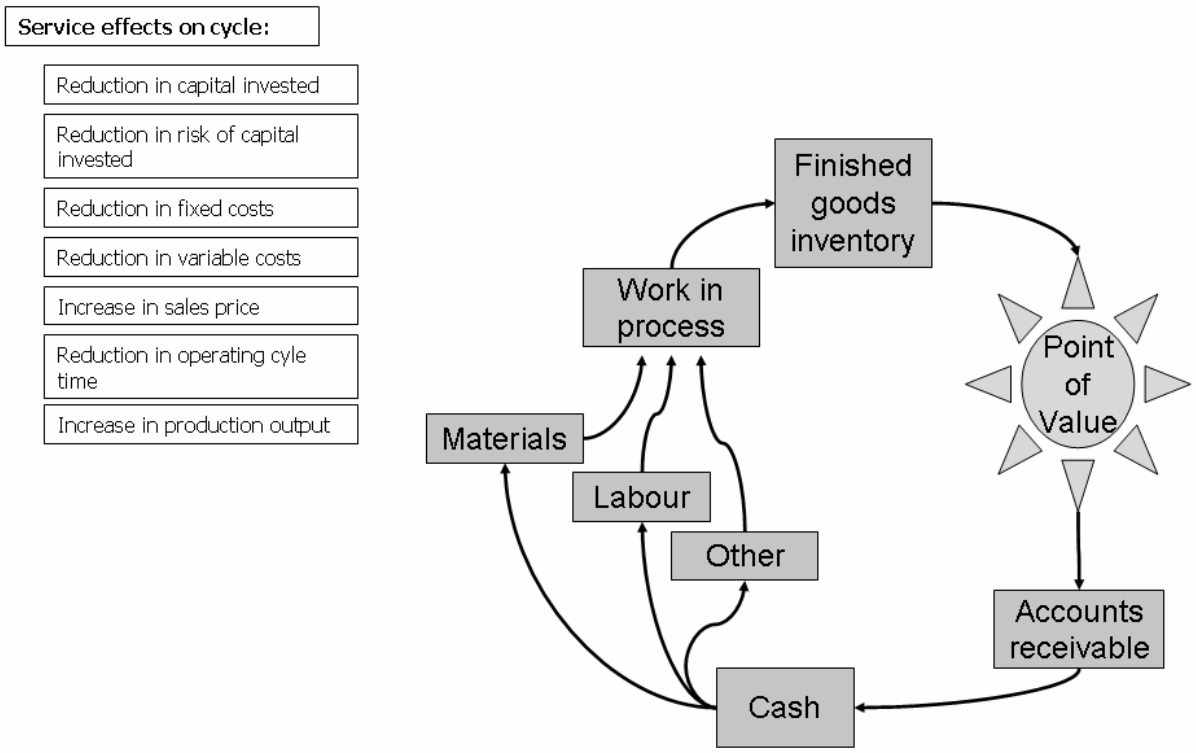

Figure 2-2: The operating cycle and corresponding effects of industrial services

Examples of such industrial services, which provide effects on the operating cycle, are maintenance services, operation of production lines, packaging, or logistics services such as vendor managed inventory. These services support in assuring the reliability of the operating cycle. Errors in production or anywhere in the cycle have disastrous effects on efforts to create value. A fault during production destroys the prospect of recovering invested costs through sales and collection (Byers, et al., 1997a).

So when the price the customer has to pay for these services is lower than if he would do it on his own, but the performance stays the same, or the performance is improved with the same costs, value is generated. The capital employed in the operating cycle is lowered and the contribution margin is increased.

One option to also increase the value generated is to shorten the payment horizon, namely the

period between the customer buys the product and pays for it. The lead time of the operating cycle is shortened, and the invested capital works more often during a given time period, adding value every run. Here it is important to understand, that this is true from an individual perspective. But considering a supply chain, a shortening of the payment cycle for the customer on the one hand decreases the cycle time of the producer, but at the same time extends the cycle for the customer, leading to a decrease in generated value in his cycle. So when focusing on collaborative environments and with a real supply chain management perspective, the only sustainable option to increase the generated value for the whole chain is to shorten the lead time from production to the point of value, which means shorter production lead times, a decrease of work in process, and a higher stock turnover rate.

Summarizing the POV approach seems to be feasible for a quantification of value generated in manufacturing environments. It is a very easily understandable concept. It offers the opportunity to show a very direct link of improved performance in the operating cycle to the cash flow, given that the performance data is available in the right format and shape.

2.4.2 Proposed methodology for measuring the customer benefit

The presented approaches for measuring the customer benefit have in common, that no one for itself is powerful enough to fulfil the needs to provide an idea about the customer benefit in a form that it can serve as a basis for defining a price, which is considered as fair from both service provider and customer. Either the approaches provide qualitative hints about the benefit or they assume that the impact of a service on the customers' processes is known. Especially the latter is hard to achieve in such a collaborative environment.

So we want to propose a combined approach, in order to employ the strengths of each proposed concept and to assure not only an appropriate measurement of the benefit, but also finally bring it into an easy to understand and communicate form. The proposed approach, which we want to name the "Service Value" (SV) approach, is as follows:

1. Define value equations (VEs) from both perspectives. The customer's VE should be developed jointly.
2. Transform the identified elements from the VEs into the operational cycle form from the point of value (POV) approach, using real data. Use exemplary data for the customer's POV if necessary.
3. Take performance data coming from an appropriately designed performance measurement system (PMS) for visualising the changes in the POVs.
4. Transform the changes in the POVs back into the VEs.
5. Use the new VEs as basis for marketing, pricing, and negotiation aspects.

The first two steps in defining the service value are the most critical ones. From the service provider's perspective, it is very important to include the customer as much as possible at this stage. Both parties have to be clear about the areas, where value is generated through the service, i.e. what the benefits are in the VEs. In the terminology as described in section 2.2 this represents the first steps of the "Design" phase of a PMS, where the "Value Creation Areas" need to be identified.

The second step is the transformation of the VEs into the form of the POV approach. Again, the service provider needs to include the customer as much as possible in order to display his POV as correct as possible, and to get correct values for the different steps in the operating cycle. When there is no possibility to get values from the customer himself, the service provider should use exemplary data, which is as realistic as possible and matches to the

situation of the customer. Using the VEs the points in the cycle where the service has an impact on can be easily identified. The InCoCo-S Reference Model (IRM) serves very well at this step, because the processes can be easily assigned to the different phases of the operating cycle.

For measuring the extent of the impact of the services on the identified elements of the operating cycle in the POV form, performance data is needed. This performance data, and therefore the used performance measurement system, plays now a crucial role in the SV approach. Especially when it comes to industrial services, current PMS do not provide all necessary data to completely cover the aspects arising from the collaborative character of the activities. At this stage our SPMS, which was especially designed for industrial service operations, enters the scenery. It comprises both the customers' and service providers' perspectives, and emphasises the collaborative character of services by including performance indicators measuring the quality of interaction processes. It also differs between indicators for service activities, which represent mainly the service providers' perspective, and indicators measuring the service object, e.g. the performance of a machine or a production process. The service object is the element of the customer, which is being serviced by the service provider. With this distinction the indicators can be easily assigned to the elements as defined in the first steps of the SV approach, even rather intangible aspects. Through the assignment of the process to the phases in the operating cycle it is now also very easy to assign the performance indicators (PIs) of the SPMS to these phases, because the PIs are assigned to the processes of the IRM.

Using real or historic performance data the impact of the services on the identified areas in the operating cycles can be assessed and quantified. These values are then being transformed and aggregated to the very simple value equations, which show the benefits and sacrifices of both customer and service provider in a very aggregated but tangible manner. The according POV sheets can always be taken for a detailed argumentation between customer and provider, if needed.

The Service Value approach combines the strengths of two established concepts, the Value Equation concept and the Point of Value approach, with the newly SPMS. The link to the comprehensive SPMS solves the weakness, that appropriate performance data for assessing the impact of industrial services in all aspects and in all areas of the customers' production processes was missing so far.

2.4.3 Discussion of the proposed methodology

However, there are some aspects which have to be considered. One is arising from the system dynamics perspective. For production systems are very complex systems, it is hard to identify all influencing factors on their performance. Although within the SPMS interaction parameters are defined, these interdependencies are hard to capture especially in collaborative environments. Just imagine a service technician of the provider working on a machine for a longer period of time directly at the customer's site, maintaining the reliability of the production asset. He might have had success in increasing the quality through lowering the amount of scrap, but what if the customer becomes careless in the production steps before that specific machine? This might have a strong negative effect on the quality of the considered production step. Although measuring this influence should be part of the SPMS, when appropriately designed and implemented, this information might be not available. Another typical example is a service on machine availability, which was increased during the run-time of a Service Level Agreement (SLA), but without an embedded engineer. It might be the case that the customer has trained his machine operators during that period. What were now the particular contributions to the increased availability of the service and the increased

level of education of the customer's personnel?

Summarizing, the Service Value approach can provide valuable results and hints on the generated value at the customer's production site. Its benefits are the simple and easy to understand tools and methods, which provide measurements of a high quality. The needed input data can be mainly taken from existing figures coming from financial reporting, cash flow analysis, and production performance. Interaction metrics are provided by the SPMS. However, it is still a simplification of practical situations with its complex interrelations. In the further activities of InCoCo-S, the concept will be further evaluated and validated.

2.5 Market pricing with reference to customer benefit and service operating costs

One aim in T4.2 was to develop a method or tool to support pricing decisions in new service environments. A basis for this was developed in T2.4, in which a methodology for calculating service operating costs was presented. In implementing this methodology, e.g. through an IT-tool, the service provider has the needed transparency on his service operating costs, so that he can avoid an under-pricing of services. The second basis for an appropriate pricing is transparency on the generated benefit for the customer. A large step towards the achievement of this goal is the "Service Value" methodology as presented in the preceding chapter.

Having transparency on these two aspects, the service provider is in the position to define the setup and conditions of new, more comprehensive service offers, without the risk of unprofitable offers. Whenever possible, this set of information is supplemented by information on the prices of competitors, although it is not necessarily the upper benchmark.

It is pretty obvious though, that by knowing one's own costs, supplemented with the knowledge on the value contribution by the service, negotiations with customers can be put on a very strong basis. Especially when there are competitors who are cheaper, the information about the generated value-added can serve as an argument for a higher-priced, but more powerful service contract.

However, every parameter relevant for an exact pricing can hardly be taken into account, considering that there are sometimes very specific, individual agreements between suppliers and customers, or strategic aspects when quoting to an important or new customer. Hence, any methodology providing transparency on costs can only support the quotation process, and the calculated prices always have to be reviewed by the responsible employees.

2.6 Simulation of correlations among PIs - Outlook on Task 4.3

Task 4.3 (Interdependence between the Performance Measures in service – supply chain) requires that causal links be determined between individual performance indicators (PI), identified in Tasks 4.1 and 4.2. This section outlines the requirements in support of work to be undertaken in Task 4.3.

Input

Task 4.3 will take, as input, the process repository and interaction diagrams for each cluster (DL 2.6) together with the PI's developed for each service cluster in DL 4.2.

Output

Task 4.3 will combine the process models with Performance Indicator's and use the causal tracing capabilities of the Vensim software to create causal trees for qualitative analysis of the connectivity between processes and the hierarchy of performance indicators. Weights of causal importance will be allocated to each PI throughout the hierarchy to enable sensitivity analysis of the impact of level 3 PI's on top-level PI's

Approach

The System Dynamics (SD) software tool, Vensim, is to be used in the development of correlation between previously isolated PI's. Vensim has powerful causal analysis and sensitivity tools including Causal Tracing™ using causes trees (see example at Figure 2-3). A hierarchy of individual performance indicators will be identified and mapped in the Vensim software, providing a causal link between high-level PI's and those at the process level (level 3).

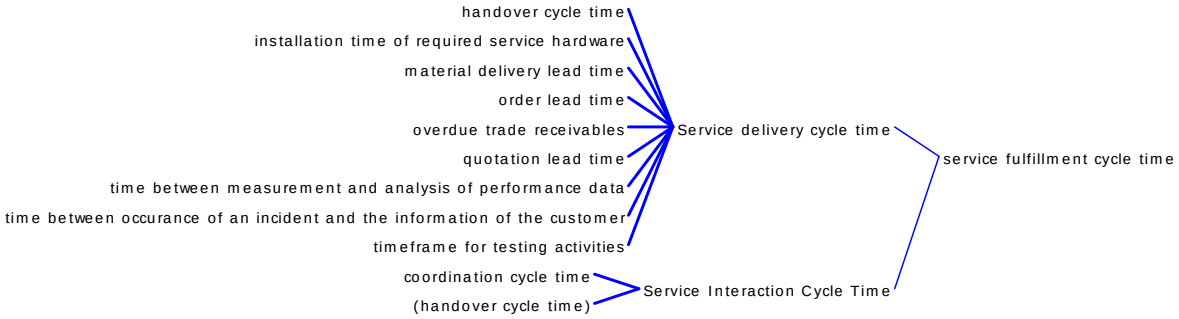

Figure 2-3: Example Causal Tree from Vensim

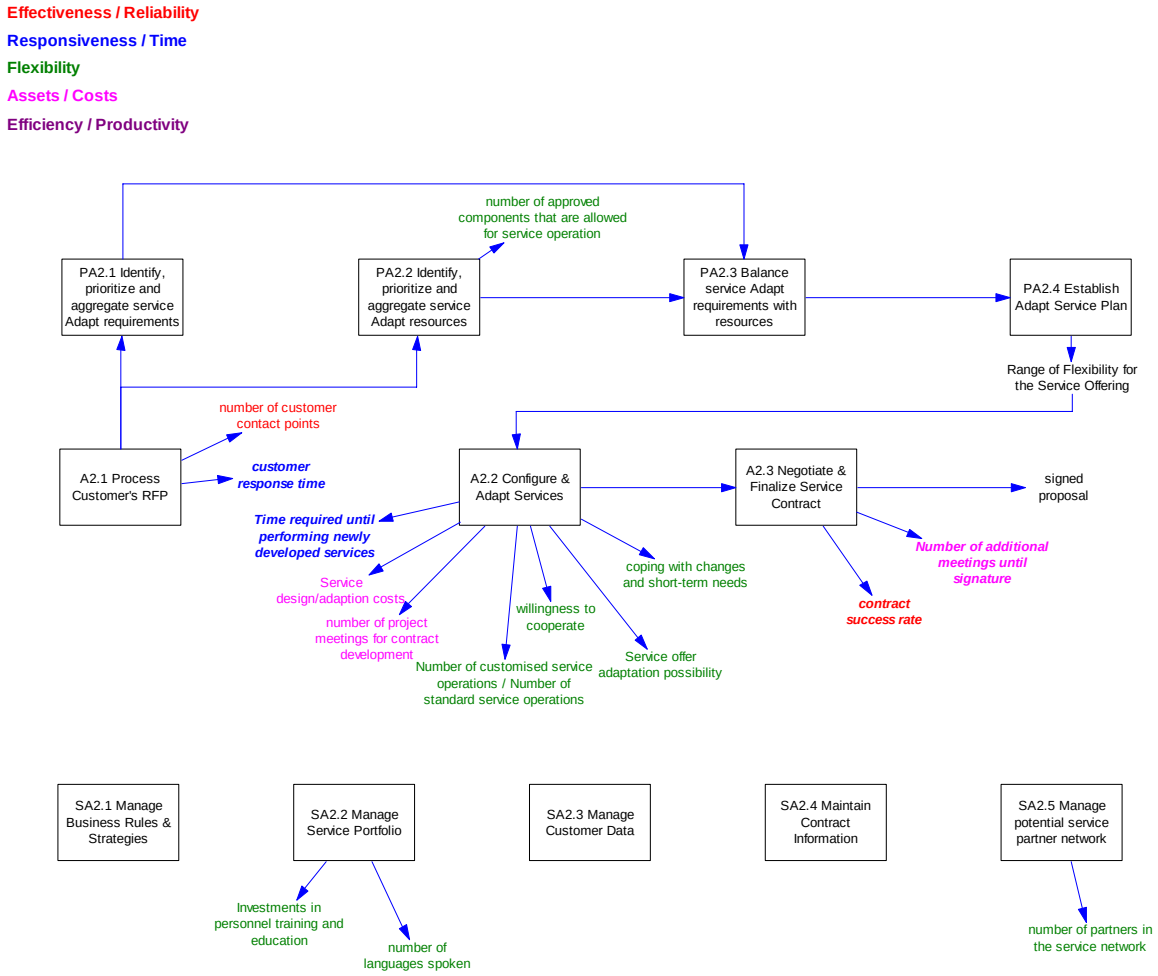

Figure 2-4: Processes represented in Vensim

In Figure 2-4, an example (packaging cluster) of processes with level 3 performance indicators is shown. This diagram can then be used to identify further linkages between PI's, for example, between level 3 PI's of related processes.

Figure 2-5 shows a Vensim diagram indicating causality between PI's from level 1 through to level 3 (left to right in the diagram). Level 3 PI's are measures of performance of level 3 processes, exemplified here by the process *A2.2 Configure and Adapt Services*.

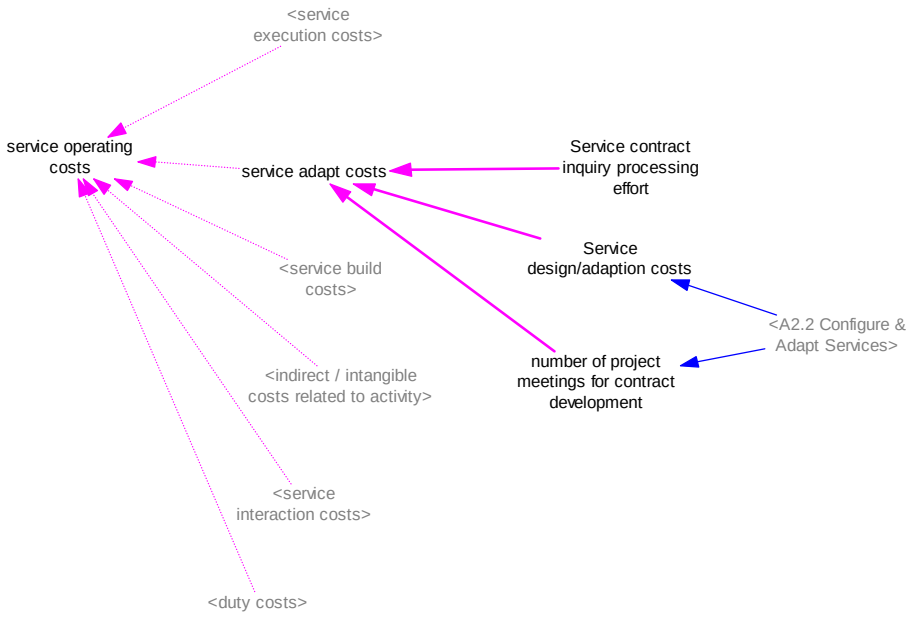

Figure 2-5: Causal relationships represented in Vensim

Once the hierarchy of PI's has been determined (example at Figure 2-6), the relative weight of impact on the next highest level in the hierarchy will need to be elicited from domain experts. This will be part of the validation phase in Task 4.4. In the example, the impact of the level 3 PI's (*warehouse picking accuracy, inventory accuracy* etc) will be aggregated to the level 2 PI *service operating output quality* by applying relative weights of importance on each of the 5 level 3 PI's contributing to this level 2 PI. In turn, the level 2 PI's will be aggregated to the level 1 PI *service operating reliability* by applying relative weights to each of the 4 level 2 PI's shown. Once all weights have been added, sensitivity analysis techniques will be used to indicate a first-cut relative importance of improvements in PI's at level 3 on higher level PI's. More detailed analysis of the impact of improvements of level 3 processes will be undertaken using simulation in Task 5.2.

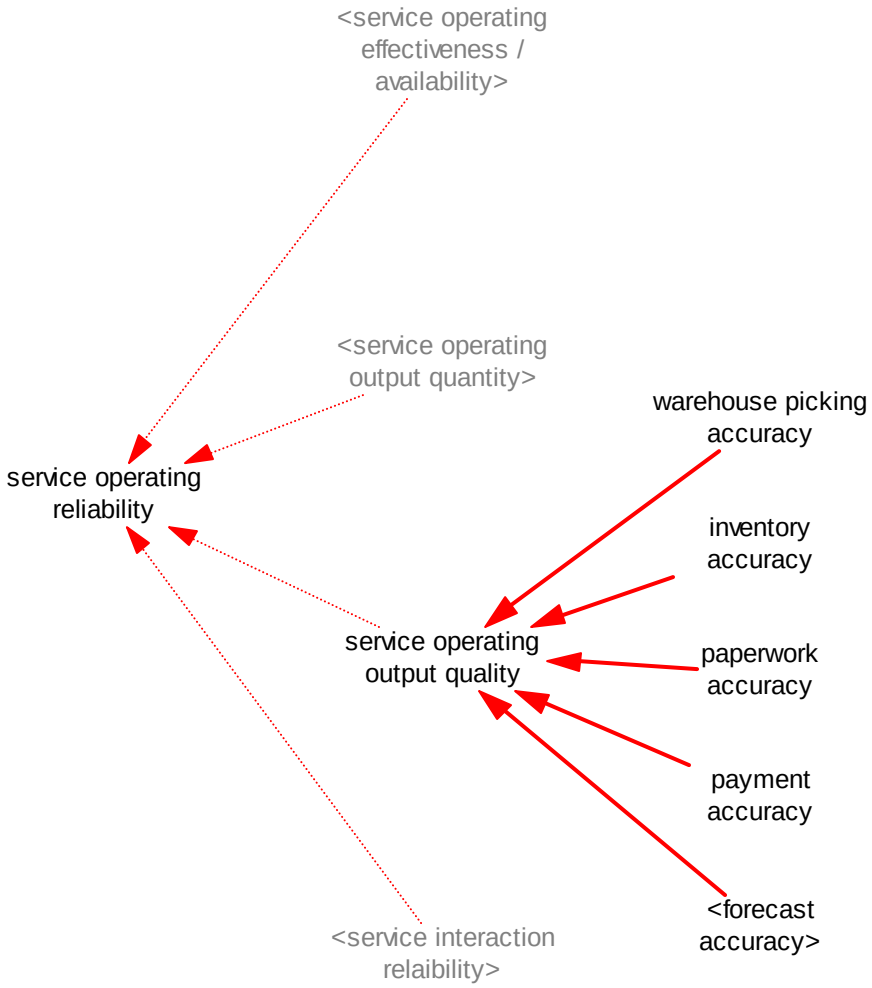

Figure 2-6: Hierarchy of Performance Indicators

Goals

- Visualise the interdependencies among Performance Indicators on different levels by using the underlying service processes and corresponding PI's.

- Indicate sensitivity of high-level PI's to changes in the performance of level 3 PI's through the use of sensitivity analysis.

The hierarchy of indicators and relative weights of impact throughout the hierarchy will be used to help determine the scope of the simulation models to be developed in Task 5.1 and the subsequent experiments with the models in Task 5.2.

3 Development of the SPMS

As mentioned in chapter 2 the research methodology incorporates the principles of action research, which consist of involvement of industrial partners through workshops, transfer of results into practice by implementation of prototypes, and a structured research process. The research process comprises first an analysis of requirements in theory and practice by means of a literature review (desk research) and industrial workshops at the partners of the InCoCo-S project. In section 3.1 a detailed goal catalogue is presented, developed from the general requirement catalogue already described in Deliverable 4.1.

Based on these results, a concept for performance measurement in the domain of industrial service operations has been developed. Within section 3.2 the design of the service performance measurement will be described in detail.

In close cooperation with industrial partners, relevant performance indicators (PIs) as an essential part of the system have been identified. Section 3.3 gives an overview of the PIs which are structured by different dimensions, target areas and different perspectives on the service activities.

3.1 Detailed goal catalogue for the SPMS

Based on literature research and industrial requirements, key design features and goal definitions for an effective SPMS have been identified and are presented in Table 2.

Goal	Description / Goal property	Goal category
Hierarchical approach	Whenever possible, the factors of the SPMS should be decomposed hierarchically into a practical level of detail.	technical
Mapping of causal chain/ Interdependencies among the PIs	The SPMS shall illustrate connections between the PIs and are linked to each other.	technical
Integration of subjective and objective measures ("soft" and "hard" measures)	SPMS should content both subjective and objective performance metrics (e.g. subjective measures for customer satisfaction, perceived quality). The "soft" measures should be quantifiable by objective PIs.	functional
Different perspectives: customer view, interaction view and internal view	SPMS should include different perspectives and provide PIs on different perspectives. The internal needs of service providers (internal view) and the external needs of customers (customer perception) as well as the interaction view between customers and providers (service encounter interface) should be measured and assessed in the SPMS.	functional
Process orientation / flow orientation	The SPMS should integrate internal processes of service providers (e.g. adapt, source, make, support). Furthermore, specific PIs should be assigned to different service clusters on the lower level of SPMS and be integrated along the specific supply chain processes of service providers.	functional
Adaptability / Modularity / Customisation	The SPMS should be adaptable to various company`s requirements and to different service clusters facilitating the assignment of specific PIs on the lower levels.	technical / strategic

Flexibility / Extensibility	The SPMS should be flexible and have a dynamic character that ensures agility and responsiveness of the system to the specific needs and environment of the company. Firm specific Performance Indicators could be added and integrated into the existing SPMS at lower levels (e.g. at 3rd and 4th level).	technical / strategic
Pre-configured standardised performance metrics	The SPMS should be pre-configurable to a certain extent on the upper levels (1st level and 2nd level). A system of generic standardised metrics provides selection support (that means SPMS helps in selecting the right metrics given a certain target within a specific environment).	technical / strategic
Limited number of PIs	To create appropriate action, it is necessary to use a limited number of performance measures. More measurement demands more analysis time and increases the risk of information overload – it becomes difficult to know which performance measures should be prioritised.	technical
Transparency	The SPMS should enable transparency between customers and service providers.	functional
Accountability	The PIs contained in the SPMS shall be quantitative and if not, a common understanding of the assessment should be established.	functional
User-friendliness	The SPMS should be designed in a way that information is easily retrieved as well as easily understood by those whose performance is being evaluated.	functional
Combination of bottom-up and top-down approach	The SPMS should integrate top-down approach (based on the general literature review and best practices) and bottom-up approach (based on specific company`s needs, surveys, interviews and workshops) that ensure practical applicability of the SPMS. Both strong-aggregated standardised PIs on the 1st level of SPMS should be integrated into the single less-aggregated PIs on the 2nd and 3rd levels.	tactical / strategic
Support strategic, tactical and operational objectives	The SPMS should support strategic, tactical and operational objectives of a service provider. The top level Performance Measures are strong aggregated PIs (e.g. service operating reliability, service operating	tactical / strategic

	cycle time) whereas lower levels include specific PIs provided by shop floor engineers and operators (e.g. direct labour costs, energy consumption, number of project meeting of contact development)	
Multidimensional target areas / Value drivers	The SPMS should consist of several target areas that deliver value for the customer and service provider (e.g. quality, flexibility, cost, time, productivity)	tactical / strategic
Different view on services	The SPMS should distinguish between service object and service activity and provide specific PIs for each service element (e.g. service object flexibility, service activity flexibility, service object availability, service activity availability etc.)	
Measurement of value added for the customer	The SPMS should be able to measure value added for the customer based on "hard" objective PIs and "soft" but quantifiable PIs (e.g. cost savings, ability to focus on core activities for the customer, high quality output, improved productivity, time savings)	

Table 2: Goal catalogue for the Service Performance Measurement System (SPMS)

3.2 Design of general SPMS

Based on the goal catalogue, the SPMS was developed. The SPMS can be illustrated by using a cube presented in Figure 3-1.

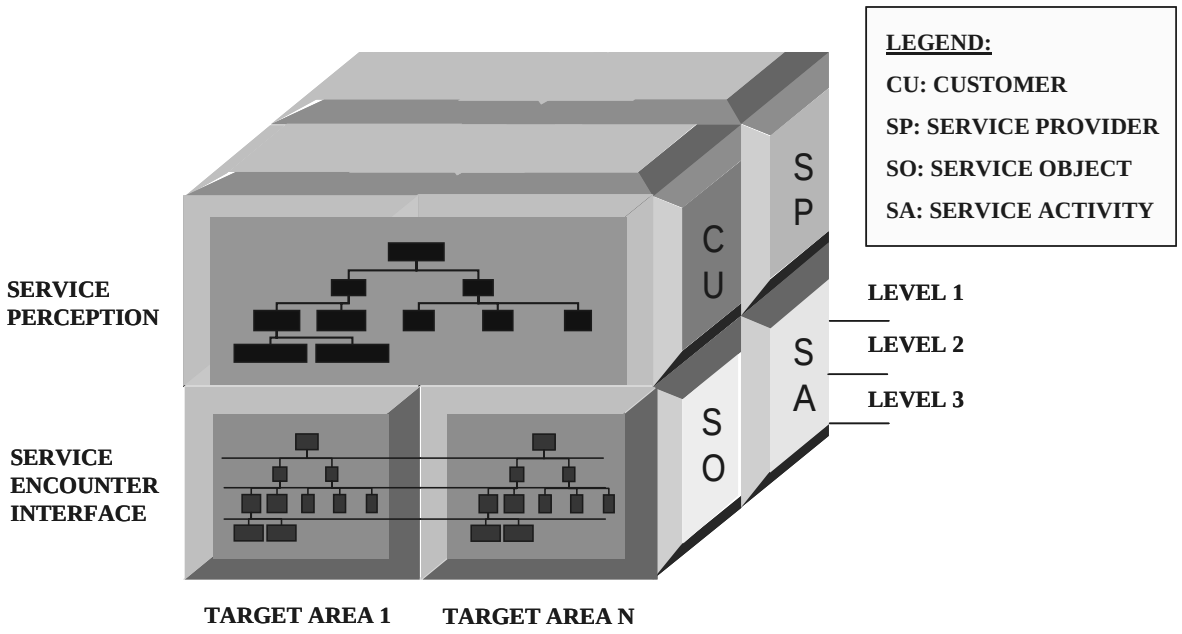

Figure 3-1: Design of Service Performance Measurement System (SPMS)

Industrial service operations are usually a result of the interaction between customers and the service provider, including the service staff, production data exchange, service equipment, service environment, and facilities. The cube is used to illustrate different dimensions, target areas, and level of detail in regards to the PIs. The components will be discussed in the following sections. In the following sections the structure of the system is explained step by step.

3.2.1 Service Perception and Service Encounter Interface

As mentioned above, service often involves some form of coordination and interaction between the customer and the service provider. Considering that the customer perception could be different from the actual delivered service, some subjective PIs for the customer are integrated. The overall behaviour of the service provider for example influences the customer perception of service offerings. The basic idea is to have a dimension quantifying the gap between actual service operation performance based on objective measures and the perceived service operation performance from the customer's perspective. Both service provider's and customer's perspectives are interdependent and they form up an opinion about each others performance. In this dimension, the SPMS provides a comprehensive set of subjective PIs structured in a hierarchical way. Most of the PIs in the Service Perception dimension correspond with the PIs used in the additional Service Encounter Interface dimension. In contrast to the PIs in the Service Encounter Interface dimension, the evaluation in the Service Perception dimension results basically from the subjective perception of the customer and of the service provider. As a consequence, the Customer Perception and Service Provider

Perception is a function of the actual service operations performance measured objectively in the Service Encounter Interface dimension: Service Perception (CU, SP) = f (SO, SA) with SO = Service Object and SA = Service Activity, see below. As an enhancement of existing PMS the Service Encounter Interface is divided into the sections service activity (SA) and service object (SO) as illustrated in Figure 3-2.

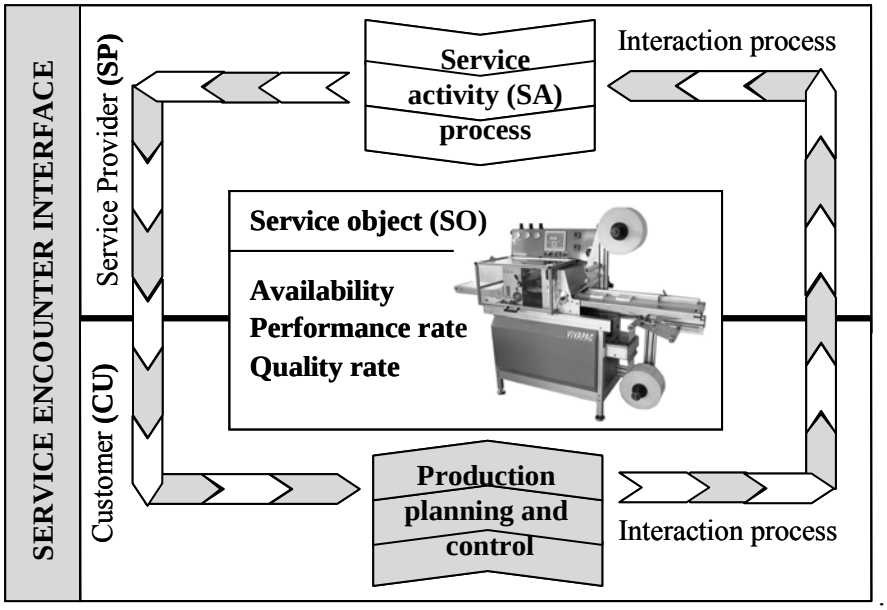

Figure 3-2: Service activity and Service object within the Service Encounter Interface

In the following, the two perspectives on the service activities are defined.

Service activity (SA) relates to all process steps to be taken to fulfil the specified level of service; e.g., alignment of required production capacities and planned maintenance service or productivity consulting. The SA view is measuring how efficient and reliable the service offerings like maintenance, modernisation, and trainings are offered to the customer.

Service object (SO) refers basically to the element (process and/or object) in the customer's manufacturing supply chain that is being serviced. In reference to a production system, this implies the resulting condition of the service object (e.g., hardware, software, production process) required to guarantee a specified level of service object performance; e.g., increased availability of a packaging machine.

3.2.2 SPMS structured by target areas

In reference to the SCOR model, the differentiation in overall goals (target areas) helps in selecting specific PIs according to the companies strategic goals. In the dimension Service Encounter Interface, the SPMS contains five target areas which are defined below referring to Chan and Qui (2003):

Service effectiveness/reliability (quality): These PIs relate to the ability of SA and SO to achieve an intended or agreed service operation level or availability. Reliability refers to the ability of SA to perform a required operation under stated conditions for a stated period of time.

Service responsiveness (time): These PIs reflect the time between the beginning and completion of SA and measure time related to the service object (e.g., set-up time).

Service flexibility: These PIs provide the basis for measuring the ability of SA and SO to adapt to changing requirements.

Service assets (cost): These PIs highlight the financial expense to carry out SA and run the SO.

Service efficiency/productivity includes relative PIs measuring static PIs in relation to time and costs and shows how efficient the resources are being used in transforming inputs to outputs.

3.3 Performance indicators within the SPMS

The SPMS consists of approx. 200 PIs structured by the mentioned dimensions, target areas, and three different levels of details. In reference to SCOR, each target area is providing a hierarchical tree of generic PIs on level 1-3. Level 3 PIs are representing the service operation performance in accordance to reference service operation processes developed in InCoCo-S.

After having introduced the structure within the SPMS Figure 3-3 gives an idea how the PIs as the essential element are integrated in the system.

		1st level	2nd level	3rd level	1st level	2nd level	3rd level	1st level	2nd level	3rd level	1st level	2nd level	3rd level	1st level	2nd level	3rd level
Target Area		**Effectiveness/ Reliability (Quality)**			**Responsiveness (Time)**			**Flexibility**			**Assets/ Costs**			**Effectivity/ Productivity**		
Service Perception		PI_1	PI_{12}	PI_{123}	PI_2											
						S	E	R	V	I	C	E				
					P	E	R	C	E	P	T	O	N			
Service Encounter Interface	Service Activity (SA)	PI_{SA1}														
						S	E	R	V	I	C	E				
						A	C	T	I	V	I	T	Y			
	Service Object (SO)	PI_{SO1}														
						S	E	R	V	I	C	E				
						O	B	J	E	C	T					

Figure 3-3: Structure within the SPMS

In order to get a better understanding of the underlying differentiation between SA and SO in the dimension Service Encounter Interface, some PIs are described exemplarily within the dimension Service Encounter Interface (see Table 3 and Table 4).

TARGET AREA: Service effectiveness/ reliability (quality)		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***
Service Operating Reliability:	Service Operating Effectiveness/Availability	Material availability, Quality of material used, personnel availability, IT availability, Number and probability of late services performed, Number and probability of backorders, on-time service operations and deviations, Number of additional unscheduled trips, Number of partner contact points, Average availability of service at point of consumption, partner performances, market share

TARGET AREA: Service responsiveness (time)		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***
Service Fulfillment Cycle Time:	Service delivery cycle time (if initiated by order/signal)	Order lead time, Quotation lead time, Material delivery lead time, handover cycle time, Overdue trade receivables, installation time of required service hardware, time between measurement and analysis of performance data, time between occurance of an incident and the information of the customer, timeframe for testing activities

Table 3: PIs on three levels focusing on service activity (SA) (examples)

The following set of example PIs refer to the service object (SO):

TARGET AREA: Service effectiveness/ reliability (quality)		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***
Service Object Reliability:	Service Object Effectiveness/Availability	Adherence to schedule, Unscheduled Downtime, Scheduled Downtime, Effective run-time
	Service Object Output Quantity	Nominal output, Setup output, Effective output, Operating output, Downstream capacity, Upstream input

TARGET AREA: Service responsiveness (time)		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***
Service Object Production/Operating Cycle Time:	Production/operation lead time	Setup time
		Run-time (nominal run-time, setup run-time, effective run-time, operating run-time)

Table 4: PIs on three levels focusing on service object (SO) (examples)

The Service Perception dimension contains all corresponding PIs from the Service Encounter Interface dimension in the particular target areas as exemplarily presented in Table 3 and Table 4. In addition some subjective PIs are provided. For instance, the first-level PI named "Perceived Service Quality" contains second-level PIs such as service credibility, service communication, service empathy, service accessibility and service security. These PIs are broken further down to third-level PIs, e.g. image, trustworthiness, honesty, appearance of personnel (service credibility) and sensitivity, problem solving capability, complaint handling behaviour (service empathy). A complete overview of relevant PIs in the SPMS is provided in Table 5, Table 6 and Table 7.

Overview of PIs for the Service Perception Dimension (1/2)

SERVICE PERCEPTION VIEW											
Effectiveness/Reliability (Quality)			**Responsiveness/Time**			**Flexibility**			**Assets/Costs**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Perceived Service Quality	*Service Operating Effectiveness/Availability*	*See encounter interface, plus corrective factor for perception*	Perceived Service Responsiveness	*Service delivery cycle time*	*See encounter interface, plus corrective factor for perception*	Perceived Service Flexibility	*Service Operating Flexibility:*	*See encounter interface, plus corrective factor for perception*	Perceived Service Costs	Service Provider's Invoice	
	Service Operating Output Quantity	*See encounter interface, plus corrective factor for perception*		*Service interaction cycle time*	*See encounter interface, plus corrective factor for perception*		*Service Adapt flexibility*	*See encounter interface, plus corrective factor for perception*		Reference Value	The reference value is the cost of whatever competing service the customer views as the best substitude for the service being evaluated
	Service Operating Output Quality	*See encounter interface, plus corrective factor for perception*		*Service object operation lead time*	*See encounter interface, plus corrective factor for perception*		*Service Build flexibility*	*See encounter interface, plus corrective factor for perception*		Differentiation Value	The added value is the increased level of economic value that the customer can expect from the service offered compared to the Reference Service
	Service Interaction Reliability	*See encounter interface, plus corrective factor for perception*		Promptness of service provider's reaction			*Service Operating Adaptability:*	*See encounter interface, plus corrective factor for perception*		Total Value Added	The total value is determined first and foremost by what customers` alternatives are. It is the custumers` best alternative plus the value of whatever differentiates the offering from the alternative. The total value also is the maximum price a buyer, fully informed about the market and seeking the best value, would pay
	Company's innovativeness	*See encounter interface, plus corrective factor for perception*					*Service Interaction Flexibility*	*See encounter interface, plus corrective factor for perception*		Sharable Value	The sharable economic value is the difference between the total value and the sellers` costs, which the seller can share with customers

Overview of PIs for the Service Perception Dimension (2/2)

Effectiveness/Reliability (Quality)			Responsiveness/Time			Flexibility			Assets/Costs		
Level 1 metric:	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*
	Service Object Effectiveness/Availability	*See encounter interface, plus corrective factor for perception*					*Resource adaptability to modifications of the service object production/operatio*	*See encounter interface, plus corrective factor for perception*		Willingness to pay	The perceived value of a product is the maximal price the customer is willing to pay for the total bundle of benefits the service delivers
	Service Object Output Quantity	*See encounter interface, plus corrective factor for perception*					*Resource flexibility in service operations*	*See encounter interface, plus corrective factor for perception*			
	Service Object Output Quality	*See encounter interface, plus corrective factor for perception*					*Service Object Production/Operating flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity*	*See encounter interface, plus corrective factor for perception*			
	Service credibility	image, trustworthiness, visibility/transparency, honesty, appearance of personnel					*Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30*	*See encounter interface, plus corrective factor for perception*			
	Service accessibility	Accessability convenience, approachability									
	Service security	Confidentiality, discretion, financial security,									
	Service communication	Provided information, appropriate language,									
	Service empathy	Sensitivity, problem solving capability, complaint									
	Service project management	Deviations of project plan, deviations from to-be to as-is									
	Customer Loyalty										

Table 5: Overview of PIs for the Service Perception Dimension

Overview of PIs for the Service Encounter Interface – Service Activity Dimension (1/2)

Effectiveness/Reliability (Quality)			**Responsiveness/Time**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Operating Reliability:	Service Operating Effectiveness/Availability	Material availability, Quality of material used, personnel availability, IT availability, Number and probability of late services performed, Number and probability of backorders, on-time service operations and deviations, Number of additional unscheduled trips, Number of partner contact points, Average availability of service at point of consumption, partner performances, market share	Service Fulfillment Cycle Time:	Service delivery cycle time (if initiated by order/signal)	Order lead time, Quotation lead time, Material delivery lead time, handover cycle time, Overdue trade receivables, installation time of required service hardware, time between measurement and analysis of performance data, time between occurance of an incident and the information of the customer, timeframe for testing activities
	Service Operating Output Quantity	Number of accurate services performed, Number of wrong services performed		Service Interaction Cycle Time	Handover cycle time, coordination cycle time
	Service Operating Output Quality	Warehouse picking accuracy, inventory accuracy, paperwork accuracy, Payment accuracy, Forecast accuracy,			
	Service Interaction Reliability	Information flow integration, availability of shared information systems, quality of shared information, number of customer contact points, number of required additional information			
Company's Innovativeness	New launches of services	New services launched in a time period, percentage sales of new services to whole service sales			
	Use of new technologies				
	New service performance accuracy	Percentage of wrong service performances after new service design is launched			

Overview of PIs for the Service Encounter Interface – Service Activity Dimension (2/2)

Flexibility			Assets/Costs			Efficiency/Productivity		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Activity Flexibility:	Service Adapt flexibility	Service contract inquiry success rate, Service offer adaptation possibility, number of partners in the service network	Service Activity Costs:	Service Adapt costs	Service contract inquiry processing effort, Service design/adaption costs, number/costs of project meetings for contract development, direct labour costs	Service Activity Cost Efficiency (= Service Operating Reliability / Service Operating Costs)	Average costs per correct service delivery	
	Service Build flexibility	Time required until performing new developed services, Number of additional contacts to customer/suppliers after contract signment		Service Build costs	Number/costs of conducted HW / SW tests, direct labour costs	Service Activity Input Efficiency (= Service Operating Reliability / Service Fulfillment Cycle Time or SA Input Quantity)	Average cycle time for correct service delivery, stock turnover	
	Service Operate Flexibility:	Number of customised service operations / Number of standard service operations, number of approved components that are allowed for service operation, number of containers, Service intensiveness flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity/intensiveness delivered)		Service Operate costs	Cost of material used, Transportation and handling costs, material inventory costs, waste/costs of materials due to out-of-specification operations, direct labour costs, travel and subsidy costs, number/costs of conducted analyses at partner's site, frequency/costs of data measurements, service equipment maintenance costs, number/costs of analyzed measurement points, number/costs of (planned) service activities	Service Activity Profitability (= Service Operating Costs / Total Service Costs)	Profit contribution (Deckungsbeitrag)	
	Service Operate Adaptability:	Service delivery adaptability (the maximum sustainable percentage increase in quantity/intensiveness that can be achieved in 30 days)		Indirect / intangible costs related to activity	Transaction costs, Administration costs, Incentive costs, Taxes, Service Quality costs, Service Adaptation costs, Performance Measurement costs, Productivity changes costs, wage changes costs, exchange rates costs, Core competence maintenance and improvement costs	Service Activity Time Efficiency (= Service Fulfillment Cycle Time / Average Service Fulfillment Cycle Time)	Productive hourss	
	Service Interaction Flexibility	Willingness to cooperate, coping with changes and short-term needs, number of partners in the service network, number of successful process changes coming from involved operational players		Service Interaction costs	Suppliers' margins, number and costs of service activities that are non-conformant, service re-work costs, handover costs	Reference Service costs	Differentiation value, reference value, total value added	
Service Resources Flexibility	Resource adaptability to modifications of the service object production/operation process	Workforce Map of Knowledge, Workforce degrees of expertise and know-how		Duty costs				
	Resource flexibility in service operations	Investments in personnel training and education, education level, number of languages spoken						

Table 6: Overview of PIs for the Service Encounter Interface – Service Activity Dimension

Overview of PIs for the Service Encounter Interface – Service Object Dimension (1/2)

Effectiveness/Reliability (Quality)			**Responsiveness/Time**			**Flexibility**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1***	***Level 2 metric:***	***Level 3 metric:***
Service Object Reliability:	Service Object Effectiveness/Availability	Adherence to schedule, Unscheduled Downtime, Scheduled Downtime, Effective run-time	Service Object Production/Operating Cycle Time:	Production/operation lead time	Setup time	Service Object Flexibility:	Service Object Production/Operating flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity produced)	Input flexibility, production/operation process flexibility, output flexibility, improvement flexibility
	Service Object Output Quantity	Nominal output, Setup output, Effective output, Operating output, Downstream capacity, Upstream input			Run-time (nominal run time, setup run-time, effective run-time, operating run-time)	Service Object Adaptability:	Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints)	
	Service Object Output Quality	Output product quality		Interoperation time	Waiting time			
					Inspection time			
					Transportation time			
				Administration time				

Overview of PIs for the Service Encounter Interface – Service Object Dimension (2/2)

Assets/Costs			Efficiency/Productivity		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1***	***Level 2 metric:***	***Level 3 metric:***
Service Object Production/Operating Costs:	Production labor costs	Direct labor costs, indirect labor costs related to activity and non-service related	Service Object Efficiency:	Service Object Reliability / Service Object Production/Operating Costs	Cost per operating hour, hourly cost rate when running, downtime losses
	Maintenance costs (if not outsourced)			Service Object Reliability / Service Object Production/Operating Cycle Time	OEE
	Material re-work costs			Operators' behavior	
	Production equipment charges	Energy consumption, leasing rate, depreciation, (operation hours, hourly cost rate when running)			
	Consumables costs				

Table 7: Overview of PIs for the Service Encounter Interface – Service Object Dimension

3.4 Description of KPIs

After having introduced the PIs on the first three levels, an assortment of level-one and level-two PIs will be described in detail by using a template. The template description is quite similar to the one used in SCOR V.8.0 (SCOR V.8.0, Appendix A pp. 434-510).

The descriptions will be taken as an input for the glossary of the complete IRM, which will be further elaborated in the upcoming activities of InCoCo-S. Because of this, not all elements of the template are filled out yet (shaded text) For instance, the interrelations of the PIs are still to be worked out in Task 4.3.

Position in SPMS	Dimension/ SA-SO perspective **Satisfaction / Perception of Customer regarding Perceived Service Quality**
KPI/ PI	**Level 1 Metric: Perceived Service Quality**
Metric definition	The costs that the customer observes for the services he has purchased. **Note:** ./.
Hierarchical metric structure:	
Level 1	Perceived Service Quality
Level 2	Service Operating Effectiveness/Availability Service Operating Output Quantity Service Operating Output Quality Service Interaction Reliability Company's innovativeness Service Object Effectiveness/Availability Service Object Output Quantity Service Object Output Quality Service credibility Service accessibility Service security Service communication Service empathy Service project management Customer Loyalty
Qualitative relationship description	Perceived Service Quality ≈ Function of Perception of Service Provider's Quality (Service Activity + Service Object)

Quantitative relationship description	---
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service offering, negotiation, building and operational are in the scope of the service
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	Level of Satisfaction / Perception as a range from Very Good to Very Poor
Frequency of measurement	*the frequency of recording and reporting of the metric* Yearly, Half Yearly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* Survey / Interview with the workshop can give an estimate of the customer perception about the service quality.
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	Satisfaction / Perception of Customer regarding Perceived Service Quality
KPI/ PI	**Level 2 Metrics Definitions**
Service Operating Effectiveness/Availability	A perception of the customer about the overall availability of the service provider for the customer to reach and request a service
Service Operating Output Quantity	A perception of the customer about the overall volume of services offered and operated by the service provider
Service Operating Output Quality	A perception of the customer about the overall quality of services offered and operated by the service provider
Service Interaction Reliability	A perception of the customer about the overall level of interactions and the reliability of such interactions and workplan between the customer and service provider.
Company's innovativeness	A perception of the customer about the innovativeness of the service provider in being proactive to offer new solutions and be innovative in all aspects of service offering and operations.
Service Object Effectiveness/Availability	A perception of the customer about the overall availability of the service object in terms of being operational / accessible
Service Object Output Quantity	A perception of the customer about the overall volume of output produced by the service object which is serviced by the service provider
Service Object Output Quality	A perception of the customer about the overall quality of the produced by the service object
Service credibility	A perception of the service provider's credibility in terms of adherence to the service contract, financial & reporting transactions etc.
Service accessibility	A perception measure about the overall accessibility of the service provider by means of number of contact points, access hours, reach ability etc.
Service security	A perception about the financial credibility for the service provider, confidentiality standards and breach of contract in these respects
Service communication	A perception about the number of communication channels being currently used by the service provider for mutual communication requirements.
Service empathy	A measure of the service provider's agility to adapt and offer services in un-clear operating conditions and un-timely working scenarios
Service project management	A perception about the overall structure of the project management aspects - roles of the team members, responsibilities, structure, work plan, adherence and reporting.
Customer Loyalty	A measure of the number of repetitive orders assigned to the service provider over a long term duration.

Position in SPMS	Dimension/ SA-SO perspective **Satisfaction / Perception of Customer regarding Perceived Service Responsiveness**
KPI/ PI	**Level 1 Metric: Perceived Service Responsiveness**
Metric definition	The responsiveness that the customer observes for the services he has purchased. **Note:** ./.
Hierarchical metric structure:	
Level 1	Perceived Service Responsiveness
Level 2	Service delivery cycle time Service interaction cycle time Service object operation lead time Promptness of service provicer's reaction
Qualitative relationship description	---
Quantitative relationship description	Perceived Service Responsiveness ≈ (Service delivery cycle time + Service interaction cycle time + Service object operation lead time) * Promptness of service provider's reaction
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service offering, negotiation, building and operational are in the scope of the service
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)

Equation	Method of calculation must be known
Derived unit of measure	Level of Satisfaction / Perception as a range from Very Good to Very Poor
Frequency of measurement	*the frequency of recording and reporting of the metric* Yearly, Half Yearly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* Survey / Interview with the workshop can give an estimate of the customer perception about the service quality.
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Satisfaction / Perception of Customer regarding Perceived Service Responsiveness**
KPI/ PI	**Level 2 Metrics Definitions**
Service delivery cycle time	*See encounter interface, plus corrective factor for perception*
Service interaction cycle time	*See encounter interface, plus corrective factor for perception*
Service object operation lead time	*See encounter interface, plus corrective factor for perception*
Promptness of service provider's reaction	---

Position in SPMS	Dimension/ SA-SO perspective **Satisfaction / Perception of Customer regarding Perceived Service Flexibility**
KPI/ PI	**Level 1 Metric: Perceived Service Flexibility**
Metric definition	The flexibility that the customer observes for the services he has purchased. **Note:** ./.
Hierarchical metric structure:	
Level 1	Perceived Service Flexibility
Level 2	Service Operating Flexibility: Service Adapt flexibility Service Build flexibility Service Operating Adaptability: Service Interaction Flexibility Resource adaptability to modifications of the service object production/operation process Resource flexibility in service operations Service Object Production/Operating flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity produced) Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints)
Qualitative relationship description	---
Quantitative relationship description	Perceived Service Flexibility ≈ Service Operating Flexibility*Service Adapt flexibility*Service Build flexibility*Service Operating Adaptability*Service Interaction Flexibility*Resource adaptability to modifications of the service object production/operation process*Resource flexibility in service operations*Service Object Production/Operating flexibility*Upside SOURCE/MAKE/DELIVER adaptability
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service offering, negotiation, building and operational are in the scope of the service

Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	Level of Satisfaction / Perception as a range from Very Good to Very Poor
Frequency of measurement	*the frequency of recording and reporting of the metric* Yearly, Half Yearly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* Survey / Interview with the workshop can give an estimate of the customer perception about the service quality.
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Satisfaction / Perception of Customer regarding Perceived Service Quality**
KPI/ PI	**Level 2 Metrics Definitions**
Service Operating Flexibility:	*See encounter interface, plus corrective factor for perception*
Service Adapt flexibility	*See encounter interface, plus corrective factor for perception*
Service Build flexibility	*See encounter interface, plus corrective factor for*

	perception
Service Operating Adaptability:	*See encounter interface, plus corrective factor for perception*
Service Interaction Flexibility	*See encounter interface, plus corrective factor for perception*
Resource adaptability to modifications of the service object production/operation process	*See encounter interface, plus corrective factor for perception*
Resource flexibility in service operations	*See encounter interface, plus corrective factor for perception*
Service Object Production/Operating flexibility	*See encounter interface, plus corrective factor for perception*
Upside SOURCE/MAKE/DELIVER adaptability	*See encounter interface, plus corrective factor for perception*

Position in SPMS	Dimension/ SA-SO perspective **Satisfaction / Perception of Customer regarding Assets/Costs**
KPI/ PI	**Level 1 Metric: Perceived Service Costs**
Metric definition	The costs that the customer observes for the services he has purchased. **Note:** ./.
Hierarchical metric structure:	
Level 1	Perceived Service Costs
Level 2	Service Provider's Invoice; Reference Value; Differentiation Value; Total Value Added; Sharable Value; Willingness to pay
Qualitative relationship description	(later while preparing Task 4.3)
Quantitative relationship	Perceived Service Costs ≈ Function (**Service Provider's Invoice,** Reference Value, **Total Value Added, Differentiation Value,** Sharable

description	Value, Willingness to Pay)
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* Purchase department of the service provider Manufacturing department of the customer
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	Additional output that can be produced Additional costs that can be saved by avoiding down times
Frequency of measurement	*the frequency of recording and reporting of the metric* monthly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System: Service Provider's invoice, Reference Value calculated before ordering from Service Provider, decreasing down times.
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	Dimension/ SA-SO perspective **Satisfaction / Perception of Customer regarding Assets/Costs**
KPI/ PI	**Level 2 Metric: Service Provider's Invoice**
Metric definition	The total value of all the invoices the service provider sent to his customer for a specific service. **Note:** ./.

Position in SPMS	**Satisfaction / Perception of Customer regarding Assets/Costs**
KPI/ PI	**Level 2 Metric: Reference Value**
Metric definition	The reference value is the cost of whatever competing service the customer views as the best substitute for the service being evaluated. **Note:** Value of a similar service performance e.g. alternative offer from different service provider

Position in SPMS	**Satisfaction / Perception of Customer regarding Assets/Costs**
KPI/ PI	**Level 2 Metric: Differentiation Value**
Metric definition	The differentiation value is the increased level of economic value that the customer can expect from the service offered compared to the Reference Service **Note:** Value of the specific service performance regarding the quality of the service performance or special activities not offered by any other service provider

Position in SPMS	**Satisfaction / Perception of Customer regarding Assets/Costs**
KPI/ PI	**Level 2 Metric: Total Value Added**
Metric definition	The total value is determined first and foremost by what customers` alternatives are. It is the customers` best alternative plus the value of whatever differentiates the offering from the alternative. The total value also is the maximum price a buyer would be willing to pay. **Note:** ./.

Position in SPMS	**Satisfaction / Perception of Customer regarding Assets/Costs**
KPI/ PI	**Level 2 Metric: Sharable Value**
Metric definition	The sharable economic value is the difference between the total value and the sellers` costs, which the seller can share with customers **Note:** ./.

Position in SPMS	**Satisfaction / Perception of Customer regarding Assets/Costs**
KPI/ PI	**Level 2 Metric: Willingness to pay**
Metric definition	The perceived value of a product is the maximal price the customer is willing to pay for the total bundle of benefits the service delivers **Note:** Willingness of the customer to pay the total value of all the invoices the service provider sent to his customer.

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Operating Reliability**			
KPI/ PI	**Level 1 Metric: Service Operating Reliability**			
Metric definition	The performance of the service provider processes in delivering: the correct service, to the correct place, at the correct time, in the correct quality, in the correct quantity, with the correct documentation, to the correct customer.			
Hierarchical metric structure:				
Level 1	Service Operating Reliability			
Level 2	Service Operating Effectiveness/ Availability	Service Operating Output Quantity	Service Operating Output Quality	Service **Interaction** Reliability
Qualitative relationship description	(later while preparing Task 4.3)			
Quantitative relationship description	Service Operating Reliability ≈ Function (**Service Operating Effectiveness / Availability, Service Operating Output Quantity, Service Operating Output Quality**) + Service Interaction Reliability			
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear*			
Scope	*states the areas of business or parts of the organisation that are included* This KPI is again relevant for the complete service operations of the service provider			
Related to	Belonging key target area (main trees)			
	Is PI relevant for service object (machine) or offered service in general?			

	Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	Reliability can be expressed as a percentage of total service operations / fulfilment
Frequency of measurement	*the frequency of recording and reporting of the metric* Monthly / Quarterly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Fulfilment Cycle Time**
KPI/ PI	**Level 1 Metric: Service Fulfilment Cycle Time**
Metric definition	The flexibility that the customer observes for the services he has purchased. **Note:** ./.
Hierarchical metric structure:	
Level 1	Service Fulfilment Cycle Time:

Level 2	Service adapt cycle time; Service build cycle time; Service operate cycle time; Service Interaction Cycle Time
Qualitative relationship description	---
Quantitative relationship description	Service Fulfilment Cycle Time ≈ Service Adapt cycle time + service build cycle time + service operate cycle time + service interaction cycle time
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* Reduce Adapt + Build + Interaction / Fulfilment
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service offering, negotiation, building and operational are in the scope of the service
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* Monthly / Quarterly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data	the responsible person for collecting data and reporting the metric

collection Unit/ name	
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Service Encounter: Service Fulfilment Cycle Time**
KPI/ PI	**Level 2 Metric Definitions**
Service Adapt Cycle Time	Service Adapt Cycle Time measures the overall time needed by the service provider to adapt a service to specific customer requirements.
Service Build Cycle Time	Service Build Cycle Time measures the overall time needed by the service provider to build a service for the customer that has requested it.
Service Operate Cycle Time	It is the cycle time needed to carry out a contracted service
Service Interaction Cycle Time	Defines the cycle time of the interaction between the customer and the service provider in terms of exchange of data, mutual collaborations, adaptations of work plan etc

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Activity Flexibility**
KPI/ PI	**Level 1 Metric: Service Activity Flexibility**
Metric definition	The flexibility of the service activity offered by the service provider. **Note:** ./.
Hierarchical metric structure:	
Level 1	Service Activity Flexibility
Level 2	Service Adapt flexibility Service Build flexibility Service Operate Adaptability Service Operate Flexibility Service Interaction Flexibility
Qualitative relationship description	---

Quantitative relationship description	Service Activity Flexibility ≈ Service Adapt flexibility*Service Build flexibility*Service Operate Adaptability* Service Operate Flexibility*Service Interaction Flexibility
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* The aim is to increase flexibility
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service offering, negotiation, building and operational are in the scope of the service
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* Monthly / Quarterly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	Service Encounter: Service Activity Flexibility
KPI/ PI	**Level 2 Metrics Definitions**
Service Operate Flexibility	It is flexibility that the service provider can support in operating the service in terms of customisation variation of intensiveness, number of components for service operations etc.
Service Adapt flexibility	It is flexibility that the service provider can support in the adapt phase of the service in terms of service offer adaptation possibilities, success rate of the service contract inquiry etc.
Service Build flexibility	It is flexibility that the service provider can support in the build phase of the service in terms of time to start performing an offered service
Service Operating Adaptability	It is adaptability that the service provider can support in operating the service in terms of service delivery adaptability
Service Interaction Flexibility	It is flexibility that the service provider can support in the interaction

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Resources Flexibility**
KPI/ PI	**Level 1 Metric: Service Resources Flexibility**
Metric definition	The flexibility of the resources used by the service provider to supply the service. **Note:** ./.
Hierarchical metric structure:	
Level 1	Service Resources Flexibility
Level 2	Resource adaptability to modifications of the service object production/operation process Resource flexibility in service operations
Qualitative relationship description	---
Quantitative relationship description	Service Resources Flexibility ≈ Resource adaptability to modifications of the service object production/operation process*Resource flexibility in service operations
Aim/ goal/ objective/	*the relation of the metric with the organisational objectives must be clear*

purpose	What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* Resource Management, Human Resources Departments
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* Monthly / Quarterly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Satisfaction / Perception of Customer regarding Perceived Service Quality**
KPI/ PI	**Level 2 Metrics Definitions**
Resource adaptability to modifications of the service object production/operation process	Express the knowledge, the expertise and the know-how of the workforce

Resource flexibility in service operations	Measure the investments on personnel training and education, the education level and the languages spoken

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Assets/Costs regarding Service Activity**
KPI/ PI	**Level 1 Metric: Service Operating Costs**
Metric definition	The costs that the service provider has through normal flow of operation. **Note:** /.
Hierarchical metric structure:	
Level 1	Service Operating Costs
Level 2	Service execution costs; Service Adapt costs; Service Build Costs; Indirect / intangible costs related to activity; Service Interaction costs; Duty costs
Qualitative relationship description	(later while preparing Task 4.3)
Quantitative relationship description	Service Operating costs ≈ Service executions costs + Service Adapt costs + Service Build Costs + Indirect / intangible costs related to activity + Service Interaction costs + Duty costs
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear*
Scope	*states the areas of business or parts of the organisation that are included* Selling department of the service provider "Production" department of the service provider
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)

Equation	Method of calculation must be known
Derived unit of measure	see Level 2
Frequency of measurement	*the frequency of recording and reporting of the metric* monthly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Service Encounter: Assets/Costs regarding Service Activity**
KPI/ PI	**Level 2 Metric: Service Operate costs**
Metric definition	The sum of costs associated with the operate phase of a services. **Note:** e.g. material costs, direct labour, transportation, travel costs

Position in SPMS	**Service Encounter: Assets/Costs regarding Service Activity**
KPI/ PI	**Level 2 Metric: Service Adapt Costs**
Metric definition	The sum of costs associated with the adapt phase of services. **Note:** each service has to be specifically adapted to the customer, mostly the costs will consist of: Service contract inquiry processing effort, Service design/adaption costs, number of project meetings for contract development

Position in SPMS	**Service Encounter: Assets/Costs regarding Service Activity**
KPI/ PI	**Level 2 Metric: Service Build Costs**

Metric definition	The sum of costs associated with the build phase of a service. **Note:** /.

Position in SPMS	**Service Encounter: Assets/Costs regarding Service Activity**
KPI/ PI	**Level 2 Metric: Indirect / intangible costs related to activity**
Metric definition	The sum of any other costs possibly associated with the performance of the service. **Note:** overhead costs: transaction costs, administration costs, Taxes, …

Position in SPMS	**Service Encounter: Assets/Costs regarding Service Activity**
KPI/ PI	**Level 2 Metric: Service interaction costs**
Metric definition	The sum of costs associated with the interaction of the service provider during performance of the service. **Note:** Suppliers' margins, number and costs of service activities that are non-conformant, service re-work costs, handover costs

Position in SPMS	**Service Encounter: Assets/Costs regarding Service Activity**
KPI/ PI	**Level 2 Metric: Duty costs**
Metric definition	The sum of costs associated with the duties of the service provider. **Note:** e.g. any fees that the service provider has to pay to the government in order to operate his business

Position in SPMS	**Service Encounter: Assets/Costs regarding Service Activity**
KPI/ PI	**Level 2 Metric Definitions**
Service Operating Effectiveness/Availability	Availability of the service measures the overall accessibility of the service provider for the customer in terms of number of attempts to get the requested service or information, service provider access time, number of communication channels etc.
Service Operating Output Quantity	The total volume of services performed by the service provider for the customer. For logistics - the total number of shipments delivered, quality control - total number of parts checked for their quality
Service Operating Output Quality	An analysis of the quality of the service offered by the service provider.
Service Interaction Reliability	Defines the reliability of the interaction between the customer and the service provider in terms of exchange of data, mutual collaborations, adaptations of work plan etc

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Activity Cost Efficiency**
KPI/ PI	**Level 1 Metric: Service Activity Cost Efficiency**
Metric definition	The cost efficiency of the activity of service being performed, in terms of ratio between the reliability and the costs sustained to achieve such reliability.
Hierarchical metric structure:	
Level 1	Service Activity Cost Efficiency
Level 2	Average costs per correct service delivery
Qualitative relationship description	---
Quantitative relationship description	Service Activity Cost Efficiency = Service Operating Reliability / Service Operating Costs
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service related to operational and costing aspects
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	see Level 2
Frequency of	*the frequency of recording and reporting of the metric*

measurement	Yearly / Half Yearly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Service Encounter: Service Activity Cost Efficiency**
KPI/ PI	**Level 2 Metric**
Average costs per correct service	Self-explaining

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Activity Input Efficiency**
KPI/ PI	**Level 1 Metric: Service Activity Input Efficiency**
Metric definition	The input efficiency of the activity of service being performed, in terms of ratio between the reliability and the service fulfilment cycle time
Hierarchical metric structure:	
Level 1	Service Activity input Efficiency
Level 2	Average cycle time for correct service delivery stock turnover
Qualitative	---

relationship description	
Quantitative relationship description	Service Activity Input Efficiency = Service Operating Reliability / Service Fulfilment Cycle Time or SA Input Quantity
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service related to operation
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* Yearly / Half Yearly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	Service Encounter: Service Activity Input Efficiency
KPI/ PI	**Level 2 Metric**
Average cycle time for correct service delivery	Self-explaining
Stock turnover	It measures how well the company is making use of the part of its working capital that has been invested in stock.

Position in SPMS	Dimension/ SA-SO perspective **Service Activity Profitability**
KPI/ PI	**Level 1 Metric: Service Activity Profitability**
Metric definition	The profitability of the activity of service being performed, in terms of ratio between Service Operating Costs and Total Service Costs
Hierarchical metric structure:	
Level 1	Service Activity Profitability
Level 2	Profit contribution
Qualitative relationship description	---
Quantitative relationship description	Service Activity Profitability = Service Operating Costs / Total Service Costs
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service related to operation
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2	1 sentence per Level 2 indicator

indicators	
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* Yearly / Half Yearly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Service Encounter: Service Activity Profitability**
KPI/ PI	**Level 2 Metric**
Profit Contribution	A measure of the profit the service activity brings to the service provider.

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Reference Service costs**
KPI/ PI	**Level 1 Metric: Reference Service costs**
Metric definition	
Hierarchical metric structure:	

Level 1	Reference Service costs
Level 2	Differentiation value; Reference value; Total value added
Qualitative relationship description	---
Quantitative relationship description	---
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service related to operation
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* *Yearly, Half-Yearly*
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible	the responsible person for collecting data and reporting the metric

for data collection Unit/ name	
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Service Encounter: Service Activity Time Efficiency**
KPI/ PI	**Level 2 Metric**
Differentiation value	---
reference value	---
total value added	Total value added refers to the additional value created by the supply of the service.

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Object Reliability**
KPI/ PI	**Level 1 Metric: Service Object Reliability**
Metric definition	The performance and reliability of the service object (objects are for e.g. machine being maintained, products being packed) which were serviced by the service provider.
Hierarchical metric structure:	
Level 1	Service Object Reliability
Level 2	Service Object Effectiveness / Availability; Service Object Output Quantity; Service Object Output Quality
Qualitative relationship description	(later while preparing Task 4.3)
Quantitative relationship description	Service Object Reliability ≈ Function (Service Object Effectiveness / Availability, Service Object Output Quantity, Service Object Output Quality)

Aim/ goal/ objective/ purpose	The aim is to have high level of service object reliability so that the customer can have a higher productivity / efficiency and also lead to a better service perception.
Scope	Service Objects being services – Machines (Maintenance Service), Packed Products (Packaging Service), Delivery Reliability (Logistic Services)
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	Reliability can be expressed as a percentage of total service object goals fulfilment
Frequency of measurement	*the frequency of recording and reporting of the metric* Monthly / Quarterly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	Factors that influence the performance, i.e. organisational units, events, etc. See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	Service Encounter: Assets/Costs regarding the Service Object
KPI/ PI	**Level 2 Metric Definitions**
Service Object Effectiveness/Availability	The overall availability of the service object in terms of being operational / accessible
Service Object Output Quantity	The total value of output produced by the service object which is serviced by the service provider
Service Object Output Quality	The quality of the output produced by the service object

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Object Production/Operating Cycle Time**
KPI/ PI	**Level 1 Metric: Service Object Production/Operating Cycle Time**
Metric definition	The production/operating cycle time of the service object (objects are for e.g. machine being maintained, products being packed) which were serviced by the service provider. **Note:** ./.
Hierarchical metric structure:	
Level 1	Service Object Production/Operating Cycle Time:
Level 2	Production Operation lead time; Interoperation time; Administration time
Qualitative relationship description	---
Quantitative relationship description	Service Object Production/Operating Cycle Time ≈ Production Operation Lead time + Interoperation time + Administration Time
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of customer organisation
Related to	Belonging key target area (main trees)

	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* Monthly / Quarterly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	Factors that influence the performance, i.e. organisational units, events, etc. See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Service Encounter:** Service Object Production/Operating Cycle **Time**
KPI/ PI	**Level 2 Metric Definitions**
Production/Operation Lead Time	Production/Operation Lead Time measures the sum of the run time and the setup time.
Interoperation Time	Interoperation Time is the sum of waiting time, inspection time and transportation time.
Administration Time	---

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Object Flexibility**
KPI/ PI	**Level 1 Metric: Service Object Flexibility**
Metric definition	The flexibility of the object serviced by the service provider. **Note:** ./.
Hierarchical metric structure:	
Level 1	Service Object Flexibility
Level 2	Service Object Production/Operating Flexibility
Qualitative relationship description	---
Quantitative relationship description	Service Activity Flexibility ≈ Service Object Production/Operating Flexibility
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* Increase Flexibility
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service offering, negotiation, building and operational are in the scope of the service
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* Monthly / Quarterly

Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	Factors that influence the performance, i.e. organisational units, events, etc. See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS **KPI/ PI**	**Service Encounter: Service Object Flexibility** **Level 2 Metrics Definitions**
Service Object Production/Operating Flexibility	It is the number of days required to achieved an unplanned sustainable 20% increase in quantity produced

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Object Adaptability**
KPI/ PI	**Level 1 Metric: Service Object Adaptability**
Metric definition	The adaptability of the object serviced by the service provider. **Note:** ./.
Hierarchical metric structure:	
Level 1	Service Object Adaptability
Level 2	Upside SOURCE/MAKE/DELIVER adaptability
Qualitative relationship description	---

Quantitative relationship description	Service Object Adaptability ≈ Upside SOURCE/MAKE/DELIVER adaptability
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service offering, negotiation, building and operational are in the scope of the service
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	Level of Satisfaction / Perception as a range from Very Good to Very Poor
Frequency of measurement	*the frequency of recording and reporting of the metric* Yearly, Half Yearly
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* Survey / Interview with the workshop can give an estimate of the customer perception about the service quality.
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	Satisfaction / Perception of Customer regarding Perceived Service Quality
KPI/ PI	**Level 2 Metrics Definitions**
Upside SOURCE/MAKE/DELIVER adaptability	The maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints.

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Assets/Costs regarding the Service Object**
KPI/ PI	**Level 1 Metric: Service Object Production/Operating Costs**
Metric definition	The costs that incurred at the service provider when producing/providing a specific service object **Note:** ./.
Hierarchical metric structure:	
Level 1	Service Object Production/Operating Costs
Level 2	Production labor costs; Maintenance Costs; Material re-work costs; Production equipment charges; Consumable costs
Qualitative relationship description	(later while preparing Task 4.3)
Quantitative relationship description	Service Object Production/Operating Costs ≈ Production labour costs + Maintenance Costs + Material re-work costs + Production equipment charges + Consumable costs
Aim/ goal/ objective/ purpose	the relation of the metric with the organisational objectives must be clear What are the organisational objectives?
Scope	states the areas of business or parts of the organisation that are included Production department of the service provider
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general?

	Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	see level 2
Frequency of measurement	the frequency of recording and reporting of the metric monthly
Source of the data	the exact data sources involved in calculating a metric value (or taken from ERP System for example) ERP System
Drivers	Factors that influence the performance, i.e. organisational units, events, etc. See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Service Encounter: Assets/Costs regarding the Service Object**
KPI/ PI	**Level 2 Metric: Production labour costs**
Metric definition	Costs that incur at the service provider for personnel entrusted with the performance of the service. **Note:** Direct labour costs, indirect labour costs related to activity and non-service related.

Position in SPMS	Service Encounter: Assets/Costs regarding the Service Object
KPI/ PI	**Level 2 Metric: Maintenance Costs**
Metric definition	The sum of costs associated with the maintenance of the machine. **Note:** according to the service contract

Position in SPMS	Service Encounter: Assets/Costs regarding the Service Object
KPI/ PI	**Level 2 Metric: Material re-work costs**
Metric definition	Re-work? The sum of costs associated with the re-work of materials **Note:** ./.

Position in SPMS	Service Encounter: Assets/Costs regarding the Service Object
KPI/ PI	**Level 2 Metric: Production equipment charges**
Metric definition	The sum of costs associated with the production equipment **Note: energy,** purchase, rental, leasing or depreciation

Position in SPMS	Service Encounter: Assets/Costs regarding the Service Object
KPI/ PI	**Level 2 Metric: Consumable costs**
Metric definition	The sum of costs of minor materials used during the performance of services **Note:** Overhead costs for commodities or expendable goods

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Object Cost Efficiency**
KPI/ PI	**Level 1 Metric: Service Object Cost Efficiency**
Metric definition	The cost efficiency of the object of service in terms of reliability, production and operating costs.
Hierarchical metric structure:	
Level 1	Service Object Cost Efficiency

Level 2	Cost per operating hour; Hourly cost rate when running; Downtime losses
Qualitative relationship description	
Quantitative relationship description	Service Object Cost Efficiency = Service Object Reliability / Service Object Production/Operating Costs
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service related to operation
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* *Quarterly*
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management

Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Service Encounter: Service Object Time Efficiency**
KPI/ PI	**Level 2 Metric**
Cost per operating hour	Self explaining
Hourly cost rate when running	Self explaining
Downtime losses	Self explaining

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Service Object Input Efficiency**
KPI/ PI	**Level 1 Metric: Service Object Input Efficiency**
Metric definition	The Time efficiency of the activity of service being performed, in terms of ratio between Service Fulfilment Cycle Time and Average Service Fulfilment Cycle Time
Hierarchical metric structure:	
Level 1	Service Object Input Efficiency
Level 2	OEE
Qualitative relationship description	---
Quantitative relationship description	Service Object Input Efficiency = Service Object Reliability / Service Object Production/Operating Cycle Time or SO Input Quantity
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service related to operation
Related to	Belonging key target area (main trees)

	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* *Quarterly*
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)* ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

Position in SPMS	**Service Encounter: Service Object Input Efficiency**
KPI/ PI	**Level 2 Metric**
OEE	OEE gives the overall performance governed by the cumulative impact of 3 factors, the equipment's availability, performance rate and quality.

Position in SPMS	Dimension/ SA-SO perspective **Service Encounter: Operators' behaviour**
KPI/ PI	**Level 1 Metric: Operators' behaviour**
Metric definition	--
Hierarchical metric structure:	
Level 1	Operators' behaviour
Level 2	---
Qualitative relationship description	---
Quantitative relationship description	Service Activity Time Efficiency = Service Fulfilment Cycle Time / Average Service Fulfilment Cycle Time
Aim/ goal/ objective/ purpose	*the relation of the metric with the organisational objectives must be clear* What are the organisational objectives?
Scope	*states the areas of business or parts of the organisation that are included* All aspects of service related to operation
Related to	Belonging key target area (main trees)
	Is PI relevant for service object (machine) or offered service in general? Average value or single value
Supporting Level 2 indicators	1 sentence per Level 2 indicator
Target area/ reference value	Benchmarks must be determined in order to monitor progress (based on known process capability, competitor performance and customer requirements)
Equation	Method of calculation must be known
Derived unit of measure	---
Frequency of measurement	*the frequency of recording and reporting of the metric* *Quarterly*
Source of the data	*the exact data sources involved in calculating a metric value (or taken from ERP System for example)*

	ERP-System
Drivers	*Factors that influence the performance, i.e. organisational units, events, etc.* See Level 2
Responsible for data collection Unit/ name	the responsible person for collecting data and reporting the metric
Owner of the data	Responsible for the proceeding through performance measurement and management
Comment field/ Discussion	Recommendations / next steps/ etc.

4 Assignment of SPMS to the service clusters

Following to the WP4 interaction diagram (see Figure 1-1), the comprehensive set of PIs within the SPMS (section 3.3) has been assigned to the specific service clusters in the InCoCo-S project.

4.1 Introduction (Proceeding)

According to their relevance, an assortment of the total set of PIs (introduced in section 3.3) has been taken out representing the cluster specific PIs for the particular clusters. One aim for the SPMS was the generic character in a way that using the generic SPMS a filtering would be enough to define a cluster, and later company specific PMS, without taking any additional PIs. Consequently, the generic SPMS has to cover all relevant service performance indicators.

As presented earlier, the SPMS was structured using both top-down and bottom-up approaches. Especially the bottom-up approach should have ensured that all needs coming from the industrial partners should have been covered. However, a lot of results for instance coming from the workshops, were not taken over directly, but were further adapted. So the step of the cluster specific configuration represents a verification that all needs were covered during the development of the SPMS, and at the same time this step verifies the link of the performance indicators of the SPMS to the process repositories, so that it is clear at which steps of the process reference the measures are taken. Furthermore, the assignment to the repositories enhances them further, in making sure that all clusters use one common terminology and move at the right level of detail. A lot of indicators initially defined in T2.6 were renamed and often aggregated, because they were on a more operational level and representing rather level 4 or even level 5 indicators.

4.1.1 Cluster specific configuration

During the cluster specific configuration the particular cluster managers filtered the generic SPMS, together with the industrial partners, so that all cluster relevant PIs were identified. This step ensured two things: on the one hand, it ensured that the whole structure and concept is feasible for a business environment, and on the other hand it ensured that it is complete in the sense of covering all relevant PIs of all service clusters.

Within the cluster specific configurations for each cluster the not relevant PIs are greyed out.

4.1.2 Assignment of PIs to the repositories

The second step of the cluster specification covers the enhancement of the IRM. In T2.6 a first step was undertaken by collecting already used or planned performance indicators within the defined service processes. However, these indicators were very specific and not hierarchically structured. So the step of assigning the filtered indicators from the SPMS back to the processes of the individual clusters ensures an appropriate level of definition of indicators, which are to be measured in the particular process elements. Additionally, during the filtering of the generic SPMS it happened, that PIs were identified, which were missing in the first attempt in the framework of T2.6. So the process repositories as they are right now after T4.2 are more comprehensive and in the right level of detail.

By structuring the process assignments in the form as presented in the subsequent sections, the cluster managers also see in a very transparent manner, which strategic target areas are covered in which level of extent.

4.2 Maintenance cluster

4.2.1 Cluster specific configuration

Service Satisfaction / Perception - PIs for Maintenance Services *Maintenance Services indicators are coloured black.

Effectiveness/Reliability (Quality)			Responsiveness/Time		
Level 1 metric:	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*
Perceived Service Quality	*Service Operating Effectiveness/Availability*	*See encounter interface, plus corrective factor for perception*	Perceived Service Responsiveness	*Service delivery cycle time*	*See encounter interface, plus corrective factor for perception*
	Service Operating Output Quantity	*See encounter interface, plus corrective factor for perception*		*Service interaction cycle time*	*See encounter interface, plus corrective factor for perception*
	Service Operating Output Quality	*See encounter interface, plus corrective factor for perception*		*Service object operation lead time*	*See encounter interface, plus corrective factor for perception*
	Service Interaction Reliability	*See encounter interface, plus corrective factor for perception*		Promptness of service provider's reaction	
	Company's innovativeness	*See encounter interface, plus corrective factor for perception*			
	Service Object Effectiveness/Availability	*See encounter interface, plus corrective factor for perception*			
	Service Object Output Quantity	*See encounter interface, plus corrective factor for perception*			
	Service Object Output Quality	*See encounter interface, plus corrective factor for perception*			
	Service credibility	image, trustworthiness, visibility/transparency, honesty, appearance of personnel			
	Service accessibility	Accessability convenience, approachability			
	Service security	Confidentiality, discretion, financial security, risk safety			
	Service communication	Provided information, appropriate language, channels to communicate			
	Service empathy	Sensitivity, problem solving capability, complaint handling behavior			
	Service project management	Deviations of project plan, **deviations from to-be to as-is performance**			
	Customer Loyalty				

Flexibility			Assets/Costs		
Level 1 metric:	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*
Perceived Service Flexibility	*Service Operating Flexibility:*	*See encounter interface, plus corrective factor for perception*	Perceived Service Costs	Service Provider's Invoice	
	Service Adapt flexibility	*See encounter interface, plus corrective factor for perception*		Reference Value	The reference value is the cost of whatever competing service the customer views as the best substitude for the service being evaluated
	Service Build flexibility	*See encounter interface, plus corrective factor for perception*		Differentiation Value	The added value is the increased level of economic value that the customer can expect from the service offered compared to the Reference Service
	Service Operating Adaptability:	*See encounter interface, plus corrective factor for perception*		Total Value Added	The total value is determined first and foremost by what customers` alternatives are. It is the custumers` best alternative plus the value of whatever differentiates the offering from the alternative. The total value also is the maximum price a buyer, fully informed about the market and seeking the best value, would pay
	Service Interaction Flexibility	*See encounter interface, plus corrective factor for perception*		Sharable Value	The sharable economic value is the difference between the total value and the sellers` costs, which
	Resource adaptability to modifications of the service object production/operation process	*See encounter interface, plus corrective factor for perception*		Willingness to pay	The perceived value of a product is the maximal price the customer is willing to pay for the total bundle of benefits the service delivers
	Resource flexibility in service operations	*See encounter interface, plus corrective factor for perception*			
	Service Object Production/Operating flexibility	*See encounter interface, plus corrective factor for perception*			
	Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints)	*See encounter interface, plus corrective factor for perception*			

Table 8: Service Satisfaction / Perception (maintenance cluster)

Assets/Costs			Efficiency/Productivity		
Level 1 metric:	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*
Service Activity Costs:	Service Adapt costs	Service contract inquiry processing effort, **Service design/adaption costs, number/costs of project meetings for contract development, direct labour costs**	**Service Activity Cost Efficiency (= Service Operating Reliability / Service Operating Costs)**	Average costs per correct service delivery	
	Service Build costs	**Number/costs of conducted HW / SW tests,** direct labour costs	Service Activity Input Efficiency (= Service Operating Reliability / Service Fulfillment Cycle Time or SA Input Quantity)	Average cycle time for correct service delivery, stock turnover	
	Service Operate costs	Cost of material used, Transportation and handling costs, material inventory costs, **waste/costs of materials due to out-of-specification operations, direct labour costs**, travel and subsidy costs, **number/costs of conducted analyses at partner's site, frequency/costs of data measurements, service equipment maintenance costs**, **number/costs of analyzed measurement points, number/costs of (planned) service activities**	Service Activity Profitability (= Service Operating Costs / Total Service Costs)	Profit contribution (Deckungsbeitrag)	
	Indirect / intangible costs related to activity	Transaction costs, Administration costs, Incentive costs, Taxes, Service Quality costs, Service Adaptation costs, Performance Measurement costs, **Productivity changes costs**, wage changes costs, exchange rates costs, Core competence maintenance and improvement costs	Service Activity Time Efficiency (= Service Fulfillment Cycle Time / Average Service Fulfillment Cycle Time)	Productive hours, …	
	Service Interaction costs	Suppliers' margins, **number and costs of service activities that are non-conformant, service re-work costs,** handover costs	Reference Service costs	Differentiation value, reference value, total value added	
	Duty costs				

Table 9: Service Encounter Interface - Service Activity (maintenance cluster)

Service Encounter Interface – Service object PIs for Maintenance Services *Maintenance Services indicators are coloured black.

Effectiveness/Reliability (Quality)			Responsiveness/Time			Flexibility		
Level 1 metric:	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*
Service Object Reliability:	Service Object Input Quantity	**Scheduled Downtime, Effective run-time**	Service Object Production/Operating Cycle Time:	Production/operation lead time	Setup time	Service Object Flexibility:	Service Object Production/Operating flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity produced)	Input flexibility, production/operation process flexibility, output flexibility, improvement flexibility
	Service Object Input Quality	**Adherence to schedule, Unscheduled Downtime**			Run-time (nominal run-time, setup run-time, effective run-time, operating run-time)	Service Object Adaptability:	Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints)	
	Service Object Output Quantity	**Nominal output, Setup output, Effective output, Operating output,** Downstream capacity, Upstream input		Interoperation time	Waiting time			
	Service Object Output Quality	**Output product quality, (spare parts quality)**			Inspection time			
					Transportation time			
				Administration time				

Assets/Costs			Efficiency/Productivity		
Level 1 metric:	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*
Service Object Production/Operating Costs:	Production labor costs	Direct labor costs, indirect labor costs related to activity and non-service related	Service Object Cost Efficiency(= Service Object Reliability / Service Object Production/Operating Costs)	Cost per operating hour, hourly cost rate when running, **downtime losses**	
	Maintenance costs (if not outsourced)		Service Object Input Efficiency (= Service Object Reliability / Service Object Production/Operating Cycle Time or SO Input Quantity)	OEE	
	Material re-work costs		Operators' behavior		
	Production equipment charges	Energy consumption, leasing rate, depreciation, (operation hours, hourly cost rate when running)			
	Consumables costs				

Table 10: Service Encounter Interface – Service Object (maintenance cluster)

4.2.2 Assignment of PIs to the repositories

COMAU+SKF-Maintenance Services Processes Level 2			Target areas / Performance metrics				
Process Category		**Process element name**	**Effectiveness /Reliability (Quality)**	**Responsiveness (Time)**	**Assets/ Costs**	**Flexibility**	**Effectivity/ Productivity**
Plan		Plan Adapt MAINTENANCE Service				Service Adapt Flexibility	
		Plan Build MAINTENANCE Service					
		Plan Operate MAINTENANCE Service					
Adapt		Adapt MAINTENANCE Service	New launches of services		Service Adapt costs	Service Adapt flexibility	
Build		Build MAINTENANCE Service			Service Build costs,		
Operate		Operate Maintenance Service	Service Operating Input Quantity, Service Operating Input Quality, Service Operating Output Quantity, Service Operating Output Quality, Service Object Input Quantity, Service Object Input Quality, Service Object Output Quantity, Service Object Output Quality	Service operate cycle time	Service Operate costs Service	Service Operate Flexibility, Service Operate Adaptability,	Service Activity Cost Efficiency (= Service Operating Reliability / Service Operating Costs)
Support		Support MAINTENANCE Service	Service Project Management, Service Interaction Reliability		Indirect/intangible costs related to activity, Interaction costs	Resource flexibility in service operations, Resource adaptability to modifications of the service object production/operation process, Service Interaction Flexibility,	

COMAU+SKF-Maintenance Services Processes Level 3			Target areas / Performance metrics				
Process Category	**Interaction View**	**Process element name**	**Effectiveness /Reliability (Quality)**	**Responsiveness (Time)**	**Assets/ Costs**	**Flexibility**	**Effectivity/ Productivity**
Adapt	**Execute**	Process customer request	number of orders initiated by the field service				Quotation lead time
		Configure & adapt services	number of customer contact points, number of required additional information,		Number of project meetings for contract development, Service design/adaption costs, direct labour costs, number/costs of (planned) service activities	Number of customised service operations / Number of standard service operations, number of approved components that are allowed for service operation, number of containers	Number of additional contacts to customer after contract signment,
		Negotiate and finalize service contract				Service contract inquiry success rate	
	Plan	Identify, prioritize and aggregate service Adapt requirements					
		Identify, prioritize and aggregate service Adapt resources					
		Balance service Adapt requirements with resources					
		Establish Adapt Service Plan					
	Support	Manage Business Rules & Strategies	number of project meeting attendendees				
		Manage Service Portfolio	New services launched in a time period			Investments in personnel training and education, Workforce Map of Knowledge, Workforce degrees of expertise and know-how,	
		Manage Customer Data					
		Maintain Contract Information					
		Manage potential service partner network	partner performances			number of partners in the service network	

COMAU+SKF-Maintenance Services Processes Level 3			Target areas / Performance metrics				
Process Category	**Interaction View**	**Process element name**	**Effectiveness /Reliability (Quality)**	**Responsiveness (Time)**	**Assets/ Costs**	**Flexibility**	**Effectivity/ Productivity**
Build	**Execute**	Coordinate involved service partners				number of partners in the service network	
		Transport and/or procure needed component & services	Quality of material used, partner performances				Material delivery lead time
		Setup and/or install service system	installation time of required service hardware				process lead time
		Test and/or certify service system			Number/costs of conducted HW / SW tests		
	Plan	Identify, prioritize and aggregate “Build” service requirements					
		Identify, prioritize and aggregate “Build” service resources				Workforce degrees of expertise and know-how	
		Balance “Build” service req’ments with resources					
		Establish “Build” Service Plan					
	Support	Manage service components’/elements’ profiles	number of customer contact points, number of required additional information,			Investments in personnel training and education	
		Manage “Build” documentation					
Operate	**Execute**	Schedule MAINTENANCE activities	Quality of shared information, information flow integration			service delivery adaptability	
		Issue MAINTENANCE material	Output product quality, (spare parts quality),Number of additional unscheduled trips				
		MAINTENANCE and Test	Quality of material used, on-time service operations and deviations, number of accurate services performed, number of wrong services performed, Nominal output, Setup output, Effective output, Operating output, on-time service operations and deviations		Waste/costs of materials due to out-of-specification operations, productivity changes costs, number and costs of service activities that are non-conformant,		downtime losses

COMAU+SKF-Maintenance Services Processes Level 3			Target areas / Performance metrics				
Process Category	**Interaction View**	**Process element name**	**Effectiveness /Reliability (Quality)**	**Responsiveness (Time)**	**Assets/ Costs**	**Flexibility**	**Effectivity/ Productivity**
Operate	**Execute**	Monitor MAINTENANCE process	Adherence to schedule, Unscheduled Downtime, Effective run-time, deviations from to-be to as-is performance, timeframe for testing activities	Time between measurement and analysis of performance data, time between the occurrence of an incident and the information of the customer	number/costs of conducted analyses at partner's site, frequency/costs of data measurements, number/costs of analyzed measurement points,		
		Conduct maintenance on MAINTENANCE equipment & software	on-time service operations and deviations, Number of accurate services performed, Number of wrong services performed, reaction time in case of failure				
		Report MAINTENANCE Service Performance	time between occurance of an incident and the information of the customer,			Number of customised/number of standard service operations, Number of approved components that are allowed for service operation, number of containers	
	Plan	Identify, Assess and Aggregate MAINTENANCE requirements	Information flow integration, quality of shared information				
		Identify, Assess and Aggregate MAINTENANCE resources					
		Balance MAINTENANCE resources with MAINTENANCE requirements					
		Establish MAINTENANCE Plans	Scheduled Downtime				
	Support	Manage MAINTENANCE rules and strategies	partner performances		direct labour costs	Service contract inquiry success rate	
		Manage MAINTENANCE performance	Quality of shared information, information flow integration, project meeting attendance, number of order initiated by the field service, Number of additional unscheduled trips, deviations from to-be to as-is performance		service re-work costs, service equipment maintenance costs	willingness to cooperate, coping with changes and short-term needs, number of successful process changes coming from involved operational players,	Average costs per correct service delivery
		Manage MAINTENANCE equipment, software and related services					
		Manage MAINTENANCE material inventory	Warehouse picking accuracy, inventory accuracy, Forecast accuracy				

Table 11: Assignment of PIs to the repositories (maintenance cluster)

4.3 Packaging cluster

In this section the packaging cluster specific configuration of the generic SPMS is presented. First the structure of the according packaging PMS is shown, and then the assignment of the level 3 PIs to the process repository is displayed.

4.3.1 Cluster specific configuration

Service Satisfaction / Perception – PIs for Packaging Services * Packaging Services indicators are coloured black.

Effectiveness/Reliability (Quality)			Responsiveness/Time		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Perceived Service Quality	*Service Operating Effectiveness/Availability*	*See encounter interface, plus corrective factor for perception*	Perceived Service Responsiveness	*Service delivery cycle time*	*See encounter interface, plus corrective factor for perception*
	Service Operating Output Quantity	*See encounter interface, plus corrective factor for perception*		*Service interaction cycle time*	*See encounter interface, plus corrective factor for perception*
	Service Operating Output Quality	*See encounter interface, plus corrective factor for perception*		*Service object operation lead time*	*See encounter interface, plus corrective factor for perception*
	Service Interaction Reliability	*See encounter interface, plus corrective factor for perception*		Promptness of service provider's reaction	
	Company's innovativeness	*See encounter interface, plus corrective factor for perception*			
	Service Object Effectiveness/Availability	*See encounter interface, plus corrective factor for perception*			
	Service Object Output Quantity	*See encounter interface, plus corrective factor for perception*			
	Service Object Output Quality	*See encounter interface, plus corrective factor for perception*			
	Service credibility	image, trustworthiness, visibility/transparency, honesty, appearance of personnel			
	Service accessibility	Accessability convenience, approachability			
	Service security	Confidentiality, discretion, financial security, risk safety			
	Service communication	Provided information, appropriate language, channels to communicate			
	Service empathy	Sensitivity, problem solving capability, complaint handling behavior			
	Service project management	Deviations of project plan, deviations from to-be to as-is performance			
	Customer Loyalty				

Flexibility			Assets/Costs		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Perceived Service Flexibility	*Service Operating Flexibility:*	*See encounter interface, plus corrective factor for perception*	Perceived Service Costs	Service Provider's Invoice	
	Service Adapt flexibility	*See encounter interface, plus corrective factor for perception*		Reference Value	The reference value is the cost of whatever competing service the customer views as the best substitude for the service being evaluated
	Service Build flexibility	*See encounter interface, plus corrective factor for perception*		Differentiation Value	The added value is the increased level of economic value that the customer can expect from the service offered compared to the Reference Service
	Service Operating Adaptability:	*See encounter interface, plus corrective factor for perception*		Total Value Added	The total value is determined first and foremost by what customers` alternatives are. It is the custumers` best alternative plus the value of whatever differentiates the offering from the alternative. The total value also is the maximum price a buyer, ful
	Service Interaction Flexibility	*See encounter interface, plus corrective factor for perception*		Sharable Value	The sharable economic value is the difference between the total value and the sellers` costs, which the seller can share with customers
	Resource adaptability to modifications of the service object production/operation process	*See encounter interface, plus corrective factor for perception*		Willingness to pay	The perceived value of a product is the maximal price the customer is willing to pay for the total bundle of benefits the service delivers
	Resource flexibility in service operations	*See encounter interface, plus corrective factor for perception*			
	Service Object Production/Operating flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity produced)	*See encounter interface, plus corrective factor for perception*			
	Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints)	*See encounter interface, plus corrective factor for perception*			

Table 12: Service Satisfaction / Perception (packaging cluster)

Service Encounter Interface - Service activity PIs for Packaging Services *Packaging Services indicators are coloured black.

Effectiveness/Reliability (Quality)			Responsiveness/Time		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Activity Reliability:	Service Operating Input Quantity	Material availability, personnel availability, IT availability	Service Fulfillment Cycle Time:	Service Adapt cycle time	(Process lead times), Contract lead time, quotation lead time
	Service Operating Input Quality	Quality of material used, Number and probability of late services performed, Number and probability of backorders, on-time service operations and deviations, Number of additional unscheduled trips, Number of partner contact points, Average availability of service at point of consumption, partner performances, market share		Service Build cycle time	(Process lead times), Handover cycle time, installation time of required service hardware, timeframe for testing activities
	Service Operating Output Quantity	Number of accurate services performed, Number of wrong services performed		Service Operate cycle time	(Process lead times), Order lead time, Quotation lead time, Material delivery lead time, Overdue trade receivables, time between measurement and analysis of performance data, time between occurance of an incident and the information of the customer, reaction time in case of failure
	Service Operating Output Quality	Warehouse picking accuracy, inventory accuracy, paperwork accuracy, Payment accuracy, Forecast accuracy, number of orders initiated by field service		Service Interaction Cycle Time	Handover cycle time, coordination cycle time
	Service Interaction Reliability	Information flow integration, availability of shared information systems, quality of shared information, number of customer contact points, number of required additional information, project meeting attendance			
Company's Innovativeness	New launches of services	New services launched in a time period, percentage sales of new services to whole service sales			
	Use of new technologies				
	New service performance accuracy	Percentage of wrong service performances after new service design is launched			

Flexibility			Assets/Costs			Efficiency/Productivity		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Activity Flexibility:	Service Adapt flexibility	Service contract inquiry success rate, Service offer adaptation possibility, number of partners in the service network	Service Activity Costs:	Service Adapt costs	Service contract inquiry processing effort, Service design/adaption costs, number/costs of project meetings for contract development, direct labour costs	Service Activity Cost Efficiency (= Service Operating Reliability / Service Operating Costs)	Average costs per correct service delivery	
	Service Build flexibility	Time required until performing new developed services, Number of additional contacts to customer/suppliers after contract signment		Service Build costs	Number/costs of conducted HW / SW tests, direct labour costs	Service Activity Input Efficiency (= Service Operating Reliability / Service Fulfillment Cycle Time or SA Input Quantity)	Average cycle time for correct service delivery, stock turnover	
	Service Operate Flexibility:	Number of customised service operations / Number of standard service operations, number of approved components that are allowed for service operation, number of containers, Service intensiveness flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity/intensiveness delivered)		Service Operate costs	Cost of material used, Transportation and handling costs, material inventory costs, waste/costs of materials due to out-of-specification operations, direct labour costs, travel and subsidy costs, number/costs of conducted analyses at partner's site, frequency/costs of data measurements, service equipment maintenance costs, number/costs of analyzed measurement points, number/costs of (planned) service activities	Service Activity Profitability (= Service Operating Costs / Total Service Costs)	Profit contribution (Deckungsbeitrag)	
	Service Operate Adaptability:	Service delivery adaptability (the maximum sustainable percentage increase in quantity/intensiveness that can be achieved in 30 days)		Indirect / intangible costs related to activity	Transaction costs, Administration costs, Incentive costs, Taxes, Service Quality costs, Service Adaptation costs, Performance Measurement costs, Productivity changes costs, wage changes costs, exchange rates costs, Core competence maintenance and improvement costs	Service Activity Time Efficiency (= Service Fulfillment Cycle Time / Average Service Fulfillment Cycle Time)	Productive hours, …	
	Service Interaction Flexibility	Willingness to cooperate, coping with changes and short-term needs, number of partners in the service network, number of successful process changes coming from involved operational players		Service Interaction costs	Suppliers' margins, number and costs of service activities that are non-conformant, service re-work costs, handover costs	Reference Service costs	Differentiation value, reference value, total value added	
Service Resources Flexibility	Resource adaptability to modifications of the service object production/operation process	Workforce Map of Knowledge, Workforce degrees of expertise and know-how		Duty costs				
	Resource flexibility in service operations	Investments in personnel training and education, education level, number of languages spoken						

Table 13: Service Encounter Interface – Service Activity (packaging cluster)

Service Encounter Interface - Service object PIs for Packaging Services *Packaging Services indicators are coloured black.

Effectiveness/Reliability (Quality)			Responsiveness/Time		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Object Reliability:	Service Object Input Quantity	Scheduled Downtime, Effective run-time	Service Object Production/Operating Cycle Time:	Production/operation lead time	Setup time
	Service Object Input Quality	Adherence to schedule, Unscheduled Downtime			Run-time (nominal run-time, setup run-time, effective run-time, operating run-time)
	Service Object Output Quantity	Nominal output, Setup output, Effective output, Operating output, Downstream capacity, Upstream input		Interoperation time	Waiting time
	Service Object Output Quality	Output product quality			Inspection time
					Transportation time
				Administration time	

Flexibility			Assets/Costs			Efficiency/Productivity		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Object Flexibility:	Service Object Production/Operating flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity produced)	Input flexibility, production/operation process flexibility, output flexibility, improvement flexibility	Service Object Production/Operating Costs:	Production labor costs	Direct labor costs, indirect labor costs related to activity and non-service related	Service Object Cost Efficiency(= Service Object Reliability / Service Object Production/Operating Costs)	Cost per operating hour, hourly cost rate when running, downtime losses	
Service Object Adaptability:	Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints)			Maintenance costs (if not outsourced)		Service Object Input Efficiency (= Service Object Reliability / Service Object Production/Operating Cycle Time or SO Input Quantity)	OEE	
				Material re-work costs		Operators' behavior		
				Production equipment charges	Energy consumption, leasing rate, depreciation, (operation hours, hourly cost rate when running)			
				Consumables costs				

Table 14: Service Encounter Interface - Service Object (packaging cluster)

4.3.2 Assignment of level 2 and level 3 PIs to the repositories

Assignment of level 2 PIs to the Level 2 Processes

SIGPACK-Packaging Services Processes Level 2			Target areas / Performance metrics				
Process Category		**Process element name**	**Effectiveness /Reliability (Quality)**	**Responsiveness (Time)**	**Assets/ Costs**	**Flexibility**	**Effectivity/ Productivity**
Plan		Plan Adapt Packaging Service	Service Interaction Reliability			Service Operate Flexibility	
		Plan Build Packaging Service					
		Plan Operate Packaging Service	Service Interaction Reliability				
Adapt		Adapt Packaging Service	Service Adapt Effectivity	Service Adapt cycle time	Service Adapt costs	Service Adapt flexibility, Service interaction flexibility	
Build		Build Packaging Service		Service Build cycle time		Service Build flexibility	
Operate		Operate Packaging Service	Service Operating Input Quantity, Service Operating Input Quality, Service Operating Output Quantity, Service Operating Output Quality, Service Interaction Reliability, Service Object Input Quantity, Service Object Input Quality, Service Object Output Quantity	Service Operate cycle time, Interoperation time, Production/operation lead time	Service Operate costs, Service interaction costs, Production equipment charges, Material rework costs	Service operate flexibility, Service operate adaptability, service object flexibility, service object adaptability	Service Activity Input Efficiency, Service Activity Profitability, Service Object Cost Efficiency, Service Object Input Efficiency
Support		Support Packaging Service			Indirect/intangible costs related to activity	Resource flexibility in service operations, Service Adapt flexibility	Service Operating Costs / Total Service Costs, Service Operating Reliability / Service Fulfillment Cycle Time, Service Object Reliability / Service Object Production/Operating Cycle Time

Assignment of level 3 PIs to the Level 3 Processes

SIGPACK-Packaging Services Processes Level 3			Target areas / Performance metrics				
Process Category	**Interaction View**	**Process element name**	**Effectiveness /Reliability (Quality)**	**Responsiveness (Time)**	**Assets/ Costs**	**Flexibility**	**Effectivity/ Productivity**
Adapt	**Execute**	Process customer request	Number of customer contact points	Customer response time			
		Configure & adapt services		Time required until performing newly developed services	Number of project meetings for contract development, service adaptation costs	Number of customised/number of standard service operations, service offer adaptation possibility, willingness to cooperate, coping with changes and short-term needs	
		Negotiate and finalize service contract	Contract success rate		Number of additional meetings until signature		
	Plan	Identify, prioritize and aggregate service Adapt requirements					
		Identify, prioritize and aggregate service Adapt resources				Number of approved components that are allowed for service operation	
		Balance service Adapt requirements with resources					
		Establish Adapt Service Plan					
	Support	Manage Business Rules & Strategies					
		Manage Service Portfolio				Investments in personnel training and education, education level, number of languages spoken	
		Manage Customer Data					
		Maintain Contract Information					
		Manage potential service partner network				number of partners in the service network	

SIGPACK-Packaging Services Processes Level 3			Target areas / Performance metrics				
Process Category	**Interaction View**	**Process element name**	**Effectiveness /Reliability (Quality)**	**Responsiveness (Time)**	**Assets/ Costs**	**Flexibility**	**Effectivity/ Productivity**
Build	**Execute**	Coordinate involved service partners					
		Transport and/or procure needed component & services					
		Setup and/or install service system		installation time of required service hardware			
		Test and/or certify service system		Handover cycle time, timeframe for testing activities			
	Plan	Identify, prioritize and aggregate “Build” service requirements					
		Identify, prioritize and aggregate “Build” service resources					
		Balance “Build” service req’ments with resources					
		Establish “Build” Service Plan					
	Support	Manage service components’/elements’ profiles					
		Manage “Build” documentation					
Operate	**Execute**	Schedule PACKAGING activities	Quality of shared information, information flow integration			Service intensiveness flexibility, service delivery adaptability	
		Issue PACKAGING material	Supplier delivery performance				
		PACKAGE and Test	Quality of material used, personnel availability, number and probability of late services performed, number of accurate services performed, number of wrong services performed, forecast accuracy, **level 3 PIs from:** service object effectiveness, service object output quantity	Run-times, Setup time, Transportation time (of product and material)	Waste of material due to out-of-specification operations, Incentive costs, productivity changes costs, wage changes costs, exchange rates costs, number of activities that are non-conformant, energy consumption, leasing rate	Input flexibility, production/operation process flexibility, output flexibility, improvement flexibility	Cost per operating hour, downtime losses
		Transfer packaged products		Transportation time (of product)			

SIGPACK-Packaging Services Processes Level 3			Target areas / Performance metrics				
Process Category	**Interaction View**	**Process element name**	**Effectiveness /Reliability (Quality)**	**Responsiveness (Time)**	**Assets/ Costs**	**Flexibility**	**Effectivity/ Productivity**
Operate	**Execute**	Monitor packaging process		Time between measurement and analysis of performance data, time between the occurrence of an incident and the information of the customer	Number of conducted analyses at partner's site, frequency of data measurements		
		Conduct maintenance on PACKAGING equipment & software			Travel and subsidy costs, costs of materials used		
		Report Packaging Service Performance					
	Plan	Identify, Assess and Aggregate PACKAGING requirements	Quality of shared information, information flow integration				
		Identify, Assess and Aggregate PACKAGING resources					
		Balance Packaging resources with Packaging requirements					
		Establish PACKAGING Plans					
	Support	Manage PACKAGING rules and strategies					
		Manage PACKAGING performance			Service quality costs, core competence maintenance and improvement costs, performance measurement costs		Profit contribution
		Manage PACKAGING equipment, software and related services					OEE
		Manage PACKAGING material inventory					Stock turnover

Table 15: Assignment of PIs to the repositories (packaging cluster)

4.4 Retrofit Cluster

4.4.1 Cluster specific configuration

Service Satisfaction / Perception – PIs for Retrofit Services *Retrofit Services indicators are coloured black.

Effectiveness/Reliability (Quality)			**Responsiveness/Time**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Perceived Service Quality	*Service Operating Effectiveness/Availability*	*See encounter interface, plus corrective factor for perception,* **Adherence to the contract costs (PB3.2, PB3.3),**	Perceived Service Responsiveness	*Service delivery cycle time*	*See encounter interface, plus corrective factor for perception*
	Service Operating Output Quantity	*See encounter interface, plus corrective factor for perception*		*Service interaction cycle time*	*See encounter interface, plus corrective factor for perception*
	Service Operating Output Quality	*See encounter interface, plus corrective factor for perception*		*Service object operation lead time*	*See encounter interface, plus corrective factor for perception*
	Service Interaction Reliability	*See encounter interface, plus corrective factor for perception*		Promptness of service provider's reaction	
	Company's innovativeness	*See encounter interface, plus corrective factor for perception*			
	Service Object Effectiveness/Availability	*See encounter interface, plus corrective factor for perception*			

Effectiveness/Reliability (Quality)		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***
Perceived Service Quality	*Service Object Output Quantity*	*See encounter interface, plus corrective factor for perception*
	Service Object Output Quality	*See encounter interface, plus corrective factor for perception,* **Fulfillment of customer requirements and parameters regarding service object (O3.4, O3.5, O3.7, O3.8)**
	Service credibility	image, trustworthiness, visibility/transparency, honesty, appearance of personnel
	Service accessibility	Accessability convenience, approachability
	Service security	Confidentiality, discretion, financial security, risk safety
	Service communication	Provided information, appropriate language, channels to communicate
	Service empathy	Sensitivity, problem solving capability, complaint handling behavior
	Service project management	Deviations of project plan, deviations from to-be to as-is performance
	Customer Loyalty	

Flexibility			**Assets/Costs**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Perceived Service Flexibility	*Service Operating Flexibility:*	*See encounter interface, plus corrective factor for perception*	Perceived Service Costs	Service Provider's Invoice	
	Service Adapt flexibility	*See encounter interface, plus corrective factor for perception*		Reference Value	The reference value is the cost of whatever competing service the customer views as the best substitude for the service being evaluated
	Service Build flexibility	*See encounter interface, plus corrective factor for perception*		Differentiation Value	The added value is the increased level of economic value that the customer can expect from the service offered compared to the Reference Service
	Service Operating Adaptability:	*See encounter interface, plus corrective factor for perception*		Total Value Added	The total value is determined first and foremost by what customers` alternatives are. It is the custumers` best alternative plus the value of whatever differentiates the offering from the alternative. The total value also is the maximum price a buyer, ful
	Service Interaction Flexibility	*See encounter interface, plus corrective factor for perception*		Sharable Value	The sharable economic value is the difference between the total value and the sellers` costs, which the seller can share with customers
	Resource adaptability to modifications of the service object production/operation process	*See encounter interface, plus corrective factor for perception*		Willingness to pay	The perceived value of a product is the maximal price the customer is willing to pay for the total bundle of benefits the service delivers
	Resource flexibility in service operations	*See encounter interface, plus corrective factor for perception*			
	Service Object Production/Operating flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity produced)	*See encounter interface, plus corrective factor for perception*			
	Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints)	*See encounter interface, plus corrective factor for perception*			

Table 16: Service Satisfaction / Perception (retrofit cluster)

Service Encounter Interface - Service activity PIs for Retrofit Services *Retrofit Services indicators are coloured black.

Effectiveness/Reliability (Quality)			**Responsiveness/Time**			**Flexibility**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Operating Reliability:	Service Operating Effectiveness/Availability	Material availability, **Quality of material used (B3.4, B3.5, O3.2),** personnel availability, IT availability, Number and probability of late services performed, Number and probability of backorders, on-time service operations and deviations, Number of additional unscheduled trips, Number of partner contact points, Average availability of service at point of consumption, partner performances, market share, **Partners' time reliability (B3.1, B3.4, O3.6)**	Service Fulfillment Cycle Time:	Service delivery cycle time (if initiated by order/signal)	Order lead time, **Quotation lead time (A3.1, A3.2), Material delivery lead time (B3.4), handover cycle time (O3.6),** Overdue trade receivables, installation time of required service hardware, time between measurement and analysis of performance data, time between occurance of an incident and the information of the customer, timeframe for testing activities, **Process lead time (SA3.1, PB3.2, PB3.3, B3.2, B3.3, B3.5, O3.2, O3.3, O3.4, O3.5, O3.7, O3.8) Disassembly lead time (B3.1, B3.2, O3.6) Assembly lead time (O3.1, O3.6) Transportation lead time (B3.1, O3.6), MTTR (Mean time to respond or repair) (O3.8)**	Service Activity Flexibility:	Service Operating Flexibility:	Number of customised service operations / Number of standard service operations, number of approved components that are allowed for service operation, Service intensiveness flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity/intensiveness delivered)
	Service Operating Output Quantity	Number of accurate services performed, Number of wrong services performed		Service Interaction Cycle Time	Handover cycle time, coordination cycle time (PA3.1, PA3.2, PB3.1), **Process lead time (PO3.1), Contract lead time (A3.3)**		Service Adapt flexibility	Service contract inquiry success rate, Service offer adaptation possibility, number of partners in the service network

Effectiveness/Reliability (Quality)			Responsiveness/Time			Flexibility		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Operating Reliability:	Service Operating Output Quality	Warehouse picking accuracy, inventory accuracy, **paperwork accuracy (O3.3)**, Payment accuracy, Forecast accuracy, **Service providers time reliability (PB3.2, PB3.3, B3.1, B3.2, B3.3, B3.4, B3.5, SB3.2, PO3.1, O3.1, O3.2, O3.3, O3.4, O3.6, O3.7), Installation accuracy (O3.2), Disassembling accuracy (B3.1, B3.2, O3.6), Assembling accuracy (O3.6), Transportation accuracy (B3.1, O3.6)**				Service Activity Flexibility:	Service Build flexibility	Time required until performing new developed services, Number of additional contacts to customer after contract signment
	Service Interaction Reliability	Information flow integration, availability of shared information systems, **quality of shared information (A3.2),** number of customer contact points, number of required additional information					Service Operating Adaptability:	Service delivery adaptability (the maximum sustainable percentage increase in quantity/intensiveness that can be achieved in 30 days)
Company's Innovativeness	New launches of services	New services launched in a time period, percentage sales of new services to whole service sales					Service Interaction Flexibility	Willingness to cooperate, coping with changes and short-term needs, number of partners in the service network, number of successful process changes coming from involved operational players
	Use of new technologies					Service Resources Flexibility	Resource adaptability to modifications of the service object production/operation process	Workforce Map of Knowledge, Workforce degrees of expertise and know-how
	New service performance accuracy	Percentage of wrong service performances after new service design is launched					Resource flexibility in service operations	Investments in personnel training and education, education level, number of languages spoken

Assets/Costs			**Efficiency/Productivity**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Operating Costs:	Service Operation costs	**Cost of material used (O3.4, O3.5, O3.7), Transportation and handling costs (O3.6),** material inventory costs, waste of materials due to out-of-specification operations, **direct labour costs (O3.1, O3.2, O3.3, O3.4, O3.5, O3.6, O3.7**) travel and subsidy costs, number of conducted analyses at partner's site, frequency of data measurements, service equipment maintenance costs, **maintenance costs (O3.8)**	Service Activity Cost Efficiency (= Service Operating Reliability / Service Operating Costs)	Average costs per correct service delivery	
	Service Adapt costs	Service contract inquiry processing effort, Service design/adaption costs, number of project meetings for contract development, **direct labour costs (SA3.1, A3.1, A3.2, A3.3)**	Service Activity Input Efficiency (= Service Operating Reliability / Service Fulfillment Cycle Time or SA Input Quantity)	Average cycle time for correct service delivery, stock turnover	
	Service Build costs	Number of conducted HW / SW tests, **direct labour costs (B3.1, B3.2, B3.3, B3.4, B3.5), transportation and handling costs (B3.1)**	Service Activity Profitability (= Service Operating Costs / Total Service Costs)	Profit contribution (Deckungsbeitrag)	
	Indirect / intangible costs related to activity	Transaction costs, Administration costs, Incentive costs, Taxes, Service Quality costs, Service Adaptation costs, Performance Measurement costs, Productivity changes costs, wage changes costs, exchange rates costs, Core competence maintenance and improvement costs	Service Activity Time Efficiency (= Service Fulfillment Cycle Time / Average Service Fulfillment Cycle Time)	Productive hours, …	Productive hours, …
	Service Interaction costs	Suppliers' margins, number and costs of service activities that are non-conformant, service re-work costs, handover costs	Reference Service costs	Differentiation value, reference value, total value added	Differentiation value, reference value, total value added
	Duty costs				

Table 17: Service Encounter Interface - Service Activity (retrofit cluster)

Service Encounter Interface - Service object PIs for Retrofit Services *Retrofit Services indicators are coloured black.

Effectiveness/Reliability (Quality)			**Responsiveness/Time**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Object Reliability:	Service Object Effectiveness/Availability	Adherence to schedule, **Unscheduled Downtime (O3.8),** Scheduled Downtime, Effective run-time	Service Object Production/Operating Cycle Time:	Production/operation lead time	Setup time
	Service Object Output Quantity	Nominal output, Setup output, Effective output, Operating output, Downstream capacity, Upstream input			Run-time (nominal run-time, setup run-time, effective run-time, operating run-time)
	Service Object Output Quality	Output product quality		Interoperation time	Waiting time
					Inspection time
					Transportation time
				Administration time	

Flexibility			**Assets/Costs**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Object Flexibility:	Service Object Production/Operating flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity produced)	Input flexibility, production/operation process flexibility, output flexibility, improvement flexibility	Service Object Production/Operating Costs:	Production labor costs	Direct labor costs, indirect labor costs related to activity and non-service related
Service Object Adaptability:	Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints)			Maintenance costs (if not outsourced)	
				Material re-work costs	
				Production equipment charges	Energy consumption, leasing rate, depreciation, (operation hours, hourly cost rate when running)
				Consumables costs	

Service Encounter Interface - Service object PIs for Retrofit Services

*Retrofit Services indicators are coloured black.

Efficiency/Productivity		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***
Service Object Cost Efficiency(= Service Object Reliability / Service Object Production/Operating Costs)	Cost per operating hour, hourly cost rate when running, downtime losses	
Service Object Input Efficiency (= Service Object Reliability / Service Object Production/Operating Cycle Time or SO Input Quantity)	OEE	
Operators' behavior		

Table 18: Service Encounter Interface - Service Object (retrofit cluster)

4.4.2 Assignment of PIs to the repositories

3rd level PIs

Process Category	Process element name	Target areas: Service Reliability (Quality)	Service Responsiveness (Time)	Service costs	Service Flexibility	Service Productivity
Adapt	PA3.1 Define Project Team for Adapt Phase		Coordination cycle time (Time needed for defining the project team)			
	PA3.2 Define draft work plan		coordination cycle time (Time needed for defining the draft work plan)			
	A3.1 Process Customer request		Quotation lead time (Time needed for generating the first offer)	Direct labour costs (Costs for generating the first offer)		
	A3.2 Redefine customer specific requirements	Quality of shared information (Level of deviation from the first offer)	Quotation lead time (Time needed for generating the final offer)	Direct labour costs (Costs for generating the final offer)		
	A3.3 Negotiate Final Offer & Finalise the contract		Contract lead time (Time needed for finalizing the contract)	Direct labour costs (Costs for finalizing the contract)		Contract success rate (Success rate),
						Profit contribution (Deckungsbeitrag) (Margin (benefit in %))
	SA3.1 Request offers from component / service suppliers		Process lead time (Time needed for receiving the offers)	Direct labour costs (Costs for requesting offers)		
Build	PB3.1 Define Project Team for Build Phase		Coordination cycle time (Time needed for defining the project team)			
	PB3.2 Plan Transportation	Service providers time reliability (Time Reliability)	Process lead time (Time needed for completing the transportation plan)			
		Adherence to the contract costs				
	PB3.3 Plan Procurement	Service providers time reliability (Time Reliability)	Process lead time (Time needed for completing the procurement plan)			
		Adherence to the contract costs				

Process Category	Process element name	Target areas: Service Reliability (Quality)	Service Responsiveness (Time)	Service costs	Service Flexibility	Service Productivity
Build	B3.4 Procure Component / Services from suppliers & quality check	Supplier on schedule,	Material delivery lead time (Time needed for the procurement & quality check)	Direct labour costs (Cost of the procurement & quality check process)		
		Quality of material used (Quality of the procured components),				
		Partners' time reliability (Time Reliability)				
		Service providers time reliability (Time Reliability)				
	B3.5 Restorate / Retrofit & quality check of the components	Quality of material used (Quality of the self made components),	Process lead time (Time needed for the retrofit & quality check)	Direct labour costs (Cost of the retrofit & quality check process)		
		Service providers time reliability (Time Reliability)				
	SB3.1 Maintain list of suppliers & logistic providers					
	SB3.2 Manage Transportation	Service providers time reliability (Time Reliability)				
	SB3.3 Support Procurement Documentation					
Operate	PO3.1 Plan Preliminary Production Test	Service providers time reliability (Time Reliability)	Process lead time (Time needed for completing the preliminary production test plan)			
	O3.1 Reassemble / Install of the improved system	Service providers time reliability (Time Reliability)	Assembly lead time (Time needed for reassembly / installation)	Direct labour costs (Costs of the reassembly / installation process)		
	O3.2 Start-up and quality check of the main system modules	Quality of material used (Quality of the modules),	Process lead time (Time needed for the start-up & quality check)	Direct labour costs (Costs of the start-up & quality check process)		
		Installation accuracy (Number of installation errors),				
		Service providers time reliability (Time Reliability)				
	O3.3 Document the Retrofitted Production System	Paperwork accuracy (Legal conformity (EU, ISO standards)),	Process lead time (Time needed for prepare the documentation)	Direct labour costs (Documentation costs)		
		Paperwork accuracy (Customer requirements conformity),				
		Service providers time reliability (Time Reliability)				
		Paperwork accuracy (Completeness)				
	O3.4 Internal test and failure elimination	Service providers time reliability (Time Reliability)	Process lead time (Time needed for the tests & failure elimination)	Direct labour costs (Tests & failure elimination costs)		

Process Category	Process element name	Target areas Service Reliability (Quality)	Service Responsiveness (Time)	Service costs	Service Flexibility	Service Productivity
Operate	O3.5 Preliminary acceptance of the customer		Process lead time (Time needed for tests & failure elimination)	Direct labour costs (Tests & failure elimination costs)		
		Fulfillment of customer requirements and parameters regarding service object (Fulfillment of customer requirements and parameters)		Cost of material used (Tests & failure elimination costs)		
	O3.6 Deliver the system (disassembling – transport – reassembling at the customer)	Disassembling accuracy (Amount of defects during disassembling),	Disassembly lead time (Time needed for transportation and disassembling)	Transportation and handling costs (Transportation and disassembling costs)		
		Assembling accuracy (Amount of defects during assembling)	Assembly lead time (Time needed for transportation and disassembling)	Direct labour costs (Transportation and disassembling costs)		
		Transportation accuracy (Amount of defects during transport),	Transportation lead time (Time needed for transportation and disassembling)			
		Partners' time reliability (Time Reliability)	Handover cycle time (new)			
		Service providers time reliability (Time Reliability)				
	O3.7 Support Testing & Tuning of System Performance	Service providers time reliability (Time Reliability)	Process lead time (Time needed for testing, tuning, failure elimination, training)	Direct labour costs (Costs for testing, tuning, failure elimination, training, Paid auxiliary services)		
		Fulfillment of customer requirements and parameters regarding service object (Fulfillment of customer requirements and parameters)		Cost of material used (Costs for testing, tuning, failure elimination, training, Paid auxiliary services)		
	O3.8 Maintain the Performance of Machine	Unscheduled Downtime (Machine availability (MTBF – Mean time between failure)),	Process lead time (Time needed to maintain the machine)	Maintenance costs	MTTR (Mean time to respond or repair)	
		Fulfillment of customer requirements and parameters regarding service object (Adherence to quality parameters)				
	SO3.1Manage Testing Equipment					

Table 19: Assignment of PIs to the processes (retrofit cluster)

4.5 Quality Control cluster

4.5.1 Cluster specific configuration

Service Encounter Interface - Service activity PIs for Quality Control Services *Quality Control indicators are coloured black.

Effectiveness/Reliability (Quality)			**Responsiveness/Time**			**Flexibility**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Operating Reliability:	Service Operating Effectiveness/Availability	Material availability, **Quality of material used**, **personnel availability**, IT availability, Number and probability of late services performed, Number and probability of backorders, **on-time service operations and deviations**, Number of additional unscheduled trips, **Number of partner contact points**, Average availability of service at point of consumption, partner performances, market share	Service Fulfillment Cycle Time:	Service delivery cycle time (if initiated by order/signal)	**Order lead time, Quotation lead time,** Material delivery lead time, **handover cycle time,** Overdue trade receivables, **installation time of required service hardware**, **time between measurement and analysis of performance data**, time between occurance of an incident and the information of the customer, **timeframe for testing activities, time for definition of requirements, negotiation time, lead time for correction of wrong parts**	Service Activity Flexibility:	Service Operating Flexibility:	**Number of customised service operations** / **Number of standard service operations,** number of approved components that are allowed for service operation, **Service intensiveness flexibility** (the number of days required to achieve an unplanned sustainable 20% increase in quantity/intensiveness delivered)
	Service Operating Output Quantity	**Number of accurate services performed, Number of wrong services performed**		Service Interaction Cycle Time	**Handover cycle time**, coordination cycle time		Service Adapt flexibility	**Service contract inquiry success rate, Service offer adaptation possibility**, number of partners in the service network
	Service Operating Output Quality	Warehouse picking accuracy, inventory accuracy, paperwork accuracy, Payment accuracy, Forecast accuracy,					Service Build flexibility	**Time required until performing new developed services**, **Number of additional contacts to customer after contract signment**
	Service Interaction Reliability	**Information flow integration, availability of shared information systems, quality of shared information, number of customer contact points, number of required additional information**					Service Operating Adaptability:	**Service delivery adaptability** (the maximum sustainable percentage increase in quantity/intensiveness that can be achieved in 30 days)

Service Encounter Interface - Service activity PIs for Quality Control Services *Quality Control Services indicators are coloured black.

Effectiveness/Reliability (Quality)			Responsiveness/Time			Flexibility		
Level 1 metric:	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*	*Level 1 metric:*	*Level 2 metric:*	*Level 3 metric:*
Company's Innovativeness	New launches of services	New services launched in a time period, percentage sales of new services to whole service sales				Service Activity Flexibility:	Service Interaction Flexibility	Willingness to cooperate, **coping with changes and short-term needs**, number of partners in the service network, **number of successful process changes coming from involved operational players**
	Use of new technologies					Service Resources Flexibility	Resource adaptability to modifications of the service object production/operation process	Workforce Map of Knowledge, Workforce degrees of expertise and know-how
	New service performance accuracy	Percentage of wrong service performances after new service design is launched					Resource flexibility in service operations	Investments in personnel training and education, education level, number of languages spoken

Assets/Costs			**Efficiency/Productivity**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Operating Costs:	Service execution costs	Cost of material used, **Transportation and handling costs, material inventory costs**, waste of materials due to out-of-specification operations, **direct labour costs,** travel and subsidy costs, **number of conducted analyses at partner's site**, **frequency of data measurements**, **service equipment maintenance costs**	Service Activity Cost Efficiency (= Service Operating Reliability / Service Operating Costs)	Average costs per correct service delivery	
	Service Adapt costs	**Service contract inquiry processing effort**, Service design/adaption costs, **number of project meetings for contract development**	Service Activity Input Efficiency (= Service Operating Reliability / Service Fulfillment Cycle Time or SA Input Quantity)	Average cycle time for correct service delivery, stock turnover	
	Service Build costs	**Number of conducted HW / SW tests**	Service Activity Profitability (= Service Operating Costs / Total Service Costs)	Profit contribution (Deckungsbeitrag)	
	Indirect / intangible costs related to activity	**Transaction costs, Administration costs,** Incentive costs, Taxes, **Service Quality costs**, Service Adaptation costs, **Performance Measurement costs,** Productivity changes costs, wage changes costs, exchange rates costs, **Core competence maintenance and improvement costs**	Service Activity Time Efficiency (= Service Fulfillment Cycle Time / Average Service Fulfillment Cycle Time)	Productive hours	
	Service Interaction costs	Suppliers' margins, number and costs of service activities that are non-conformant, service re-work costs, **handover costs**	Reference Service costs	Differentiation value, reference value, total value added	
	Duty costs				

Table 20: Service Encounter Interface - Service Activity (quality control cluster)

Service Encounter Interface - Service object PIs for Quality Control Services *Retrofit Services indicators are coloured black.

Effectiveness/Reliability (Quality)			**Responsiveness/Time**			**Flexibility**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Object Reliability:	Service Object Effectiveness/Availability	**Adherence to schedule,** Unscheduled Downtime, Scheduled Downtime, Effective run-time	Service Object Production/Operating Cycle Time:	Production/operation lead time	**Setup time**	Service Object Flexibility:	Service Object Production/Operating flexibility (the number of days required to achieve an unplanned sustainable 20% increase in quantity produced)	Input flexibility, **production/operation process flexibility**, output flexibility, improvement flexibility
	Service Object Output Quantity	Nominal output, **Setup output,** Effective output, Operating output, Downstream capacity, Upstream input			Run-time (nominal run-time, setup run-time, **effective run-time**, operating run-time)	Service Object Adaptability:	Upside SOURCE/MAKE/DELIVER adaptability (the maximum sustainable percentage increase in sourcing/production/delivery that can be achieved in 30 days with the assumption of no raw material constraints)	
	Service Object Output Quality	**Output product quality**		Interoperation time	**Waiting time**			
					Inspection time			
					Transportation time			
				Administration time				

Assets/Costs			**Efficiency/Productivity**		
Level 1 metric:	***Level 2 metric:***	***Level 3 metric:***	***Level 1 metric:***	***Level 2 metric:***	***Level 3 metric:***
Service Object Production/Operating Costs:	Production labor costs	Direct labor costs, indirect labor **costs related to activity and non-service related**	Service Object Cost Efficiency(= Service Object Reliability / Service Object Production/Operating Costs)	Cost per operating hour, hourly cost rate when running, downtime losses	
	Maintenance costs (if not outsourced)		Service Object Input Efficiency (= Service Object Reliability / Service Object Production/Operating Cycle Time or SO Input Quantity)	OEE	
	Material re-work costs		Operators' behavior		
	Production equipment charges	**Energy consumption**, leasing rate, depreciation, (operation hours, hourly cost rate when			
	Consumables costs				

Table 21: Service Encounter Interface - Service Object (quality control cluster)

4.5.2 Assignment of PIs to the repositories

			Target areas / Performance metrics				
Process Category	**Interaction view**	**Process element name**	**Effectiveness /Reliability (Quality)**	**Responsiveness (Time)**	**Assets/ Costs**	**Flexibility**	**Effectivity/ Productivity**
Adapt	**Execute**	Process customer request	success rate	response time	Service contract inquiry processing effort	number of customized service operations, number of standard service operations	
		Examine Customer Specific Requirements (products and quality levels)	number of additional contacts to the customer	handover cycle time, time for definition of requirements	Transaction costs	service intensivenesss flexibility	
		Check availability of supplier's capacity					
		Negotiate Service Contract between Customers and Service Provider	number of additional contacts to the customer and the supplier	negotiation time	negotiating / contracting costs, number of project meetings for contract development, transaction costs	service offer adaptation possibility, service contract inquiry success rate	
		Finalize Service Contract between Customers and Service Provider	success rate		administration costs		
		Identify, Prioritize and Aggregate own service competencies and capacities	number of required additional information				
	Plan	Balance customer requirements with own competencies and capacities	quality of shared information			coping with changes and short term needs	
	Support	Manage supplier profiles					
Build	**Execute**	Transfer customer requirements to the supplier		handover cycle time	handover costs	time required until performing new developed services	
		Set up, install and test quality control equipment, software and related services	set-up output	installation time of required service hardware, set-up time	costs for rework, number of conducted HW/ SW tests, handover costs	number of additional contacts to the customer after contract signment	number for rework
		Certify supplier (sample production & quality check)	output product quality		number of conducted analyses at partner`s site		
	Support	Manage product profiles					
Operate	**Execute**	Process customer order	number of partner contact points	order lead time, quotation lead time	service quality costs, performance measurement costs	number of successful process changes coming from involved operational players	average costs per correct service delivery
		Receive products and check quality	product quality, quality of material used, personnel availability	time between measurement and analysis of performance data, timeframe for testing activities	material inventory costs, direct labor costs, costs related to activity and non-service related, service equipment maintenance costs	service delivery adaptability	average cycle time for correct service delivery, OEE
		Process defect parts		lead time for correction of wrong parts, effective run-time	frequency of data measurement	production/operation process flexibility	costs per operating hour
		Ship correct orders to customer	perfect order fulfillment	transportation time	transportation and handling costs		
		Conduct quality workshops with suppliers	number of workshops with suppliers				
	Support	Manage supplier availability		waiting time			
		Manage defect parts policies					
		Monitor suppliers' performance	Information flow integration, availability of shared information systems				

Table 22: Assignment of PIs to the repositories (quality control cluster)

5 Application of SPMS to practical surroundings

5.1 Introduction

In chapter 5, first, the methodology to implement and make use of the SPMS is outlined. It describes as a guideline how the SPMS can be used and is based on the discussion given in section 2.2. Therefore, in section 5.2 some general considerations and a procedure are given. Second, in section 0 the approach for the validation of the SPMS is outlined as starting point for deliverable DL.4.4.

5.2 Methodology to implement and make use of SPMS

Some recommendations for the realisation of the following phases:

- Workshops with cross-functional teams (top management, operations, services, marketing, customers support etc.) should be used.
- Management commitment is very important.
- Use asking techniques to determine requirements.
- Build prototype in order to give ideas of the results and demonstrate potential benefits.
- Take concepts (reports, scorecards etc.) and approaches for performance measurement that are already in use in the company into account.

5.2.1 Design

Goal definition

1. *Identify strategic objectives:* A service provider has to identify the firm`s strategic objectives related to the services using the following input:
    - Normative input: mission statement, vision, corporate values, quality policy
    - Strategy: corporate and competitive strategy, competitive advantages, competitive positioning
    - Requirements from stakeholders, in particular from customers
    - Order qualifiers (minimum requirements a company has to fulfil in order to be a viable competitor in a specific market) and order winners (requirements that cause customers to choose the goods and services from a specific enterprise (competitive advantage)) (Hill, 1989). The common categories of order qualifiers and order winners are: price, quality, reliability, speed, flexibility, support, etc.
    - SWOT analysis (strengths, weaknesses, opportunities, and threats) as a conclusion
2. *Identify value creation areas (VCAs) and critical success factors (CSF):* Based on these strategic objectives, identify how customer benefit (value-added) is created, e.g.,
    - improving quality of output,
    - increasing output (capacity),
    - increasing availability,

- improving reliability,
- improving speed/time (cycle time, lead time),
- improving Overall Equipment Effectiveness (OEE),
- enhancing flexibility,
- decreasing life cycle costs.

These areas correspond to the VCAs. When identifying them, the aforementioned order qualifiers should be considered. For instance, customers in a certain market require low prices. This can be supported, for instance, by the VCAs of low life cycle costs. Furthermore, CSFs have to be identified that relate to the VCAs. CSFs are a limited subset of VCAs (or a decomposition of them) in which good performance is critical in order to ensure competitiveness. Often, they relate to the aforementioned order winners. In the example given above, a company may focus on those customers who want low maintenance costs. Thus, the company may gain competitive advantage by fulfilling this CSF.

3. *Mapping to the SPMS:* The identified strategic objectives now have to be mapped to the target areas covered by the SPMS. For example, quality and cost, or flexibility and productivity could be chosen as the most important target areas concerning the external needs of the customers and internal factors of success of the service provider himself. This should be done as a team effort, involving different decision makers (e.g. senior managers, business units or functional managers etc.).
4. *Prioritisation of target areas:* In the next step, the chosen target areas should be prioritised in accordance with the results of the preceding considerations. For example, following a productivity strategy, costs may have the highest priority since customers are very cost-sensitive as long as their requirements are mostly fulfilled.

PI definition

Based on the previous phase of goal definition, the aim of this phase is to define relevant key performance indicators (KPIs) and performance indicators (PIs) from the repository of PI given in sec. 3.4. To ensure the successful implementation of the SPMS, the company's management commitment and the commitment of the personnel staff is needed.

5. *Define KPIs:* Individual performance "modules" could be picked by the service provider from the highest levels of the SPMS and arranged dependent on their specific needs, particularly according to the CSFs. This is enabled by the simple structure of the SPMS and ensures the limited number of KPIs collected by the company.
6. *Define PIs:* The further step is to add specific PIs on the 3rd and 4th levels of the SPMS and to adapt the SPMS to the specific business environment of the service provider.
7. *Identify influencing factors, if necessary:* If there are some relevant influencing factors, which are specific and more technical and influence some relevant performance indicators to a very high degree, they have to be included. For example, if quality rate is influenced by humidity, an indicator for humidity will be added. Of course, humidity is no performance indicator.
8. *Consider clusters and processes:* Additionally, PIs can be added that are related to the specific clusters and processes as presented in chapter 4: Processes of the InCoCo-S

Reference Model (IRM) can be identified that contribute to the VCAs and CSFs, i.e., that add value to industrial service and improve competitiveness. They are connected to PIs (see chapter 4). The set of PIs to be measured and improved can be supplemented accordingly.

5.2.2 Implement

In order to implement the SPMS, particularly the following aspect should be taken care of:

9. *Define processes:* Processes related to the collecting, processing, storage, and presentation of data have to be defined. In particular, reports and scoreboards have to be specified in detail such as level of detail and aggregation, measurement frequency, comparisons. In particular, the process of measuring the performance has to be specified. For this, the processes that are related to the PIs can be identified on the basis of the InCoCo-S Reference Model (IRM) according to chapter 4. Moreover, the processes to be carried out in the use phase have to be specified: assessment of performance (see section 2.2.3), communication, performance improvement, and rewarding (see section 2.2.2).
10. *Assign responsibilities:* Accordingly, organisational responsibilities have to be set, i.e., who, when, and how.
11. *Set-up information system (IS):* A system and processes have to be established that facilitate collecting, processing, storage, and presentation of data related to the PIs. Usually, such systems are supported by information technology (IT), and, as a consequence, attention has to be paid to IT related issues such as hardware, software, support, etc.

5.2.3 Use

In this phase, the SPMS is being used (operated).

12. *Establish a performance plan:* A plan has to be elaborated, which specifies the quantified targets of the PIs in a short, middle, and long term perspective.
13. *Assign responsibility for achievement:* In order to get results and encourage commitment, it is important to assign the responsibilities for the achievement of the objectives as defined in the performance plan.
14. *Measure performance:* The PIs have to measured according to the defined processes and responsibilities.
15. *Assess performance:* The measurements have to be compared to the targets (taken from the performance plan) and possibly to benchmarks, they have to be interpreted. Gaps and improvement potential have to be identified.
16. *Initiate performance improvements (action):* Possible actions to improve performance have to be identified. For this, for example, related processes (see chapter 4) have to be analyzed and best practices (deliverables DL.3.1 and DL.3.3) can be used. An action plan has to be set up and implemented.
17. *Communicate performance:* The measurement and the assessment as well as the proposed actions have to be communicated in an appropriate way, e.g., using reports and scoreboards. This serves as a feedback to organisational units and individuals.
18. *Reward performance:* Individuals and organisational units have to be rewarded for their performance based on the performance plan. By this, they are further encouraged. The rewarding should be connected to the overall reward system of the

company.

19. *Repeat and adapt:* The steps of the use phase have to be repeated and adapted on a regular basis. In particular, the performance plan and the performance improvements (actions) have to be updated. Moreover, the SPMS has to be scrutinised periodically whether it has to be adapted to changes in the company (strategy, vision etc.) or its environment (customers, competition etc.).

5.3 Preparation of validation at the industrial partners

5.3.1 Theoretical approach

The purpose of the validation foreseen in task T.4.4 of the InCoCo-S project is to demonstrate that the SPMS (including the methodology to implement and make use of it) is

- complete in terms of target areas, levels, perspectives, phases, and steps;
- consistent among levels and steps as well as to the other deliverables, in particular the InCoCo-S Reference Model;
- correct, i.e., reflects technically state-of-the-art and industrial requirements and does not have flaws;
- applicable in practice at industrial partners and is
- beneficial for them, i.e., is of value added with regard to transparency of performance and leads to improved decision making.

The validation will be done by means of case studies at industrial partners. However, they serve only as proof of concept, i.e., the SPMS will not be implemented, it will be assessed in terms of the aforementioned criteria.

In order to ensure validity and reliability of the case studies, particularly, the following measures will be taken (Yin, 2003; Stuart et al., 2002): Subjective judgments will be precluded by conducting several workshops and a large number of interviews as well as using multiple sources. Moreover, chains of evidence have to be developed using the SPMS and the methodology to implement and make use of it. Internal validity is supported by the use of both as well as by comprehensive argumentation. External validity will be sufficient but remains restricted due to the limited cases that will be described. Nevertheless, findings are expected to be more or less generalisable since the cases differ widely in terms of their characteristics of companies and their contexts. Moreover, reliability is guaranteed thorough detailed documentation prepared during the project.

The validation will be done in workshops using structured interviews and guidelines. This will be documented by means of case study protocols (Yin, 2003).

5.3.2 Practical approach

The realisation of the validation will be carried out in several phases:

- Phase 1: assess completeness, consistency, correctness, novelty of the SPMS as outlined above.
- Phase 2: assess completeness, consistency, correctness, and novelty of the methodology to implement and make use of the SPMS as outlined above.
- Phase 3: carrying out the methodology to implement and make use of the SPMS as a simulation: design phase as described, the other two phases on a hypothetical basis. In particular, the following questions should be answered:
    - Are the steps logical and aimed? Do they lead to meaningful results?
    - What is the difference to the as-is? Is this beneficial?
    - What will be the resources and efforts required in implementing it?

- What are the limitations?
- What are the overall benefits? What is the impact?

In order to facilitate these phases, a plan has to be set up, which specifies workshop contents and agendas as well as detailed guidelines. The workshops will be guided by academic partners and held at industrial partners. For efficiency, preparatory work will be taken into consideration.

6 Conclusion & Outlook

From a service provider`s perspective transparency on service operation performance can be seen as an essential precondition facilitating them to commit themselves to long-term service agreements with customers. The application of the SPMS enables service providers to measure the performance and to identify potential for service operation improvement. Thus, it helps increasing customer satisfaction. Transparency on service activities (particularly costs) and the resulting influence on the customers` service object provides providers with a strong argumentation with regard to benefits and pricing of services. The customer can make use of the system regarding benchmarking service offerings among competitive service providers. Referring to the packaging machine industry, the customer is interested in high machine availability and increased machine output as well as low operational and maintenance costs. The SPMS gives them the opportunity to create the basis for make-or-buy decisions relating to outsourcing elements of their production system. In addition, the SPMS helps customers to realise the influence of well co-coordinated proactive services on their overall production performance.

The presented SPMS addresses the integrative character of industrial service operations by highlighting the interaction between customers and service providers. The SPMS provides both, service providers and customers with a structured set of comprehensive PIs, which are qualified for measuring service operations performance and are applicable to a wide range of industrial services. Within further research activities in Task 4.3, the interdependencies and correlations between PIs will be investigated by using a simulation tool. Therefore, the PIs will be assigned to several service processes over all three levels in order to show the impact of service activity processes (level 3) on the service object highlighting the importance of coordination and collaboration.

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8 Annex

8.1 Budapest workshop results

Workshop Results		SIGPACK	COMAU	SKF
Benefits from customer perspective/ Value-added for the customer	**Identify the two high level PIs which are most important for your customer (e.g. machine availability/ costs)**	•Output: increase production capability,lower alternative cost •Cost: direct EBIT impact	•Machine productivity**:** Increase the availability of the machine Increase the output per unit time (when the machine is available) •Cost**:** Manufacturing costs (trade-off between production and maintenance costs) Production costs (influenced by maintenance costs) Maintenance costs	•Time •Decrease Costs • Increase Quality
	Identify 1-3 more high-level PIs important for your service operation	•Logistics KPIs/Delivery reliability: Order lead time, overdue trade receivables, productive hours, order time on delivery •Production/Capacity KPIs: Machine speed, error rate,effective run time (run time/total plan), effective output (actual/plan) •Assets/Cost/Price KPIs: cost transparency, customer specific pricing, material group pricing	•Uptime •Material (spare parts) availability •Knowledge of the operators (assessed through a map of knowledge and a degree of expertise)	•Quality of SKF response/ Responsiveness of SKF to customer requests •Quality of SKF analysis •Process cost •Customer Satisfaction with SKF response •Price of SKF service •Performance of SKF-Service / unscheduled downtime
	Filter the relevant PIs from the pool through all levels	•Manufacturing costs(MC): Labour costs Maintenance costs (overall cost of the maintenance service provider) Re-work costs (possible re-works due to out-of-specification operations) Down-time losses Purchased material costs (possible wastes of raw materials due to out-of-specification operations) Equipment charges •Machine productivity /output (MP): Machine availability Down time caused by technical reasons Machine stops caused by technical reasons Down time caused by organisational reasons Machine stops caused by organisational reasons Product availability Machine output per unit time (when the machine is available) Nominal output, setup output, effective output, operating output, product quality number of defect products, amount of waste	• Manufacturing costs(MC): Labour costs Maintenance costs (overall cost of the maintenance service provider) Re-work costs (possible re-works due to out-of-specification operations) Down-time losses, purchased material costs (possible wastes of raw materials due to out-of-specification operations), equipment charges •Machine productivity(MP): Machine availability, down time caused by technical reasons, machine stops caused by technical reasons, down time caused by organisational reasons, machine stops caused by organisational reasons, product availability, machine output per unit time (when the machine is available), nominal output, setup output, effective output, operating output, product quality number of defect products, amount of waste	•Time: Customer response time Lead time: Production lead time, distribution lead time, product lateness, delivery flexibility, delivery rate, late/wrong deliveries, order cycle time, perfect order fullfillment •Quality: customer satisfaction number of customer complaints product quality •Cost: Transportation and handling cost, safety stock cost, duty cost manufacturing cost: labour cost, maintenance cost, re-work cost, purchased materials cost, equipement charges, supplier`s margins; profit: cash-to-cash cycle time, profit margins; Sales: Total revenue

Identify influencing factors for the selected performance indicators and potential activities for the selected high-level performance indicators	•Continuous Line Optimizations through Continuous Measurements/Observations/ Preventive Maintenance •Exchange of wear and tear parts through Continuous Measurements/Observations/ Use normal downtimes to exchange parts/parts logistic transparency; •Organizational Optimizations through Continuous Measurements/ Observations; •Factory Environment through Continuous Measurements •Material Cost (Customer and Bosch perspective): through spare parts cost / pricing transparency •Labor Cost (customer perspective) through Preventive Maintenance/ Line Know-How;	•Optimal trade-off between manufacturing costs and machine productivity •Optimal trade-off of planned maintenance interventions and breakdown maintenance interventions •More ready-to-operate maintenance personnel co-located at customer site •More experienced and trained maintenance personnel •High spare parts availability •High frequency and quality of the production information collected	•Downtime of the customers asset through higher frequency of monitoring activities, install automatic tools for monitoring & alerting, improved communication towards the customer regarding SLA definitions •Rework activities through set up proper project team with adequate skills, improved efforts for pre-sales activities, set up •Downtime of the customers asset through higher frequency of monitoring activities, install automatic tools for monitoring & alerting, improved communication towards the customer regarding SLA definitions •Rework activities through set up proper project team with adequate skills, improved efforts for pre-sales activities, set up of quality control mechanisms •Lead time order execution through define clear responsibilities before project initiation, order tracking / implementation of a proper order management tool, •Customer specific implementation through enhanced standardized service portfolio, communicate standardized products to customer •Price of SKF service by establishment of Service Catalogues, standardized procedure to generate an offer •Availability of IT infrastructure through clear responsibilities, improvement of the employees' skills, upgrade IT-infrastructure, installation of a high-availability solution, define fail over scenarios, define operation strategies •Success rate of incoming inquiries through increase awareness of customer specific requirements, increase communication between customer service and business managers, offer market conform solutions •Customer Satisfaction with SKF response by establishment of Service Catalogue, standardized procedure for modifying an offer, using Service Level Agreements
Define PIs for the essential steps and activities	•Continuous Line Optimization: Input / Output / Machine Speed / Error Rate / Effective Run Time (Run Time/Total Plan)/ Effective Output(Actual/Plan), •Coordination of Production Plans: Planed Run/Down Times, Planed Line Input /Output, Product / Packaging Material •Exchange of wear and tear parts: Run Time, Backlog Order, Intake Order, Order Lead Time, Order on Time Delivery, List of outstanding orders, Overdue trade receivables, productive hours, number of customer complaints •Organisational Optimisations: Machine Speed •Factory Environment:Temperature, Humidity	•Uptime (including set-up time) •Spare parts availability: number of missed picks, replenishment time, frequency of replenishment, average spare parts stock level •Knowledge of the operators: number of competence areas and expertise in each area): •Frequency of data measurements/Accuracy of data (data resolution)	•Downtime of the customers asset the intervall of the measurement points, number of conducted analysis, frequency of data measurements; number of operation activities that are non-conformant, communication •Rework activities number of unplanned additional effort for project execution, number of hours spend for pre-sales activities, return rate of components •Lead time order execution number of tasks assigned to one person or defined group •Customer specific implementations ratio of inquiries of standardized products to all the inquiries •Availability of IT infrastructure number of tasks assigned to one person or defined group, number of trainings, number of changes within a period, unplanned downtime at the customer, existance of operation manuals •Success rate of incoming inquiries number of attended meetings of Business Managers towards the customer, number of workshops / meetings, number of inquiries for existing solutions

Workshop results	SIGPACK	COMAU	SKF
Work out (critical) influence factors which may have a positive or negative impact on the identified Pis	failed	Critical for Uptime: •Machine operators (not) performing the right checks and daily maintenance operations. •Maintenance operators expertise. •Maintenance strategy based on accurate/inaccurate data. Critical for Frequency and accuracy of data measurements: •Lack of historical data from the manufacturer (or inaccuracy of the historical data). •(Lack of) precision in reporting data on a daily basis from the operators. Critical for Knowledge of the operators: •Insufficient/sufficient training programs •Obsolescence of technologies and relative training programs. Critical for Spare parts availability: •Inefficient suppliers. •Wrong replenishment plans due to inaccurate historical data	•Workers‘ council (Betriebsrat) •Missing Top Management commitment •Changes within the organization •Technology for measuring the process is not developed yet (Performance Measurement System) •Missing awareness of the employees for continuous improvement •Commitment of employees towards changes and innovations •necessary investments are not done by the (top) management
Structure your critical influence factors /Pis hierarchy according to the needs of your service cluster	failed	•Uptime •Spare parts availability •Knowledge of the operators •Frequency and accuracy of the information	•availability of IT Infrastructure •decreased downtime of the customers‘ assets •rework activities •lead-time for order execution (implicitly) •customer specific implementations •success rate of incoming inquiries