D13.1
KPIs and SLAs for ecosystem governance
M06

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DELIVERABLE PEER REVIEW SUMMARY

ID	Comments	Addressed (✔) Answered (A)
1	Diagram readability issues	Creation of a dedicated Annex section
2	Need for references & consistency issues	References added. Consistency revision.
3	Need for functional requirement level characterization	Requirement ”level” added
4	Version 07 (23/07/2012) Need for modifying the structure of deliverable	Table of content revised
5	Version 08 (18/08/2012) need for reference modification	Reference chapter revised

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Executive Summary

As defined in the DOW, the aim of WP1.3 is to lay down the foundations for governance framework, providing methods to measure and defining specify performance measurements and service level agreements to create trust relations and meet customer needs and priorities, by sharing resources among potentially unknown parties for SME, VME and also single Manufacturing Service enterprise.

A performance indicator may be defined as "a quantified data which measure the efficiency of decision variables (as a quantity that the decision-maker controls) in the achievement of objectives, defined at a considered decision level and in coherence with the defined business strategy (Ducq.Y, V. B.2005)".

An SLA (i.e. Service Level Agreement) is a part of a service contract where the level of service is formally defined. In practice, the term SLA is a technical contract between two types of businesses, producers and consumers.

In order to be able to develop a coherent and comprehensive set of performance indicators, four types of Knowledge source to drive KPIs (i.e. key performance indicators) and SLAs (service level agreement) have been investigated:

1. Service (with BSM- TIM- TSM focus)
2. Servitization Process
3. Ecosystem Governance
4. Innovation in Ecosystem

While bearing in mind that several methods are available to identify relevant KPIs, ECOGRAI has been investigated and discussed in details, thus showing that its decision-based approach properly supports the selection of effective KPIs, while aiming at business control and improvement.

Therefore, KPIs have been evaluated at BSM, TIM and TSM, to associate adequate performance indicators at different level of decomposition and aggregation of an organization, while assuring consistency and effectiveness to support the decision making process.

ECOGRAI allows us to define when and how performance indicators are originated. Actual definition and sorting out of KPIs and SLAs have been carried out by means of the VRM (i.e. Value Reference Model), developed by BIBA, which provides different types and categories of KPIs together with their calculation formula.

A further step has been taken, to evaluate the effectiveness of GRAI model, to represent a service ecosystem and its interaction with the external environment, stakeholders, laws and regulations, etc.

UGF (i.e. Unified Governance Framework) has been analyzed and considered adequate to meet the above mentioned needs, which will be further investigated in the next iteration.

As far as the servitization process is concerned, a distinction has been made between the level of servitization and relevant KPIs used to monitor servitization performances. A wide range of methods and models, such as InnoScore, IMP^{3}rove, DIUS and Norms, have been evaluated on the basis of their innovation capabilities. The InnoScore-model used for measuring and assessing the innovation capabilities and innovation enhancement in companies. On the other hand, various types of KPIs need to measure the innovation performance during the process.

Reference is also made to SLAs, which represent contractual performance indicators, and to their interaction with KPIs in service ecosystem, which should essentially control internal processes and be consistent with the customers' requirements.

1. Introduction

The objectives of WP13 are related to the development of:

- a coherent set of service-driven KPIs, to steer and regulate the value exchange in an enterprise network;
- end-to-end SLAs, dynamic monitoring and controlling procedures;
- governance, liability, trust and reputation recommendation models using advanced IT tools;
- integration and deployment methodologies for actors offering, utilizing and sharing services;
- Service operation monitoring and control methodologies and toolbox.

The WP essentially consists of three main tasks, which are related to the definition of KPIs and SLAs for governance (T1.3.1), liability, trust and reputation models (T1.3.2) and service operations monitoring & control toolset (T1.3.3).

As far as the first task (T1.3.1) is regarded, a coherent and comprehensive set of KPIs has to be developed, to measure actors' performances with respect to given contractual SLAs and to create the conditions for disclosing sharing, composing and orchestrating services within an enterprise network.

T1.3.2 main goal is to create trust among actors and players, based on the value added exchanges into the different processes and enterprises.

End-to-end SLAs with dynamic monitoring and control procedures will also be developed (implemented with T2.1.3) so to create trustworthy and straights relationships. The use of KPIs and SLAs, properly embedded in the system to manage enterprise's interactions, should provide the basis for an adequate distributed governance of a service ecosystem in SP2.

This deliverable has to be considered as the first of two, containing the developments of T1.3.1 and T1.3.2 that are going to be released in separately: the former (D13.1, this document) at M6 contains the initial definitions and the framework for the developments of KPIs and SLAs indicators, while D13.2, due at M15, is the continuation of this document, including the developments of the topic and the basis for the implementation in the other tasks and WPs of the project.

After the definition of different methods to manage performance measurement in production systems, which has been discussed in chapter 3, ECOGRAI has been selected as the reference model, to design and to implement Performance Indicators for industrial and service organizations.
ECOGRAI is based on the decision models and on the consideration that performance indicators are effective only if the decision makers can rely on variables, i.e. drivers, necessary to reach the objectives.

In chapter 4 KPIs and SLAs for service oriented production system have been examined. The Model Driven Service Engineering Architecture (MDSEA) method and GRAI model are introduced to provide a hierarchical decomposition. KPIs have been defined by ECOGRAI, VRM (Value Reference Model) is used to sort out specific KPIs and to define their characteristics. VRM provides a method to define, to process, to prioritize and to evaluate the PIs which are needed to govern every process.

The servitization process and its needs for control and monitoring is dealt with in chapter 5, where servitiziation level goes from "tangible product", as lowest level, to "product as a service", as the highest level. Apart from measuring service performance through proper KPIs and SLAs, the level of servitization reached by an enterprise is evaluated by means of specific tools, such as Innoscore, which aims at ranking the servitization level of enterprises regardless of their current performance.

In chapter 6 ecosystem governance has been discussed and UGF method has been presented, being the integration with GRAI model one of the aims of the next iteration.

Chapter 7 is focused on specific indicators that can be used to describe and assess innovation process in an ecosystem, while chapter 8 essentially consists of initial assumptions made on pilot use cases.

2. Definition, methods and set of the KPIs of the controlled Service and Ecosystem

2.1. Principles of performance measurement in production systems

The evaluation of the production system performances becomes more and more important in the current economic context. Until the 80's, the concept of industrial performance was only linked to the minimization of production costs. Then, the production system performances evaluation consisted in controlling the costs using essentially analytic accounting. The "Stiglitz Report" (Stiglitz, Sen, & Fitoussi, 2009), commissioned by the French former President Sarkozy , is a clear signal of the global concerns about the shortcoming of present tools of economic and social performance measurement, mismatch between market prices and things (or qualities) that society (i.e. people) value, and the nature of societal goals. As the report puts it: "what we measure shapes what we collectively strive to pursue - and what we pursue determines what we measure". The evolution of industrial environment (intensification of the international economic competitiveness, product diversification...) leads the industrial performances to become today a real multi-criteria performance combining the cost objectives with quality, lead time, flexibility and environment.

This evolution has created new requirements for the performances evaluation of a production system in order to improve the effectiveness the coherence and the accuracy; Therefore, System controlling is method which helps to reach the mentioned results.

A System Control is a device, or set of devices to manage, command, direct or regulate the behaviour of other devices or system. (http://www.answers.com/topic/control-system#ixzz1tWDOfRK2)

So, the first question to ask before to begin the definition of a performance indicator system is WHY?

Indeed, the role of a Performance Indicator System is to allow the decision makers to know the status of the production system. They must use the performances indicators as a control tool, i.e. to measure the efficiency of their actions and to react in the appropriate response time, in coherence with the global objectives of the production system (figure 1).

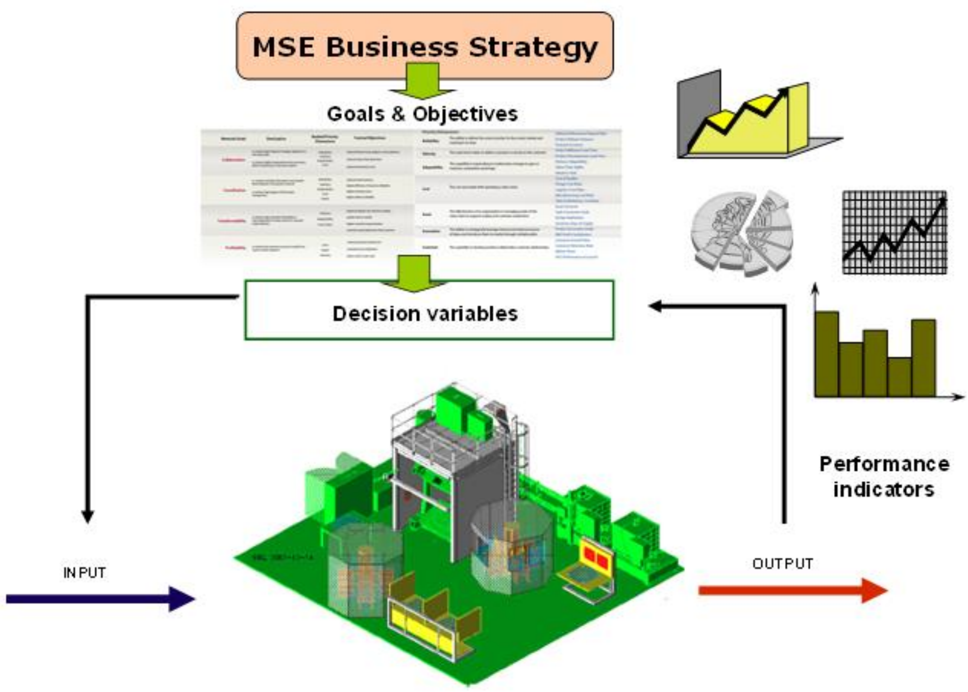


Figure 1- Principles of Performance Indicators in a production system

The figure 1 shows the principles of performance measurement in MSEE. First of all, the business ecosystem forming inputs (information, raw material, requirements…) in outputs: product and related services.

The business strategy is transformed in goals at the strategic, tactical and operational levels. For each objective, decision variables are defined. These are the action means on the controlled production system to reach the objectives. Brief definition of each set of decisions mentioned here below:

At the strategic level, the project goals must be defined, as well as the policy of involvement of human and technical resources, the image of the project and partners, the strategy of cooperation with partners.

At the tactical level, the project aims to decide on the harmonization of methods and means of collaboration between partners (i.e. collaborative platform...) on the dissemination of information inside the project in order to maintain a coherent level of knowledge among the partner, on the technical survey.

At the operational level, the decisions aim to manage the project added value with taking into account the customer requirement changes, to master cost, lead time and results quality, to synchronize the partners work, to measure intermediate customer satisfaction to manage the sub-contracting and finally to take into account the return of experience.

Then, the performance indicators are implemented in the controlled ecosystem to evaluate its performance.

2.2. Definition of PI's and KPI's and existing situation in companies

A performance indicator is a quantified data which measure the efficiency of decision variables in the achievement of objectives defined at a considered decision level and in coherence with the defined business strategy (Ducq.Y, V. B.2005). "Definition and aggregation of a performance measurement system in three Aeronautical work shop using the ECOGRAI Method").

Several kinds of PIs can be defined. The first kind is the PIs for results. These are measuring directly the achievement of objectives. Let's consider for instance total amount of turn over raised by service against over all organization revenue. The second kind is the progress PIs. These are measuring a progress in the achievement of the objective. For example: total number of service occurrences per month and average service value vs organization monthly objectives.

So, these two kinds of PI's are complementary.

The second typology concerns the decision level (Strategical) and relevant PI's. Indeed, in order to control the system, it is necessary to measure strategic PI's which are measuring the performance of the whole controlled system. Then, tactical PI's are required to measure middle term PI's. Finally operational PIs are required to measure the performance of a part of the system at the daily routine work tasks and usually referred to short term.

So, Key Performance Indicators (KPI's) are those which are the most important to measure to know the achievement of the strategy. These are strategic PIs.

If we analyse the current situation in industry concerning Performances Indicators (PI), we have the following status.

i. First, there is a difficulty to determine which indicators to use, where to implement them and to update them. There are a lot of Performance Indicators if we consider the literature but it is not easy to choose an efficient and representative set. Usually, the number of Performance Indicators is high and then it is difficult to maintain their updating. With this huge number of PI, we do not cover the totality of the Production domain we consider in terms of functions and levels of decisions.

ii. Often, these Performances Indicators are not efficient because they are not directly connected with the various actions (drivers) on which the decision makers can act in order to reach the objectives. Certainly, this last situation explains why the production people do not use with profitability the information given by the Performances Indicators: there is a lack of approbation because it is difficult to understand the meaning of the indicators.

iii. Finally, a very important point concerns the coherence of the PI system. They must cover all the decision levels (strategic, tactical and operational) but also the various functions of the domain. Often, there is no coherence between them. We think this situation is the result to the fact it does not exist an explicit link between the objectives, the variables (or drivers) on which people can act to reach their objectives and the evaluation of the situations.

2.3. Existing methods for PI's definition and implementation

Numerous tools (recommendations, models, methods, systems, frameworks) proposed by various researchers and business managers were born from 1900s until today with the aim of helping organisations to measure and manage their performance. The 80s were especially marked by the recommendations concerning the choice of performance indicators (PIs) further to the ineffectiveness of exclusively financial indicators used in the years previously. Especially from the 90s appeared other characteristics based on the concepts: well-balanced (several dimensions), integrated (centred on external and other dimensions), determinants and results concept (causes and effects relationship), and still other recommendations relating to their elaboration (definition, implementation, revision) to obtain an efficient Performance Measurement System (PMS) or an effective PIs. Many positive and/or negative criticisms were expressed by various authors on these tools on various points such as: the nature of PIs used, dimensions retained, well-balanced and/or integrated character, procedure for the PIs selection and their connections etc. Even the Balanced Score Cards (BSC), the most known and used is deeply criticized with regard to the reduced stakeholders, the absence of procedure for the choice of PIs etc. **(**Neely and al, 1995, Ghalayini and al., 1996 and others**)**. In spite of these criticisms, it turns out that these tools present a lot of similarities and differences, advantages and inconveniences.

Among all these methods, more or less used and well known, one can cite the most famous ones or the more used or disseminated around the world as Balanced Score Card **(**Kaplan, 1996**)**. The Performance Prism **(**Neely, 2002**)**, ECOGRAI **(**Ducq, 2005**)**, IPMS **(**Bititci, 1997**)** and DPMS **(**Ghalayini, 1997**)**.

Several studies have been done to compare methods for PMS from several points of views. For instance, classifies these methods in three categories: financial, goal centred and behavioural, concluding that each one has its own advantage to obtain consistent PIs.

In **(**Franco, 2007**)** 17 definitions of what a Business Process Measurement System (BPMS) is, are analysed through methods available or theoretical articles. This analysis was made on the main features of a BPMS, on its role in an organisation and on the process of use. The main conclusion are that a BPMS must be multi-dimensional (financial and non-financial), must include strategic objectives, performance targets and supporting infrastructure **(**Franco, 2003**).** uses systematic review to analyse few methods in order to detect why some of them are more useful to manage organisations through measure, i.e. to obtain an efficient BPMS. The most important aspect is that a method for BPMS must help to the definition of detailed action plans extracted from measures, to measure progress, to have a vision (a perspective as a strategic map) and to have cause and effect relationships (links between indicators).

The table 1 below shows a collection of existing methods without classification.

Dupont PYramid [Dupont, 1900]	Wisner & Faw [Wisner,1991]	TOPP [Sintef,1992]	SCOR [Scc, 1996]
PMMatrix [Keegan et al, 1989]	PBSCW [Kaplan et N., 1993]	IDPMS [Ghalayni et al.,1997]	IPMS [Bititci et Carrie, 2002]
Sink & Tuttle [Sink,1989]	CPMS [Flapper, et al. 1996]	QMPMS [Bititci, S., C.,1997]	ENAPS [Esprit, 1999]
PMSSI [Fitzgerald et al, 1991]	PPMS [Kueng, 1999]	Tableau de Bord [1930]	
PPS [Cross et Lynch, 1992]	GIMSI [Fernandez, 1999]	ABC /ABM [J. et Kaplan, 1987]	
BSC [Kaplan et Norton, 1992]	IPMF [Medori et S., 2000]	TdC [Goldratt, 1990]	
Scandia Navig [E. et Malonne,1994]	MSDP [Rentez, 2002]	PRISM [Neely et al.,2001]	
Strategy Map [Kaplan et N.1992]	SMM [Bititci, 1995]	MBNQA [19878]	
PCS [Globerson, 1985]	PMQ [Dixon et al.,1990]	AMBITE [Bradley, 1998]	
ECOGRAI [Ducq, 2005]	PROMES [Pritchard., 1990]	EFQM [EFQM, 2000]	

Table 1 - The existing methods to define and/or implement Performance Indicator systems

Several methods developed around the world by academic or practitioners for PIs definition & implementation that we described some of the most know methods here below:

Balanced Scorecard (BSC) method was originated by Drs. Robert Kaplan and David Norton as a performance measurement framework that added strategic financial performance measures to traditional financial metric to give managers and executives a more “balances” viewed of organizational performance **(**Kaplan, 1996**)**.

EFQM (formerly known as the **European Foundation for Quality Management**) is a non-profit membership foundation based in Brussels. EFQM is the custodian of the EFQM Excellence Model, a non-prescriptive management framework that is widely used in public & private sector organizations throughout Europe and beyond.EFQM is method for simulating and assists management teams in adopting and applying the principles of organizational excellence, improving the competitiveness of European companies and close the competitiveness among European and USA and Japan.(http://www.efqm.org/en/tabid/108/default.aspx)

Interior point methods (**IPMs**) are among the most efficient methods for solving linear and wide classes of convex optimization problems. Any convex optimization problem can be transformed into minimizing (or maximizing) a linear function over a convex set (Robert M.Freund, M.I.T & Shinji mizuno “Interior Point Methods”).

In the next part, we will focus on ECOGRAI Method that will be used to support the selection of KPI’s in the MSEE as presented in the introduction.

2.4. Focus on ECOGRAI Method

Several methods are available, which can be used to define and to implement KPIs. All of them have pros and cons and it is quite difficult to say which the best is. The main reason to adopt ECOGRAI as a standard method is that this is the only one based on decision modelling, thus focusing everyone’s attention on why we need PIs (to make decisions and which decisions), instead of sorting out the best indicators directly. In addition, in the past twenty years a significant experience have been gained by University of Bordeaux 1 (see also D11.1) with good results and such a method has been applied to service too.

ECOGRAI is a method to design and to implement **P**erformances **I**ndicators **S**ystems for industrial and service organizations. This method is applied with the implication of the decision makers of the organisation. There are two main steps in this method: design and implementation. The results of the design step are a coherent set of specification sheets describing each Performances Indicator (indicators, concerned actors, required information and processing...) and coherence panels describing the coherence in the control of the system. The implementation and the operating of the PIS are supported by an EIS (Executive Information System) tool or Business Intelligence tool.

The main characteristics of the ECOGRAI method are:

- a logical process of analysis / design using a top-down approach, based on enterprise models (process and decision) and allowing to decompose the objectives of the strategic levels into objectives for operational levels,
- a concrete process of participative implementation, creating a dialogue between the various levels of the hierarchy, and favouring the identification of indicators by the future users involved in the study : it is a bottom-up implementation,
- the use of a number of tools and graphic supports : GRAI grids, GRAI nets, actigrams (IDEF0), splitting up diagrams, coherence panels, specification sheets,
- a coherent distribution of Performances Indicators covering the various functions and the various decision levels (strategic / tactical / operational),
- The search of a limited number of Performances Indicators by an original approach (figure 10). In a first step, we identify the objectives assigned to the decision makers (target situations which have to be reached inside the functions, depending on the decision level which is considered); in a second step, we identify the variables (called "Drivers") on which the decision makers can act to reach their objectives; and in a third step, we identify the Performances Indicators (quantified data which measure the efficiency of an activity or a set of activities of a function in the process to reach the objectives). In fact, the originality of the ECOGRAI method is not in the definition of Performances Indicators, but the search of Drivers on which decision makers can act to reach their objectives. The Performances Indicator is a consequence of the preliminary choice.

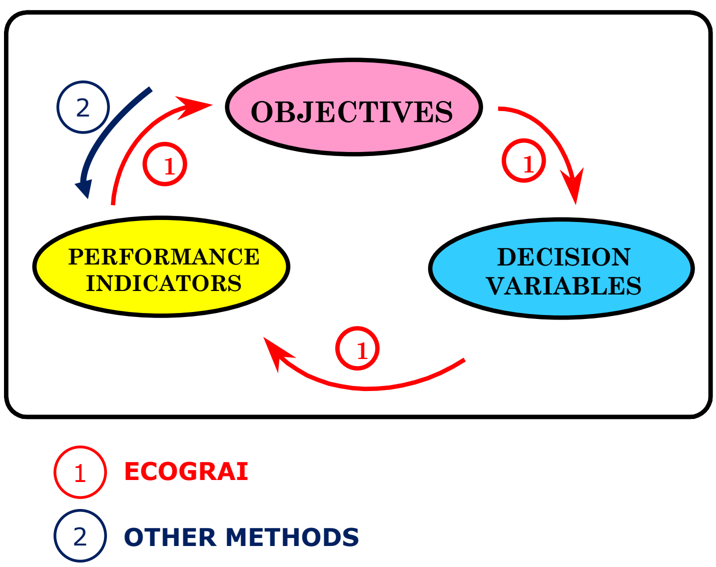


Figure 2 - The ECOGRAI original approach

3.4.1 The six phases of ECOGRAI method

The logical structured approach of the method is decomposed into six phases (figure 3). The first phase (phase 0) consists in modelling the control structure of the organisation (the MSEE in our project but also each part of the MSEE) and its business processes on which the performance will be measured. The two following phases (phase 1 and 2) aim at identifying the basic elements which are required: the objectives and the drivers. The fourth phase (phase 3) consists in identifying the Performances Indicators, the fifth (phase 4) in designing the information system to build the Performances Indicators, and the sixth (phase 5) in implementing it inside the Production Management Information System.

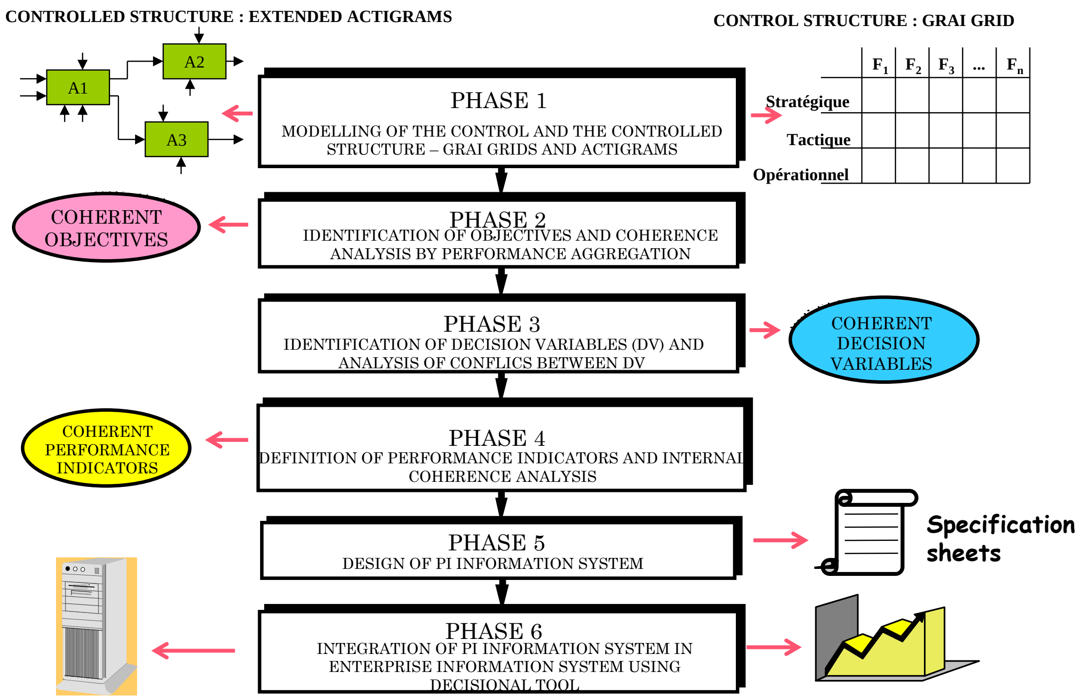


Figure 3 - The six phases of the structured approach

3.4.2 Phase 0: Modelling of the organisation Business Processes and Control Structure and Identification of the Decision Centres (DC).

The objective of this phase is to determine the Decision Centres of the organisation to which the Performances Indicators will be connected.

3.4.3 Phase 0.1- Modelling of the organisation Business Processes.

This phase aims at describing the controlled part of the organisation which has in charge to add the value to the product or the service. For this modelling, we traditionally use IDEF0 (actigrams) or extended actigrams. This phase is very important in order to understand clearly the processes on which the performance will be measured.

3.4.4 Phase 0.2- Modelling of the organisation Control Structure.

As written above, ECOGRAI uses the GRAI tools (grids and nets) to model the organisation control structure in order to identify the set of the decision centres, their activities, their links (decisional and informational) and the basic elements which are taken into account to design a Performances Indicator: the objectives and the drivers.

This deliverable does not aim at describing the GRAI method. Therefore, to understand better ECOGRAI, a short description of the GRAI tools used (the grid and the nets) is presented below.

The GRAI grid takes up the hierarchical and functional approach. It allows identifying the set of decision centres of the studied system, as well as their links.

The GRAI grid is presented in the form of a matrix with:

- The managerial axis or control axis which represents the various levels of decision which can be found in the organisation. Traditionally, this axis is decomposed hierarchically in several levels, according to the nature of the decisions: strategic, tactical, and operational levels.
- The functional axis which describes the various activities required to the product life cycle. However, in MSEE this axis can be adapted to service life cycle without any problem. It is decomposed into several functions which group a set of activities having a same identified finality (Engineering, Manufacturing, Quality, Maintenance, and Delivery, Recycling...).

Each function of this axis is decomposed in: to manage the products/service (internal or external, it means supplying and purchasing), to manage the resources (human or technical) and to plan (to synchronize at each level product and resource management).

A decision centre is defined at a cross of a function and decision level.

The GRAI nets are aiming at describing in details all the activities identified inside each decision centre of the GRAI grid.

3.4.5 Phase 1 / Identification of the Decision Canter objectives and coherence analysis

This phase is aiming at identifying the objectives of each Decision Centre identified in the GRAI Grid. We follow a top-down approach: it means that the first step consists in identifying the organisation global objectives, the second in identifying the global objectives of each function belonging to the functional axis, and the third in defining the objectives of each Decision Centre inside the functions. These identifications are based on the notion of contribution. Actually, each objective must contribute to the achievement of the objectives identified at the upper level. Each step is supported by graphic tools (splitting up diagrams) allowing to verify if a sub-objective contributes to an objective at the upper level.

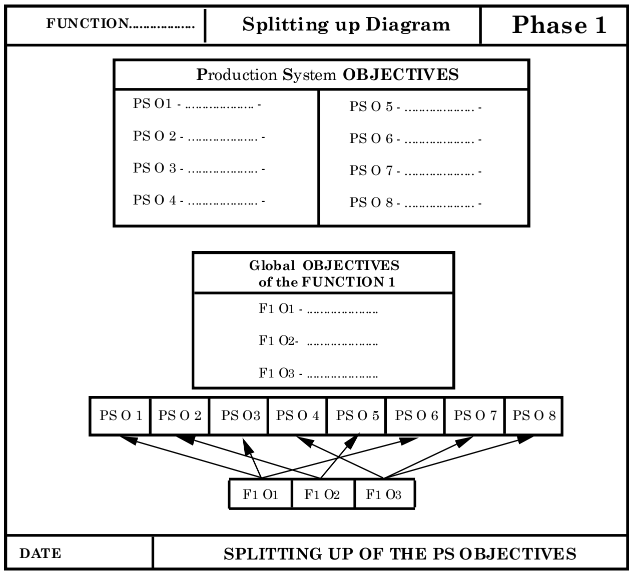


Figure 4 - Splitting up diagram

Then, the inter-function coherence between the global objectives is analysed. The links which exist between the global objectives of the various functions are identified in order to check there are no perverse effects (the objectives assigned to a function do not prevent another function to achieve its objectives).

3.4.6 Phase 2: Identification of the DC Drivers and analysis of the conflicts

As already mentioned, if it is necessary to know the objectives in order to build relevant performances indicators, it is not sufficient. Actually, the drivers, corresponding to each objective of Decision Centres must be identified (figure 5). This identification must be interpreted as one of the steps leading to the building of the triplets (Objectives / Drivers / Performances Indicators). This notion of triplet is another valuable characteristic of the method, and it expresses the controllability principle.

During this phase, it is necessary to highlight the intra-function and inter-function influences of the Drivers. The aim here is to evaluate the relationships which appear inside a function and between the functions. Indeed, the proposed objectives (and by consequence the Performances Indicators) for a given Decision Centre are sometimes related to drivers that belong to another Decision Centre. In this case, we must evaluate the degree and the origin of the influence. The notions of "driver with direct effect and indirect effect" refer to this phenomenon. A direct effect is assigned to the driver which has a dominating influence on the considered objective.

3.4.7 Phase 3: Identification of the DC Performances Indicators and internal coherence analysis

Phase 3.1: Identification of the Performances Indicators for the Decision Centres.

The previous phases allow, for each Decision Centre, to identify one or several objectives (coherent with the global objectives of the function, themselves coherent with the global organisation objectives) and the associated drivers. The determination of the Performances indicators is performed during this phase 3. The approach uses the knowledge of all the people involved in the study and this identification is validated by an internal coherence analysis inside each Decision Centre.

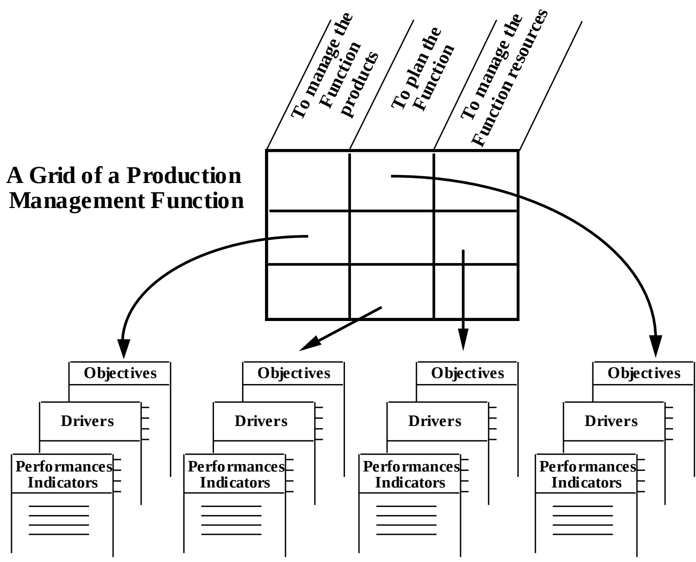


Figure 5 - Identification of the DC Performance Indicators

In MSEE, this will be possible to use several models in order to select the appropriate performance indicators. For instance, the SCORE model or the Value Reference Model will be used.

Phase 3.2: Internal coherence analysis in the DC

This study consists in verifying the internal coherence inside the Decision Centre in terms of triplet {Objectives / Drivers / Performances Indicators}. A triplet is coherent if:

- It is composed of one objective, one or several drivers and one or several performances indicators,

- The performance indicators allow measuring the efficiency of an activity or a set of activities of the considered function in the process to reach the objective, and are influenced by actions on the drivers (figure 6).

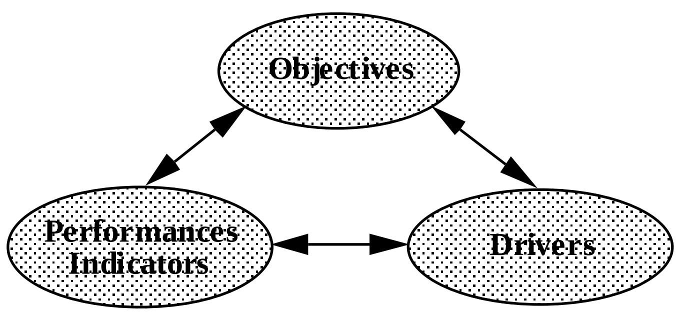


Figure 6 - Internal coherence studied in each Decision Centre

In order to verify this coherence, coherence panels are built. They allow identifying the various links between the elements of the DC as well as their weight.

Then, "coherence panels" are filled in (figure 7). The links between the DC elements are classified according to the connection (strong link / weak link / no link).

Function		Decision Center : Level :	INTERNAL COHERENCE ANALYSIS		
OBJECTIVES	O1	**	**	**	*
	O2		*		**
	PERFORMANCES INDICATORS	IP1	IP2	IP3	IP4
DRIVERS	DV1		*		**
	DV2	**		**	
	DV3		**		*

Strong link (**) / Weak link (*) / No link ()

Figure 7 - Coherence panel

3.4.8 Phase 4: Design of Performances Indicators information system

An indicator is basically a measure which will become more and more sophisticated: "measure -> raw information -> process -> review -> statistical process" can be an example of a possible chain. ECOGRAI is completely oriented towards the phase of specification, which is preliminary to any possible automation of the performances evaluation system. Two aspects are considered: the data aspect (which information are necessary?) and the processing aspect (the processing which are necessary to build the indicators, starting from basic information). Whatever the case of study, it is always necessary to define clearly each indicator with fundamental parameters. The tool which guides these definitions is the specification sheet for each indicator which contains:

- The identification of the indicator (name, decision centre, horizon, period),
- The objectives and the drivers related to the indicator,
- The perverse effects which have been identified,
- The identification of the data required for the implementation of the indicator,
- The definition of the associated processing,
- Finally, the way of representing the indicator, determined by the future users (using graphics for most of the time).

3.4.9 Phase 5: Integration of the Performances Indicators information system inside the enterprise or the MSEE IT system

The phase five consists in integrating the performances indicators system inside the organisation IT system. This integration phase is developed using an EIS tool or a business intelligence tool. It is used to converse with the existing data bases. Data on MSEE IT system are located and the extraction frequencies, the processing and the visualisation choices to exploit the Performances Indicators are then specified into the EIS tool. This work is performed from the specification sheet.

3.4.10 the implementation of ECOGRAI method

One cannot define a method to design and to implement PIs without defining also the way to implement it. So the ECOGRAI structured approach is based on the GRAI structured approach. In particular, the notions of involvement (creation of various working groups), and top-down / bottom-up approach have been kept.

Three kinds of groups are defined (figure 8):

- The synthesis group is composed of the people in charge of the considered business unit. They define objectives and orientations, and they check the results presented by the analysis group during the synthesis meetings. They also structure the information and locate them in their context;
- The functional group, is composed of the main actors of the considered function of the organisation (managers, supervisors, and if necessary, operators). During the functional meetings with the analysis group, this group is involved in the organisation analysis of the function they are in charge of the definition of the indicators;
- The analysis group, composed of one analyst (eventually two or three depending on the size of the study) has in charge to help the two other groups to collect information, to organize meetings, to formalize the results and to propose solutions to the problems which may appear during the study.

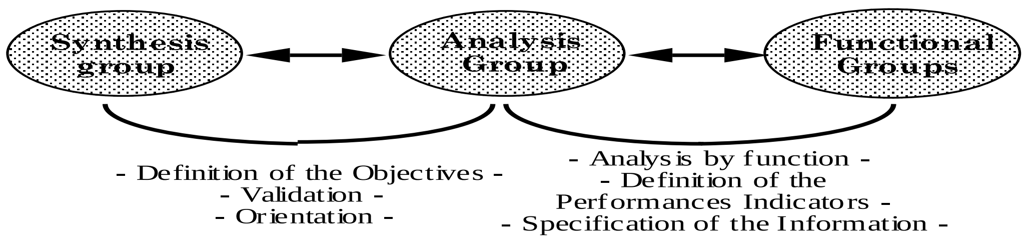


Figure 8 - The various groups involved in the structured approach

The information technology department involved in the design, with the help of an EIS specialist, ensures the physical implementation of the performances indicators.

Thus, after having constituted the various groups, the structured approach follows the six phases of the method. The main remark that can be made is the continuous iteration between the functional groups and the synthesis group all along the study.

2.5. Service Level Agreement Modelling and governing

A service level agreement (SLA) is a technical contract between two types of businesses, producers and consumers. A SLA captures the agreed-upon terms between organizations with respect to quality of service (QoS) and other related concerns. In simple cases, one consumer forms a SLA with a producer. In more complex cases, a consumer may form a SLA that defines a set of producer businesses (*By Edward Wustenhoff –Sun Professional ServicesSun BluePrints™ OnLine* - *April 2002*).

A Good SLA Help to promise what is possible to deliver and deliver what is promised. The Service Management lemniscates shows the role and the importance of SLA as means for bridging a gap between User & Service Provider. A SLA supports a communication about services and forms a basis for implementation of the Service process.

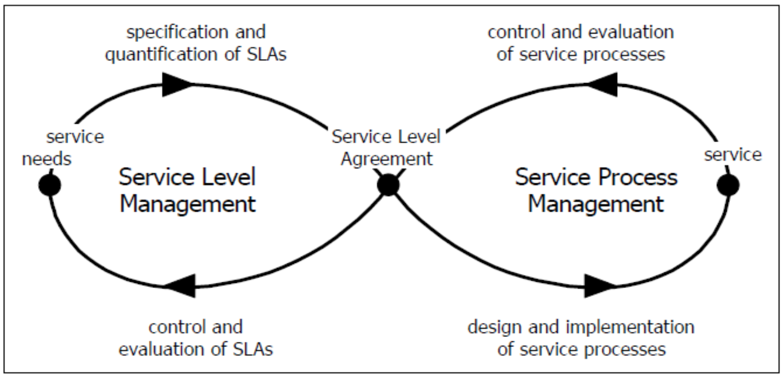


Figure 9 - SLA role is Service structure

A Good SLA addresses five key aspects:

- What the provider is promising.
- How the provider will deliver on those promises.
- Who will measure delivery, and How
- What happens if the provider fails to deliver as promised?
- How the SLA will change over time.

The SLA defines a clear relationship between the customer and the provider by setting boundaries, conditions, penalties and expectations.

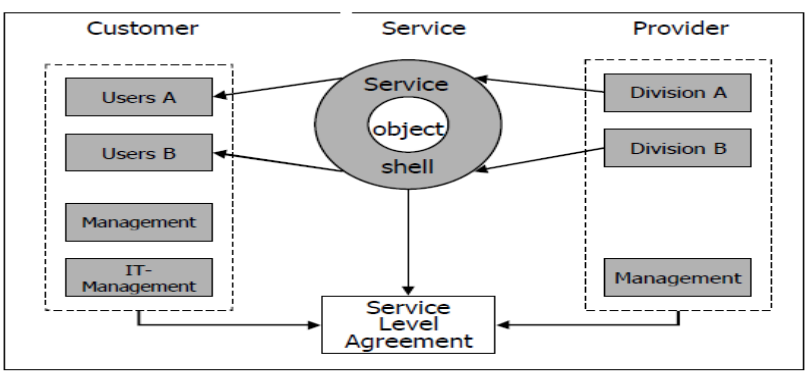


Figure 10 - SLA relationship among Customer and the Provider

The benefits of a good SLA are many, but the most important ones are:

- Sets Clear customer relationships;
- Sets Goals for internal organizations;
- Sets a framework for continuous quality improvement;
- Drives the SLM system architecture.

The SLA drives the definition of key performance Indicators (KPIs) at the service, application, system and network level. Defining these KPIs facilitates the proper tools selection, process definition and skills (people, process and technology) for an organization.

2.6. How an SLA Maps to Key Performance Indicators

As services and technologies change, the SLA may change to reflect the improvement and / or changes. This SLA will be reviewed in fixed period and updated as necessary. In this chapter we try to describe how SlA availability is measured in strategic, tactical and operational levels. A good SLA is important because it sets boundaries and expectations for the following aspects of service ecosystem:

- Customer commitments: Clearly defined promises reduce the chance of disappointing a customer. These promises also help to stay focused on customer requirements and assure that the internal processes follow the right direction.
- Key performance indicators for the customer service: By having key performance indicators in service, it is easy to understand how they can be integrated in a quality improvement process (like six sigma). By doing so, improved customer satisfaction stays a clear objective.
- Key performance indicators for the internal organizations: an SLA drives internal processes by setting a clear, measurable standard of performance. Consequently, internal objectives become clearer and easier to measure.
- Key performance indicators for claims: if the SLA has penalties (something that some organization prefer to avoid but should not) non-conformance can be costly. However, by having penalties defined, the customer understand that the organization truly believe in its ability to achieve the set performance levels. It makes the relationship clear and positive.

The capability to segment service offering with different options (price, SLA and etc) for different service levels benefits both the vendor and the customer. The vendor widens its target market by being able to customize its service and the customer only pays for what it needs.

Having the ability to measure against key performance indicators facilitates the continuous quality improvement process. Being able to raise the performance bar at a steady pace help the service ecosystem to remain competitive. By trying the problem resolution process to an SLA, a service performance problem becomes an opportunity to structurally improve overall service quality and customer satisfaction, as opposed to just resolving the symptoms of the real issue.

Knowing what to measure eliminates redundant data collection, which reduce the total overhead of the SLM system on the service infrastructure. A good SLM system collects data only once.

3. KPIs and SLAs for Service oriented Production Systems

3.1. Service system modelling frameworks

This chapter stressed out on two deferent models on the basis of decomposition: decomposition by level of decision and decomposition by abstraction level. The hierarchical decomposition of the GRAI model with different (Strategic, Tactical and operational) levels will be explained. Then, MDSEA method defines a framework for service modelling around three abstraction levels (BSM, TIM and TSM) just to remind.

4.1.1 Service system based on GRAI (Graph with Results and Activities Interrelated) model

The GRAI conceptual reference model is a recursive structure which allows to represent with the same concepts, the global and the local models of a manufacturing system in an enterprise. In fact, the GRAI model defines the various concepts that will be represented in the GRAI graphical formalisms.

GRAI model is composed by three principles:

- The first principle is control of the system (based on the information which is received by customers or materials);
- The second principle is the decomposition of the control system in two sub-systems: the decision and the information sub-system;
- The third principle is the decomposition of the decision sub-system according two criteria: temporal and functional.

The control of the Physical system is the result of decisions taken according to various functions (to manage sales, to manage design, to manage engineering, to manage manufacturing, to manage delivery…). The decisions have various natures: strategic at long term (define the objectives), tactical at medium term (define plan the resources) and operational at short term (to perform the actions). This Grid is called the "Functional Grid". At the cross of a function and a level of decision we define a decision center (shown in the Figure No.11).
The decomposition principles are based on the "Hierarchical System Theory" of (Mesarovic) which decentralizes the decision-making, keeping coordination in order to reach the objectives of the enterprise. This decomposition is called "Hierarchical decomposition" or "Temporal decomposition" because each level is determined by a time horizon of decision.

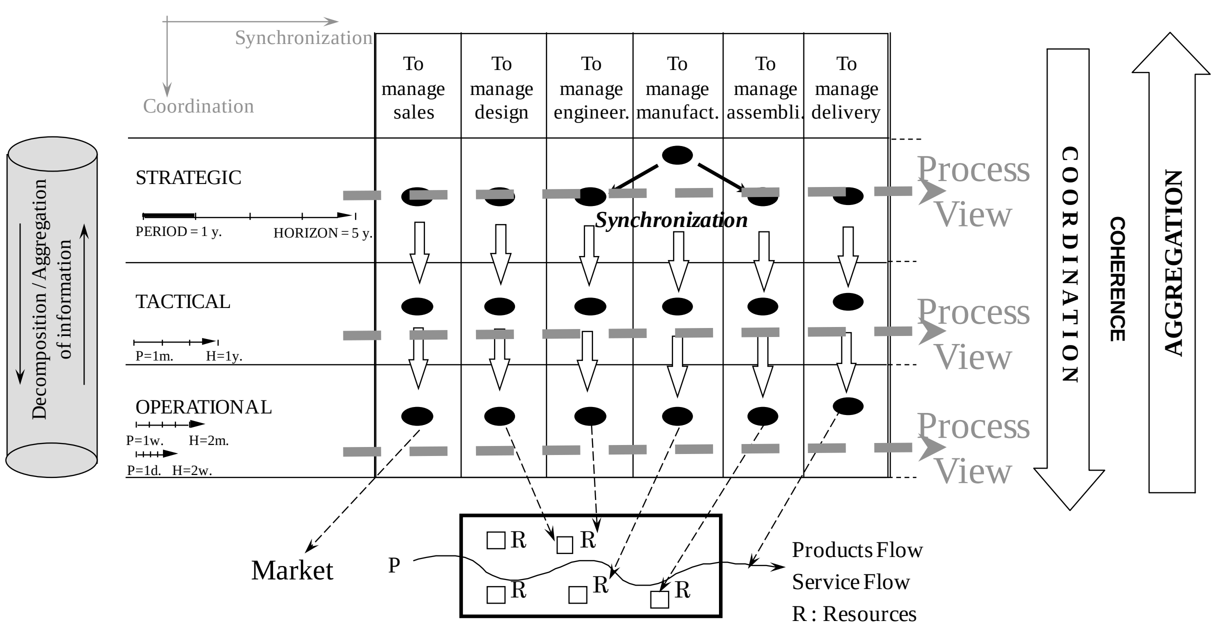


Figure 11 - The hierarchical or temporal decomposition of the Decision System

The principles of GRAI approach allow to represent and to study the system at the global level and at the detailed level (it is the case at the level of System of Systems and at the level of System). The fact to describe explicitly the control system (Decision plus Information) determines the elements which allow to reach the objectives.

4.1.2 The Model Driven Service Engineering Architecture (MDSEA) and its decomposition levels

Inspired by MDA/MDI (Model Driven Architecture/Model Driven Interoperability, the proposed MDSEA developed in MSEE project, defines a framework for service system modelling around three abstraction levels (also see Deliverable D11.1).

- Business Service Modelling (BSM): which specifies the models, at the global level, describing the running of the enterprise or set of enterprises as well as the links between these enterprises. BSM level focused on the representation of the service (and its functionalities) and the service system in virtual enterprise, capturing information on its related product, customer and service KPIs and values. The models at the BSM level must be independent from the future technologies that will be used for the various resources. In this sense, it’s useful, not only as an aid to understand a problem, but also it plays an important role in bridging the gap between domain experts and the development experts that will build the service system. In fact we develop the BSM in two sub-levels: the Top BSM and the Bottom BSM: the Top BSM sub level models the enterprise and its environment at a global level in order to analyse the possibilities to develop the System Service and the Bottom BSM will allow to model in details each directly concerns by the development of the Services System. Based on this first analysis, the service system will be decomposed in the various components (IT, Organisation/Human and Physical Means). For example at Bottom BSM we will describe in details the model of the IT domain, or the model of the Organisation/Human component, or the model of the Physical means.
- Technology Independent Modelling (TIM): which are the models at a second level of abstraction independent from the technology used to implement the system. It gives detailed specifications of the structure and functionality of the service system that do not propose technological details. More concretely, it focuses on the operation details while hiding specific details of any particular technology in order to be suitable for use with several different technologies. At TIM level, the detailed specification will be elaborated with respect to IT, organization / Human and Physical Means for service system.
- Technology Specific Modelling (TSM): that combines the specification in the TIM model with details that specify how the system uses a particular type of technology (such as for example IT platform, Machine technology Organisation structure or Human profile). At TSM level, modeling and specifications must provide sufficient details to allow developing or buying software/hardware components, implementing specific Organization, recruiting human operators / managers or establishing internal training plans, buying and realizing machine devices, for supporting and delivering services in interaction with customers. For instance for IT component, a TSM adds to the TIM, technological details and implementation constructs that are available in a specific implementation platform, including middleware, operating systems and programming languages (e.g. Java, C++, EJB, CORBA, XML, Web Services, etc).

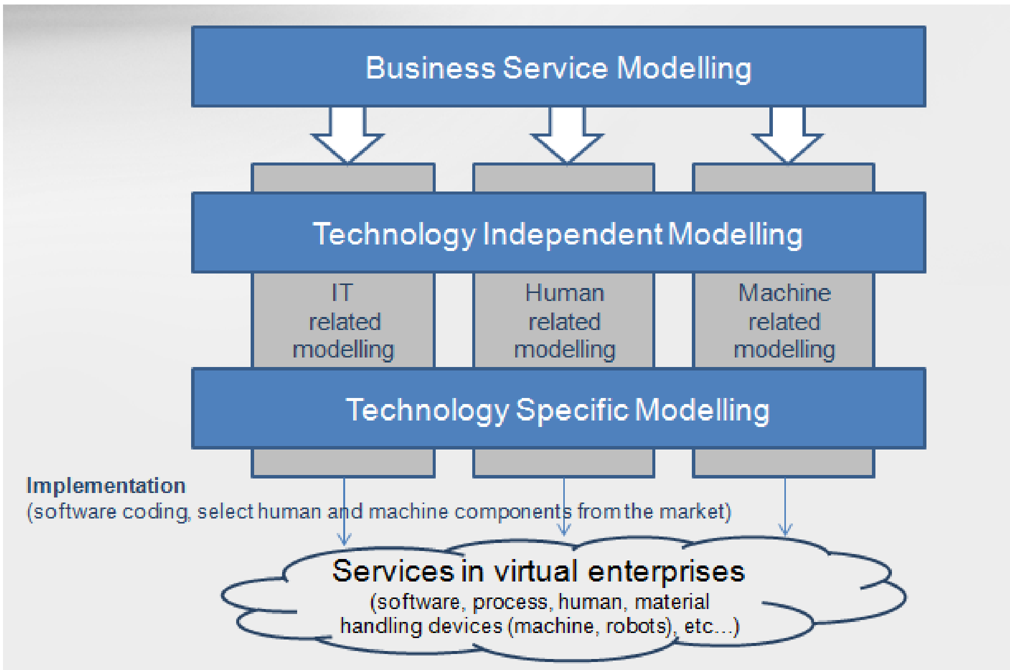


Figure 12 - MDSE Architecture

3.2. KPI's at various MDSEA levels

So, based on the previous decomposition, it is necessary to ensure that at each level of decomposition, performance evaluation is possible in order to verify the achievement of objectives and the use of action means or interoperable solutions.

The framework of performance indicators is proposed in the figure below:

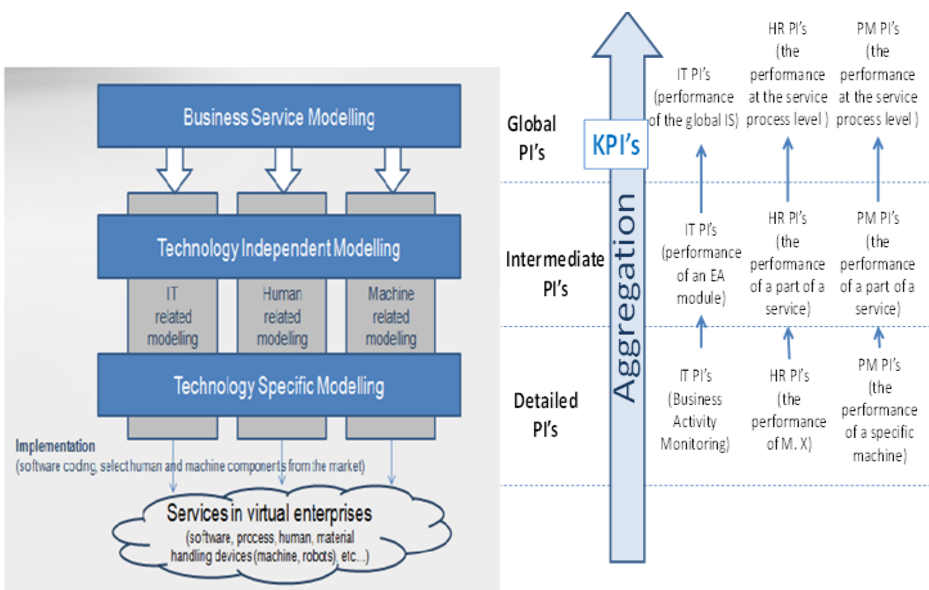


Figure 11 - Performance indicators in the frame of MDSEA

So, PI's must be defined related to the three kinds of components: IT, Organization/Human resources and Physical means resources. Several PIs maybe applied for an organization but just a few are meaningful in terms of process control, improvement, efficiency, effectiveness and business performances, in general sense. There are some companies with several KPIs at different levels but all the information which are collected to the regular basis may be overwhelming and not supporting the management in the decision making process. Therefore it is recommended to sort out the KPIs only which can effectively contribute to define necessary information for every level of business model. Lets us assume that KPIs have been defined at BSM level only (e.g. turnover, EBIT, WIP, etc...): in this case we organization should define an appropriate deployment policy to share these KPIs within all levels of the organization. In other terms BSM KPIs should be translated into TIM KPIs which are strongly bounded to the previous ones and the results of each will contribute in the same direction to meeting the organization objectives: if you want to increase the EBIT at TIM level we must increase total output of the production and reduce operational costs. To do that KPIs at TSM level should be defined which are consistent with TIM KPIs. Therefore the operator at CNC machines should be aware that his PIs are the number of pieces manufacture per day and total number of scrap/ rework downgrading

The criteria of these performance indicators will then be related to traditional performances as cost, quality, lead time or other kinds of performances as interoperability, flexibility, environment…

However, when we are at the top level (BSM level), the models are global and then the PIs must be global (PI’s), at the level of a complete service process. When we are at the TIM level, the resources are detailed and we are at the level of a part of the service process. So, the PI’s will be detailed but we will keep the same performance criteria. The PI’s will be at the level of a set of resources, or at the level of Enterprise Software Application (ESA) modules.

At the TSM level, the principles will be the same. The PI’s will have the same criteria of performance but will be more detailed than at the TIM level. For instance, the PI’s will be at the level of a machine, at the level of a process activity and at the level of specific organisation or specific human resources. Business Activity monitoring will be used in order to measure the performance of a web service in the IT system.

3.3. Links between SLA and KPI’s

Service Level Agreement (SLA) is a generic document which drives the definition of Key Performance Indicators (KPIs) at the service, application, system and network level. Defining these KPIs facilitates the proper tools selection, process definitions and skills (people, process and technology) for an organization (Edward Wustenhoff, “Service Level Agreement in the data center” April 2012).

Used in the 90’s by telecommunication companies, and then by software companies, the SLA is now used by most of the bid service companies in the domain of water supply, environment…SLA can be related the performance level but also to the modality of execution of services, responsibilities, warranties, after sales service etc.

So, SLA must define performance level that will have to be measured using PI’s and KPI’s.

The main problem of SLA is to define a set of coherent performances. This coherence must be ensured first at the objectives level. The various objectives must be linked and the level of these objectives must be coherent between the various parts of the services.

This coherence might be identified through the service system modeling and the decision modeling.

The figure below shows that some global PIs (KPI’s) can be used to SLA definition and measurement (external visible PIs) but other KPI’s would only be used as internal PI’s for the control of the system (internal PIs).

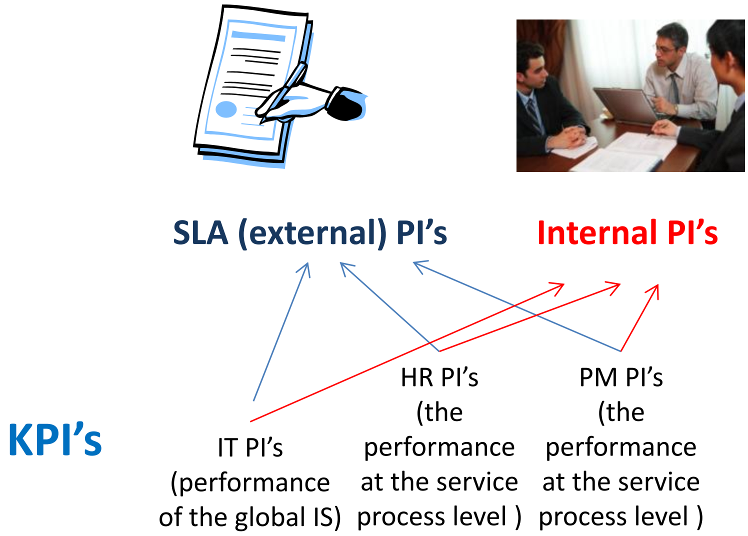


Figure 12 - Links between SLA and KPI's

This is important to mention that a lot of PI's will be only available for internal managers based on their own decisions and the KPI's are in the SLA contract are only those dedicated to the customer decision.

While a KPI is a measure of performance, the Service Level Agreement or SLA is the ideal state of those measurements. For instance our body temperature is a KPI for our health, while 98.3 degrees Fahrenheit is the SLA i.e. the ideal state of affairs.

Hence, if we were to control our health, we would create a mechanism in which our temperature is being automatically measured. When the KPI deviates from the desired SLA i.e. temperature deviates from 98.3 degrees Fahrenheit, it must send some sort of a message to the management that management interference is required.

The beauty of KPI's and SLA's is that it provides required solutions in required time. Hence management can take preventive action instead of having to cure the problems.

4. KPIs and SLAs for servitization

4.1. Servitization Process

An overview of the transition from product to product+service or service as a product, named as servitization process **(**K.D Thoben et al., 2001**)**, is derived from the DOW and is herewith discussed.

First of all, for the companies to survive under nowadays market pressure, it is necessary to provide extended products and an appropriate model to link products, product related services and the needs of the users.

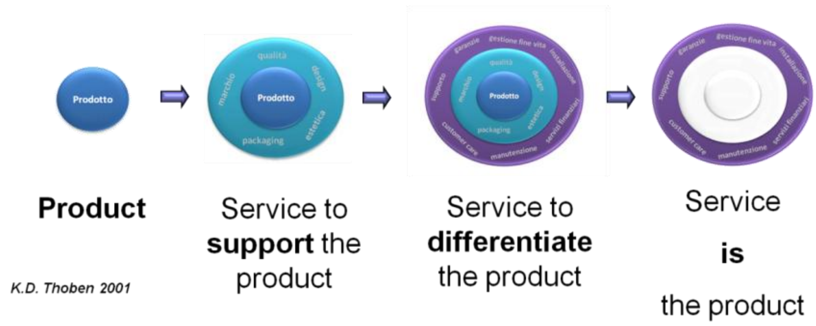


Figure 13 - Product shift to service

A smooth and steady shift is taking place from consumers buying products towards consumers buying solutions and benefits (see figure 15).

Customers and consumers have new and more complex requirements regarding products, therefore the role of additional services and product solutions need to be enhanced.

Both time-to-market and service-product offer leverage to gain sustained competitive advantage.

Finally, by the term *extended product* focus should be drawn on more functionalities than just the core or tangible product; therefore we aim at moving our attention from a tangible product to an intangible shell around the tangible product (i.e. Service as a Product).

The above mentioned transition represents one axe of the diagram only. MSEE has to consider also the transition from the management of a supply chain (planned, strictly controlled) to an ecosystem, where the added value is mainly due to the emergence of unexpected business possibilities (un-planned) and the openness to enterprise members within an appropriate environment.

Figure 16 depicts such transition phases from an OEM company, with its own supply chain, to a product+service configuration (i.e. servitization), to better tackle consumers. The company's ecosystem is still controlled and governed by the enterprise, which cannot take advantage of additional expertise and cross combination offered by other parties. By getting other SMEs involved in an adequate environment, additional services could be provided, thus leading to real service innovation within an open and unplanned ecosystem, where every player might take advantage of cross-functional business opportunities.

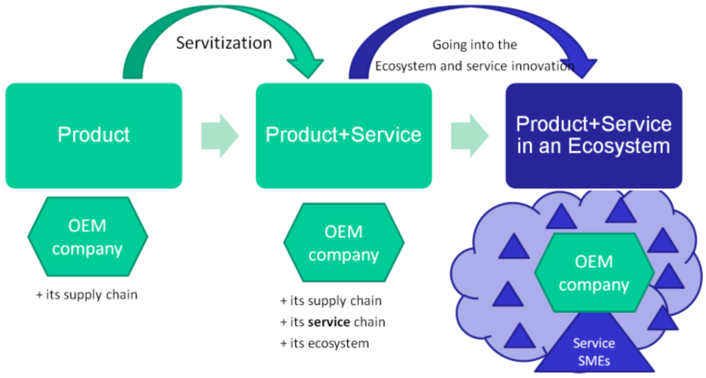


Figure 14 - From PLM to SLM synchronization

As far as SLM is to be reckoned, different service engineering components are to be defined, as described in WP 1.1 to WP 1.3, in order to properly manage the transition within the MSEE. In particular, figure 16 shows service lifecycle phases, ranging from service identification/concept to operation/implementation/decommissioning vs service components, expressed in terms of modeling (WP1.1), methodology (WP 1.2) and KPIs/SLAs (WP 1.3).

Focus of current document is to set the path for KPIs and SLAs, necessary to control both effectiveness of servitization and governance of the ecosystem.

	WP1.1				WP1.2					WP1.3				
Service lifecycle phases\Service engineering components	Service modelling language (CIM)	Sevice modelling language (PIM)	Sevice modelling language (PSM)	Model transformation method	Service engineering methodology	Procedure / recommandat° for service design and test	Model for simulating and testing service	ServLab	Role model for SLM		KPIs and SLAs for governance	Liability, trust and reputation model	Service operations monitoring & control toolset	
Identification	?				X						X			
Concept	?				X						X			
Requirement	X	X		X	X						X	X		
Design	X	X	X	X	X	X	X	X			X	X		
Implementation			X	X	X	X	X	X			X			
Operation									X		X	X	X	
Decommission											X			

Table 2 - Service engineering components defined in WP 1.1 - 1.2&1.3

Service Engineering components can cover the whole service lifecycle phases from early stages, where both intrinsic and extrinsic parameters and requirements should be defined and measured, to the final decommissioning steps, which could give rise to further business opportunities (recycling, refurbishing, different use, etc).

This work aims at developing measurement systems (KPIs and SLAs):

- To measure actors' performances and to create the conditions for disclosing and sharing resources within an enterprise network;
- To create trust among actors and players based on the value added exchanges into the different processes and enterprises;
- To define end-to-end SLAs with dynamic monitoring and control procedures;
- To manage enterprise's interactions, thus granting adequate distributed governance.

4.2. Servitization assessment

Many firms always complain that market pressure is increasing when it comes to the product related services on offer, and the requirements of commercial clients are constantly on the rise. These factors can only be handled with a well developed innovation management with a greater focus on aspects of service engineering.

The innovative capacity of a producing firm with regard to the development of relevant product-related services is becoming decisive for competitiveness. Furthermore the decision makers has to make sure that service processes are designed to act quickly, customer-focused and flexibly.

That`s why is it very important for the companies to measure their own performances in the transition process of servitization.

In the following part selected methods for the evaluation of the innovation capability are presented. These approaches are chosen because of their scientific basis. In the first part every approach is described. After that they are going to be assessed.

IMP³rove

IMP³rove is a developed portal in the scope of the initiative of the European Commission "Europe INNOVA" to support the consultancy of small and medium-sized companies (SME), as well as benchmarking them. A structured process leads the company through a consultancy, and assessment process, mainly with the help of IMP³rove trained consultants (Engel et al. 2010).

"The House of Innovation" is used as a meta-model in IMP³rove. Originally suggested by A.T. Kearny, it is completely revised and developed by the IMP³rove group, meanwhile. The following dimensions are developed: (Engel et al. 2010):

- Innovation Strategy,
- Innovation Organisation and Culture,
- Innovation Life Cycle Process, with the dimensions Idea Management, Product/Service/Process and Business Model Development, Launch/Continuous Improvement, Enablers.

DIUS

The department for Business Innovation and Skills (DIUS, 2012) is a ministry of the British government. It offered an "Innovation Self Assessment" for free. Via web-application is the user invited to answer assessment questions. The User is guided through the applications and has to answer questions in three areas. He receives the results directly after the questions. Following areas are inquired:

- "Inspire" includes questions for the idea development,
- "Create" encloses cultural questions,
- "Connect" contains questions for the network development.

InnoScore

The InnoScore-Model measures, assesses and enhances the innovation capability of companies. It´s oriented on the frequently used and accepted EFQM Model (Lay et al. 2009). With linking the consulting methods of the "InnoAudits" (Rogowski et al. 2007) and the innovation model of the Fraunhofer – Institute for Industrial Engineering and Organization it is developed a self-assessment tool. It is comprehensive and precisely at the meassurement of the innovation capability. It´s implemented as a web based benchmarking platform (Rogowski/Slama, 2008).

There are defined nine areas (Spath et al., 2006). These nine areas create the Meta-Model. In the next figure they are visualized.

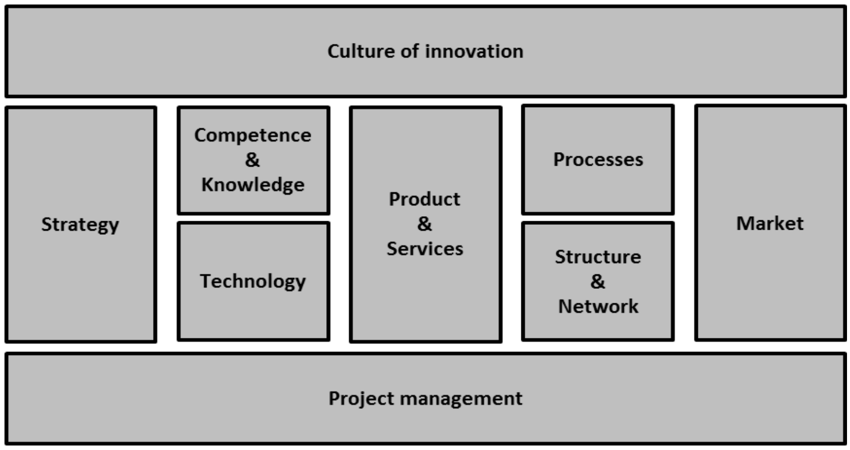


Figure 15 - The nine areas of InnoScore (Wagner et al., 2007)

Norms

The DIN PAS 1073 (2008) suggests an approach to measure and assess the innovation capability of producing enterprises. This Norm is based on the InnoScore Model. The classifications and the indicators are used as well as the description of the potential application as a basis for comparisons of companies.

Summary and shortcomings of the methods assessing the innovation capability

In the following figure you can see comparisons between innovation valuation methods. Tested are “IMP³rove”, “DIUS”, “Innoscore” and “Normen”.

Methods	Completeness with product related Services	Consistency, derivation of options for action	Simple, quick comparison	Accepted, transparent, comprehensible
IMP³rove	◔	◐	◐	◐
DIUS	◔	◔	◐	◔
InnoScore	◔	◕	●	◕
Norms	◔	◐	◐	◐

Table 3 - Comparison of innovation evaluation method

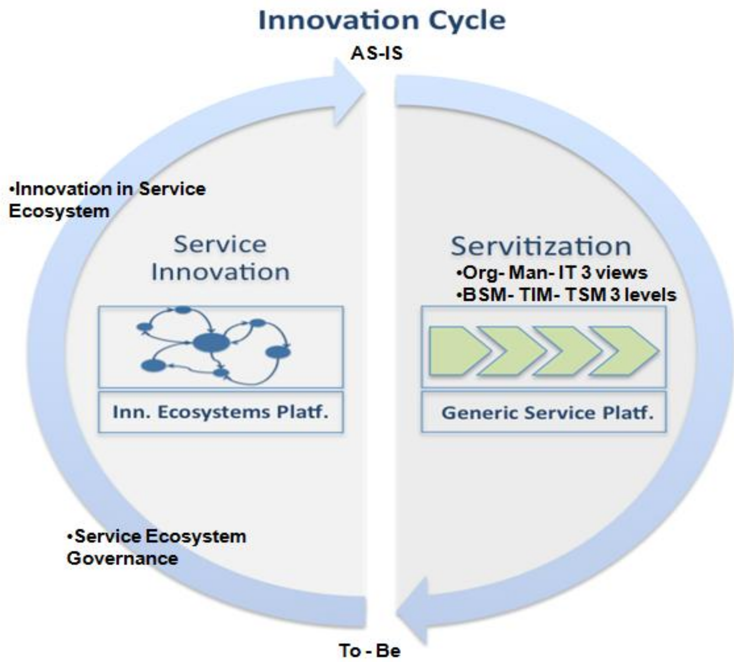
(● = appropriate, ○ = not appropriate) - Rogowski, 2011

This comparison shows that no method regards the development of product-related services in an adequate way. Consequentially, there is a need of valuation methods, which include product-related services. With regard to simplicity of the implementation and comprehensible validation “InnoScore” turns out as the most suitable approach, based on PAS 1073.

The tool “InnoScore® Service can be used in two ways

- To measure the performance of a single company and to make the comparison with the benchmark of the base (only possible in Germany, dataset is based on German companies of product and manufacturing branch),
- To measure the performance of a single company before (AS-IS) and after (TO-BE) a service innovation improvement.

The second way is more important for the MSEE project. Fig. 18 shows the connection between AS-IS and TO-BE situation.



AS-IS

Figure 16 - Innovation Cycle of the MSEE project

4.3. Example of measurement tool for Servitization level

In the following paragraphs a **self-assessment**-tool will be introduced, which can measure the level of servitization of a single company in the product and manufacturing industry. The chapter consists of the following points:

- Introduction of the self-assessment-tool "InnoScore® Service",
- Methodical background of "InnoScore® Service",
- How to use "InnoScore® Service",
- Short summary.

4.4. Introduction of the self-assessment-tool "InnoScore® Service"

"InnoScore® Service" (www.innoscore-service.de) is an appropriate tool for measuring, evaluating and improving the innovative capacity of firms in relation to product-related services. Without the need to spend much time, and requiring little existing knowledge of method, it can offer a benchmark and identify initial scope for improvement.

The following short description is based on **(**Freitag & Rogowski 2011**)** and **(**Freitag & Ganz 2011**)**.

The "InnoScore® Service" online test makes it possible to evaluate innovative capacity when it comes to the development of product-related services. Any interested company may participate free of charge. The test takes between 15 and 20 minutes. The results of the individual evaluation are shown in relation to a benchmark based on 126 firms from the plant and engineering sector, but both the questions and their evaluation are applicable to all manufacturing firms.

Additional information, possibly including methods to improve innovative capacity, may be derived from the recommendations for action that the “InnoScore® Service” tool then produces. What’s more, case studies suggest ways forward for those areas where the need for action is particularly great.

“InnoScore® Service” measures the innovative capacity of a company on the basis of nine organisational aspects, presented on the next page. A total of 31 questions within these nine areas must be answered from a selection of five options, “completely disagree”, “not particularly”, “mainly agree”, “agree completely”, and “no response”. At the end of the online questionnaire there is an individual analysis and evaluation of the company’s innovative capacity, using the “InnoScore® Service” tool for self-evaluation.

5.4.1 Methodical background of “InnoScore® Service” - The nine-aspect model

“InnoScore® Service” is based on the InnoScore® approach that has a strong relation to the EFQM-model **(**European Foundation for Quality Management 2003).

This is a model that aims at being as comprehensive as possible while still permitting a relatively high level of detail in the measurement of a firm’s innovative capacity. There are nine relevant organisational aspects spread through the innovation process. These permit the measurement, evaluation and targeted augmentation of innovative capacity for the development of product-related services. The balance of results between these aspects makes it possible to distinguish between innovative and less innovative companies. The nine aspects presented in are discussed in greater detail below **(**Freitag et al. 2006).

STRATEGY

Above all, innovative strategy includes a firm’s development of goals over the medium and long term as well as the formulation of steps to enable the realisation of these goals. If product-related services are to be successful, the correct approach must also be consistently taken at a purely strategic level. It becomes easier to create a common understanding of innovative product-related services if these are enshrined in strategy.

INNOVATION CULTURE

Innovative culture includes those aspects of a company’s culture that are seen as especially important for the process of innovation for product-related services. It describes the values, norms and ways of behaving present in the company, together with the operational atmosphere arising from them. Especially when it comes to product-related services, which are after all not the core business, both support from top management and a heartfelt service culture are decisive factors for success.

The “culture” area checks on the status of a customer-focused service culture, where employees are allowed the room for manoeuvre they need. Also of interest are staffs training sessions, which form an important part of the development of product-related services.

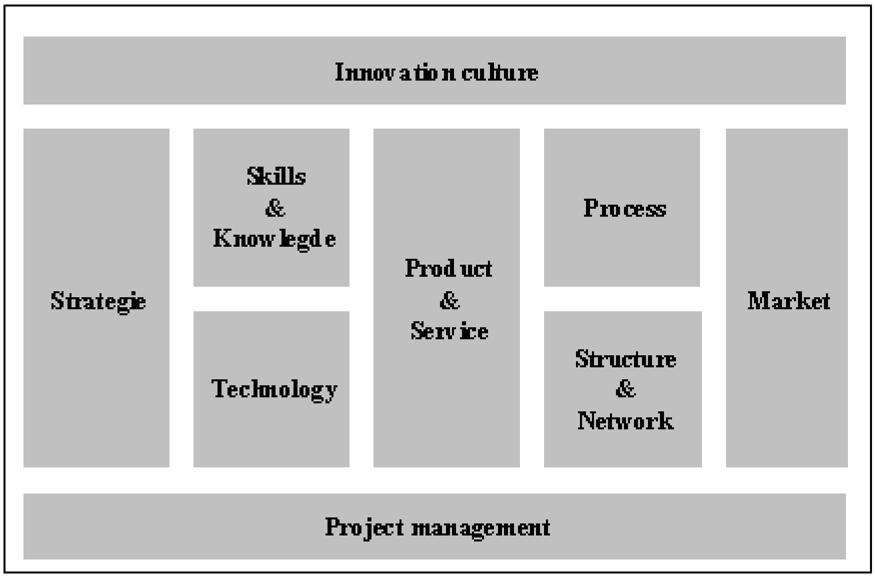


Figure 17 - The nine-aspect model

TECHNOLOGY

According to Sommerlatte und Deschamps (, the concept “technology” refers to “the practical application of scientific or technical possibilities to generate productive characteristics of products and operational devices”. In order to be capable of innovation, the correct technology must be employed and mastered. The service accompanying the product must be tailored to the core technology and interfaces must be defined. The development of product-related services calls for a suitable infrastructure as well as the actual provision of the services. This is often based on the interaction of several IT systems.

PROCESS

Just as in the case of the development of products, product-related services require transparent, reproducible development processes. This includes the definition of the interfaces within the process.

The “process” aspect, which is involved throughout a successful innovation process, includes sets of questions relating to the development process for product-related services.

PRODUCTS AND SERVICE

Products and services should be developed in harmony with existing technological skills, feasible production processes and available resources. The main factor deciding whether a product-related service is successful is whether the client’s wishes are fulfilled or whether solutions are provided for the client’s problems. The product-related service under development must be specified with sufficient exactness at the beginning of the process. It is also important to describe the service concept and the processes needed to carry it out in sufficient detail. The resources that need to be made available in order to deliver the service should also not be neglected. The aspect “Product and service” also examines interaction processes among clients and employees, as well as back-office processes; these have an important role to play in the development of product-related services.

MARKET

The market brings together supply and demand in the form of consumers (customers) and competitors. Customers in particular constitute a source of ideas and can also be a touchstone for new products and services. In order to utilise the knowledge of purchasers, it often makes sense to include customers in product development in a targeted way as well as testing the product-related service before launching it on the market.

The "Market" section establishes whether the firm uses so-called service prototypes to test the demand for new services. The aim is also to find out whether the system provides for product-related services to be tested before going to market.

PROJECT MANAGEMENT

In this context, project management refers to the leadership of a project, principally covering the planning, monitoring and guidance of a project as well as the institution in charge of the project **(**Freitag et al. 2006**)**. The focus lies on questions of cost, time and quality.

As part of the "project management" aspect, it is determined whether it is always possible to complete the development of product-related services within the planned period of time. This part of the questionnaire also establishes the extent to which the company's IT infrastructure and IT tools are used to support the development and delivery of product-related services.

SKILLS AND KNOWLEDGE

"Knowledge" embraces all the information and abilities that are used to solve a problem. The precise way this knowledge is applied in the form of actions is referred to as skill. The skill of an agent corresponds to his ability to apply knowledge to achieve set objectives through actions. The skills required to develop and deliver product-related services must be built up and further developed in a targeted way. In particular, it is a decisive factor for the success of a new product-related service that those staff delivering it is trained at the right time.

STRUCTURE AND NETWORK

In this context, "network" refers to the company's networking with other organisations and firms. One of the aims is to complement skills in areas where the company is unable or unwilling to provide the required resources. One important example is links to other research entities or universities.

The aspect "structure and network" determines whether the firm has a cooperation scheme in place with universities or other research entities.

SERVICE INDICATORS

The area "service indicators" deals with the proportion of product-related services within the firm's overall turnover. If the information is available, the specific proportion of research and development expenditure (R & D) devoted to product-related services within total R & D expenditure should be given.

The use of the online tools involves two phases, data input and then evaluation of the data collected including a comparison with the existing benchmark (Rogowski/Slama, 2008).

5.4.2 How to use "InnoScore® Service"

Within each of the nine aspects, questions are asked regarding the indicators as determined. To make this clear, we will use two questions from the "strategy" aspect as an example. This field asks whether product-related services have been continually introduced over the past three years. Participants are also asked to what extent these services are supported by a concrete strategic process. 15 is an example of the appearance of the input mask for the company.

Figure 18 - Example questions

(Translation:

Question 1: During the last three years, we have continually introduced new product-related services for our customers?

Answer 1: Completely disagree, not particularly **(here marked)**, mainly agree, agree completely, no response.

Question 2: My Company has an explicit strategy for product-related services (for new and existing services).

Answer 2: Completely disagree **(marked here),** not particularly, mainly agree, agree completely, no response)

At our example company, hardly any product-related services were introduced in the past three years, and there is no strategy for product-related services yet.

INTERPRETING THE COMPANY'S DATA

After the questionnaire phase has been completed, the firm receives a personalised evaluation of its innovative capacity straight away.

First, the average values are interpreted. The information is presented in the form of a diagram giving a clear overview of the firm's innovative capacity across the individual aspects.

Shows such a diagram in this way, the company can compare its situation with a benchmark based on 126 datasets that are based on German companies of the product and manufacturing branch.

The evaluation of the averages shows that in the case of our example company, innovative capacity for the development of product-related services is above the level of the benchmark. However, the aspects "strategy", "skills and knowledge", and "process" received a below-average evaluation. It may be surmised that the scope for improvement in these areas is considerable.

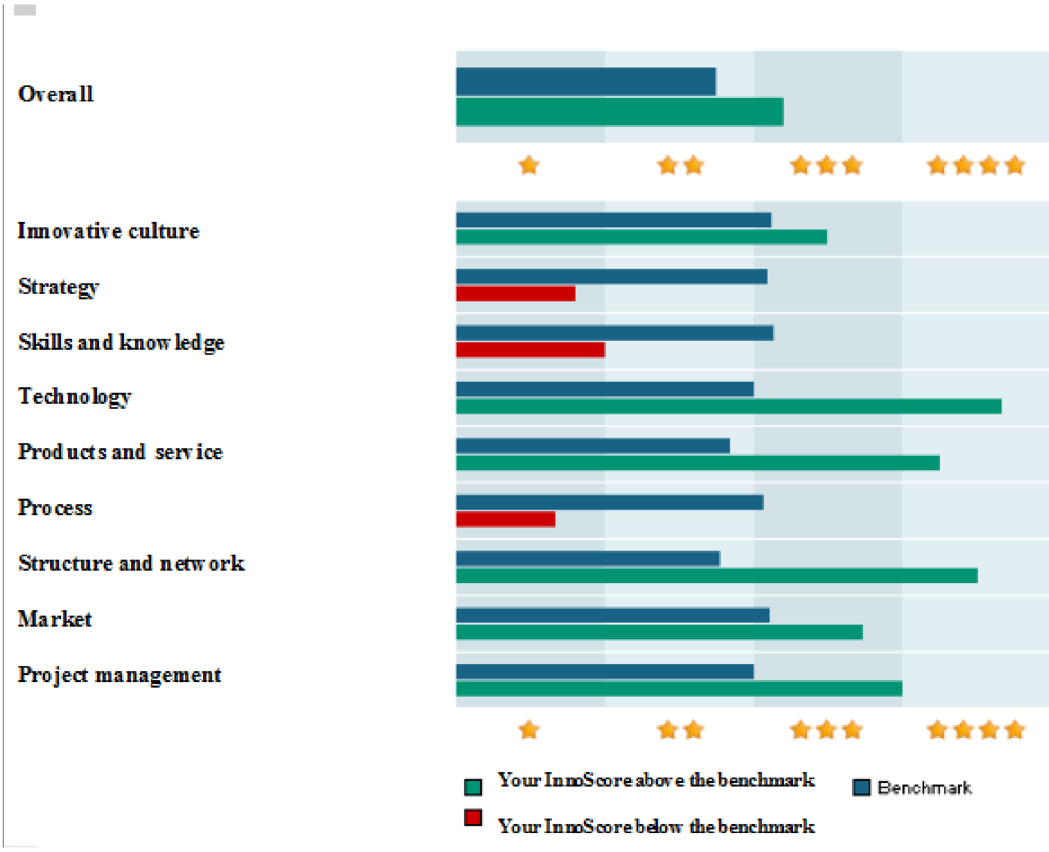


Figure 19 - Example of a result of a company in comparison with the benchmark

Immediately after the personalised evaluation, “InnoScore® Service” provides additional information on each of the aspects. The tool also offers specific recommendations for actions which provide a starting point for the improvement of innovative capacity.

After this, details are provided relating to the evaluation. First of all the service figures entered are evaluated, revealing the proportion of turnover deriving from product-related services and also the average development time for product-related services.

Immediately after this, the final stage consists of specific recommendations for action to complement the evaluation. Companies may for instance be given additional information about individual aspects. Examples of methods and case studies are provided for those areas showing the greatest scope for improvement.

In this way, in a short period of time “InnoScore® Service” gives you an overview of your innovative capacity, with a special focus on product-related services. The complete process, from data entry to benchmarking and initial recommendations, is guided, and with little effort you can improve both awareness and transparency in relation to important determinants of success in the development of product-related services.

5.4.3 Short summary on InnoScore

"InnoScore® Service" is a tried-and-tested tool that can help companies to improve their innovative capacity and so make a lasting contribution to their success. Firms gain transparency regarding their strengths and weaknesses in relation to innovative capacity for product-related services. They can compare themselves directly with their competitors and react to the increasing importance of product-related services.

The online tool helps firms achieve improvements to their innovative capacity, but this must be maintained and checked over the long term. Repeated use of the tool allows for regular monitoring of the success of steps taken to increase innovative capacity and effectiveness, especially in relation to product-related services. Moreover the results may be used to support communications with third parties, e.g. with banks in support of lending requests or to demonstrate the firm's viability, or in an auditing context, or to develop relations with suppliers. Additionally, participating companies can benefit from the tried-and-tested evaluation methodology.

5. KPI and SLAs for Service Ecosystem Governance

5.1. Introduction

The after – sales (service) activities are nowadays acknowledged as a relevant source of revenue, profit and competitive advantage in most manufacturing industries. Top and middle management, therefore, should focus on a structured business Performance Measurement System for the service business. The perception of Service as a source of competitive advantage and business opportunity requires a shift from a traditional Product – Centric view, in which service is considered a necessary evil, to a Service – centric view.

5.2. Supply Chain performance measurement system

Supply Chain Management can be defined as "the systematic, strategic coordination of the traditional business function across these business functions within a particular company and cross business within the supply chain, for the purpose of improving the long – term performance of the individual companies and supply chain as whole" **(**Paolo Gaiardelli, Performance measurement of the after-sales service network – evidence from automotive industry, June 2007**)**. Performance measurement, thus, acquire an Inter – Organizational perspective. Performance Measurement System, may serve as a method to ensure, enforce or strengthen the coordination between organization inside a supply chain or network. Performance measurement is a process for collecting and reporting information regarding the performance of an individual, group or organizations; therefore, three separated types of performance measurement are:

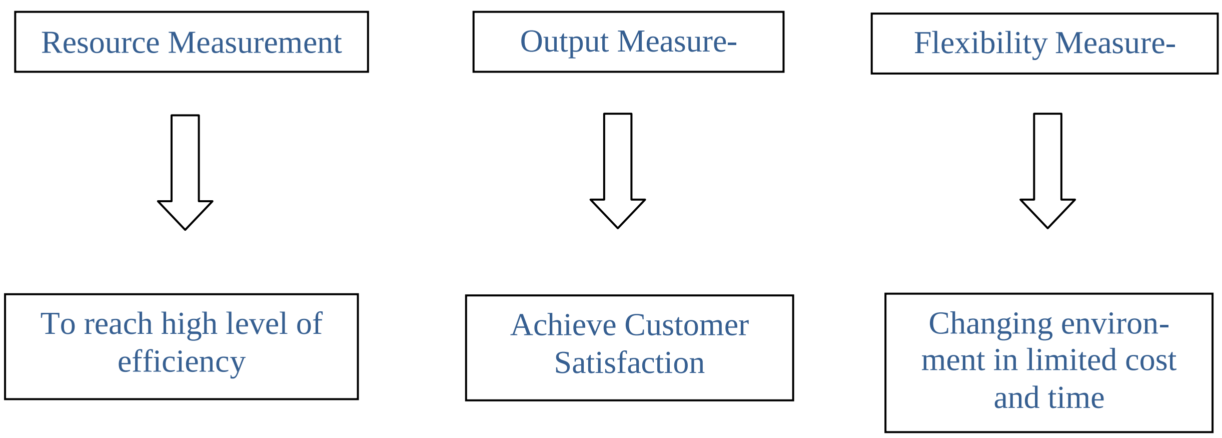


Figure 20 - Performance Measurement Type

5.3. PMS organized collection of various performance indicators.

Performance measurement systems (PMS) serve as a method to ensure enforce or strengthen the coordination between organizations inside a supply chain or a network **(**Paolo Gaiardelli, Performance measurement of the after-sales service network – evidence from automotive industry, June 2007**)**. The PMS is articulated in four levels: (i) The business area, (ii) The process level, (iii) The activity and organizational unit level, (iv) the development and innovation level. These areas of performance at each level are defined and linked consistently with their impact on effectiveness (performance area in the left side of the framework below) or efficiency (in the right side) (P.Gaiardelli, N. Saccani, L. Songini, Performance measurement systems in the after-sales service: an integrated framework, International Journal of business performance measurement 9 (2) (2007) 145-171).

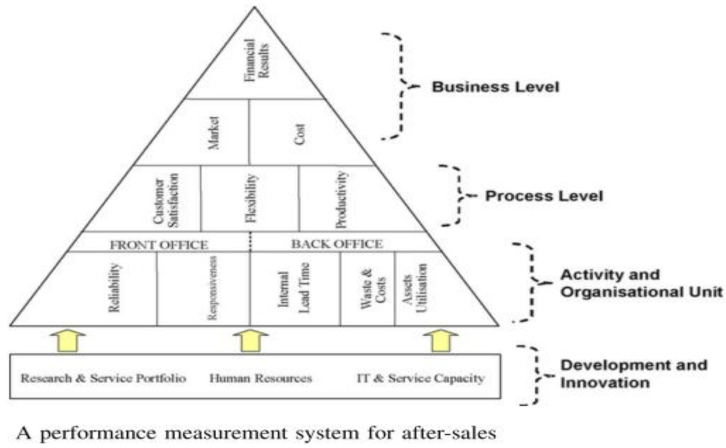


Figure 21 - A performance measurement system for after-sales

In fact, after – sales (service) is a process, composed of different activities, carried out by multiple actors. Efficiency and effectiveness of each activity at each actor impact on the overall service chain performance in terms of customer satisfaction, flexibility and productivity. Several KPI may be adopted to control the effectiveness process, e.g. customer service satisfaction & customer satisfaction toward the network, the percentage of variable cost for flexibility and total costs of service for productivity (Paolo Gaiardelli, Performance measurement of the after-sales service network – evidence from automotive industry, June 2007**)**.

But how could a performance measurement system be defined and deployed consistently across the different organization in a supply chain?

5.4. Need for Key Performance Indicator (KPI) within an enterprise.

After analyzing supply chain performance measurement problems from a system perspective, several types of concerns are identified, namely:

- Lack of connection between strategy and measurement,
- Biased focus on financial metrics,
- Use of inappropriate measures,
- Lack of system thinking.

The predominant method of performance measurement which can cover the above mentioned lacks is KPI is represented by an overall approach, which is based on KPI models, such as ECOGRAI or VRM.

Key Performance Indicators (KPIs) can be defined as measures that provide managers with the most important performance information to enable them or their stakeholders to understand the performance level of the organization.

KPIs should clearly link to the strategic objectives of the organization and therefore help monitor the execution of the business strategy.

KPIs serve to reduce the complex nature of organizational performance to a small number of key indicators in order to make performance more understandable and digestible for us. This is the same approach we use in our daily lives. For example, when you go to your doctor he might measure blood pressure, cholesterol levels, heart rate and your body mass index as key indicators of your health. With KPIs we are trying to do the same in our organizations. Best practice organizations

- Clearly understand what indicators are required for learning and improvement and focus on those,

- They separate out the external reporting indicators if they are not relevant internally to avoid confusion and data overload, and
- They create the right culture to drive high-performance.

5.5. The problems with KPIs

In practice, the term KPI is too loosely defined and very much overused. For many it describes any form of measurement data and performance metrics used to measure business performance. Instead of clearly identifying the information needs and then carefully designing the most appropriate indicators to assess performance, we often observe what we have termed the 'ICE' approach (see also attached picture):

- Identify everything that is easy to measure and count
- Collect and report the data on everything that is easy to measure and count
- End up scratching your head thinking "What the heck are we going to do with all this performance data stuff?

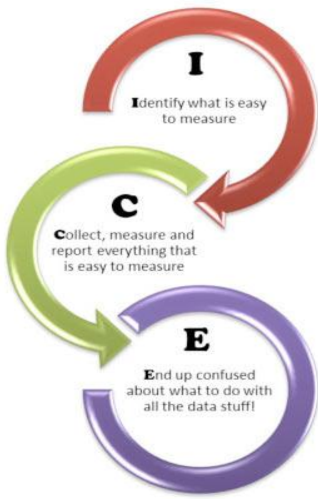


Figure 22 - ICE approaches

5.6. How to design KPI

A good starting point is therefore to come up with the questions you want to have an answer to, before starting and designing KPIs. One or two so-called Key Performance Questions (KPQs) should be identified for each strategic objective **(**Bernard Marr, How to design Key Performance Indicators, October 2006**)**.

6.6.1 Start with strategic objectives

KPIs should be clearly linked to the strategy, i.e. the things that matter the most. Once you have agreed, defined and mapped your strategic objectives you can design KPIs to track progress and gain relevant insights to help manage and improve performance. KPIs have to provide you with answers to your most important questions (decision models).

6.6.2 How will the data be collected?

In this part of indicator design template we look at the more technical aspects of the data collection. Instead of just selecting any existing measurement method it is important to consider the strengths, weaknesses, and appropriateness of different data collection methods. Here the designer of an indicator should include a brief description of the data collection method, specify the source of the data, what scale will be used to measure it, how, etc **(**Bernard Marr, How to design Key Performance Indicators, October 2006**)**.

1	**Strategic Objective** Which strategic objective is this indicator relating to?	
2	**Key Performance Question (KPQ):** What Question do you want to have an answer to? What are our information needs?	
3	Who is asking this question? Who is the information customer?	
4	What will they do with the information? Why are they asking?	
	Performance indicator basics:	
5	KPI ID	
6	KPI Name	
7	KPI Owner	
	How will the data be collected	
8	What is the data collection method?	
9	What is the source of the data?	
10	What is the formula / scale / assessment method?	
11	How often, when and for how long do we collect the data?	
12	Who collects the data?	
	Target	
13	What is the target or performance threshold(s)?	
	Good measures tests	
14	How well is the indicator measuring performance?	
15	What are the costs for collecting the data? Justified?	
16	What dysfunctional behavior could this indicator trigger?	
	Reporting	
17	Who is the primary and secondary audience for this indicator	
18	Reporting frequency (when and for how long will this indicator be reported?)	
19	Reporting channel (which channels will be used to report this indicator?)	
20	Reporting formats (in which formats will the information be reported?)	

Figure 23 - Key Performance Indicator template

6.6.3 Reporting frequency, channels & format

If the indicator is to serve as a decision-making purpose within the organization, then the indicator needs to provide timely information. The possible outlets or reports are identified which are used to communicate the data. An indicator can for example, be included in the monthly performance report to directors, could be presented in the bi-monthly performance review meeting, or included in the quarterly performance report to the abroad, in the weekly performance report to head of service.

The indicator designer should clarify whether the indicator is reported as, for example, a number, a narrative, a table, a graph or a chart. The best results are usually achieved if performance is reported by means of visual tools, e.g. charts, or by a mix of numerical, graphical and narrative formats.

5.7. Governance

Governance has become a huge topic in the business world. Key drivers are increasing regulatory pressure and the desire of enterprise to monitor and influence their business performance faster. A good starting point for elaborating governance framework can be borrowed from Unified Governance Framework (UGF) **(**Birgit Pfitzmann, IBMs Unified Governance Framework (UGF) initiative, December 2007) and GRAI conceptual reference model explanation.

- UGF is intended to cover the entire space of enterprise governanceThe core parts of UGF are a component model and a lifecycle. The component model is structured in layers.
- The GRAI conceptual reference model is a recursive structure which allows to represent with the same concepts, the global and the local models of a manufacturing system in an enterprise. The interest of a conceptual model is to relate the various concepts in order to show their coherence, to avoid redundancies and to have a complete modeling.

Generally, in GRAI model for typical enterprise, six functions are taken in to account: to production, to manage commercial, to manage design, to manage development, to manage production, to manage assembling, and to manage delivery (G. Doumeingts, Y. Ducq, Enterprise modeling techniques to improve efficiency of enterprises, International Journal of Production Planing & Control, 2001, Vol. 12. N^{o}2, 146-163).

By synthesizing UGF model and GRAI model in next deliverable we will try to make hierarchical decomposition to facilitate the integration between decisional levels and between functions.

In this chapter we try to explain UGF model and components which it can be covered the enterprise governance space.

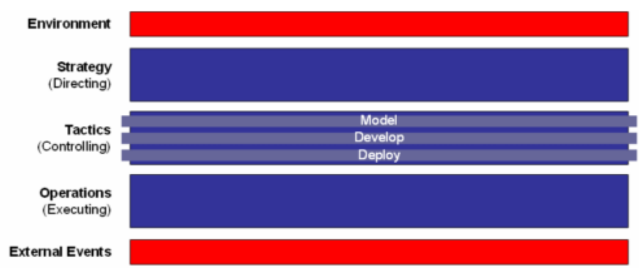


Figure 24 - Component Model

In UGF, The inner three layers are those of an enterprise, while the outer (red) layers represent the Environment. The names used are consistent with generic Component Business Model (CBM). A component model is a grouping of related functions and capabilities into components that communicate over relatively well-defined interfaces. A component can contain organizational structures, processes, people, and technology.

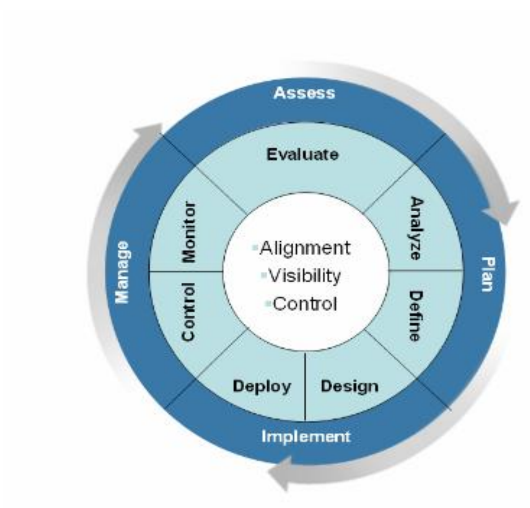


Figure 25 - Dynamic UGF lifecycle

A dynamic UGF view at a similar degree of abstraction is the above lifecycle figure. It can be mapped to enterprise governance as in the UGF component model, as well as to smaller scopes such as IT governance, or to completely different governance scopes like politics.

A PDCA (i.e. Plan Do Check Act) approach is presented in the figure, which mainly consists of the following stages:

- Plan, i.e. analyze and definition
- Do (Implement), i.e. design and deployment
- Check (Manage), i.e. control and monitor
- Act (assess), i.e. evaluation

While considering a UGF framework relevant aspects should be taken into account as far as the whole model and its components are regarded; therefore every specific topic, such as KPIs, should be accessed through the different stages of planning, implementing, checking and acting, in order to continuously verify its effectiveness and to drive improvement.

The core of UGF is the highest-level components, which are shown in figure below **(**Birgit Pfitzmann, IBMs Unified Governance Framework (UGF) initiative, December 2007).

A component model is a grouping of related functions and capabilities into components that communicate over relatively well-defined interfaces. A component can contain organizational, structures, processes, people, and technology. The specific purpose of UGF is to focus on enterprise governance, i.e., to distinguish and describe governance components in more depth than the rest of the enterprise. Three specific layers are described on the following figure and they may be referred to the business service management as well as to the organization as a whole.

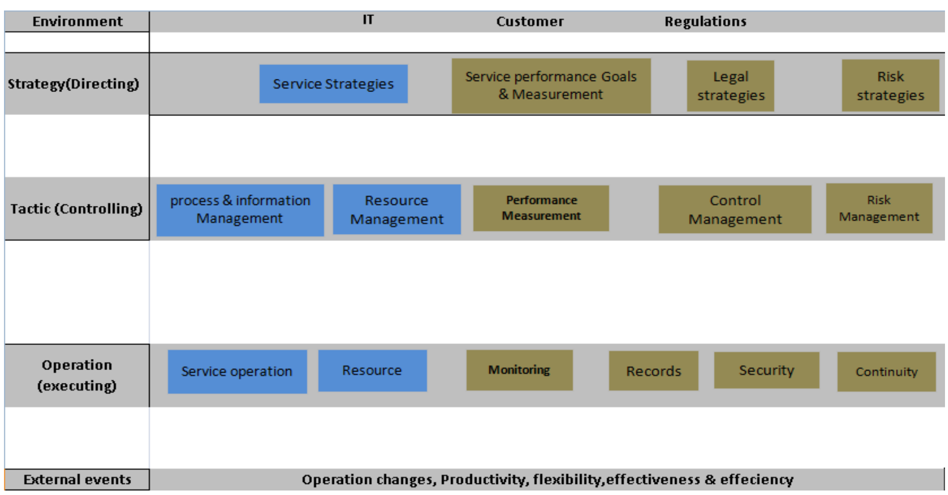


Figure 26 - UGF component Model

On the strategy layer, the normal enterprise capabilities are summarized. Governance deals with three main aspects: business performance goals, legal issues, and risk. On the strategy layer, this involves overall analysis, goal setting, and establishment of appropriate organizational structures, such as service performance goals and measurements.

On the tactical layer, the normal enterprise capabilities are defined in terms of process and information management and resource management. The former corresponds to business parts organized by lines of business and business processes, the latter to functional units like IT, HR (human resources), and facilities. Each of the components performance management, controls management and risk management correspond to the strategy component above it.

On the operations layer, the normal enterprise capabilities are evaluated in a similar way and they are based on day-to-day tasks.

The following figure shows the information flow between different layers of UGF framework. The arrows roughly ordered according to the main components that produce and consume the information.

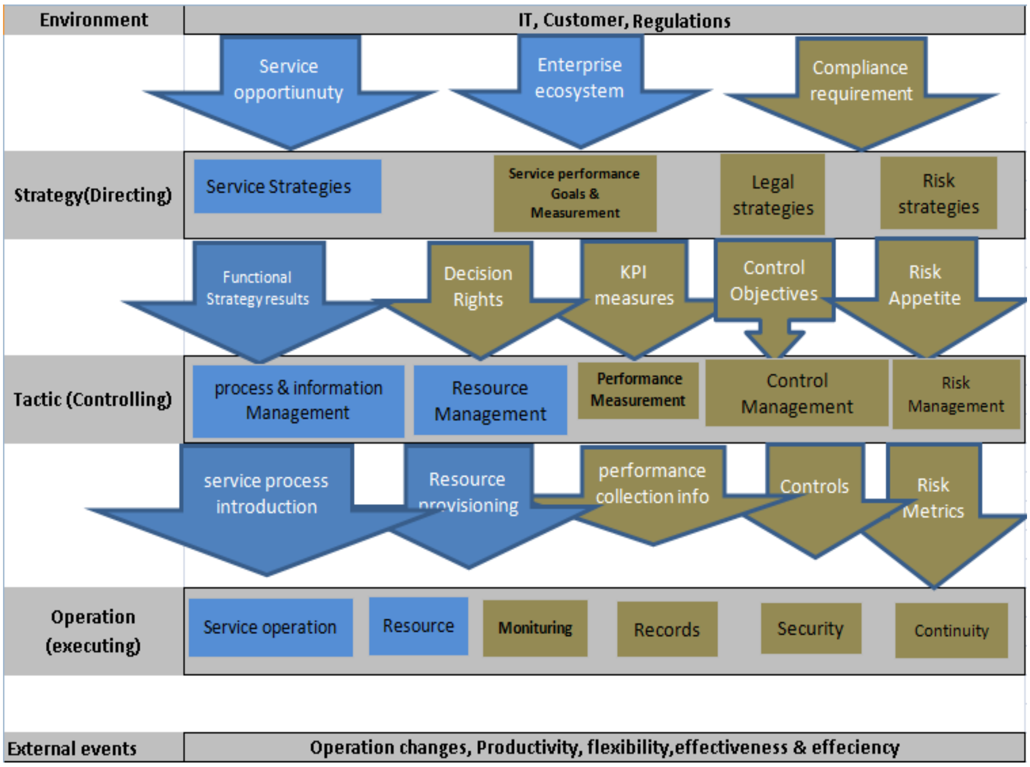


Figure 27 - Downward information flow between UGF layers

At the top there are flows from the environment into the strategy layer. The normal (blue) information is the service opportunities and enterprise. They influence the service strategies and service performance goals. The main additional governance input is external compliance requirements, in particular laws and regulations, but also important standards and customer expectations (Birgit Pfitzmann, IBMs Unified Governance Framework (UGF) initiative, December 2007).

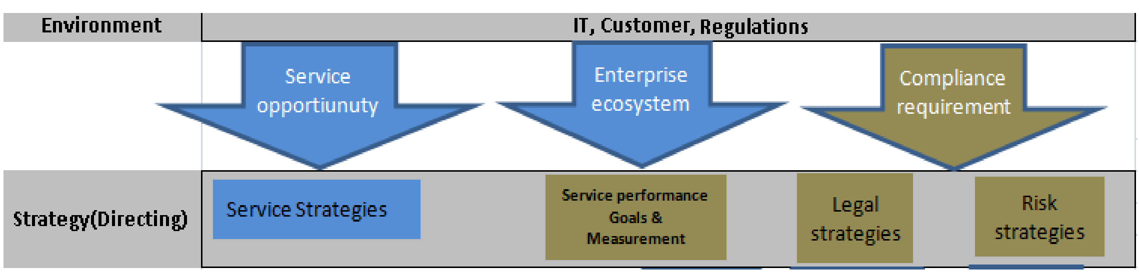


Figure 28 - Information flow between Environment & strategy

Between the strategy layer and the tactical layer, the results of the business strategies are summarized, as they are communicated to the normal tactical components, as "functional strategy results". Decision rights are a separate arrow in blue – brown because they are an important result of normal service strategies already, but become even more important for governance, and they are strongly influenced by the governance – specific (brown) strategy components. The main information communicated from the setting of service performance goals and measurement is called KPI measures. Control objectives are core output from the legal strategies is called Risk appetite (desire); it tells in broad term how willing the enterprise is to take Risk in different areas, and how it avoids or mitigates other risks.

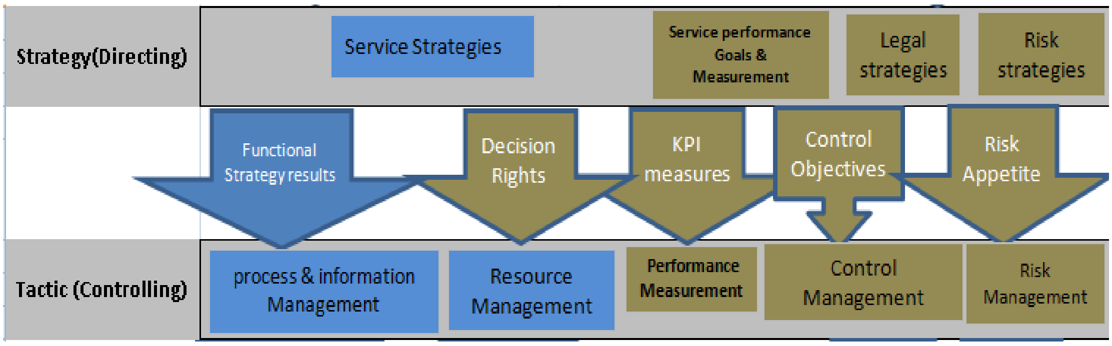


Figure 29 - Information flow between strategy & Tactics

From the tactic to the operation layer, we show two normal information flows: bringing service oriented design decision into practice is summarized as "service process introduction"; this includes introducing corresponding system and human education. Information from the resource management to operation on resource is called "resource provisioning". Performance management mainly produces information about performance metric to be collected. But indirectly also influences in particular the resource provisioning. Controls management mainly produces concrete controls. Those are distributed almost throughout the enterprise, in particular into the process and information management within the tactic layer. However, important controls go to the governance – specific and continuity, often in the form of policies.

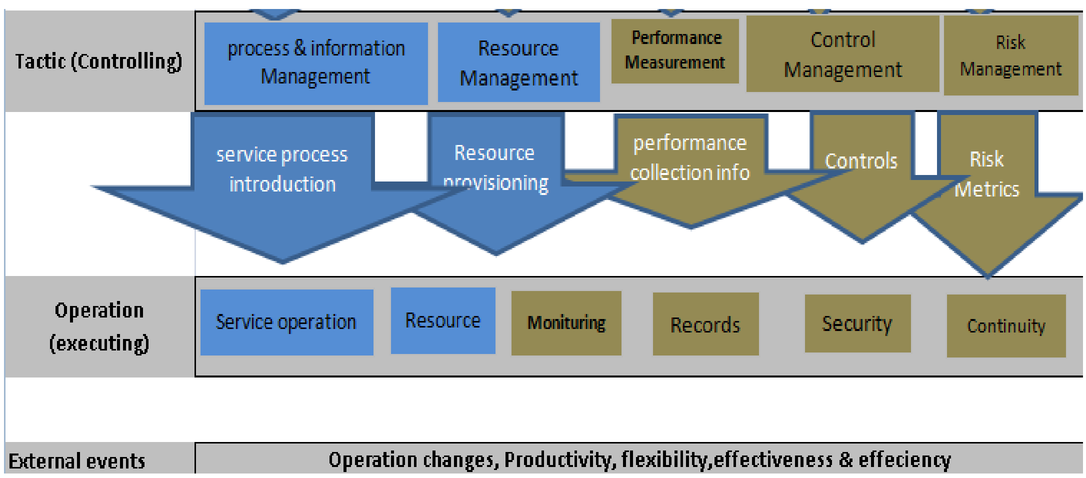


Figure 30 - Information flow between tactics & operation

At the bottom, we have external events that are sensed at the operational layer. We distinguish the main ones into service environment changes and operations disruptions. The distinction between these events and the information from the environment into the strategy layer is not fixed; with increasing real – time processing more and more information will be monitored and analyzed by operations system first.

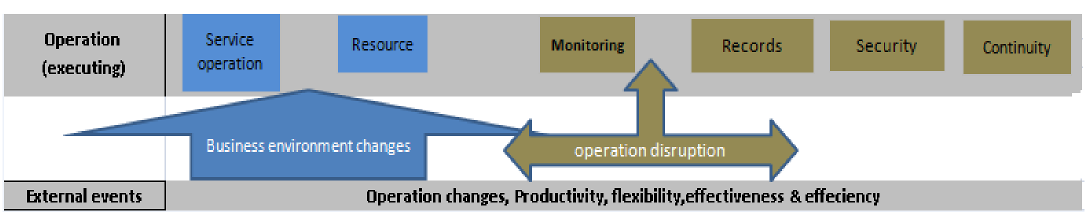


Figure 31 - Upward information flow between events & operation

From the operation layer to the tacticl layer, we mainly see feedback at the level of detail where tactics goals were set. This is normal service execution difficulties and performance results mainly detected by the monitoring component, control evidence from all components that got controls, and risk and loss information. Furthermore, there is more tactics up flow about the real situation on the operations layer, at least as long as everything happening here is fully planned in advance.

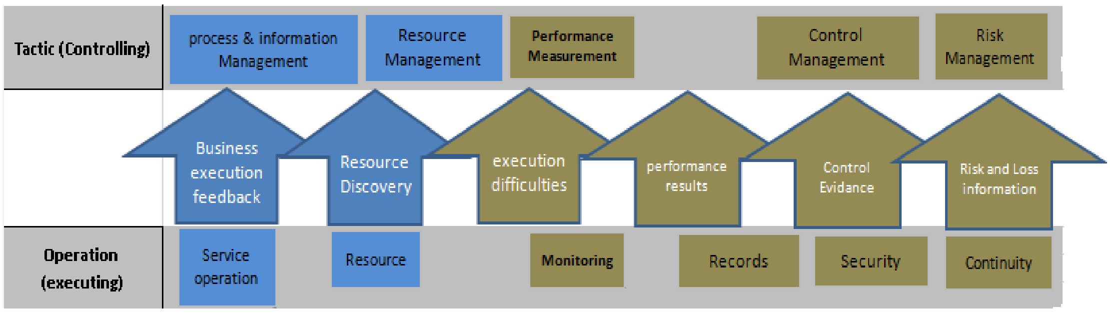


Figure 32 - Upward information flow between operation & Tactics

The main information from tactics to the strategy is aggregated measurement, i.e., the tactics layer evaluates low-level information into meaningful strategic summaries. The best known such data are the measured KPI data. Control results are mostly statistics of passed and failed controls. Similarly, risk and loss summaries, including KPI data, are communicated. Decision exception data correspond to feedback about the decision rights and about internal standards. Service reality knowledge summarizes information that the strategy layer gets, in pull and push models, outside the pre-planned standard summaries and indicators.

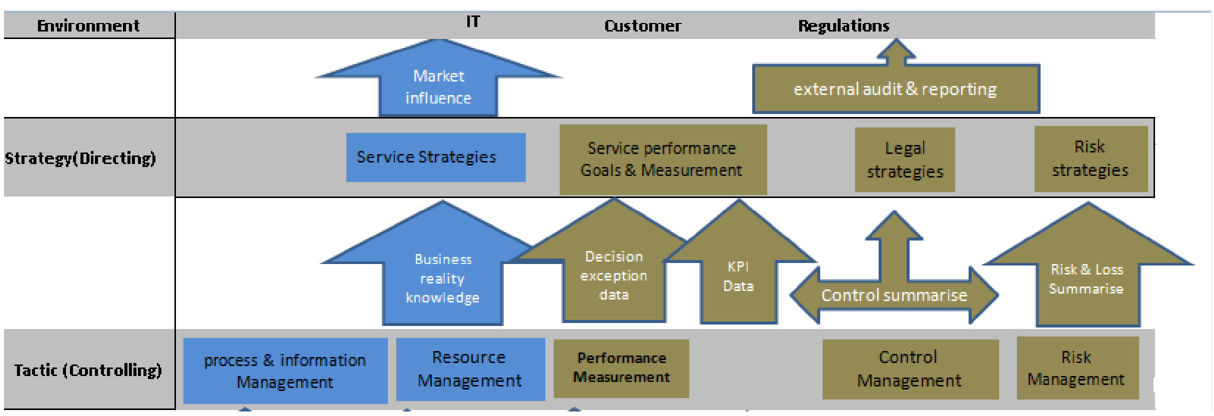


Figure 33 - Upward information flow between Tactics & Strategy

The strategy layer also informs the environment, e.g., by telling analysts about service results or by influence the business ecosystem. (Operational interactions with customers, suppliers etc. do not belong here.) As to legal and risk strategies, external audit and reporting is the core outflow of information.

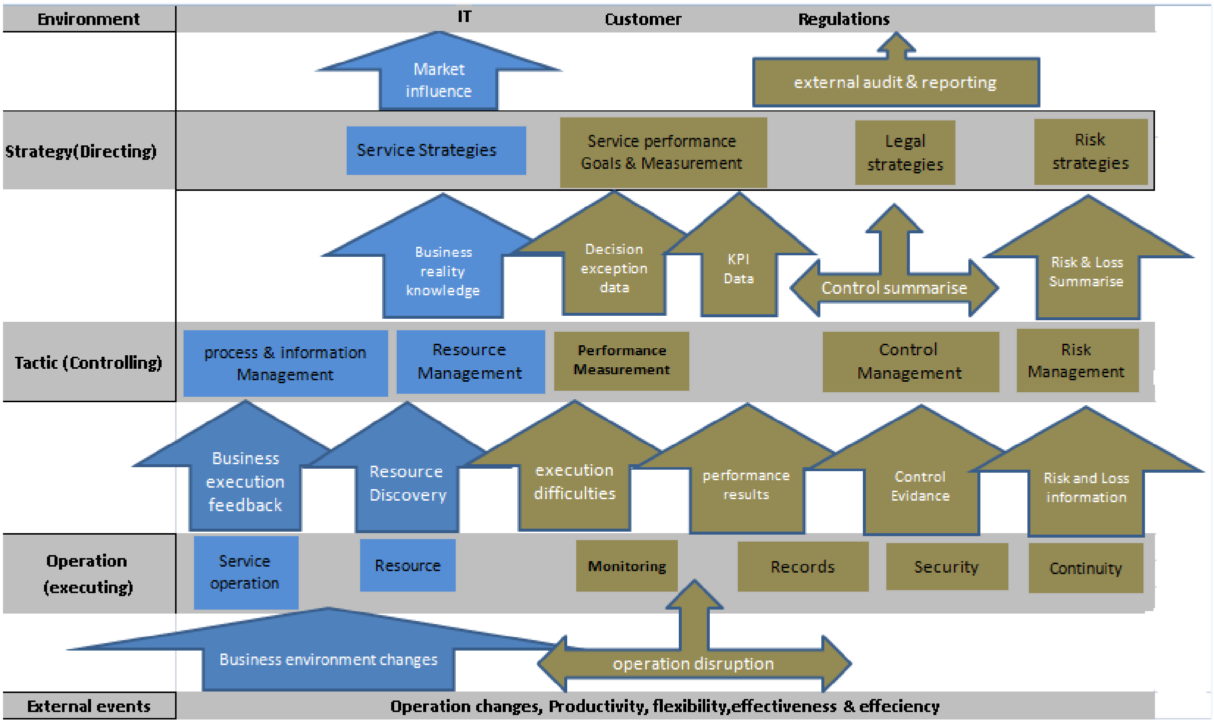


Figure 34 - Upward information flow between UGF layers

As a summary, if we consider a dynamic UGF view, a combination of a top-down measuring model and bottom up KPI analysis is necessary to manage service within an ecosystem.

In the future, by synthesizing the UGF model with GRAI conceptual reference model we will try to improve governance framework in service ecosystem.

5.8. Global and specific KPIs for governance and timeframe

A further analysis about both global and specific KPIs will be carried out on the next iteration, after examining results for business model analysis and D51.2 Methodology for Requirements Engineering & Evaluation in Manufacturing Service Ecosystems. Appropriate timeframe is a key issue while defining and monitoring KPIs.

Meanwhile, in order to be able to classify the KPIs refer to design time and run time scope, further more following the ECOGRAI to define the method and using the VRM model for list and govern the tool for KPIs and SLAs, a dynamic repository should be defined and implementation.

The next iteration sheds light on how synthesize both GRAI and UGF models to support governance framework by using relevant KPIs.

A complete list of KPIs and management approach is described by VRM and presented in the next paragraphs.

5.9. SLAs within the ecosystem (this needs to be expanded)

It is reasonable to think that organizations moving through the servitization process tend to integrate KPIs more and more with SLAs, to achieve a better control of the SMEs ecosystem, regardless of the supply chain and production processes.

These assumptions will be verified in the next iteration, after implementing simulation with test cases.

6. KPI and SLAs for Innovation in Ecosystems

In the previous chapters different perspective on KPIs and SLAs in innovation Ecosystems were described. Methods to define appropriate Performance Indicators (PI) like ECOGRAI were described.

This chapter directs the focus on specific indicators that can be used to describe and assess innovation processes in an Ecosystem. This provides a kind of general information basis that can be used as input for the selection and definition of PI, e.g. according to the ECOGRAI method.

Literature has already provided several suggestions for Indicators that are related to innovation.

The VRM model that will be discussed in the next chapter describes also innovation processes and some related PI. However, the set of PI regarding innovation is quite limited. The offered PI is "*Product Innovation Index* "and„ *R&D Profit Contribution*".

A more comprehensive source of PIs that describe innovation is the **KPI library**, an internet website that is dedicated to Performance Indicators. There is a community of users that are registered to the KPI library, provide content and discuss the existing content. The following table represents an extract of PI from the KPI library that considers Innovation.

Indicator	**Description**
Research Cost Ratio	Cost of research expresses as a ratio of Total Operating Cost. This includes all employees involved in research. This ratio indicates the budget percentages allocated for research and development. Indicates a company's interest & investment in future science and technology innovation.
Number of Engineering Changes	Average number of monthly engineering changes approved for each design. A high ratio may indicate poor upfront product design, especially if the number of engineering changes increase after design release, or if there is high innovation before design release. A low ratio may indicate lack of insight into potential problems downstream. This computation can be applied to the design of a complex product or to a subset of that product. This measure needs to be customized to the client's environment. This number in itself may not be meaningful, but its trend over time would demonstrate effectiveness of the design group.
Product Innovation Index	Number of new, innovative, or upgraded product features distinguishable from the previous product.
Budget, New Concepts Breakthrough	Budget allocated the front end innovation to develop new to the world concepts / products.
Must-Have Effect	to analyze the convenience of converting in continuative products, items that instead should last just one season, but that are so appreciated and successful to become must-have bestsellers. The success of an item in fact should be determined by measurable factors (such as the quality/price ratio) but also by non-tangible effects (i.e. advertisement, innovation, trendiness, VIPs wearing publicly the item etc.)
% dedicated resources for radical innovation	Percentage of dedicated resources (in FTE) for radical innovation.
% of investment in non-core innovation projects	Percentage of investment in non-core innovation projects.
Total funds invested in non-core innovation projects	Total funds invested in non-core innovation projects
% of senior management	Percentage of senior management time invested in growth innovation.

Indicator	Description
time invested in growth innovation	

Table 4 - Innovative PI in KPI library

Different authors have suggested approaches to classify indicators related to innovation. The common elements of these approaches are summarized in the following graphic

.

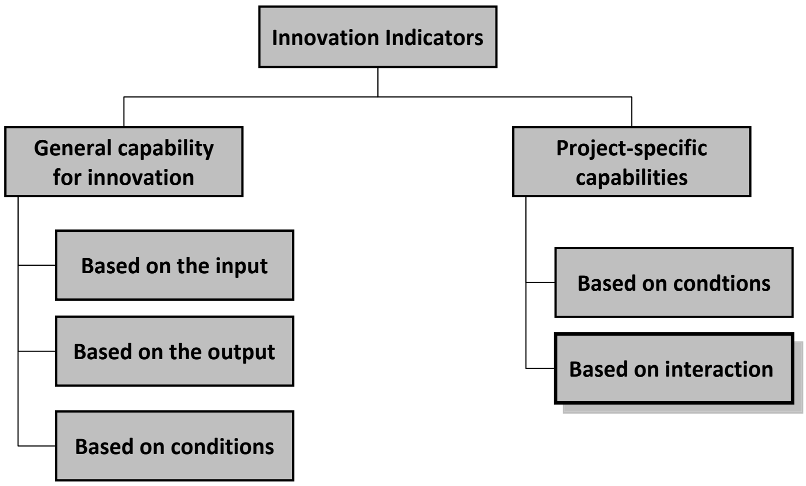


Figure 35 - Innovation Indicators

The first differentiation is between a company's general capabilities for innovation and the innovation performance in a particular project.

The general capability answers the question: "*Is the company itself innovative?*" The InnoScore approach and the RKW-InnoCheck take this point of view. The results can be used for a self assessment (comparison with benchmarks or analysis of internal improvements over time) or for the selection of partners in an innovation.

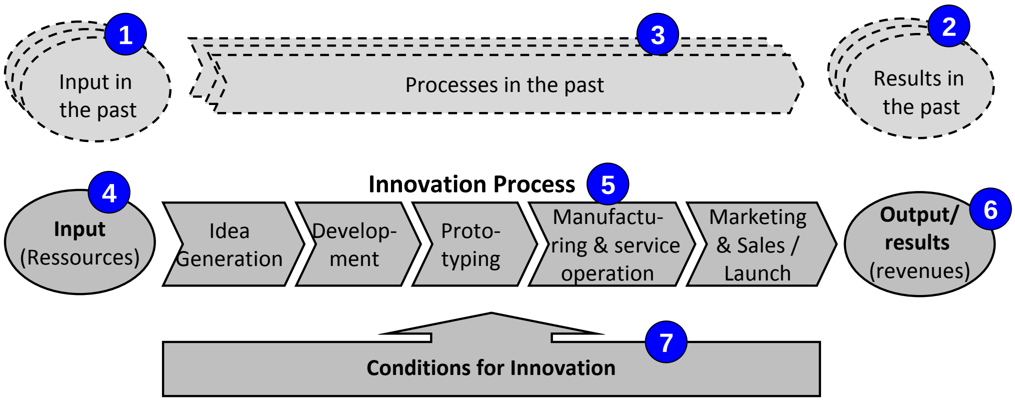


Figure 36 - Innovation Process

Typical indicators for the provided input for Innovation Processes (1).

- R&D Budget
- …

Typical indicators for the achieved output of Innovation Processes (2).

- Number of patents.
- Share of new products in the overall profit.
- …

Typical indicators for the performance of Innovation Processes (3).

- Number of suggested ideas
- Number of engineering changes
- Number of ideas/builds collected
- Number of Event Visitors / Contributors
- Number of Idea/Build Authors
- Number of ideas reviewed and concluded
- Number of Ideas passed through to concept development
- …

Although there are various models to describe the innovation process (e.g. Stage-Gate, ….), there is no approach with a related model for corresponding KPI, like it is the case in the SCOR Model (in the VRM Model innovation is only process besides various other processes and there is only a very limited set of indicators that are more related to the output than to the process).

Finally, Refer to the specific indicators for innovation process evaluating which is mentioned in previous paragraphs and regarding the collection of general information for using as input during the PIs selection process, this chapter focuses on classifying KPIs and SLAs for innovation due to ECOGRAI method and VRM model.

7. Selection, Evaluation and Assessment of PIs in MSEE Pilots

In D51.2 a Methodology for Requirements Engineering & Evaluation in Manufacturing Service Ecosystems is discussed. In particular, an assessment of the MSEE Impact on Process Performance is performed.

By using ECOGRAI model which is adopted as a method to design and to implement performance indicators and refer to The MSEE Business Evaluation Approach which is based on the Value Reference Model (VRM) **(VCG 2012)**, this model provides pre-defined measurable indicators for Value Chain goals in several dimensions. Following this model, the MSEE end-user scenarios are used to select appropriate processes and dimensions, featuring the preferential goals and objectives for each end user.

Strategic, tactical and operational priorities have been developed for each end user, thus allowing selection of appropriate Key Performance Indicators (KPIs).

MSEE Business Evaluation will be performed using a 4-step approach to indicate MSEE benefits for the end-users. The following actions are performed during the steps:

1. Selection of VRM Processes, based on scenarios and the expected benefits through MSEE;
2. Definition of VRM Priority Dimensions;
3. Usage of the VRM Framework for Identification of KPI‘s according to selected processes and priorities;
4. Measurement of AS-IS situation/processes before using the MSEE Services.

The VRM model is structured to support the integration of the three domains product development, the supply chain and customer relation in a reference model for an integrated value chain.

The Top Level of the model encompasses all the high level processes in Value Chains which are represented through the Process Categories *Plan – Govern – Execute* (see the following figure). The Plan process is used to align strategic objectives with tactical and execution abilities. Govern supports the strategic objectives by rules, policies and procedures for the Value Chain. Execute encompasses all execution processes in a strategic context within the management criteria from Govern and the parameters defined by Plan.

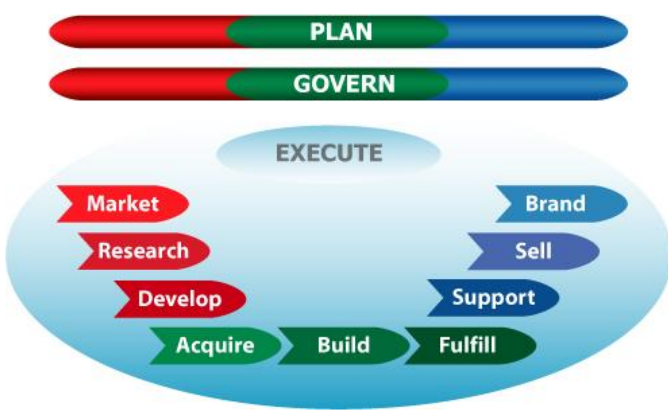


Figure 37 - VRM Strategic and Tactical Level Processes (VCG 2012)

The Second level of the model contains “abstract” processes decomposed from the Strategic Level. The Value Reference Model processes decompose from Strategic to the Tactical Level with Plan and

Govern keeping their respective naming. Execute decomposes to *Market-Research-Develop-Acquire-Build-Sell-Fulfill-Support* (VCG 2012**)**.

The third level of the model represents specific processes in the value chain related to actual activities being executed. On this level focus is usually vertical business process improvements or business process re-engineering (see figure below).

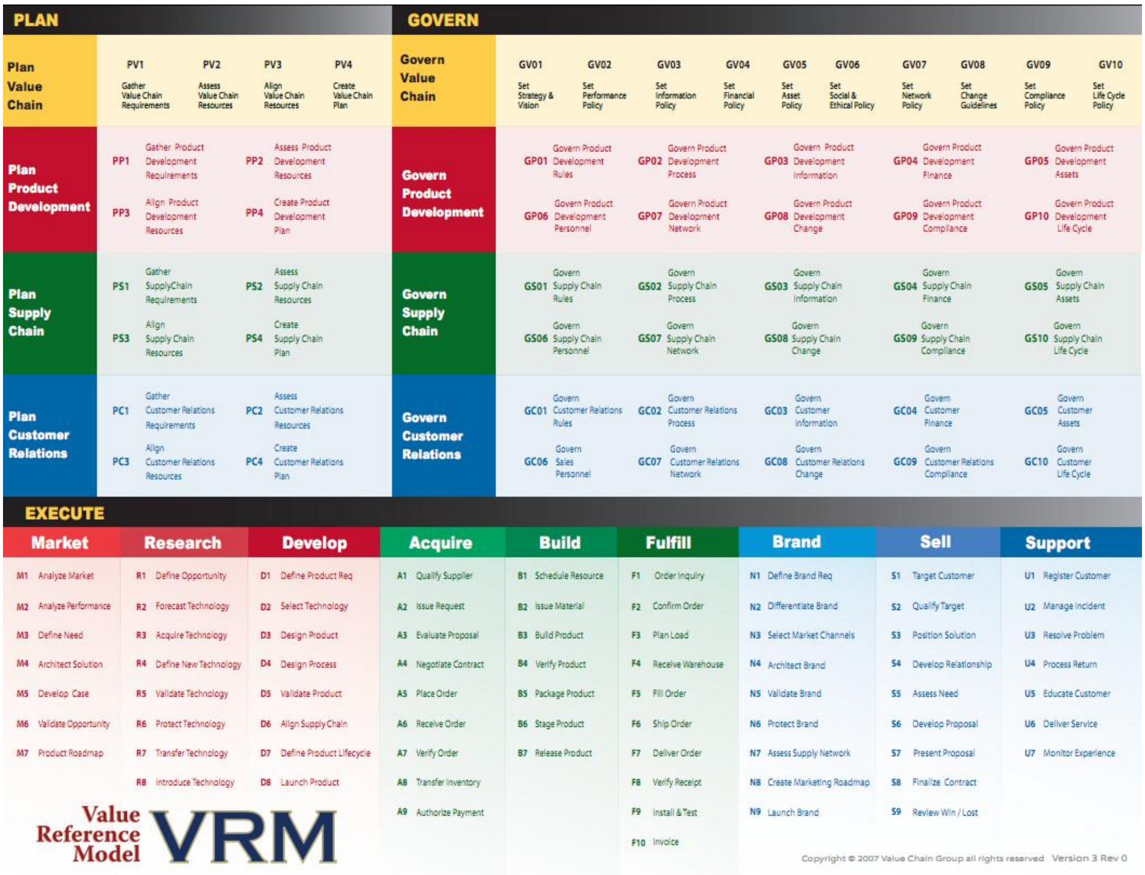


Figure 38 - VRM Operational Level Processes (VCG 2012)

The metrics provided by VRM are not only mapped to the processes of the framework, but also grouped into seven distinct dimensions, each representing a different area for optimization (see Table 5).

Table 5 - VRM Priority Dimensions (VCG 2012)

Priority Dimension	Description	Examples for KPI‘s
Reliability	The ability to deliver the correct product to the correct market and customers on time.	*Delivery Performance, Request Date* *Product Release Variance* *Forecast Accuracy*
Velocity	The cycle time it takes to deliver a product or service to the customer.	*Order Fulfillment Lead Time* *Product Development Lead Time*

Priority Dimension	Description	Examples for KPI‘s
Adaptability	The capability in responding to market place changes to gain or maintain competitive advantage.	*Delivery Adaptability* *Value Chain Agility* *Ideation Yield*
Cost	The cost associated with operating a value chain.	*Cost of Quality* *Design Cost Ratio* *Logistics Cost Ratio* *Manufacturing Cost Ratio* *Sales & Marketing Cost Ratio*
Asset	The effectiveness of an organization in managing assets of the value chain to support market and customer satisfaction.	*Asset Turnover* *Cash Conversion Cycle* *Design Realization* *Inventory Days of Supply*
Innovation	The ability to strategically leverage internal and external sources of ideas and introduce them to market through multiple paths.	*Product Innovation Index* *R&D Profit Contribution*
Customer	The capability to develop positive collaborative customer relationships.	*Customer Growth Rate*

After processes and priority dimensions have been identified for each of the MSEE end-users, the VRM gives information about possible metrics to measure business process improvements. Table 6 shows the information delivered for each metric by the VRM.

Table 6 - VRM Metric Information

Information	Content
Metric Name	Brief descriptive name less than 50 characters.
Metric Definition	Detailed definition usually one sentence to two paragraphs in length.
Priority Dimensions	Strategic Classifications used in Value Chain Alignment.
Metric Class & Sub Class	Classification for navigation and search index.
Formula	Algorithm for calculating metric value. Some metrics are considered a „Base Metric“ in which calculations are not required.
Input Requirements	Suggested application data fields and sources to acquire information necessary for performing the calculation.
Dimensions	Sources of input from different areas of involvement.
Calculation Rules	General notes and guidelines for use of the metric.

The selection of metrics for the various test cases in MSEE follows the methodology for business evaluation described above.

8. Conclusion

This deliverable sheds light on some models and methods used to define, classify and implement KPIs within a manufacturing service ecosystem.

As shown on the figure 41 below, ECOGRAI has been chosen as the reference method to manage KPIs within a manufacturing service ecosystem, based on models determined in WP 1.1.

The interaction among different SPs has been herewith summarized: the method, defined by SP1, is integrated by the list of KPIs and SLAs, provided by SP5, aiming at controlling and monitoring the servitization process and service innovation governance within a manufacturing ecosystem, as detailed in SP2. Finally, use cases are tested to verify feasibility and effectiveness of the relevant methods and processes accordingly.

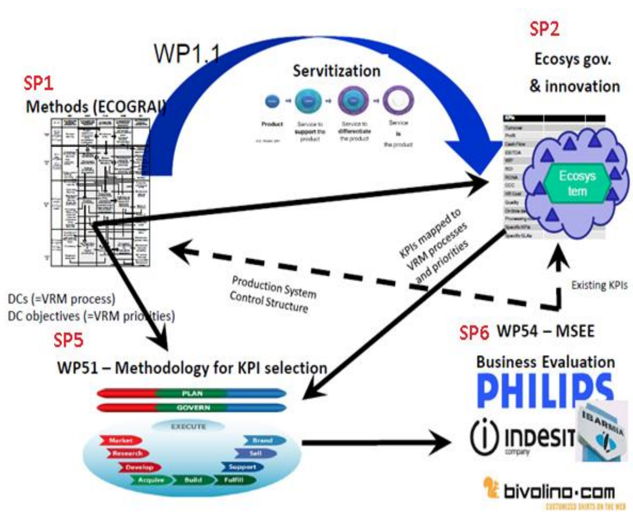


Figure 39 - KPI management method

In addition, KPIs and SLAs should be used to monitor and govern the ecosystem both at design and run time stages. Smart editor should be developed at the design stage while monitoring tools should be implemented to control performance of the partners and of the ecosystem over time.

Finally, this deliverable represents the first iteration step towards the final goal, which is the definition of appropriate KPIs/SLAs, methods and tools for the transition from product to product+service companies within a manufacturing service ecosystem, aiming at exploiting effective service innovation.

Assumptions have been made, which should be verified against relevant findings of industrial partners and on the models developed by other WPs.

A deeper analysis of KPIs vs company status and business industry should be further analyzed. In this way, enterprises will be able to provide the required information in the correct timing to enable the full usage of KPIs and SLAs during the relations with others, achieving trust and reputation within the system.

Expected results are therefore the definition of KPIs, models and tools which apply to different industry classes.

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