D12.2 – Report about Service Scenarios

M15

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Dissemination:	Public
Contributing to:	WP1.2
Date:	22/2/2013
Revision:	1.0

VERSION HISTORY

NO.	DATE	NOTES AND COMMENTS
0.1	3.12.2012	DELIVERABLE STRUCTURE
0.4	6.1.2013	REVISED STRUCTURE
0.8	29.1.2013	COMPLETE VERSION FOR INTERNAL REVIEW
0.9	3.2. 2013	COMMENTS BY PROJECT COORDINATORS
0.95	15.2.2013	COMMENTS PROCESSED
1.0	21.2.2013	DELIVERABLE FNISHED

DELIVERABLE PEER REVIEW SUMMARY

ID	**Comments**	**Addressed (✔) Answered (A)**
1	More detailed description of the four service types	✔
2	More detailed description of use case examples	✔
3	Integration PLM/ SLM: more details	Partly addressed, other points will be addressed in D12.4

TABLE OF CONTENTS

TABLE OF FIGURES

1. Executive Summary

The MSEE proposal addressed the servitization trend uniquely from the **M**anufacturing perspective, by adopting the four steps proposed by Prof. Thoben, which describe a roadmap for manufacturing enterprises on how to approach their market by an evolutionary and progressive service-oriented approach. In the course of MSEE SP2, a new reference model for collaborative service innovation in business **E**cosystem is designed and validated. In SP1 and in particular in WP1.2 the main aim is to define a framework for describing how **S**ervice scenarios in virtual factories and enterprises could affect the service business.. A **first** aspect of this framework is a quadrant classification of services according to two orthogonal dimensions: the intensity of the contact with the user (service is value co-creation) and the variety of cases and scenarios where this contact takes place. According to this quadrant diagram, four types of services have been identified (Low-Low Process-focused services; Low-High Flexibility-focused services; High-Low Customer-focused services; High-High Knowledge-focused services) described in detail, interpreted in the light of MSEE pilots and for each of them some guidelines and recommendations have been issued to be followed during a servitization process. Two of these classes seem finally applicable to our MSEE industrial pilots.

A **second** aspect of the framework consists in identifying the different characteristics of the four typologies of services which result in other consequences for service engineering as well as for the lifelong interaction between Product Lifecycle Management (PLM) and Service Lifecycle Management (SLM) activities. In this respect, a model for representing in what way products and product-related services can interact along the respective lifecycles was developed and validated. Based on research and empirical work, four alternatives (identified with the letters A-B-C-D) of the interaction-based integration of SLM and PLM have been described: SLM depends on PLM / SLM and PLM have reciprocal interconnections / fully integration of SLM and PLM / PLM is dependent on SLM. For each of these four alternatives examples have been provided and validation performed in our four Pilots.

A **third** aspect addressed in this deliverable is the identification of methods and tools for representing and modeling the mutual relations between PLM and SLM phases. For instance the so-called Design Structure Matrix (DSM) has been used to analyze interdependencies of information flows between various elements of a Product Service System by depicting the influences and dependences of each element to one another.

Empirical studies were also conducted with the objective to find out more about **Service Business** in practice. The evaluation of the expert interviews prepared in the previous deliverable leads to a variety of perceptions about service scenarios of manufacturing companies regarding product-related services of the future. It was determined how the management of services in manufacturing companies is accomplished, with regard to a life cycle management for services.

In fact, the survey revealed that in the near future the importance of the service business will grow among the interviewees and the challenges that have to be faced are growing. This is justified with the fact that the demand of services/solutions by customers are constantly increasing. For example so-called carefree service packages are requested by users to approach high-technology products more often or highly customized and personalized solutions rather than standardized services are sought. Among these challenges, we mention

- the technical changes especially in digital technologies also represent a challenge and offer much potential for the different phases of the service life cycle management,
- because the service business is not yet as mature as the product business, there are additional difficulties for future services: specific competences have to be established, because currently not enough suitable staff is available,

- as the questioned companies said, future services will show some more characteristics like higher transparency or stronger integration between services and products.

The questionnaire also included a part for service life cycle management with some of its components. It was found that the surveyed companies mainly have a product focused understanding of SLM, but say that product-related services have a rising significance. Also, an increase of differentiating customer demands can be obtained (e.g. Individualization or comprehensive services). Furthermore the Integration of new (digital) technologies gets more important and like this aspect, all other areas of service lifecycle management have a need for support seen from a practical aspect (i.e. Defined processes and responsibilities; Methods and tools or IT tools).

Out of these findings, several service scenarios could have been described. Each of these has specific requirements and they can either stand alone or appear in combination with each other so that there highly demanding challenges appear for future service business.

2. Objectives and Structure of Deliverable D12.2

2.1. Objectives of Deliverable D12.2

Deliverable 12.2 shall provide the continuation of the work on the future service scenarios, which includes the trends to-be and findings from practice for manufacturing companies regarding product-related services.

Challenges, generated by the different types of services and the interplay with products and their lifecycle management, will also be studied, as these are important factors for future service scenarios. The results and evaluation of the empiric study, which was prepared in the previous deliverable and serves as a basis for the development of future service scenarios, will be provided.

2.2. Structure of Deliverable D12.2

Deliverable 12.2 consists of two main and overall seven chapters. At the beginning, the executive summary gives an overview of the contents of this deliverable. In chapter 2 the objectives and contents of this deliverable are being described.

To develop future service scenarios for product-related services, it is essential to clarify the requirements that are given by the nature of services. On this account, the approach on integrating PLM and SLM that was presented in deliverable 14.1 (chapter 4.4) will be developed further in the third chapter. Therefore the product-related service types are explained. Specific conditions that arise from the different types of product-related services regarding their development are derived therefrom.

After the different types of product-related services are explained, the focus will shift to the integration of product and product-related services in matters of their lifecycle management. Therefore the state-of-the-art of the integration of SLM/ PLM will be presented, before the MSEE Framework will be adapted using the example of the engineering phase within the lifecycle management of products as well as product-related services.

Chapter 4 consists of three parts. First, the preparation of the empiric study will be summarized and repeated briefly. Thereafter the realization phase of the interview is being described – for that the final interview guideline will be provided (which you can find in the appendix). The third part of this chapter will be one of the main parts of this deliverable – the evaluation of the expert interviews. Here it will be described what purpose is pursued with the survey. Also, the profile of the participating companies will be given. The following subchapters are about the service business of these companies and which scenarios in the sense of trends and challenges they envision for the future. Furthermore the results of the questions about service lifecycle management, service engineering, service operations management and the phasing out of existing services in these companies will be presented. In the last part of this chapter, some service scenarios with their specific characteristics are presented.

At the end, the conclusions are drawn and a forecast is given (chapter5), also the list of references (chapter 6) and the beforementioned interview guideline (chapter 7) are being provided.

3. Challenges for future services concerning Integration of PLM & SLM

To identify the challenges ahead for manufacturing companies aiming at implementing service innovation, it is necessary to consider various factors of influence on services. First, it is essential to examine the different types of services and determine their different priorities, so that appropriate methodological approaches can be chosen. Second, the interplay of products and product-related services is from organizational and business process viewpoints to be considered as well, because - depending on the different types of services - the interconnection between the two domains could present different needs and require different measures and solutions. Third, these factors, which are due to the nature of services, are complemented by others that are dependent on the management of services across the entire life cycle, including the development of new services. The three factors mentioned above are being explored and discussed in the subsequent chapter within the survey of experts. There it was finally asked what influencing factors are to be considered and how they could have effects in future service scenarios.

3.1. Typology for service products

As far as the use of methodologies, methods and tools to develop services is concerned, an undifferentiated approach is most definitely inappropriate owing to the heterogeneous nature of the service sector and of the service products. In order to be able to perform meaningful analyses and to derive recommendations for action regarding methodology, method and tool deployment, it is useful to identify characteristic service “types” in advance and then take these as a basis for a more detailed examination. (Bullinger et al. (2003))

Although previous academic studies have already devised a set of so-called typologies for the service sector (e.g. Schmenner (1986), Kellog and Nie (1995), Buzacott (2000)), hardly any of them are explicitly geared to service development and product-related services. The classification approach evolved by Fähnrich et al. represents an exception (Fähnrich et al. 1999), even today. It moreover offers the advantage that it was derived empirically from a survey of 282 companies and can hence claim a considerable degree of practical relevance. Moreover, this typology is chosen in this project since the service portfolios of all the company cases inside MSEE can be clearly addressed to the specific illustrated service types shown in Figure 1.

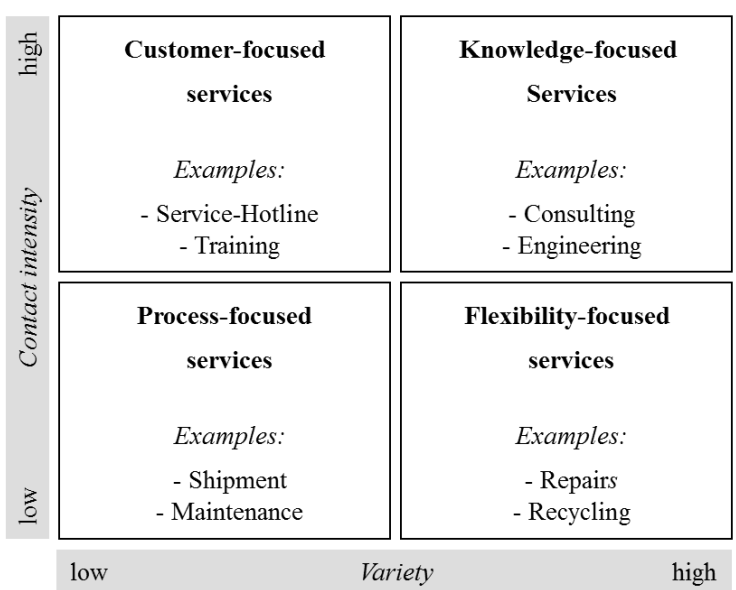

Fig. 1: Service typology

Contact intensity and **variety** were revealed by a factorial analysis to be the two critical classification variables. Contact intensity can be seen as a yardstick of the interrelationships between employees and customers, whereas variety describes the total number of determined manifestations of the service product. These two classification variables allow four service types to be defined (Bullinger et al. (2003)):

- **Service type A** is addressing *process-focused services*; they are characterized by low contact intensity and low variety, making it particularly suitable for highly process orientated, standardized service delivery. An example is the transport of a purchased product for future use (e.g. a large machine). For the transportation company, this is a standard procedure, because tasks like that are involved in daily business. Moreover, hardly any involvement of the client is required; he must merely be present at the reception of the delivery.
- **Service Type B** is addressing *flexibility-focused services*; they are characterized by low contact intensity but high variety, whereby from the developer's point of view the focus is on the systematic variant creation aspect. As an example a repair service can be mentioned: If a machine is broken, it requires only a small interaction between customer and service provider to charge the required service. The variety, however, is high, as the service provider supports various machines, which usually have different defects. He has to adapt to the specific situation with every job.
- **Service Type C** is addressing *customer-focused services*; they are typified by high contact intensity and low variety. It essentially consists of a single, clearly defined standard service, which may however be influenced by the customer within certain limits. Training for a new machine shows such a case. The Service Provider should describe a standardized program to the staff how the machine works. However, there is high contact intensity, as the customer is present at the service provision and may also react unexpectedly.
- **Service Type D** is addressing *knowledge-focused services*; they are distinguished by high contact intensity and high variety, so that its performance typically necessitates a considerable amount of customizations. Consulting would be an example: The high contact intensity results from the fact that service provider and customer work together on a result. Because this process cannot be standardized, but depends on the individual needs of the customer, the variety is very high, too.

3.2. Consequences of the service types to their specific development process within Product and Service Life Cycle Management

3.2.1. MSEE company cases

When looking at the company cases inside MSEE, you can find that the majority of the cases are mainly addressing services that have low variations, but more or less contact intensity during delivery, that is in service typology terms speaking of service type A, process-focused services, and service type C, customer-focused services, but also service types B and D occur. Some examples are (cf. D52.1):

- INDESIT: “Carefree Washing” (…a set of ad-hoc services providing personalized technical assistance and allowing remote control by mobile applications),
- BIVOLINO: “B2B front-end and back-end services” (…providing e-retailers with ready-to-use customized platforms for MtM shirts and blouses. The newly developed configurable 3 D database allows designing shirt collections adapted to the specific needs of the e-retailer’s clientele.),
- PHILIPS: “Services around the Integration of Facebook/Twitter” and “Recommendation Service” (With these services the consumer can interact with

friends. Services like Picasa, Facebook and Twitter are available as service. These services make it possible to share photos and tweets with friends)

- IBARMIA: "Remote Maintenance Service" (…read available data and logs and try to diagnose and find a solution to the problem.);

The following section will address some specifics of a new service development process by using the proposed Service Engineering Framework by Fraunhofer IAO shown in Figure 2.

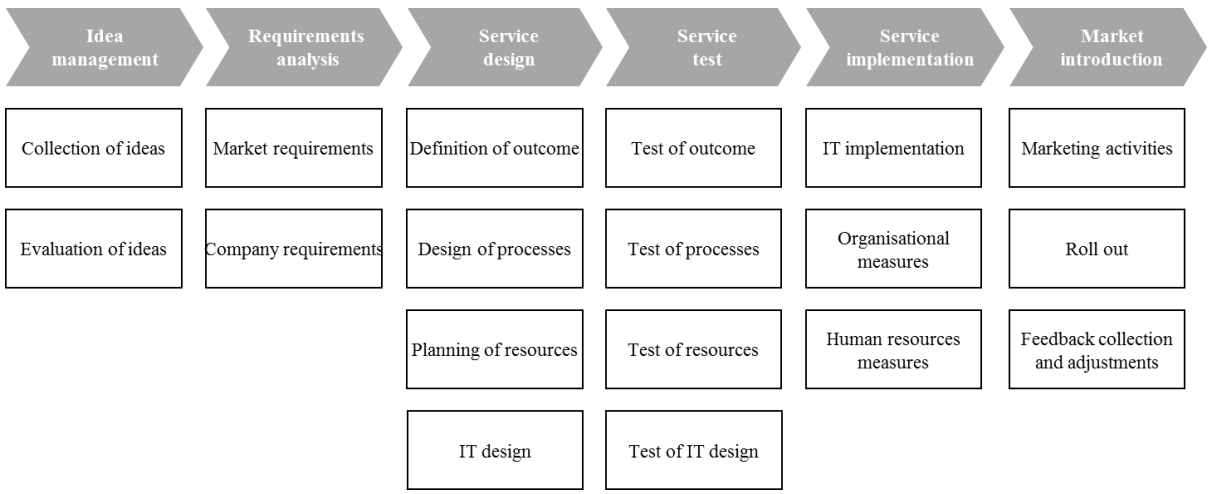

Fig. 2: Service Engineering Framework

3.2.2. Process-focused services

As mentioned earlier, a process-focused service is characterized by low contact intensity and low variety, making it particularly suitable for highly process orientated standardized service delivery. Silvestro et al. (1992) states, that a "process-oriented service is where the emphasis is **on how** the service is delivered to the customer".

Service development activities should therefore focus on collecting process-focused requirements, developing the service process model and especially defining the customer contact points within the service process model. Furthermore investigation should be done towards the resource model development, not only from a technological perspective, but also from a personnel and qualification perspective. Testing should also center on process-focused activities.

3.2.3. Flexibility-focused services

The flexibility-focused services are represented by low contact intensity and high variety, which means that the actual service is certain not until the provision. The order from the customer can be highly standardized (e.g. contact form, automated hotline, etc.) so there is no need for high interaction. The variety on the other hand is higher – individual problems or demands can arise though the related products may be standardized.

Service development activities should therefore concentrate on maximization of the flexibility of services, i.e. those who perform the services have to be trained well to be able to respond to individual situations and specific customer demands. That means, that the focus should be on the analysis of requirements (to cover as many possible situations and demands as possible) as well as the human resources, who need to have comprehensive knowledge to react flexibly to different requirements.

3.2.4. Customer-focused services

A customer-focused service is typified by high contact intensity and low variety. It essentially consists of a single, clearly defined standard service, which may however be influenced by the customer within certain limits. Therefore, Gustafson et al (1999) as well as Alam and Perry (2002) suggest, that there must be systematic work involved in (1) involve customers in the service delivery and development process, (2) collecting customers input and then (3) using customer's input either to improve the existing service product or to develop something new.

Service development activities should therefore focus on developing the service product model and especially defining how and where in the overall development process customer contacts occur, from where input to optimization and innovation can be gathered. Special methods and tools for customer integration and collecting input from customers need to be used in the development process as well integrated into the delivery process. Testing should also focus on customer orientation activities.

3.2.5. Knowledge-focused services

The fourth type of services is characterized by high contact intensity as well as high variety. Due to the high degree of individualization of the service, the interaction between customer and service provider is very intensive. Examples therefore are consulting services or the development of products that are tailored exactly to the needs of customers.

During service ideation and development, the users must be integrated in the process from the very beginning. During service operations it means monitoring and analyzing sentiments, opinions and reputations. The focus of the activities should therefore be on the Requirement analysis and the definition of outcome, which is carried out in close collaboration with the customer. Organizational measures like a knowledge management are also essential, because the high variety of the provided services places great demands (complexity, heterogenity) to the service provider.

3.2.6. Analysis

Two levels are important to mention. First, it could be interesting to examine the order in which certain phases and activities need to take place within the development process of a certain service type. For instance, is there any difference in the order of the phases and activities between a service development process for service type A and a service development process for service type B, C or D? Until today, no empirical analysis and proof exist here for.

In addition, and as Bullinger et al. (2003) already states, it is necessary to consider which methods are preferred for developing which service types. A series of methods familiar from traditional product development is evidently used in practice for services with relatively low contact intensity. These include quality function deployment (QFD), Structured Analysis and Design technique (SADT, e.g. Congram and Epelman (1995)), failure mode and effects analysis (FMEA) as well as service blueprinting (Shostack (1984)) and other process modeling methods. One **possible explanation** for this might be that services with low contact intensity (type A and B) are only influenced to a very limited extent by customer-imposed variances, so that the characteristics exhibited by these services bear numerous resemblances to those of physical goods and the services concerned can consequently be developed **using similar** methods.

Whereas engineering methods are relatively widespread as instruments for developing services with low contact intensity, their relevance for the development of contact-intensive services (type C D) is comparatively minor. Business and recently also service-specific methods predominate here - especially when the aim is to systematically integrate customer retention into the service development process (Fähnrich et al. 1999). In the case of Type D, **social and behavioral science** method, tailored to qualifying employees or shaping customer interaction, are also encountered.

It is the contact intensity criterion which thus seems to mainly determine the methods preferred in practice. It is evident that, particularly with service types where so-called soft factors play a vital role, traditional product development methods are no longer transferable and approaches originally devised by other scientific disciplines are demanded more and more frequently. This is also the conclusion drawn by Fähnrich et al. (1999): "For this reason, simply transferring traditional product development concepts blindly would appear to be inexpedient, and an exclusively engineering-oriented approach for service development is likewise bound to be inadequate. On the contrary, more interdisciplinary approaches are needed to be able to map the interaction of human resources, technology and organization and of rendering them planable."

3.3. Integration of Service and Product Life Cycle Management (SLM & PLM)

3.3.1. Research questions, focus and methodology

As described in deliverable 14.1, section 4.4., the integration of SLM and PLM offers advantages for companies that have both types of life cycles, but at the same time exhibits a certain complexity which is addressed by the following aspects:

- The length of SLM and PLM in comparison towards each other,
- the degree of interaction between SLM and PLM, and
- the degree of integration of SLM and PLM.

Within this deliverable, the focus is set on the development phase in SLM and PLM, more precisely on the phase of new service development in SLM, and accordingly on the phase of new product development in PLM. The service operations phase will be addressed in deliverable 14.2.

First of all, approaches on the integration of SLM and PLM in literature will be presented – firstly without focusing on a specific phase of SLM or PLM. Secondly, a methodology to support the integration of SLM and PLM in the development phase will be introduced.

3.3.2. State-of-the-Art of SLM and PLM integration

3.3.2.1 Relevant approaches in literature

During literature research it became clear that there are only very few approaches that aim at combining existing research and practice on SLM and PLM. So research has been extended, including approaches for the management of PSS and of hybrid service solutions.

Meyer et al. (2012b) propose a so-called product-related service life cycle management (**PSLM**), integrating an SLM in the existing PLM approaches. They promote a common **database** for products and services within a company, and instruments or tools that support management of collaboration and information exchange between stakeholders that are involved in the management processes. Relevant IT-supported methods for *PLM* in this context are e.g.

- project management,
- test management,
- resource management,
- sales management,
- idea management,
- customer care management, and
- technology management

(Meyer et al., 2012b). For *SLM*, Meyer et al. (2012b) propose the IT-supported methods

- service strategy,
- service portfolio management,
- quality management,
- service level management,
- process management,
- process modelling,
- configuration management,
- resource management,
- supply chain management, and
- customer management,

each of which covering the service life cycle partly, except of customer management that accompanies the whole service life cycle. In detail, Meyer et al. (2012a and 2012b) refer to relations between product and service *components*. As an example, maintenance (service) can be performed only if a hardware element (product) has already been installed and is ready for or necessitates maintenance. So there is a certain temporal and status-related interdependency in **service operations**. In terms of management this means that the required service is triggered by the status of the product, either event-driven (i.e. product is broken) or according to a plan (i.e. regular maintenance). For SLM it is therefore important to anticipate service requests and to plan service capacity according to sold products.

Furthermore, Meyer et al. (2012a) state that there may be services that a provider should recommend to the customers so that a technical product (in their example photovoltaic systems) works properly. During the **development of a product** it is thus necessary to develop appropriate services to support the functionality of the offered products. In terms of SLM, the development of service-intensive products automatically leads to a higher importance of supporting services and more activities within service operations. If a specific service is essential for the product functionality, this must also be communicated to employees (i.e. sales) and then to customers, in order to enforce the use of the service. Latter may lead to different pricing models than services that are used event-driven or additionally (e.g. training).

Another aspect is seen in **context-dependent services**. In the photovoltaic example, the supplier should recommend a set-up service if the incline on a customer's roof is between 20 and 50 degrees (Meyer et al., 2012a). So the service unit has to collect specific information about i.e. the environment on-site at the customer where a technical product shall be deployed, in order to recommend or even enforce a service (if e.g. statutory).

Concerning **SLM**, trigger points for service processes should be defined, that lead to the execution of a service if specific conditions are fulfilled which is done be requirements collection and analysis. The authors furthermore describe the fact, that some services simply increase the value, especially the perceived quality of a technical product if the customer uses

the supporting service. Another approach on interactions between products and related services is seen on the level of modules if e.g. a service or product portfolio is built up modularly (cf. Meyer et al., 2012a). Generally, Meyer et al. (2012a) say that **a common database** is an integrative element between SLM and PLM, representing a foundation of IT-based methods and tools that support the integrated management of both life cycles.

Another approach on the integration of SLM and PLM, specifically focusing on the development phase, is presented by the research project "fit2solve" (cf. Gärtner 2008a), concentrating on the information aspect as integrative element of SLM and PLM as well. The integration of the development of products and services may be seen as **hybrid** bundles of products and services, called product-service-systems (PSS). Gärtner (2008a) says that in order to integrate the new service and new product development process for a PSS it is of utmost importance to create **transparency about information dependencies between the processes**. For the indication and analysis of information dependencies, a so-called **Design Structure Matrix** (DSM) is used, facilitating the modeling and analysis of interdependencies between elements of a system by visualizing and communicating these and considering involved organizational units as well. Gärtner (2008a) uses a matrix to show the functionality of a DSM (cf. figure 3).

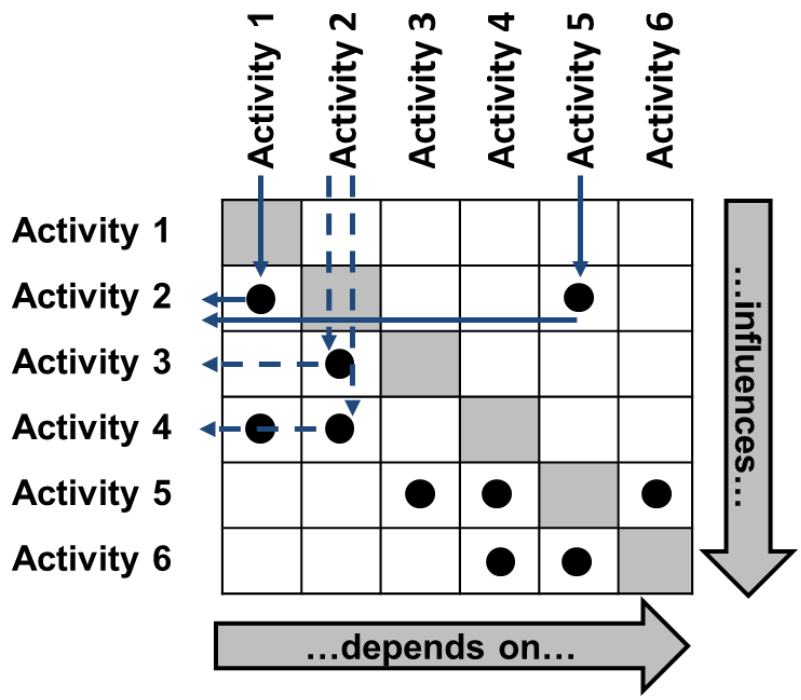

Fig. 3: Functionality of a Design Structure Matrix (DSM) (Gärtner 2008a)

In figure 3, activity 2 depends on information that is produced in activities 1 and 5. On the other hand, activity 2 influences activities 3 and 4 by its output (ibid.). For the integration of the development processes of products and services – the PSS – Gärtner (2008a) proposes to insert all required activities within both the new service and the new product development process line by line and column by column, to eliminate redundancies and to mark all activities with a "1" that receive information from the corresponding other activities (input) or that pass information to other activities indicated in the matrix (output).

In summary of the two approaches presented, it can be said that the most common way to look at the integration of SLM and PLM is in regards to the **information sharing** between processes, activities and thus persons and information systems that are involved in service and product development processes and associated activities that represent the first phase of life cycle management.

3.3.2.2 Relevant results from the expert interviews

One part of the expert interviews among companies that offer product-related services (see chapter 4) focused on SLM. In most cases, the interviewees stated that the impulse for developing a new or decommissioning an existing service comes from the product which the service is intended to be or is attached to: When a new product is developed, or at least a new type or generation of an existing product, the accompanying service (i.e. maintenance, repair) is necessarily setup, too, in a **reactive manner** ("event-driven"). The same is more or less true for the decommissioning of product-related services.

Other impulses such as coming from customers or employees may lead to further services, very often additional services such as training or logistics (e.g. transport, consignment warehouses). Here, new products are the (necessary) basis for new services, but they are not a "sufficient" condition: **strategic decisions**, additional value for customers or differentiation from competitors are additional drivers.

The first case – new service development and service decommissioning are triggered by products – may be depicted like in figure 4, which is in the following named as "alternative A" and refers to a one-sided relation between the two types of life cycle management: SLM depends on PLM, which also means that SLM phases are triggered by impulses or changes in PLM. The main focus is set on the management of the product life cycle. The management of the service life cycle happens accordingly to PLM; however, **adjustments are one-sided** (product-dominant) and only happen from time to time.

In many cases, SLM and PLM are interconnected through a person, function or role within the company, e.g. **the portfolio manager** for a technical product is responsible both for the product and the related service(s). Furthermore it is possible that a service is offered in order to lengthen the PLM, e.g. if customers' demands on technical products increase faster than the technology can be delivered, or if high-end solutions are too expensive for customers, services such as software or partially upgrades increase the use in the technical product just like a new generation, without replacing it.

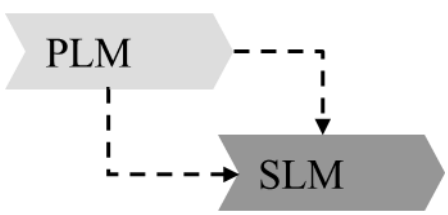

Fig. 4: Alternative A - SLM is dependent on PLM

In the course of the interviews, another type of SLM-PLM-relation occurred. Here, SLM and PLM are two dependent, but equally important management tasks and the idea of a new service, customer or employee feedback through a service may lead to adjustments in PLM; as well as the other way round (cf. alternative A). So both life cycles are managed with equal care. Adjustments take place on both sides, e.g. within product and service life cycle, and happen regularly. This interaction type is reciprocal and named as "Alternative B" in figure 5. Mostly, the product and the according service life cycle are the same length.

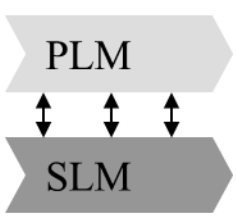

Fig. 5: Alternative B - SLM and PLM with reciprocal interconnections

3.3.2.3 Further constellations for SLM-PLM interaction

From the interviews, two alternatives for the interaction of SLM and PLM could be elaborated, where either SLM is dependent on PLM (alternative A) or SLM and PLM are two equally important management tasks with reciprocal impacts (alternative B). If the shift from alternative A to B is seen as a movement along an axis according to the servitization model, shifting to a service-dominant view, two further alternatives can be derived: **alternative C** would be a thorough integration of SLM and PLM, where both life cycles are managed in a highly integrative way, so that the separating managerial boundaries between SLM and PLM "disappear". Decisions always have influence on both components of the integrated life cycle (cf. figure 6), until the highest degree of integration is reached where products and services are not looked at separately anymore ("SLM & PLM"), but treated as integrated (hybrid) solutions or systems ("PSS") with an integrated (**hybrid solution) management** ("HSM").

Fig. 6: Alternative C - Fully integrated SLM and PLM

Just in opposite of alternative A, another constellation is that PLM depends on SLM: The main focus is put on the management of the service life cycle. The management of the product life cycle happens accordingly to SLM, however, adjustments are one sided and only happen from time to time. **This alternative (D)** is shown in figure 7.

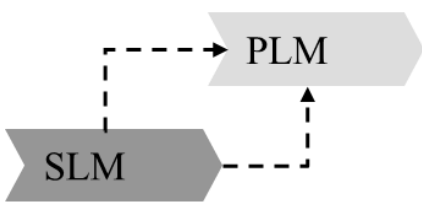

Fig. 7: Alternative D - PLM is dependent on SLM

3.3.2.4 Integration of SLM and PLM (conclusion and summary)

As a conclusion from the findings in literature, it can be said that the interaction between the life cycles refers to information flows between elements of PLM on the one side and SLM on the other side, or specified concerning the development phase: processes and activities of both new service and new product development generate output of information that is important for other activities within the processes or – the other way round – require information (input) that is produced in other processes and related activities.

Furthermore, from the literature review and regarding the objective of the MSEE project to develop supporting ICT systems (software, platform etc.), it became clear, that the focus of an SLM-PLM integration approach must be set on information as foundation or common element of all business processes. But not only ICT-based information flows are important, also interpersonal communication plays a crucial role in triggering and conducting development processes, as the results of the interviews have shown.

3.3.3. Examples of SLM-PLM integration in the development phase

In order to illustrate the four alternatives of SLM-PLM integration (alternatives A to D) in the development phase, four cases of combined or parallel offered products and services have been chosen and are described in the following sections.

3.3.3.1 Alternative A: new service development is dependent on new product development

Here, existing products or the development of new ones initiate the creation of new product-supporting services. As an example for this case, the development of customer services **for cars** will be described. Experiences concerning previous products and results of prototype testing lead to requirements for customer services for cars. Parts and components of the automobile do not have the same life cycle duration as the core product. In order to maintain all functions along the whole desired lifetime of the car, wear parts have to be replaced before breaking. The required information for that is a result of product development processes and leads to the definition of service cycles and their corresponding tasks. So new service development is dependent on new product development.

In our use cases an example would be IBARMIA's **Intelligent maintenance services**: The already existing machines of this company should be supplemented with a new product-related service. Therefore IBARMIA wants "to provide the customer with a more automated, transparent and less problematic support and maintenance service in order to enhance the machine's availability and thus, the customer's productivity and satisfaction" (cf. D 52.1). Within the lifecycle of the product, several services are offered, to extend the product lifecycle.

3.3.3.2 Alternative B: new service and new product development with reciprocal interconnections

Alternative B describes a situation in which the development of new products and services are in a reciprocal connection to each other. For example, the interconnection between products such as **smartphones or MP3**-players and the service to supply customers with music via internet can be mentioned. On the one hand, the product and the service are developed independently from each other. On the other hand, the new product development processes require information from the new service development processes, and vice versa, and knowledge about functions to generate the best possible benefit for customers. Therefore, a bidirectional information exchange between both life cycles is necessary.

This can also be noticed in the use case of PHILIPS' Net TV: The television set is being developed with strong interconnections to the development of related services, such as Social Media services (Facebook/ Twitter etc.), Chatch up TV (watch TV programs which have been broadcasted in the past) or Game services (play games on the Net TV). The technical requirements (implementation of the services, control via Net TV ...) to the device are strongly dependent on the design and functionality of the Services. Both development processes have to be coordinated with each other regularly to ensure the integration of product and product-related services.

3.3.3.3 Alternative C: Fully integrated new service and product development (new hybrid solution development)

This case needs a new development perspective. Here, neither an alone-standing product nor a single service, but a **complete solution** is developed. New car wash programs like i.e.

automatic cleaning of rims or foam polish include process, product and service components. These are fully integrated and depend on each other in order to accomplish the complete desired performance, so the development process is fully integrated as well. None of the components are able to generate the desired benefit for customers when offered apart, but the combined solution only. This fact has consequences on the development phase: Neither new product nor new service development singly, but a holistic development process for the hybrid solution is required, in order to integrate the two originally different disciplines.

BIVOLINO's intended hybrid solution "Shirt-as-a-Service" illustrates that. With this service, the company wants to offer not only a shirt, but a carefree shirt, which means that this shirt can be configured and afterwards rented, including a laundry service. Moreover the shirt is tagged to allow tracing of the washings. A possible customer can be e.g. a hotel, which needs customized shirts (maybe with the hotel logo for the service personnel) that are picked-up, cleaned and dropped-off on a daily basis.

3.3.3.4 Alternative D: new product development depends on new service development

The opposite case to alternative A (as described in 3.3.3.1) is that the product has to support the service performance. In another service offer from the use case of BIVOLINO, a service was generated in order to create custom-made shirts on a website. The conditions for realizing this kind of offer to the customers lead to specific information that creates the basis for the product. The customers who configure their shirt do not have extensive possibilities just as professional tailors to define the required information. So the shirt has to be produced according to customer-specific information input, but at the same time desirably according to comparable output. In conclusion, in this case the offered service determines the product that has to be developed specifically for it.

3.3.4. Methodology for the integration of service and product development (top down)

In a first step, the framework concentrates on the development phase of SLM and PLM, also known as "Beginning of Life" (BoL).
The **DSM** that has been introduced in section 3.3.2.1 is now used to illustrate the integration between the SLM and the PLM approach within the MSEE project. Figure 8 shows an overview of possible processes and according activities for new service and product development as a phase of SLM or PLM.

The management aspect is to integrate both development phases by visualizing and analyzing information input and output between activities in the development process. In the following, the process of new service development is called **service engineering**, and the process of new product development is referred to as **product engineering and production**.

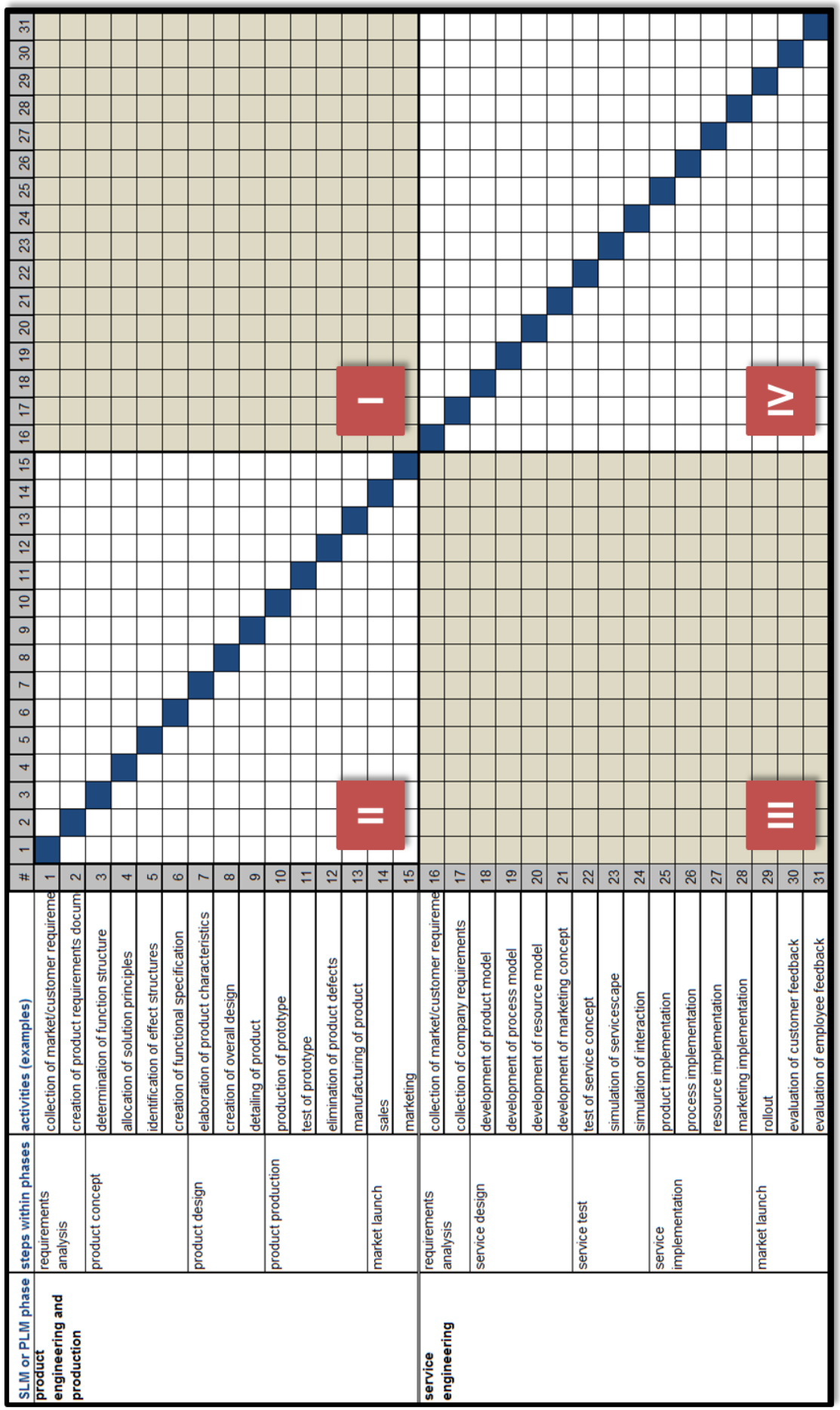

Fig. 8: Blank DSM with example process steps and activities for service engineering and product engineering and production

The matrix has been derived from literature research, according to Gärtner 2008a, Gärtner 2008b and the MSEE Service Engineering process in deliverable D14.1. It contains four fields – I, II, III, and IV:

- I) concerns product engineering and production activities that depend on information output of activities in the service engineering process,
- II) concerns activities within the product engineering and production process that depend on information output of other activities within the product engineering and production process,
- III) concerns service engineering activities that depend on information output of activities in the product engineering and production process, and
- IV) concerns activities within the service engineering process that depend on information output of other activities within the service engineering process.

The DSM is blank and intended to be filled in with "1"s where there is an interdependency (interaction in the form of information input or output) between activities in the development processes. The second step would be to derive an optimized, integrated development process of product and service by using a sequencing algorithm (Gärtner 2008a). One important criterion is efficiency, which means that the number of feedback loops between the single activities must be minimized, in order to create a lean process without iterations. After the optimization process, the matrix shown in figure 6 should contain boxes marked with "1" *under* the diagonal only, which means that the sequence of activities is rearranged. Finally, the integrated product-service development process can be visualized in an optimized process model (cf. Gärtner 2008a).

As an example, the DSM in figure 8 is used to describe how to get from alternative B (SLM and PLM exhibit reciprocal interconnections in the development phase) to alternative C (SLM and PLM become an HSM in the development phase).

For the illustration, the example in 3.3.3.3 (alternative C) is used – the development of MP3 players (product) and the development of end-user services to load music via internet. The results are shown in figure 9. Generally, the DSM can be used to analyze and optimize interdependencies between all activities, which means within the new product engineering and production process and within the service engineering process as well, in order to achieve a holistic, efficient development process.

For the purpose of this deliverable, only fields I) and III) of figure 6 are examined more closely, because interactions between service engineering and product engineering and production represent the research focus. For this first step, there is no differentiation concerning the direction of effect (input vs. output), so fields I) and III) are merged. Where there is an information-based interconnection (interaction) between the activities of the (initially separate) development processes of product and service, a "1" is set – in order show the complexity of interactions, and the direction of informational dependency (input vs. output). The decision, whether to set a "1" or not is based on an analysis of the development processes and activities, and simple pragmatic conclusions. For further scientific work it would be useful elaborate several DSMs of this kind in company workshops.

The filled in matrix shows that in the example, there are a few informational dependencies (84 of 240 matrix fields) between the service engineering and the product engineering and production process. The following assumptions were made, leading to the visual pattern indicated in figure 9:

			product engineering and production															
			require-ments analysis		product conception				product design			product production				market launch	
		84/240	collection of market/customer requirements	creation of product requirements	determination of function structure	allocation of solution principles	identification of effect structures	creation of functional specification	elaboration of product characteristics	creation of overall design	detailing of product	prduction of prototype	test of prototype	elimination of product defects	manufacturing of product	sales	marketing
service engineering	require-ments analysis	collection of market/customer requirements	1	1												1	1
		collection of company requirements	1	1											1	1	1
	service design	development of product model		1				1			1		1			1	1
		development of process model		1				1			1		1			1	1
		development of resource model		1				1			1		1			1	1
		development of marketing model		1				1			1		1			1	1
	service test	test of service concept		1				1			1		1	1			
		simulation of servicescape		1				1			1		1	1	1	1	1
		simulation of interaction		1				1			1		1	1		1	1
	service implementation	product implementation						1			1				1	1	
		process implementation						1			1				1	1	
		resource implementation						1			1				1	1	
		marketing implementation						1			1				1	1	1
	market launch	rollout									1				1	1	1
		evaluation of customer feedback	1	1							1					1	1
		evaluation of employee feedback	1	1							1					1	1

Fig. 9: DSM for the visualization of informational dependencies between service engineering and product engineering and development

- **The requirements analyses as first phase of both the service engineering, and the product engineering and production process, are highly interconnected**. Referring to the original research work of Gärtner (2008a), this phase may be seen as redundant and integrated in one holistic requirements analysis for both the product and service of the hybrid solution. In figure 9, the requirements analyses are treated as separate, but inter-connected, so the whole area of four fields in the upper left corner was marked with "1"s.
- **To some degree, the beginning (requirements analysis) and the end of a life cycle (sales and marketing) may be interconnected (form of a cycle), depending on the view of different disciplines and functional roles in a company**. I.e. market research can be part of both requirements analysis and marketing; as well as sales may also collect information that is important for product or service development. This assumption leads to an accumulation of interconnections (marked with "1") in figure 9.
- It was also assumed that **the service test and the product test phase are connected because malfunctions that are detected on the service and the product side can be used as "requirements" for the re-engineering process of both the product and the service**. An example would be that a service (i.e. repair or maintenance) for a physical product (mid-size technical equipment including software) turns out to be in some cases more efficient when performed on-site at the customer or even via remote maintenance, depending on the distance between the company's and the customer's location, and especially depending on the costs of the logistics partner; during the test of the service variant "on-site at the customer", additional requirements for the physical product may become evident , such as functionality of automatic self-diagnosis, internet connectivity, or an interface for transportable service equipment. The interconnections between the service

and the product test phase lead to an accumulation of fields marked with a "1" in the "test matrix" of the DSM in figure 9.

- **The product engineering and production process is one-dimensional, while the service engineering process is multi-dimensional**. The activities of the product engineering and production process shown in the matrix are built as a process themselves within each phase (i.e. in the form of sequential steps that lead to final results that may be defined as project "milestones") while the phases and the activities of service engineering process represent a modular structure where the sequence of the activities – which may also be seen as work packages – within one phase is not fixed.
  Nevertheless, this fact rather reflects a situation in practice than it is a disturbing inhomogeneity, because in reality new product and new service development processes may be defined and organized differently. Anyway it is possible that the derivation of an integrated new product-service development process leads to an optimal sequence of service-related "work packages" (i.e. development of process model, simulation of interaction) where the sequence is fixed. This possibility may be seen as an interesting further research object, accompanied by the questions, if the service engineering and the product engineering and production process have to be "translated" to a homogeneous representation of activities and if there is an optimal granularity of activity definition (i.e. larger, logically aggregated work packages vs. small and singly defined work steps). The described aspect (activities in the product engineering and development process are connected sequentially) leads to the pattern indicated in figure 9: the matrix fields marked with "1" accumulate at the end of the product development phases, because there, the information is bundled as a result of the previous activities within the development phase.

3.4. Key Issues and further action

In the course of section 3, different aspects of the integration of SLM and PLM, concerning the interaction between processes and activities, were elaborated. Based on the literature research and the MSEE expert interviews, four types of interaction-based integration of SLM and PLM were derived, described, and illustrated regarding the development phase (BoL) using four simple examples.

It was shown that the essential element of SLM-PLM integration is encompassing information flows between processes and according activities, and that information can have the role as both input for and output of single activities within the development processes of products and services. If the four types of interaction-based integration of SLM and PLM are seen as structured along a maturity model while a fully integrated SLM and PLM (HSM) represents the highest level, the analysis of informational interdependencies between service engineering on the one hand and product engineering and production on the other hand, followed by the optimization of the single processes towards an integrated process according to the DSM analysis, represents a method to show how to get to a higher integration of SLM and PLM in the BoL. In addition to the analysis and the methodical support of information flows between the two development processes (product and service), an integrated hybrid solution management and information system and database should be set up.

The next research step will consist of a likewise analysis of MoL (service operations, use of a product) and EoL (service or product decommissioning) of SLM and PLM, and how to get to an integrated management along the whole life cycle, an HSM.

As the results presented are models that have been concluded by research in theory and analysis of simple practical examples, it would be also useful to validate and consolidate the results in interviews and workshops together with companies.

In contemplation of future service scenarios in the sense of requirements of companies concerning life cycle management, several issues have to be considered: It is necessary to find out about the extend to what companies make use of service life cycle management (procedures, methodologies and (it-) tools) now and in future. Also what role does SLM play hereby in future service business? An analysis of current challenges and trends taking place in **mechanical and plant engineering** will be included in the ensuing survey and supplement the challenges that were discovered in the previous chapter.

The following chapters will help to determine the state-of-the-art of SLM within manufacturing companies and to detect what methods and tools are being used by these companies or being non-existent (yet).

4.1. Significance of Service Scenarios

In mechanical and plant engineering, a strong increase is observed from services and also a growing integration of product and product-related services. Since this process is still at an early stage, many of the upcoming requirements can't be estimated yet. The development of so-called service scenarios should help companies in mechanical and plant engineering to be able to meet future challenges.

Service Scenarios thereby represent different ways of how the business with products and product-related services will develop in the future and what needs arise from them. Based on the current trends and challenges they represent different perspectives, how products and product-related services have to be handled in the course of their life cycles or their common life cycle. Based on these scenarios various measures can be formulated that can support these changes (see chapter 4.4).

4.2. Organization of Expert Interviews concerning Service Life Cycle Management in Manufacturing Companies

As adumbrated in the previous deliverable (D 12.1), expert interviews have been conducted as empirical foundation for subsequent project work, in particular for the recognition of future service trends (scenarios that describe the service business in five years). The therein illustrated preparation will be recalled briefly.

4.2.1. Preparation of Expert Interviews

4.2.1.1 Organizational Aspects

It was planned to conduct at least a dozen interviews with experts out of industrial practice by service specialists of MSEE project partner Fraunhofer IAO in spring and summer of 2012.

For the conduction of interviews semi-standardized questionnaires have been developed adopting Fraunhofer IAO´s broad experience in empirical studies concerning the service business, mainly of manufacturing industries (e.g. Spath/ Bamberger, 2012, Lamberth/ Meiren, 2012, Meiren et al., 2011; Münster/ Meiren, 2011; Spath/ Ganz, 2011; Bienzeisler/ Czabon, 2010; Edvardsson et al., 2009; Spath/ Ganz, 2008; Freitag et al., 2007; Meiren, 2006; Meiren, 2002).

The interview partners are mainly in managing positions within the service businesses of Small and medium-sized (SME) as well as large-scale manufacturing companies. Every interview partner received a preparation e-mail with the final questionnaire to be answered as well as information about the objectives of the empiric study and the MSEE project itself before the appointment took place. That preparation e-mail gave the interviewee a chance to prepare himself for the interview and collect necessary information concerning his company.

The interviews were conducted in the interviewees´ native tongues and documented in the same way. After having evaluated all interviews, a summary about the empiric study was written that serves as input for the development of future service scenarios. The evaluating summary of the interviews follows in section 4.3 of this deliverable.

4.2.1.2 Aspects with Regard to Contents

Due to the objectives and goals of the empiric study, the interview consisted of the following topical blocks:

- Companies and interviewee,
- The service business of interviewed companies,
- Trends and challenges in service business,
- Service life cycle management in general,
- Service Engineering,
- Service Operation Management,
- Service Re-Engineering and Displacement.

4.2.2. Realization of Expert Interviews

As in the previous deliverable was mentioned, we wanted to provide you with the complete list of interviewees and the companies they work for. Unfortunately, some of the participants didn’t want their contact information mentioned, so we decided to leave all the interview partners out.
Still, the post-pre-test version of the questionnaire will be presented. You can find the final questionnaire in the appendix of this deliverable.

4.3. Evaluation of expert interviews within the scope of MSEE

From January to August 2012 a total of 14 experts from the field of production industry were interviewed on service business in their companies. The main focus here was place on determining how the companies professionally manage the services offered by the companies with regard to a live cycle management for services (compare with Deliverable D12.1). Within the scope of the study such service life cycle management shall be understood as defined in the previous work in the MSEE project (compare with Deliverable D14.1 as well as Chapter 2.4 in this Deliverable D12.2).

In the following the procedure method of the study is described in detail. The required work is divided into four steps:

- Development of the interview guideline,

– Selection of the interview partners,
– Conducting the interviews,
– Analyzing and processing the results.

Development of the interview guideline is carried out on the basis of comprehensive research and analyses with reference to service business in the production industry as well as studies and projects on Service Engineering and Service Management carried out in the past. The interview guideline is illustrated in full in the enclosure. General questions on service business of the companies as well as on trends and challenges were compiled as central topic groups in the interview guideline. In conclusion thereof concrete questions were asked on the following areas of life cycle management of services (compare with Deliverable D12.1):

– service engineering,
– service operations management and
– improving and, if applicable, cancelling existing services.

The question groups on these individual areas of service life cycle management each follow the same structure. First questions are defined, whereby some could detect how professionally the companies carry out management of each life phase. On this basis typical problems and difficulties were inquired as well as – consequentially – concrete requirement for support (for example, on the part of science). Subsequently, inquiries were made on how the interview partners are satisfied with the current support of each life phase by modern information and communication technologies, for example within the scope of software, and/or where in practice this is especially desirable (compare with Deliverable D12.1).

Selection of the interview partners is carried out according to the project context of the MSEE project. Thus, it was defined that primarily companies of production industry, for example mechanical engineering or electrical engineering shall be questioned. Small and medium-sized companies were questioned as well as large-scale companies for conducting the interviews. They were directly addressed (e. g. via social Media, e-Mail or telephone). Interviews of less than one hour were held with the service experts (e. g. service supervisors or managers) for compiling data of the questioned companies. This was carried out either in a personal conversation at the location of the companies or by telephone. The companies were assured that their statements would be included in the evaluation only anonymously.

4.3.1. Profile and general information on service business of the questioned companies

The large majority of questioned companies belong to the field of mechanical and plant engineering. Moreover, companies of vehicle construction, electrical engineering, consumer electronics as well as medical engineering were represented.

Correspondingly, also the nature of product business was established. Here the majority of companies state that they primarily sell (complete) machinery and plants, followed by solutions and/or systems and modules, and/or components.

Most of the companies of the study directly address their final customers (i. e. for example the user of the corresponding machinery or components) regarding the product services. However, retailers – as intermediaries on an indirect channel of the products to the final customer – are also frequently considered primary customers of the companies.
The majority of questioned companies consider themselves large-scale companies, only a few companies are small and medium-sized companies.

In all questioned companies more importance shall be placed on service business in the future; in almost all of them it is already significant today. This is expressed in the fact that merely two of the companies state that service business is currently still neglected.

All services of the questioned companies are related to production, i.e. they have a direct connection to the primary products which are offered to the customers by the companies. Without the existence of the primary products the company would lose the basis for service business.

If the offered services are considered as being (temporally) dependent on the time of product sale to the customer, a distinction can be made between pre-, at- and after-sales services. In this regard a clear image emerges: most of the questioned companies locate their service offer primarily in the after-sales area, however, some of the companies interviewed also see their services greatly offered in the pre-sales area. This primarily includes services such as individual customer development or adjustment of products including the corresponding engineering.

Based on the determined focus on after-sales services, the questioned companies primarily offer classic technical services like spare parts service, repair, servicing and maintenance. More than half of the companies, however, state that they also offer extensive value-added services (e. g. remote services or consulting services) and service contracts (above all by means of service contents of classic technical services).

Based on the example of the company introduced in the excursus in the following Chapter 4.3.2 it can be determined that especially for companies which already carry out their product business on a greatly customer-related basis (e. g. by individual customer development and production of machinery or plants) and not only the typical customer-related service part, the lines between product and service business are increasingly indistinct. For them it is – for example within the scope of the interviews carried out – difficult to differentiate where exactly product business stops and where service business begins.

Of great interest within the scope of the study was how service business as a whole is linked to the organization of the companies. The question here is: It there a separate department or a separated company area for service or is it covered by other organization units?

The results of the study supply a distinct conclusion: Predominately, service business is reflected by its own organization units (mentioned five times) and/or by its own company area or divisions (mentioned three times). However, depending on the company context it is also not unusual to have service business strongly linked to the product field (mentioned five times) and fields of duty of service business taken over by other organization units. Usually this is the case with companies which classify product business as clearly dominant compared with service business.

4.3.2. Case example: A gear manufacturer actually only a service provider?

The following situation arose in an interview with a company which manufactures gear units: During the conversation with the interview partner it first appeared as if service business of the company was not especially important.

This was noticed by the fact that on the one hand the sales contributions of service business was relative low compared with the total company sales and on the other hand the relatively low significance was also reflected in the organizational structure: All activities of service

business were carried out by other departments, which should focus on the actual product business. No separate organization units existed for service business.

However, this was deceptive, because the premature judgment on service business turned out to be incorrect. The results specified above merely referred to service business in the follow-up purchase phase of product business, i.e. to after-sales services like spare parts business, repair, servicing and maintenance. It quickly proved that for the company and its customers the actual main services took place in the pre-purchase phase, they were thus pre-sales services which are characteristic for the service business of the company.

Since the company adapted the development of almost every primary product to the specific customer's requests, this can be considered the most significant service provided by the company. In this example service business thus extends farther than it was first assumed (because it is fixed to the after-sales service) and even determines the nature of product business.

4.3.3. Trends and challenges in service business

For the companies of production industry there are numerous trends and challenges within the scope of service business. The questioned companies primarily stated the following aspects:

Rising demands of the customers for services

Demands on the part of the customers regarding offering and supplying services constantly increased lately. This trend will also continue in the future.

An increasing number of customers demand "comprehensive carefree packages", which supply all necessary services. In addition, they also increasingly demand customer-related services instead of standardized services. Also preventive services are being requested more and more to avoid any grave damage which might arise later.

The products of production industry in Germany are sold to customers all over the world. Therefore, it is not astonishing that the service experts in the study state that especially providing services internationally is a challenging task. In particular finding suitable service partners in the corresponding markets of the countries is often difficult.

The influence of own primary products and of information and communication technologies increases

Today's general technical change also influences service business. Especially the integration of digital technologies, above all internet technologies, poses a challenge.

Also primary product business of the own company of the interview partner is a great task for service business. Primarily the tendency of increasingly shorter product life cycles as well as rapid expansion of product assortments have a complicating effect and increase complexity of service business.

Shortage of skilled workers and qualification of employees

For service business special competences are required of the performing employees who show special skills for solving problems, exceptional technical understanding and social competences and at the same time often willingness to travel frequently. In times of shortage of skilled workers such a sophisticated requirement profile poses difficulties to the company.

Some of the interview partners state that they hardly can find suitable personnel for service and, therefore, cannot utilize the existing growth potential. Usually the poor foreign language skills of employees obstruct an improvement in international progress of service business. One the other hand, international service partners very often have unsatisfactory knowledge on the products sold to foreign countries.

What service could look like in the future

Replying to the question of what the characteristics of service business would be in the future, the questioned companies stated numerous possible aspects:

The focus on customers will increase even more compared with today which due to the increased demands also appears necessary. Attempts of making service business as transparent and understandable as possible to the customer will become stronger. This can under certain circumstances lead to the fact that service cases will no longer be experienced as »negative results«, but as a matter of fact within the scope of utilizing primary products.

Within the company the esteem for service will grow. Product and service business will be increasingly linked and knowledge exchanged in both directions. Compared with today, knowledge management will thus also gain more significance in service business.

In the interviews it appeared as if the questioned large-scale companies had less difficulty than small and medium-sized companies in setting a new course for successful service business for the future. The companies that want to fully utilize the potential grow in the service area are compelled to invest funds correspondingly, for example to create new capacities or restructure the previous service business. Above all, in the opinion of the interview partners, small companies often lack the financial resources for this purpose.

4.3.4. Service life cycle management

The majority of interviewed service experts has a product-centered understanding of “Service Life Cycle Management”. Whereby the term should describe how services can be applied assisting the life cycle of the primary products, for example to extend the life of the products. In the center of management in this field of action, therefore, would be the idea regarding at what time in product life what services can additionally be offered.

In contrast, almost one third of the questioned companies had a similar understanding of service life cycle management as the subject matter of the MSEE project.

Understanding service life cycle management in the MSEE project

Within the scope of the MSEE project the individual services are in the center of the life cycle idea. Thus it is necessary to manage a reference concrete service as it was developed, offered on the market and provided for the customer and, if applicable, removed from the market at a later period in time in a controlled manner.

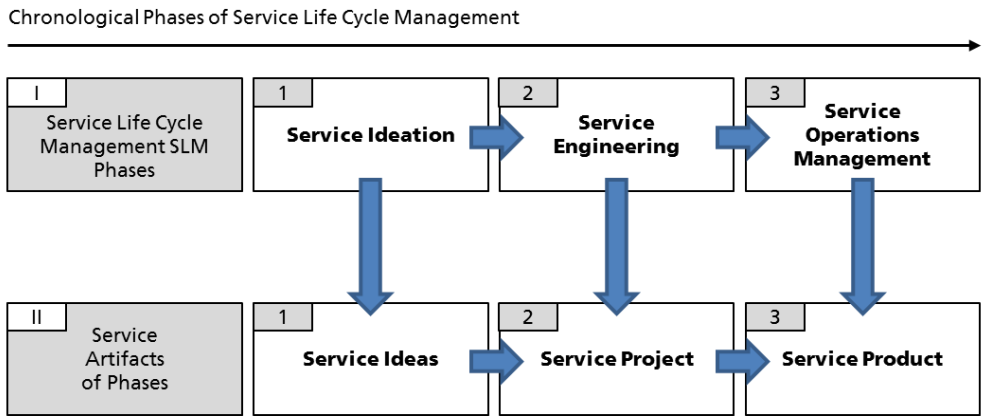

Fig. 10: Chronological Phases of Service Life Cycle Management (cf. Deliverable D14.1)

As Figure 10 shows, Service life cycle management begins with the Phase Service Ideation. In this phase the first new ideas on any services of the company which are possibly developed arise, and later within the scope of the concrete service projects can become Service Development Projects (compare with Deliverable D14.1).

If a service project has established a newly developed service, a service product can be offered and presented to the market in the form of a service product. This offer and performance period is the operative part of the life cycle. A possible phasing out of services from the service portfolio of the company illustrates the end of the operative phase on one hand and at the same time the absolute end of the service life cycle on the other.
Within the scope of the MSEE project the phase of service development is called “Service Engineering”. Service engineering is defined as systematic development and creation of new services by using suitable models, methods and tools.

The life phase of offering and performance of service is subsumed under “Service Operations Management”. The end of service life is described as “Service Decommissioning” and is the last part of the phase of service operations management. However, the end of service must not always be compulsory. With measures of “Service Re-Engineering” existing services can be adjusted and improved so that the operative phase can be extended and service does not have to be phased out. Service re-engineering is an adjusted procedure of service engineering, whereby certain aspects are revised into a modified service (e. g. service promise or customer processes).

Within the scope of the expert interviews carried out the focus was mainly on life cycle phases of service engineering and service operations management.

Estimation of service life cycle management by the interview partner

In the opinion of almost all questioned companies a life cycle oriented observation of services is in principle reasonable, because such a management initiative can utilize different utilization potentials. For example the innovative ability can be increased in the service area. At the same time the majority of questioned companies state that such a life cycle management of services is not available in the corresponding companies at present. Although the pertinence of Service life cycle managements was confirmed by the companies, only a few of them would introduce it their own company. One of the reasons is the high degree of utilized capacity of the companies in the service area.

4.3.5. Development of new services

In a clear majority of the questioned companies new services are developed in a structured manner and subsequently implemented. Merely three companies state not proceeding in a structured manner yet.

The incentive for the development of new services comes from the customers in almost all companies. The interviewed service experts, however, state that usually also the own company can be a source of new service ideas, for example through own employees.

In more than half of the questioned companies there are defined processes and responsibilities for the service development.

Only a minority of companies have specialized organization units which are mainly engaged with the development of new services. More frequently these development tasks are taken over by other organization units.

The majority of service experts state that new services are tested by their companies with selected pilot customers prior to introduction to the market. Two of the questioned companies do without such trial runs and test new services directly on the market.

Difficulties in the development of new services

It is difficult for many companies to develop new services, since operative service business binds all resources of the service area and the capacities are fully utilized. The service employees hardly find time to engage in the development of new services, since the development task is mostly carried out by existing personnel and parallel to daily business.

However, in principle it is everything but trivial for the company to detect in advance what service ideas would be worth carrying out a development project and which would not. Therefore, a concrete illustration of the utilization of service ideas is necessary to support the decision-making process regarding realization of a development project. Here on one hand it must be examined whether the customers would accept the new service at all (analogous to customer acceptance) and what the customer reaction to the assumed benefit would be (i. e. customers' benefit perception). Moreover, the readiness of the customer to pay for this is an uncertain factor.

Requirement for assistance in service development

Consequently, the companies require assistance regarding the development of new services. Thus some companies said it was desirable to receive more practical methods and tools for the development task from the field of science, instead of academic and theoretical approaches.

IT support in service development

In the opinion of the majority of service experts IT support in service development tasks has not been satisfactory up to now. An improvement of this situation would be desirable for the companies. Depending on the context of service business the individual companies, therefore, envision various IT tools to support the corresponding service business (e. g. IT support of idea and knowledge management or IT tools to describe future scenarios in service).

4.3.6. Service Operations Management

Within the scope of this study the following task fields were considered typical for service operations management:

- Marketing and sale of services,
- Providing services,
- Quality management in the service area as well as
- Planning, supervision and control of operative activities.

Somewhat less than half of the interview partners state that an own organization unit was intended in the company organization structure for service operations management.

In the opinion of the majority of the interviewed service experts operative service business is managed professionally in their companies. Merely two companies state that their management is rather unprofessional.

Regarding marketing and sale of services the proactive and reactive procedure is about equal. More than half of the companies can report having a defined responsibility for marketing and sale of services. However, only two companies have their own organization unit for this field of activities.

Companies that offer services reactively – that is for example only at the request of the customers – usually already have difficulties with high workload in operative service. That means they must attempt to cope with the existing service projects and orders using the available resources and, therefore, they might not be able to accept new orders. Here, too, reference is once more made to the relatively low capacity available in the service area – in contrast to product business, where in most companies there is no lack of manpower to market or sell the primary products. Four of the interviewed companies market and sell services together with the primary services from the product area.

Only less than one third of the companies have specialized organization units to provide services. In three companies services are provided by the product area.

A clear majority of questioned companies state that the quality in service business is constantly measured. At least this happens indirectly with regard to the satisfaction of the customers. Customer satisfaction is regularly surveyed, for example in personal conversations or inquiries by means of standardized questionnaires. In some cases the surveys revert to assistance and support from the corresponding specialized service provider.

Regarding operative service business, the majority of companies state that regular reporting is carried out. Customer complaints also are handled professionally. In some cases the employees are especially trained how to handle customers in the event of complaints. However, only two companies state that they analyze what the causes for the received customer complaints are.

The majority of the interviewed service experts consider productivity in service business an interesting subject. The productivity in the in-house service area was measured by less than half of the companies.

Difficulties in Service Operations Management

Within the scope of the study the questioned companies state numerous difficulties regarding operative service business.

The already existing high degree of capacity utilization in the service area prevents proactive procedure (e. g. in marketing and sale, see above). The fact that service cases frequently have to be internationally processed has a negative effect on this situation. It is also not very beneficial that service business in the opinion of the service experts is characterized by unpredictable situations and therefore is hard to plan.

Especially regarding performing services in the international context, cross-border logistics (e. g. within the scope of spare parts business) play an important role, as well as intelligently located service branches which carry out the actions. For practical companies these two aspects, however, are often connected with difficulties.

Support required in service operations management

The study shows that most companies cope with operative service business – despite the specified complexity. However, there is still a need for support which the questioned companies could specifically describe in rare cases only.

Explicitly desired is that a suitable code system be provided which can be used to monitor service business better. This can be understood as a code method system which supports the fields of action of operative service business (e. g. sale, quality or productivity of services).

IT support for service operations management

More than half of the service experts are not satisfied with the previously available IT support for the fields of action of service operations management. In their opinion improved support by modern information and communication technology is desirable. Merely four of the questioned companies state that they are satisfied with the existing IT support for operative service business.

These differing opinions were expressed almost equally also regarding the satisfaction of the illustration of service business by the Enterprise Resource Planning (ERP) Systems used by the companies. Based on the financially intensive adjustment projects some companies have established a service-related ERP system, others have realized their own IT solutions for an illustration of service business.

Some companies specified where IT support was especially required: Service databanks would be helpful to gain an impression of all current and past service cases in the operative service business or also tools for customer relations management (CRM) and sales chance management for carrying out professional IT-aided service marketing and sales.

4.3.7. Further development or improvement and phasing out of existing services

All questioned companies state that they carry out further development or improvement as soon as a need therefore become evident. This can for example be eliminating concrete deficits of the concerned services.

In principle the majority of questioned companies further development of existing services is not a rare instance, for example within the scope of customer-related adjustments. Four companies state that the services were developed further in the course of time, however, did not change extensively.

In general according to the questioned companies the endeavor to continue improvement does exists in service business and the persons employed there (ten companies are stated). Five companies state that the time for further development of services is determined by the product departments. The method of further development of existing services is rarely defined.

Only in one of the companies in the study does such systematics prevail. In comparison more than half of the companies state that services are tested again after the further development, before they are offered on the market.

In a clear majority of the questioned companies there is no structured phasing out of services from the service portfolio. That means that in the companies there is no »End of Life« of services.

How long services are on the market in more than half of the questioned companies depends on the corresponding products including the corresponding life cycles.

More than one third of the service experts assume that the standard services in producing industry – especially the classic technical services – are at least permanently included in the services offered. For phasing out of the service portfolio, therefore, changing value-added services (e. g. service contracts or consultation) or services greatly based on technology (e. g. remote services or other Internet-based services) are more likely in the course of time and depending on customer requirements.

4.4. Impact of these trends and challenges for future service business

Summary of the study

The results of the study show that the significance of product-related services continues to increase even more in the questioned companies. Not only the development of new services, but also the further development of already existing services has a certain potential. Especially the individualization of the offered services is in the focus of some companies.

The challenges taken on in service business are also due to the fact that the customers demand increasingly comprehensive services and that integration of new (also digital) technologies into service business is a large task.

The cause for the development of new services is mostly stated as being an unsatisfied customer request. The development of new services is carried out in a structured manner in most of the questioned companies. However, few companies have an organization unit having this as a primary task. For this reason bottlenecks arise due to fully utilized capacity of company resources by product business which has a negative effect in service development regarding proactive procedure.

In the opinion of all questioned companies **all areas of service life cycle management have a need for support seen from the practical aspect**. Such support of service business can in general be carried out in the form of methods and tools which are closely related to practice, but also concretely by suitable IT tools. For example, special service databanks as well as customer relations management or sales management tools are stated to improve service marketing and sale.

At the end of the service life cycle only a few companies carry out a structured phasing out of the service portfolio. This is, however, dependent on the type of services – standard services

usually remain in the portfolio permanently, whereby the services related to customer needs frequently are not offered permanently.

Summarizing, it can be stated that in the opinion of the interview partners in the future, services will continue to increase in significance. The life cycle observation will thus also become increasingly important for service business. The approach elaborated within the scope of the MSEE project for service life cycle management attempts to offer the companies an initial guideline of orientation for companies in practice.

Service Scenarios

From the survey and the studies which emerged from Chapter 3, trends and challenges to different service scenarios can now be summarized. It can be filtered out four such case scenarios that can occur both independently and in combination with each other. These scenarios each have different priorities that shape the future service business – respectively form other demands for the SLM. Hereinafter the characterizing features of various service scenarios are listed.

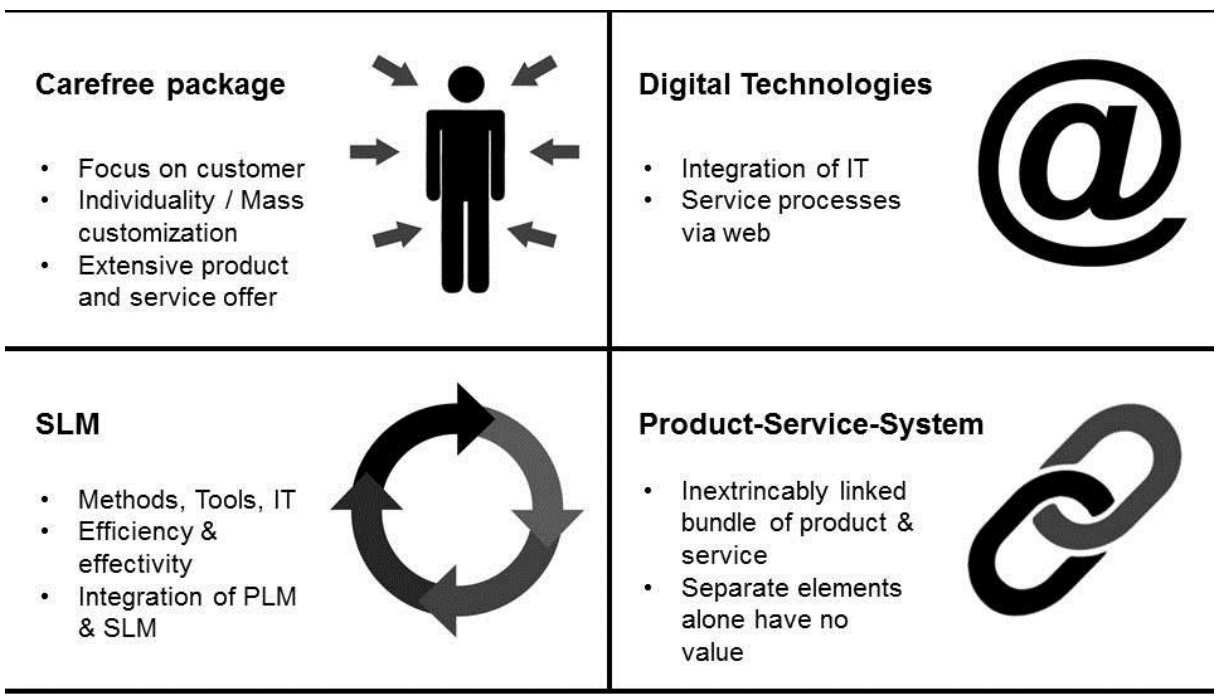

Fig. 11: Service Scenarios

For each of these scenarios, there are other starting points to support the service business. Some cases will now be explained:

- The “carefree package” responds to the desire of the customer, to get a single solution for his problem with a single contact. He does not want to buy a product and a service, too, he wants to get the desired result, regardless of how the combination of products and services looks like – if necessary, a particular solution will be specifically adressed to the needs of the customer. Also preventive services are often required in addition to guarantee the highest possible long-term functionality of the solution. Customers require an extensive offering of products and services that bring them reliable the use they desire, as long as possible.
- The integration of digital technology in the service business will continue to grow. This requires new skills of the service providers, because they have to integrate these capabilities either in their products (e.g. through web access and software that links

the product with the services), or they have to build external platforms that help to provide various services with use of digital technologies. For employees do these future changes mean that they have to face new challenges: Competences are required to embed these technologies in existing product and service business as well as to integrate them into the development of new offers.

- Since Service Lifecycle Management is still in a maturation process, it should be improved following the example of PLM – In this, methods, tools and IT can be used to create, develop and improve services more effectively and efficiently over their entire life cycle. The integration of PLM and SLM creates complex requirements: e.g. there is a tendency that product lifecycles are getting shorter, while service lifecycles are expanded. Hence, one of the future challenges is to combine different products with one or more services that cover the whole span of the product life cycle(s) (cf. 3.3.2.2 and 3.3.2.3)
- In the fourth scenario, the bundling of products and services to a PSS (product-service-system) confronts employees with new demands. Product specialists and service professionals need to work together much more closely - at best, both workspaces are coincident while there is only one specialist for PSS. In separate work areas, the respective employees know the specifics of the products / services to their colleagues and know how they optimally fit together. Important for this is a strong knowledge management in the company and a gearing of the various areas of work, for example through increased teamwork.

5. Conclusions

Deliverable 12.2 is the resumption of the work of Deliverable 12.1. It provides important findings about the future service scenarios in manufacturing enterprises and how they, themselves anticipate future service business.

It was shown that there are different types of services, depending on the integrativity of the customer as well as the diversity of the offers. Depending on these four types, different methods and tools can be used to support service business, whereby those preferred in practice are no longer those of traditional product development. Increasingly, new ways of support are needed which grant an interdisciplinary approach.

The next step in this deliverable was the continuation on the approach of integrating service and product lifecycle management: it was found four alternatives of interplay between PLM and SLM - each of these alternatives resulting from different interaction between processes and activities. Regarding these dependencies, it became clear, that the approach of integration of PLM/ SLM is based on information flows. Seen as a maturity model, the highest level is represented with a fully integrated PLM/ SLM where both lifecycles are merged to a hybrid solution.

To verify these and other findings, a study was conducted with companies from manufacturing and plant engineering. The therefore carried out expert interviews confirmed the rising importance of Services and their integration with products as well as the lifecycle oriented management of products, services and hybrid solutions. Also, increasing customer demands like the desire for more individualized offers or comprehensive PSS can be observed. Furthermore the integration of new (digital) technologies gets more important. Overall it can be stated that all areas of service lifecycle management have a need for support, seen from a practical aspect. This would include defined processes and responsibilities, Methods and tools as well as IT tools.

Finally, some service scenarios are presented, which may occur both alone and in combination with each other. They reflect the different priorities that emerge from the preceding steps. These four main scenarios are a) the demand for more individualized and extensive PSS, b) the integration of information technology, c) the life cycle-oriented view of the management of services and d) the combination or merger of products and services to integrated systems respectively hybrid solutions.

These scenarios serve as a base for manufacturing companies. Therefrom can be derived appropriate methods and tools that can support their service business and to manage the different levels of servitization.

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7. Appendix

Manufacturing Service Ecosystem (MSEE) - Interview Guide

Interviewee: ( ) Interviewer: (Fraunhofer IAO)
Date and Location of the Interview: Duration: (about 70 min.)

Topic: Current challenges and future scenarios in the service business of manufacturing companies with respect to an integrated Service Lifecycle Management (SLCM) and related IT support.

Please prepare a successful service of your own business as an example for the following questions. Based on the reference to a specific service, your answers and statements can be classified easier.

Company and Interviewee

1. To which economic sector does your company belong to?
   Which products and services are provided to your customers?

2. Which annual turnover is generated by your company?
   How many persons are employed?

3. What is your position or job in the company?

4. How many years have you been working in that field of activity?

The Service Business of your Company

5. What role does service business play in your company?

   – What is the share of service turnover in relation to the overall annual turnover of your company?
   – What role will the service business play in future?
   – Please characterize the relationship and interdependencies of service and product business in your company.

6. Which product-related services are typical for your company?

   – If necessary, define product-related services

7. How ist he service business organized in your company?

   – Separate department vs. part of another organization unit

Trends and Challenges in Service Business

8. Which significant trends and developments do take place at the moment / have taken place recently concerning the service business of manufacturing companies?

9. What are the pillar challenges for your future service business?

10. Optional question:
    Please describe certain corner points of a scenario that describes how the service business of your company may look like in future (with regard to the trends and challenges mentioned above). Doing so, please bear in mind the relationships and interdependencies with your product business.

Service Life Cycle Management in general

11. What do you comprehend by the term "Service Life Cycle Management (SLM)"? Out of which components does SLM consist of from your point of view?

    – Provide explanation of the understanding of SLM in the context of the MSEE project. Components to be explained:
        i. Service Engineering (SE),
        ii. Service Operations Management (SOM) and
        iii. Service Re-Engineering & Displacement (SRE&D)

12. Which components of SLM are established in the service business of your company?

    – Explanation:
      When product-related services are provided to customers there must be at least a more or less pronounced SOM.

13. Can you imagine such a SLM being established in your company?

    – If not, why?
    – If so, what are the conditions to be fulfilled therefore?
    – What advantages and disadvantages of such a SLM can you imagine?
    – Optional question: Which components of SLM are hard to implement / to establish from your company´s point of view? Why in detail?

Service Engineering

14. Who prompts the development of new services in your company?
    – Employees, customers or market partners?

15. Does your company develop product-related services in a structured and systematic approach, e.g. in the terms of Service Engineering?

    – Provide explanation of Service Engineering in context of MSEE project.

16. To what extent is the development of product-related services anchored organizationally in your company?

    – e.g. regarding structure and organization:
      own department, specific responsibilities, defined processes

17. Where are the difficulties of the development of product-related services from your point of view?
    What are specific characteristics?

    – E.g. Assess the feasibility of new ideas

18. Which needs of support does your company have concerning the development of product-related services? (e.g. provided by research, industrial associations etc.)
    - Which methodologies and tools need to be provided?
19. Can you imagine the development of product-related services being supported by means of IT?
    - If so, in which practical context?
20. What are the major difficulties for your company concerning the implementation of new services?
    - E.g. in terms of organization, personnel or by means of IT?
21. Are product-related services tested before the market launch?
    - If so, by what means and procedures?
    - If not, why?
22. Optional question:
    Based on your experience with product-related services, what are success factors for the development of new services?

Service Operations Management

23. Do you have established a professional management of service delivery in your company, e.g. in the context of a Service Operations Management (SOM)?
    - If so, what are its characteristics?
      Which procedures, methodologies, tools and IT systems are being used?
    - Do you provide product-related services proactively?
    - How often do you measure the quality of your services being provided?
    - How do you measure the productivity of your services so far?
    - Is there an ongoing / regular reporting for all services?
    - How do you handle internal and external complaints? E.g. by means of a professional complaint management
24. To what extent is the SOM of product-related services anchored organizationally in your company?
    - e.g. regarding structure and organization:
      own department, specific responsibilities, defined processes
25. Which difficulties can you imagine concerning a SOM?
    What are the special characteristics with respect to product-related services?
26. Which needs of support does your company have concerning the SOM of product-related services? (e.g. provided by research, industrial association etc.)
    - Which methodologies and tools need to be provided?

27. Can you imagine the SOM of product-related services being supported by means of IT?

    – If so, in which practical context?

Service Re-Engineering and Displacement

28. To what extent is the Service Re-Engineering and Displacement of product-related services anchored organizationally in your company?

    – e.g. regarding structure and organization:
    own department, specific responsibilities, defined processes

29. In average, for how many years are your service offerings on the market without being modified or displaced?

    – Are there any differences regarding various types of product-related services?

30. While being offered on the market, is it usual to enhance the services of your company?

31. Who or what prompts the enhancement or displacement of services in your company?

32. Who decides that it is time to enhance or displace services?

33. In average, how long does it take to enhance or displace services?

34. In case that services are used to be enhanced in your company, in what way are they tested?

35. Where are the difficulties of the enhancement or displacement of product-related services from your point of view?
    What are specific characteristics?

36. Which needs of support does your company have concerning the enhancement or displacement of product-related services? (e.g. provided by research, industrial associations etc.)

    – Which methodologies and tools need to be provided?

37. Can you imagine the enhancement or displacement of product-related services being supported by means of IT?

    – If so, in which practical context?