A Challenge Based Evaluation of Service Information Systems

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Abstract

Beside industrial product and solution business industrial services become increasingly important. The solution business for industrial plants poses challenges, which require the use of appropriate service information systems (SIS). In order to support the user actively during service execution the SIS developer needs to know these challenges to determine and prioritize the SIS requirements. If a gap remains between these challenges and the implemented requirements, tool-based support for industrial services can be increased significantly. This article introduces a concept to structure challenges and describes a meta-model which associates them to key concepts. By mapping key concepts to the implementation, SIS can be evaluated regarding the support they offer to cope with challenges. Results of this evaluation help tool suppliers to identify requirements of future versions and potential for innovation. It also gives support to service providers on deciding which SIS they should use to address their specific industrial service business.

1. Introduction

Manufacturing and process industries concentrate their attention on return on investment (ROI) and total cost of ownership (TCO). This applies to manufacturing facilities as well as operations related services. Because of the specificity of the many tasks involved in industrial services a great amount of different service information systems (SIS) exists. It is the service provider's duty to design its service offering adequately to address the service's objectives in an efficient manner. Therefore he has to master the global challenges the service business poses efficiently, which is why the use of appropriate SIS is needed in order to actively support service execution.

In contrast to service providers, SIS suppliers run a product business. Cost recovery of development expenses of the SIS is achieved by selling a certain amount of licenses, i.e. by duplicating the product. For sustainable business success determining the requirements concerning SIS is crucial, since service providers will not license the SIS unless it helps them cope with challenges posed by their service business. Hence tool suppliers require knowledge regarding challenges covering this service business, which need to be addressed by the SIS. Based on this knowledge the tool supplier aligns his product strategy, while facing the problem of deciding which tool concepts to use in order to address certain challenges posed by the service business.

The concept introduced in this article enables one to characterize SIS by classifying the global challenges posed by the industrial service business and by associating tool concepts with every single challenge; thereby uncovering important potentials for improvement and innovation to both the service provider and tool supplier. Therefore the first section introduces the application of SIS. Section 2 derives the global challenges posed by the industrial service business, which represent core elements of a classification methodology presented in the third section. The presented challenge-based approach to evaluation was developed at the Department for Systems Engineering, Siemens AG (CT SE 5). It is based on research work conducted and project experience gained within the context of the industrial solution, service and plant engineering business at Siemens AG, as well as supportive research work done by the Institute of Industrial Automation and Software Engineering at Universität Stuttgart and the Department of Business Studies - Business Informatics III at Friedrich-Alexander-University Erlangen-Nuremberg.

2. Service Information Systems in Industrial Solution Business

Services within industrial solution business pose very specific challenges, which have to be addressed by service providers. Therefore a short introduction of SIS and especially the environment they are used in is given.

2.1 Industrial Services

The industrial solution business concentrates on design, construction, operation, optimization and modernization as well as deconstruction of industrial plants. Tasks within the industrial solution business can be characterized alongside a life cycle model of an industrial plant. Based on the life cycle model shown in Figure 1 the term industrial services will be defined.

The first phase in a plants life cycle is called engineering and is executed by the solution manufacturer. Tasks within this phase are activities with primarily technical focus, which aim for creating a customer specific plant. During engineering a lot of technical dependencies and risks have to be managed and experts from a great variety of crafts have to be coordinated, including for example electrical-, mechanical- and service engineering. Part of service engineering is for

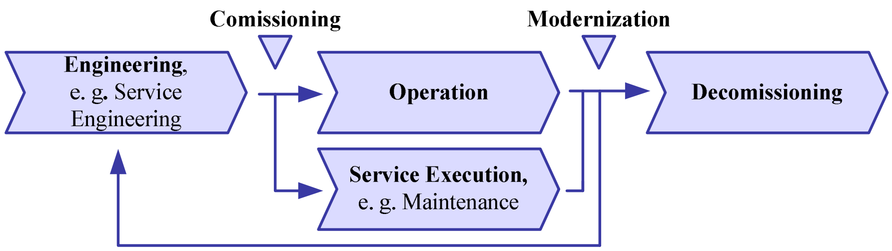

Fig 1. Industrial Plant Life Cycle.

instance the parameterization of SIS used inside the industrial plant.

Passing the commissioning and switching to the phase operation, responsibility for the plant is passed over by the solution manufacturer to an operating institution. This operating institution usually is in charge of activities associated with this phase, for instance equipping the facility with production goods. In parallel the service provider is responsible for the life cycle phase service execution. Important activities contained in service execution are those summarized by the term maintenance, which includes inspection, monitoring, compliance test, function check-out, routine maintenance, overhaul, rebuilding, repair, temporary repair, fault diagnosis, fault localization, improvement, and modification (see EN 13306, 2001 [4]). Maintenance for industrial plants is defined by Ehrlenspiel, Kiewert, and Lindemann, 2007 [3]. as „all technical measures [necessary] to obtain or restore the functional state" of an industrial facility. Minimizing the cost accumulating during service execution, which may easily exceed a multiple of the initial costs of purchase, "should be the primary goal of a cost-conscious developer" (see Ehrlenspiel et al, 2007 [3]).

In case the plant's productivity does no longer match the competition, an increase in productivity can be reached by modernization. In this case the plant's life cycle is closed via a transition back to engineering. If the plant is not to be modernized, the phase decommissioning is reached and the plant is stripped down.

Accordingly industrial services are to be understood as services within the industrial solution business with primarily technical focus on industrial plants. They include an engineering part (service engineering) as well as the essential execution part (service execution).

The three roles solution manufacturer, operating

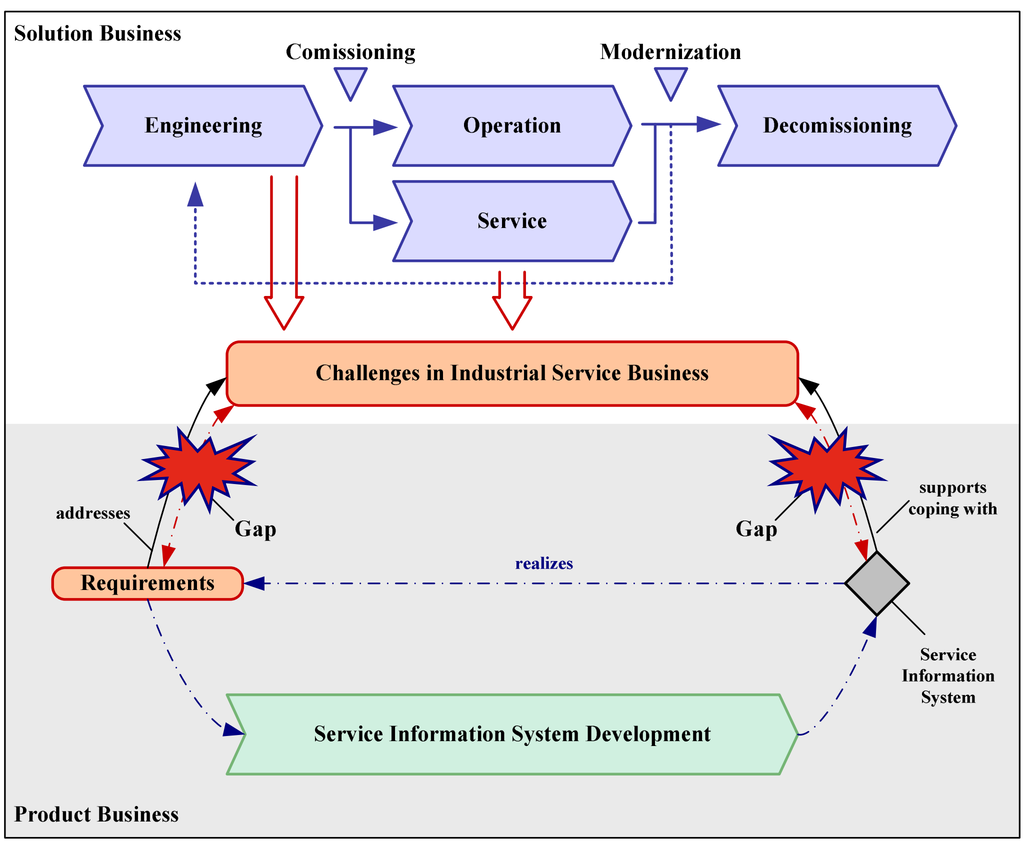

Fig 2. Gap between Requirements and Challenges of Industrial Service Business.

institution and service provider might in practice be either carried out by one single organizations or by separate ones. The business success of a service provider depends heavily on the efficiency of the implementation of it's service offerings. Therefore a service provider uses SIS. Their field of application is introduced within the next chapter.

2.2 Service Information Systems

Service Information Systems are to be defined as a combination of soft- and hardware tools, which support service activities within the industrial solution business. When determining requirements during SIS development, the SIS supplier tries to address the challenges of his customer's target business the best way possible. Only if the SIS implements the requirements derived from every single challenge within the industrial solution business, optimal support for the service providers can be offered. A major problem exists when a gap remains between the challenges within the industrial service business on the one hand and the implemented requirements on the other (see Figure 2).

One of the main objectives a service provider has when designing his service offerings is to choose SIS, that support him most efficiently by meeting the challenges he faces. The tool supplier therefore aims to determine the requirements in such a way that his tool addresses the challenges in industrial service business and contributes to an increase in efficiency. Accordingly it is a common goal for both, the service provider as well as the tool supplier, to identify the challenges in the industrial service business as well as the requirements and to dissolve the difference between them.

Therefore the challenges in industrial service business will be classified within the next chapter. By assigning tool concepts to these challenges this classification can be used to characterize SIS regarding the level of support they offer for service providers in industrial service business. The above mentioned gap (Figure 2) can thus be illustrated and eventually be dissolved by deriving a package of measures for service providers as well as the tool suppliers.

3. Classification of Challenges in Industrial Solution Business

Three different categories of challenges can be derived from the application described. These categories will now be introduced in detail.

3.1 Project Challenges

Svensson, Malmström, Pikosz, and Malmqvist, 1999 [7], describe a methodology to analyze and model engineering information management (EIM) systems using the four views process view, information view, roles view, and systems view

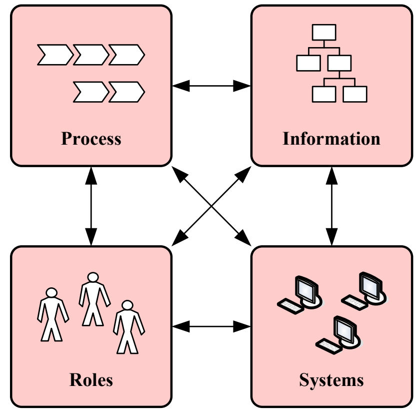

Fig 1. Views of Engineering Information Management Systems [7].

(Figure 3). The SIS described in this article correspond to the entities modelled in system views. Based on the dependencies between EIM systems and their corresponding views, three general challenges can be derived, that apply to all EIM systems and consequently SIS. These challenges are from now on named project challenges. Every project challenge is described in detail by a number of sub-challenges.

The challenges are a result of the different roles users might take as well as the often locally distributed nature of service execution. They are subsumed within the project challenge collaborative support (Figure 4). Sub-challenges of this challenge are e.g. user management, personalization and concurrent access.

Sub-challenges targeting project management issues are addressed by a challenge of the same name. They cope with the process aspect, which includes among other things risk management during service execution as well as quality management.

The project challenge configuration management outlines several aspects including the efficient management of data, plans and documents, which represent the information view. It deals with aspects of versioning, requirements management and change management.

3.2. Engineering Challenges

Challenges resulting from the necessity for efficient engineering are reuse, the standardization and size of reusable solution parts and securing seamless integration of different crafts in one project. These challenges are subsumed and named Engineering Challenges (Figure 4). They are based on Löwen, Bertsch, Böhm, Prummer, and Tetzner, 2005 [5], which introduce the four basic levers of engineering which are neat structuring of technical information, reuse of modules, seamless integration considering engineering processes and involved crafts.

The engineering challenge reuse concept groups all challenges, which result from the need to reuse solution parts. Important sub-challenges are the used reuse model, the contained information of reusable entities and the hierarchy structuring those entities. The engineering challenge engineering know-how reuse subsumes challenges, which are required to formalize and reuse know-how and automate activities. Sub-challenges are e.g. standardization of partial solutions and configuration know-how reuse. Within the engineering challenge mass data management, challenges are packaged, that deal with the need to efficiently manage changes to lots of single data sets during engineering services. The evaluation especially captures which data is covered by mass data management and whether consistency can be provided. All challenges regarding tools, which are results of a seamless integration of crafts can be found under view integration.

3.3 Service Challenges

Challenges of service execution result mainly from the existence of an actual plant, for instance the need to respond to urgent malfunctions and the plant as data source. These challenges have been identified by analyzing multiple SIS and a number of expert workshops.

Challenges during service execution arise as a result of the need to store, process and change large amounts of datasets coming from the plant. These challenges are grouped via the service challenge data handling. Sub-Challenges are e.g. the level of adaptability to communication systems and the compactness of stored data.

The challenge data processing deals with this data and characterizes e.g. the level of automation that is provides by the tool during further processing and data consistency checks that might be executed.

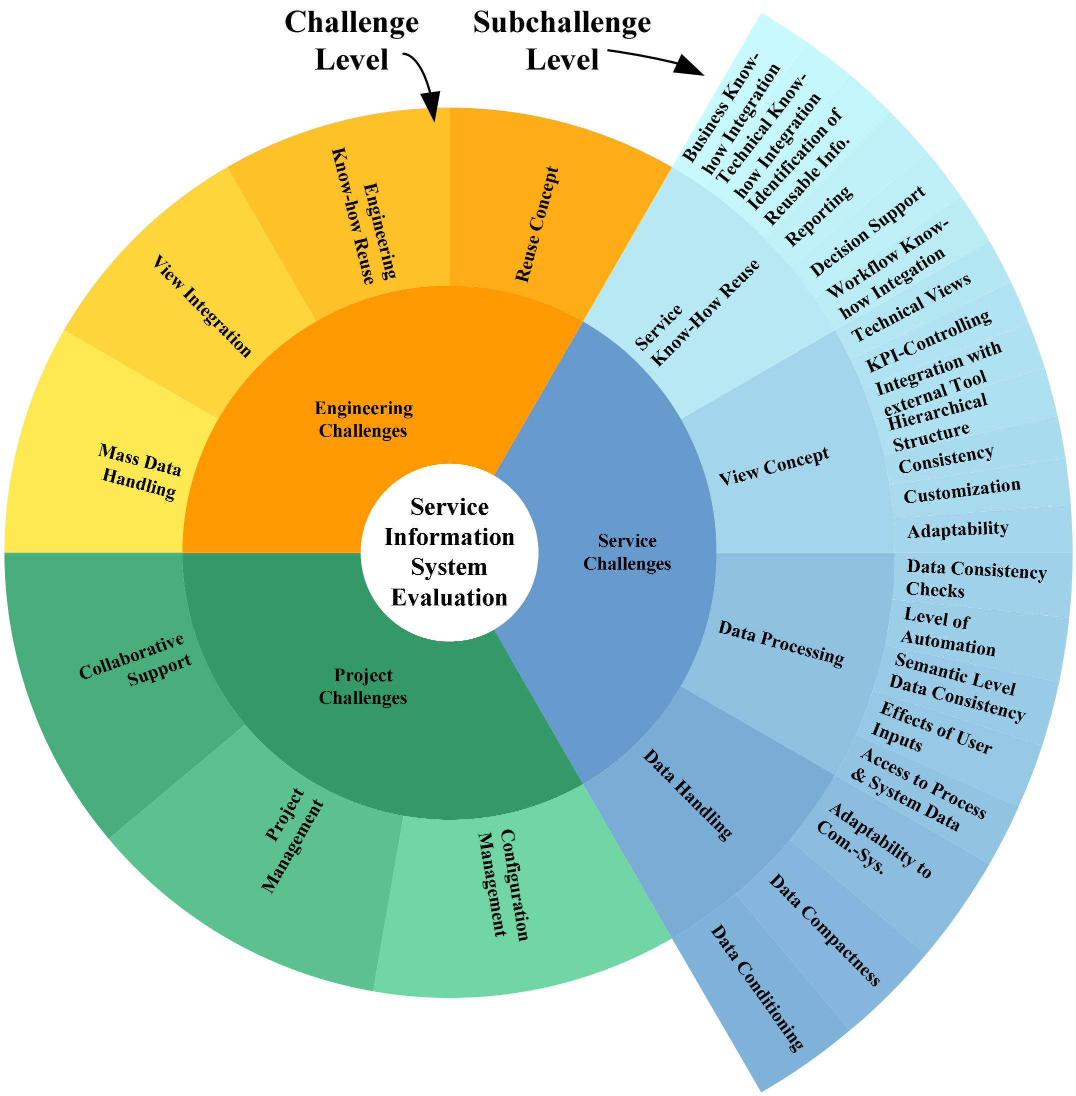

Fig 2. Overview Challenges for Service Information Systems with Service Challenges expanded to Sub-Challenge Level.

This data has to be pre-processed appropriately before it can be presented to the user. Sub-challenges, which address the visualization of service information, are subsumed by the service challenge view concept. Technical views from different crafts as well as economic views, for instance key performance indicators (KPI) and their corresponding structure, have to be considered.
The service challenge service know-how reuse deals with the necessity to formalize and reuse service know-how. Sub-challenges are e.g. reporting abilities of the SIS and the decision support it offers during service execution.

4. Evaluation Methodology

To identify and subsequently dissolve the above mentioned gap, these Challenges are now structured further and associated to so-called tool concepts.

4.1 Structuring the Challenges

The introduced tool evaluation presents an approach to characterize industrial SIS and uses three types of challenges. project, engineering- and service challenges each subsume a corresponding complex of general challenges in industrial service business. Every challenge is described in detail by a number of so called sub-challenges. Every sub-challenges describes a single determinant on the efficiency of supporting SIS regarding the industrial service business. For every determinant described by this sub-challenge five different best practices have been gathered, which reflect the corresponding determinant within the SIS. Attached to every best practice is one central question which functions as a barrier that has to be overcome in order to reach a certain concept class. Examples are used to substantiate best practices by means of precise applications and case studies. The interrelation between challenges, sub-challenges, best practices, central questions and examples is described by a meta-model (see Figure 5).

4.2 Allocation of Tool Concepts

Allocated to every sub-challenge are key concepts represented by best practices. Class 4 key concepts represent generic support for the user regarding a specific sub-challenge. In this case the tool supports the service provider extensively and is adaptable to the precise service business case. Class 3 key concepts provide extensive and explicit support to the user, they are however not adaptable to the specific characteristics of the individual service business case. Class 2 key concepts subsume those key concepts, which represent explicit but not very far-reaching support for the user. Class 1 is made up by key concepts, which are used to face the challenges, but do not provide explicit support. When being categorized in Class 0 a SIS does not provide any supporting key concept.
Table 1 shows the associated tool concepts of one exemplary determinant on the efficiency in service business by the means of sub-challenge view adaptability within the service challenge view concepts (Figure 4). A SIS, which possesses one static view to e.g. visualize the plant's status is categorized as Class 0. The scope of key concepts increases steadily until Class 4 is reached. Class 4 in this example represents tool concepts with a combination of situation and location based adaptability of real-time views. This type of view is called Augmented Reality (see Azuma, 1995 [2]).

Table 1: Association of Tool Concepts and Sub-Challenges – Example: Subchallenge View Adaptability.

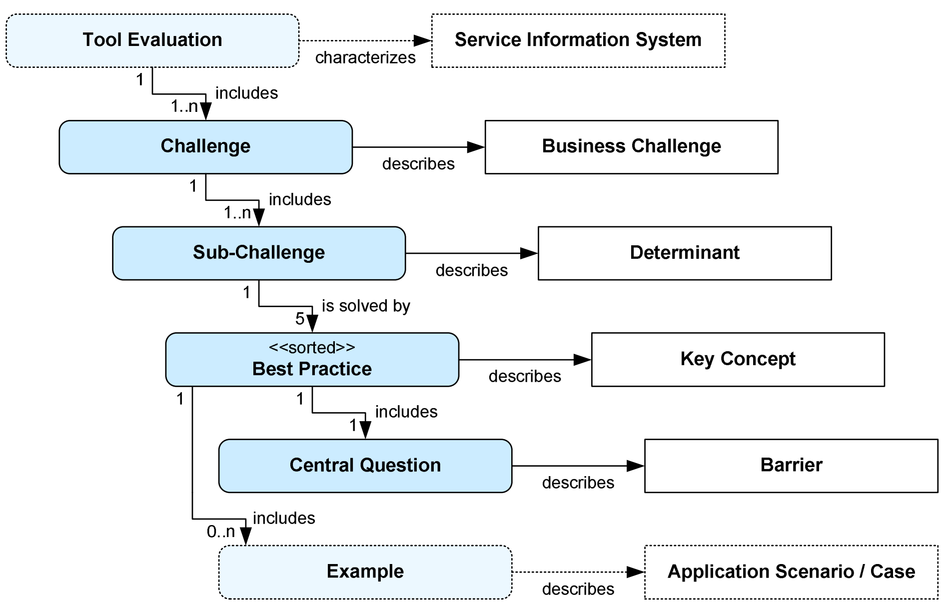

Fig 3. Meta-model of the Classification Methodology by CT SE 5, figure based on Ahern and Clouse, 2004 [1].

	General Meaning of Class	Example: Sub-Challenge View Adaptability of Service Challenge View Concept
Class 4	Concept for Generic Support of User	Augmented Reality – Combination of situation-based data and location of user in real-time
Class 3	Concept for Explicit Support of User on a High Level	Selection of views in combination with event and plant status or external factors
Class 2	Concept for Explicit Support of User on a Low Level	Event driven selection of view
Class 1	Concept for Implicit Support of User	Multiple views, user driven, manual selection
Class 0	No Concept Regarding Challenge	Single static view

4.3 Process of Tool Evaluation

The introduced evaluation methodology is embedded into an evaluation workflow (see Figure 6) which is based on the approach described by Maurmaier, Dencovski, and Schmitz, 2008 [6]. The first step of the evaluation workflow is a prioritization performed in collaboration with a customer, being either a service provider or SIS supplier. During this prioritization the relevant challenges for upcoming phases are being picked. To be able to execute the actual characterization an analysis of the tool's following technological base concepts is necessary:

- Data Management Technology – The organization and management of data within the tool has to be examined.
- Level of Abstraction of Base Object Definition – It is necessary to understand the way base objects and associations between them are defined. Base objects do not necessarily translate to computer linguistically objects, e.g. derived from the object-oriented programming paradigm, but are simply entities, users work with when executing service tasks inside the tool.
- Openness – Interfaces, import and export capabilities, application programming interfaces and concepts for integration with other tools will be examined.
- Consistency Concepts – Measures to maintain the consistency of the service model are being examined.
- Component Model from User's Point of View – A component model of base objects and associations between them has to be generated.

4.4 Result of Tool Classification

With the aid of this tool characterization a general assertion is made regarding the level of support the service provider receives when using the evaluated tool. Hence the service provider gets decision support on which SIS it should use. He can deliberate whether he should use an integrative SIS strategy, using fewer, integrated SIS to support his service activities, or to use different, dedicated SIS for several activities. The integrative approach requires generic support (Class 4) by the tool to support coping with the challenges of industrial service business. If dedicated tools are used, they must be integrated to be able to address the challenges. In this case a tool evaluation can identify sites of fracture within the integrated tool chain. The characterization results allow him to selectively pick SIS that support his industrial solution business the best and to integrate it accordingly.

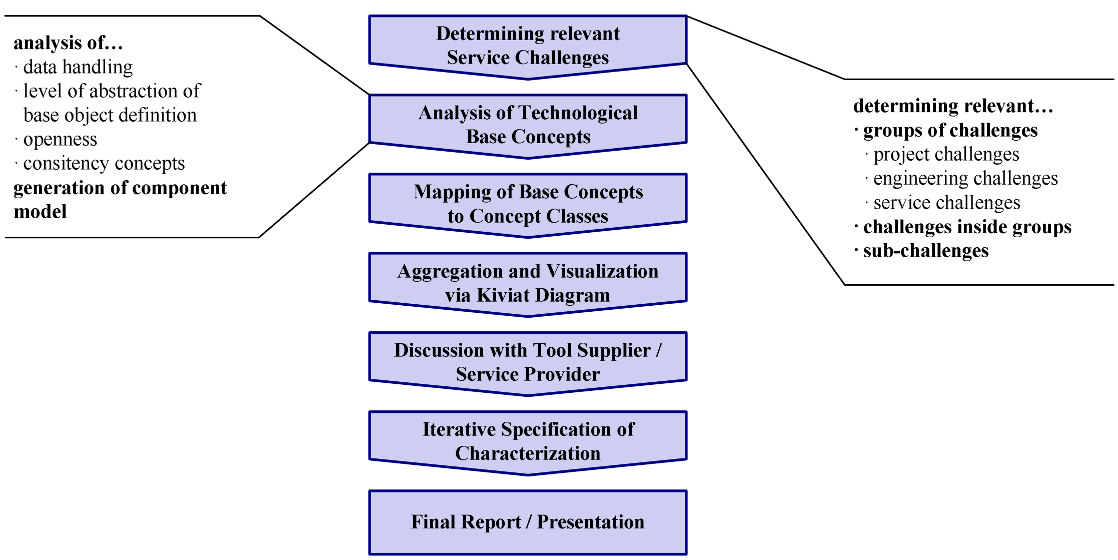

Fig 4. Evaluation Workflow.

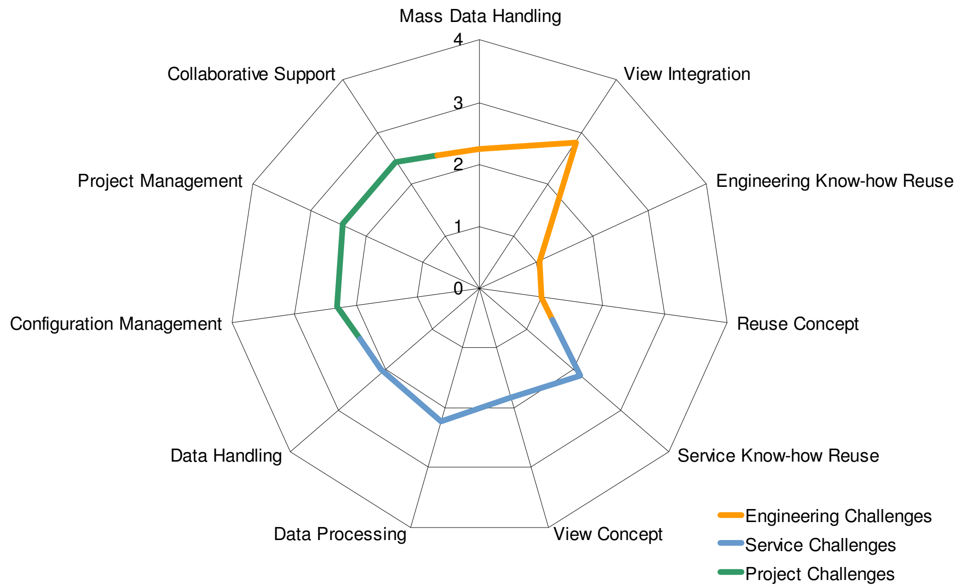

Fig 5. Example - Kiviat Diagram of a Service Information System.

5. Summary and Outlook

Industrial service business poses a lot of challenges to the service provider. To cope with these challenges appropriate tool support is necessary. Between the challenges posed by the industrial service business and the requirements implemented in SIS, a gap can often be found. To reach the best gain in efficiency possible, this gap has to be closed.

The introduced classification concept based on project, engineering and service challenges structures the challenges of industrial service business and associates them with key concepts by the means of best practices. By mapping these key concepts to challenges, challenges and requirements of SIS can be integrated. In addition SIS can be characterized by Classes 0 through 4, regarding the different challenges.

During the first applications of the described evaluation workflow it appeared, that mapping characteristics, which are implemented in the evaluated SIS to abstract challenges can be further supported by a generic service architecture. The architecture will be developed soon, to support the classification by mapping service challenges to elements of an abstract, prototypical SIS's architecture.

Using the experience gathered during formulation and application of the characterization methodology at hand, the approach is currently extended to several other life cycle phases. Hence interrelated challenges between engineering, service execution, operation and modernization can be identified and considered during service execution as well as prior and later life cycle phases.

6. References

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