Industrial Services Reference Model

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Abstract
The need to integrate service providers into an existing customer supply chain requires the collective know-how of the coordination mode, including the ability to synchronize interdependent processes, to integrate information systems and to cope with distributed learning. About this topic the EU-funded InCoCo-S project is developing a new standard business reference model with key focus on operation & integration of business related services in supply chains. Based on the requirement analysis concrete business processes have been developed to integrate services in the existing customer supply chain both on a strategic and operational level.

Keywords
Service supply chain, process modeling, reference model

1 INTRODUCTION

Nowadays, the service businesses industries have developed into an important economic force and have become an integral part of modern society [1,2]. More than eighty-five percent of all North American and European companies have outsourced at least one function [3]; sixty percent of Fortune 500 companies surveyed have at least one logistic outsourcing contract [4]. Especially over the last ten years, organizations have increasingly improved their own service operations. Many service sectors have sought and made use of various enhancement programs to improve their operations in an attempt to be highly competitive. [5]. Industrial service is becoming increasingly important to manufacturing firms for a number of reasons. To improve profitability it is not enough to sell just a product; the real impact on profitability comes from exploiting downstream opportunities, by providing the customers with products such as financing, maintenance, spare parts and consumables [6,7].

Moreover about seventy percent of the overall European GDP is generated by the service industries in total. Over fifty-four percent of the overall European GDP is generated by Business Related Services and thirty percent of all Business Related Services are consumed by the production sector [8]. This highlights the increasing relevant importance that supply chains driven by the exchange of services among service providers and customers (service supply chains) have in Europe.

In such context, the need for improving integration of service providers into an existing supply chain requires a distributed know-how of the coordination modes, including the ability of synchronizing interdependent processes, to integrate information systems and to cope with distributed learning. In this paper we deal with the design and benefits of a new Reference Model for Industrial Services resulting from the framework of the EU-funded InCoCo-S project (Innovation, Coordination and Collaboration in Service Driven Manufacturing Supply Chains, see website in the references). Moreover, the so called Industrial Services Reference Model answers to the need, for new and innovative business processes requested by the efficient integration of service provider networks. On the basis of requirement analysis, the InCoCo-S consortium developed a reference model that integrates services in the existing customer supply chains on an operational level.

2 DESIGN OF A NEW REFERENCE MODEL

2.1 Reference Model definition

A reference model is a model representing a class of domains [9]. It is a conceptual framework that could be used as the blueprint for system development. Reference models, usually labeled as “common practices” are generic conceptual models that formalize recommended practices for a certain domain. They claim to capture reusable efficient state-of-the-art practices and have the main objectives of streamlining the design of enterprise individual models by providing a generic solution, reducing the costs of designing models and facilitating the management and control of the organization. [10]

Fields of application of reference modeling address all levels and business fields of enterprises; therefore depicted domains can be very different. They can range from selected functional areas such as accounting or Customer Relationship Management to the scope of an entire industry sector, e.g. higher education. The main objective of reference models is to streamline the design of enterprise individual (particular) models by providing a generic solution. The application of reference models is motivated by the ‘Design by Reuse’ paradigm. Reference models accelerate the modeling process by providing a repository of potentially relevant business processes and structures. Moreover, with the increased popularity of business modeling, a wide and quite heterogeneous range of purposes can motivate the use of a reference model.

Generally speaking, capturing reusable efficient state-of-the-art practices, a reference model serves the following key objectives: (i) Streamlining the design of enterprise models by providing a generic solution, (ii) Reducing the costs of designing models, (iii) Facilitating the management and control of the organization, (iv) Facilitating description and optimization of organizational issues, (v) Helping to develop enterprise specific models including the reutilization of business knowledge.

2.2 Industrial Services Reference Model development methodology

In the InCoCo-S project, the Reference Model was built following the Road Map to develop a reference model, suggested by Fettke et al.[11], made by three different Phases, corresponding to the definition of Domain, Features and Language (Phase 1), Modeling Approach (Phase 2), Construction Methodology (Phase 3).

The identification of Domain, Features and Language was relatively easy, having quite a clear picture of a service supply chain reference model that could help in improving integration of service providers into an existing supply chain considering also new and innovative business processes.

Therefore to fulfill the second phase a deep literature research for relevant models that may serve as a baseline for the development of the InCoCo-S reference model has been carried out. Thereafter a "screening" process was performed to identify only relevant models, to be taken into consideration. After these activities the following reference models were considered to be relevant: SCOR reference model [12], Y-CIM reference Model [13], Aachener PPS reference model [14], GSCF [15] and CPFR [16]. Among the existing reference model, no one seemed to fit on full basis to the representation of interactions between manufactures and their service providers. Nevertheless, even though SCOR shows to be inadequate from the point of view of the service sector, it represents the best choice as a baseline for the development of the Industrial Services Reference Model (IRM) since: (i) service related activities, even though not described in detail are inferred. This fact facilitates the generation of an interface model for the service provider domain that could be in the future interfaced with SCOR; (ii) includes KPI that facilitate a better coordination and control during the supplier-manufacturer relationship; (iii) includes best practices that help companies activities benchmark and improvement.

Since a suitable reference model basis was found, the following activity to be performed was the enhancement, development and evolution of the SCOR reference model to fit with the InCoCo-S special requirements.

2.3 Grounded Theory Methodology (GTM)

Different procedures can be used to enhance, develop and evolve the starting point reference Model to fit with specific requirements. Nevertheless recommended procedures are very general or too specific and give only a summary description of the process followed. And the use of these recommended procedures result inadequate as basis of a scientific study. However, when selecting a research methodology two class of requirements should be considered: research requirements for a scientific method and the requirements relevant to the topic under study. On one hand, according to Strauss regarding research requirements, the researcher should take into consideration the following criteria: appeal, goals of the researcher, cost rigor, interpretations, usefulness and so forth. [17]. On the other hand the reference model to be developed should also have some features to reduce and control the complexity of the modeling process. These requirements correspond to the six principles of GoM theory developed by [18]. These principles are: accuracy, relevance, cost effectiveness, clarity, comparability, and systematic construction. [19]

Among the different scientific research strategies with a qualitative orientation, the Grounded Theory Methodology (GTM) calls special attention. The use of GTM attracted the attention of researchers not only of social and educational fields. Since its creation in 1967 by Glaser and Strauss, it has been used not only by academic researchers but also by managers, businessmen and professionals as they couldn't find a better way to explain practical phenomenon.[20]

Comparing the different scientific qualitative methods available, taking into consideration both the requirements of the research and topic under study, the grounded theory method fits exactly with the research needs. Furthermore, it is particularly suitable to those investigations for which little theory has been developed, where theory should emerge from data [21], which is exactly the case of the methodology to develop reference models that are large in number but the methodology used to develop them is hardly found. The synthesis of the main reasons why it was decided to use the grounded theory as the research approach to develop reference models are hereafter explained: (i) theories are derived from observation, the Reference Model had to emerge from the practice and the practice will be represented on it. (ii) GTM allows the researcher use his own experience and practical knowledge to generate new theories, (iii) the process of constant comparison assures a practical oriented and long lasting end product, (iv) it is a scientific method and has been used successfully in business and management research.

The founders (Glaser & Strauss) of this qualitative research methodology define it as an inductive method "derived from the study of the phenomenon it represents, that is, discovered, developed and provisionally verified through systematic data collection and analysis of data pertaining to that phenomenon. Therefore, data collection, analysis and theory should stand in reciprocal relationship with each other. One does not begin with a theory and then prove it. Rather one begins with an area of study and what is relevant to that area is allowed to emerge." [22]

In general, grounded theory is the systematic generation of theory from data. Grounded theory is derived inductively from observation following a specific research procedure that allows the researcher to develop a theoretical account of the general figure of a topic while simultaneously grounding the account in empirical observations or data [23]. Theories are developed based on empirical observation, due to this special characteristic; it has been used mostly for

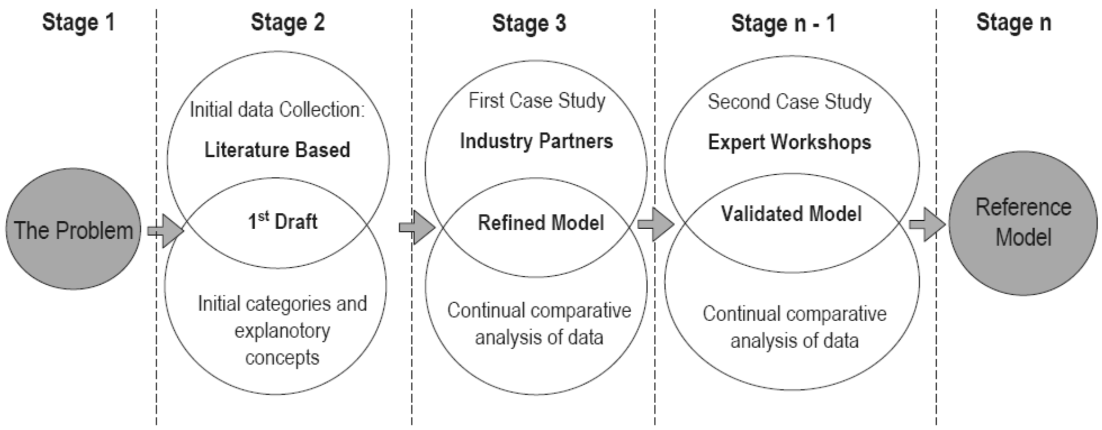

Figure 1: GTM adaptation to the specific case

domains that have no theory available. But whenever it is possible, the best domain theory should be used to give the theoretical framework of the initial study [24].

Since the SCOR reference model alone does not fulfill all the requirements of the new reference model, on the basis of the SCOR model a new one was developed with a procedure based on the GTM. For the specific case of this study, the GTM adaptation used can be represented as shown in Figure 1.

3 THE INCOCO-S REFERENCE MODEL

The Industrial Services Reference Model (IRM) is a role-based process reference model based on enterprise architectural standards. It integrates AS-IS process mapping and TO-BE process design capabilities with operational performance setting and measurements to enable service providers and their business partners to achieve best-in-class results, built on proven industry practices and supported by solutions and tools. The comprehensive IRM process repository contains standardized descriptions of service processes on different levels of detail, structured in hierarchies to enable users to perform root-cause-analyses of performance variance. IRM processes are linked through input-output relationships and offer partner interface processes to other BPM standard models. The IRM structure covers supply-chain related business services in manufacturer-service provider networks.

3.1 IRM Level 1 – Strategic Process Types

Level 1 processes define the entire scope of the service operations which are incorporated in the model. IRM incorporates all processes from the first service contact to continuous service operations using a service lifecycle approach. Based on this approach, five key process types have been identified namely: Plan, Adapt, Build, Operate and Support.

- **Plan**. Since services cannot be stored as inventory, the plan service is most crucial for a successful service business and covers ongoing activities within service business. During the Plan phase a framework of procedural methods is first established for the entire span of the service supply chain and its operations.
- **Adapt**. The Adapt Phase is primarily concerned with adapting the Service Portfolio offered by the service provider to the specific customer requirements in order to develop a service offer, which fulfil the customer needs. Key goal here is to fulfill the customer needs with the existing / enhanced service portfolio in an effective, efficient and reliable manner.
- **Build**. The Build Phase is the phase of service implementation, where the service provider and the service network bring together all the resources – hardware, software and personnel oriented to implement the service solution for the customer. The key aim of Build Phase is to reliably and efficiently implement the service solution so that the service operations can commence to the utmost satisfaction of the customer and service provider.
- **Operate.** Operate phase envelop value-adding core business transactions: here the services agreed between the customer and service provider are operated as per the service terms & conditions. Achieving the service levels and bring the benefits to the customer through enhanced performance are the key goals of the service provider. In addition, the service provider further strives to continuously improve service performance by evaluating the service performance and identifying potential for improvement.
- **Support**. Support Phase provides the infrastructural support to run and execute the service operations right from the Adapt phase to Operate phase. Key goal of support phase is to first define consistent & global business rules, governing principles which shall guide the overall service organization. The second key goal of support phase is to ensure unrestricted & uniform access to information across all service activities and all hierarchy levels.

3.2 IRM Level 2 – Configurations for Service Clusters

Level 2 refers to customer fulfillment strategies to Plan, Execute and Support a certain business process in an industry specific environment. Whereas the SCOR Model differentiates between, Make-to-Stock, Make-to-Order and Engineer-to-Order approaches to satisfy customer needs in a supply chain environment, InCoCo-S has defined 5 service clusters to deliver business related services to supply chain customers. Using an iterative approach the IRM has been defined for five different services namely Logistics, Maintenance, Retrofit, Packaging and Quality Control services. The clusters processes have been defined together with the active participation of the industrial partners, especially business cases and SMEs.

3.3 IRM Level 3 – Process elements

Process elements are a decomposition of Level 2 configurations and usually the lowest level of detail in a reference model. Level 3 processes define the transition from a generic reference model to a customer specific workflow. IRM Level 3 includes all the processes within the considered service which are of competence of the service provider. It models service supply chains as sets of connected processes: more than two hundreds processes at level 3 have been identified. This structure represents the backbone of the IRM model. To this backbone many other element are attached to form the entire IRM organism. Some other relevant information have been then added to the basic framework, including input/output, Best Practices and Key Performance Indicators. Best Practices and Performance Indicators are strictly related since the results achieved through Best Practices can be measured in an improvement of Key Performance Indicators. As a result, each process of IRM is characterized by a set of input coming from other processes, outputs, going to other processes, best practices that could improve the process performance and Key Performance Indicators that allow process performance measurement. An example of such result can be seen in Figure 2, where a process is represented with all its main attributes.

3.3.1 Input/output relationship

All the processes are connected the one to the other thanks to Input / Output relationships. In the IRM each process is characterized by some inputs and outputs connected together to form a flow, which defines sequence and associated interdependency. Inputs can come from outputs of another process or from an entity external to the service provider (e.g. a customer or a supplier). In the same way the output of a process can go to one or more other processes and/or to some external entities. This sequence of inputs and outputs represent the flow of information that ideally accompanies the execution of the service, from the first contact with the customer to the service termination. Each output of a process is the input of one or more other processes and this allows “moving” along the IRM process structure. Process interactions and relationships are highlighted by inputs and outputs and form the basis of the framework.

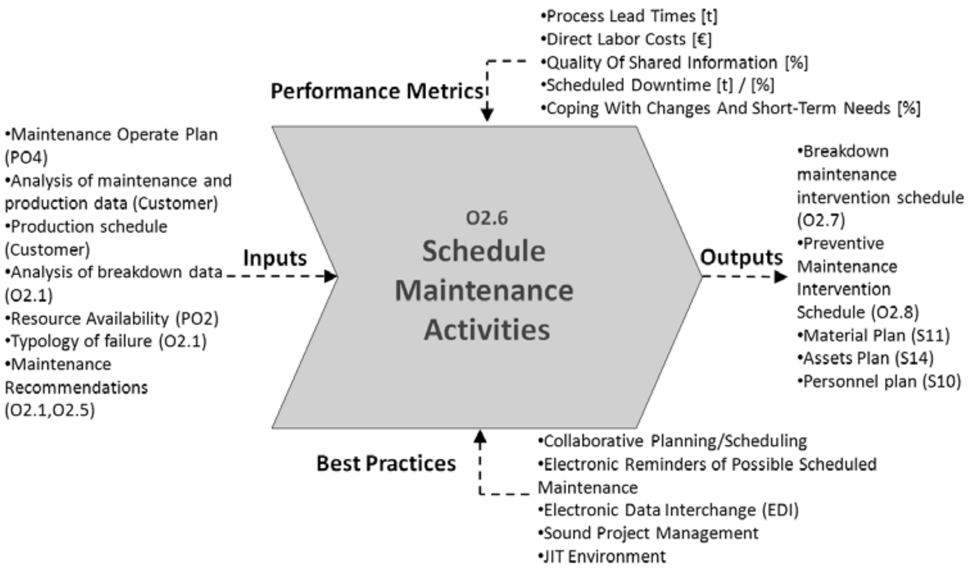

Figure 2: Example of an InCoCo-S service – supply chain process

3.3.2 Performance Indicators (PIs)

Performance indicators (PIs) present important information for the control and management of processes in terms of efficiency and effectiveness and the resulting service outcome. They measure whether set performance goals were met, and support the identification of improvement potentials. In the IRM, every process has PIs assigned on each level, indicating what needs to be measured while performing the process. On the strategic level, operational PIs are aggregated to key performance indicators (KPIs), which are important for benchmarking purposes, internally when comparing the performance of different departments or plants performing similar activities, or externally when benchmarking the service operation performance with the competitors.

The PIs are structured in a certain manner, forming altogether the so-called Service Performance Measurement System (SPMS). The SPMS was designed to quantify the efficiency and effectiveness of service operation activities from a holistic perspective. The SPMS is structured into three dimensions: Service Object, Service Activity (forming together the Service Encounter interface) and Customer Service Satisfaction.

Service activity (SA) is the measure of the service providers own internal service process performance in terms of how efficient and reliable the processes are. The dimension of Service object (SO) focuses on the performance of the objects (e.g. performance of machines in case of maintenance services) in the customers` manufacturing supply chain which are being serviced by the service provider. The basic idea of the Customer Service Satisfaction is to have a dimension quantifying the gap between actual service operation performance based on the objective measures from the Service Encounter Interface and the perceived service operation performance from the customers` perspective. For each category five key target areas have been identified to measure service performance holistically from both service provider and customer perspective:

- Service Reliability: These PIs relate to the ability to achieve an intended or agreed service operation level or availability. Reliability refers to the ability to perform a required operation under stated conditions for a stated period of time.
- Service Responsiveness (Time): These PIs reflect the time between the beginning and completion of SA and measure time related to SO (e.g. order lead time).
- Service Flexibility / Adaptability: These PIs provide the basis for measuring the ability of SA and SO to adapt to changing requirements in terms of time and volume/intensity.
- Service Assets / Costs: These PIs highlight the financial expense to carry out SA and run the SO.
- Service Efficiency / Productivity: Includes relative PIs measuring static PIs in relation to time and costs and shows how efficient the resources are being used in transforming inputs to outputs.

3.3.3 Best Practices (BPs)

Best practices can be defined as the most efficient (least amount of effort) and effective (best results) way of accomplishing a task, based on repeatable procedures that have proven themselves over time for large numbers of cases. Best Practice consists in a technique, method, process, activity, incentive or reward that is more effective at delivering a desired outcome with fewer problems and unforeseen complications.

In the IRM model, once the performance of the process has been measured and performance gaps identified, it becomes important to identify what activities should be performed to close those gaps. For each process a set of best practices is identified according to the relevance in the ambit of the service – supply chain and to the capability of making the process achieve "best-in-class" performance. To assign one or more best practices to process, several best practice were deeply analyzed, to understand the service supply chain process(es) where, if adopted, could result in "best-in-class" performance. During this task, a classification of best practices, reflecting a structure similar to the IRM phases was used. [25] Moreover, beside the best practices identified in literature, new ones were also defined in order to address the peculiarities of the maintenance service supply chain. These novel best practices were usually developed as modifications and adaptations of existing managerial practices and mainly derived by the experience of the project industrial partners.

4 POTENTIAL USAGES OF IRM

4.1 Analyze & Optimize Business Processes

Users who want to define organization specific processes and develop & evaluate AS-IS and a TO-BE scenarios before implementation of a business transformation project can apply the DMAIC (Define, Measure, Analyze, Implement and Control) approach, derived from an alignment of BPM and Six Sigma toolboxes. The IRM methodology supports the user in decisions on breakthrough or continuous improvement focus beforehand, defining strategic goals and operational targets in enterprise context, concentrating on quick and easy leverage critical to value and quality, defining fact-based baselines and agreeing upon measurement systems and KPIs to be used. A comprehensive set of practice proven tools can be used to agree on process improvement potential, define the process maturity of involved community, describe desired impact on business results, develop AS-IS, SHOULD-BE, TO-BE scope and scale, define process owners and targets, document level of detail and degree of visual aids, document improvements to be achieved and areas to be addressed.

4.2 Standardize the business processes for internal & external communication Benchmarking / Knowledge Management

Companies whose focus is on optimization, standardization and automation of internal process execution are supported in program and process management methodologies to develop and prioritize scope and scale of improvement projects. Hereby the user is guided through a multistep iteration, based on sequences of processes he can choose from depending on the project roadmap. Examples include the description of end-to-end process flows on different levels of details, allocation of resources and responsibilities, the identification of process inputs and outputs and the description of interfaces and measurement points on the respective process level. Once the analysis of a given AS-IS performance in process execution has been done, a description of input-output relationships and their impact on performance levels can be addressed. A cross-functional team now can elaborate a project roadmap and measurement plan, collect and evaluate company specific data and process disconnects, analyze and prioritize required outputs relevant for a desired TO-BE performance. Again the comprehensive toolbox supports users if needed in defining long-, medium-, and short term improvement targets, developing potential scenarios and their impact on the company baseline and applicable ICT solutions.

4.3 Use of IRM for Benchmarking Purposes

Having standard processes using the IRM structure, the according performance indicators allow for a comparison of process effectiveness and efficiency. When harmonizing the own organization's process flows, different departments or regional offices can be easily compared and improvement potentials identified.

The aim within the IRM user group is to establish a database with values for the different performance indicators, especially the key PIs, which represent real data. These values will be linked to strategic setups, so that other IRM users can match their own performance against competing strategies.

4.4 Facilitation of Software Implementation

IRM is used to align a multitude of IT Systems with business processes into a streamlined IT application which supports the business processes in a synchronized manner. The software solutions can be developed on the basis of the internal process as defined by the in-house process management team.

In addition, IRM can also be used by a supply chain partner to align the service operations of their service providers and to benchmark the performance of different service providers using a common service scorecard. IRM supports interactions with other proprietary models such as SCOR, the Aachen PPC Model and GSCF in the supply chain domain in order to develop an integrated process framework incorporating both service and supply chain domains.

5 IRM VALIDATION AND STANDARDIZATION

According to GTM the results achieved with the IRM are consequence both of the literature analysis and of the model refinement achieved thanks to the Industrial Partners support. In particular, a first validation of the IRM has been conducted on the basis of industrial business cases. Refining the model through industrial partners help has been just the first step to achieve a real validation. In fact on the basis of the InCoCo-S project external validation plan, more than 30 extensive validation tests were carried out to the end of March 2008. In the validation tests the IRM was used in industrial services offering companies to map the AS-IS scenario, in order to warrant the flexibility of the model and its adaptability to different business cases. Moreover the IRM was used to suggest possible reconfiguration and re-modeling of the service offered either reorganizing processes or using best practices to improve performance. It must also be considered that the 3rd level of detail of the Industrial Service Reference Model is not to be considered the “final” one because further decomposition of processes is possible on the basis of company specific information. From this point of view, during validation, the possibility of easily represent with such higher details real industrial processes was also tested.

Furthermore, thanks also to validation, testifying its capabilities, Industrial Services Reference Model was proposed for standardization, becoming CEN Workshop Agreement (CWA) WS 39, a valid industrial standard for business services modeling and improvement. This is also be eased by the full compatibility of IRM with well known and in use complementary models, like SCOR: the possibility of interconnect SCOR to model manufacturing processes and IRM to model business services and the similar hierarchical, process based structure, is for sure an important advantage to improve IRM diffusion and attitude towards its use.

6 CONCLUSIONS

Starting from the assumption that the increasing importance of the business service offer has to be faced with new and innovative tools to improve companies’ effectiveness and competitiveness, this paper showed the main characteristics of the Industrial Services Reference Model, and how, using the framework a company can model its processes and find hints for improvement, both considering the suggested process interaction and using Key Performance Indicators and Best Practices to monitor and improve performances. This in order to warrant to future users of the IRM framework the possibility, not only to model the service offered but also to supply tools to improve the modeled processes.

The final objective of the InCoCo-S project, to manage the interdependency between the manufacturing supply chain and service providers was achieved by developing a service oriented reference model that could increase and sustain the overall performance and competitiveness of both manufacturing supply chain and their service providers.

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