Industrial Product-Service Systems (IPS²)

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Editors
Tomohiko Sakao, Tobias Larsson & Mattias Lindahl

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Professor Tomohiko Sakao
Professor Tobias Larsson
Associate Professor Mattias Lindahl

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Potential of the Competence-Cell-based approach for services in co-operative networks

A. Rosteck[1], W. Mayrhofer[1], W. Sihn[1], J. Ackermann[2], R. Riedel[2], E. Mueller[2]

[1] Institute of Management Science, Vienna University of Technology, 1040 Vienna, Austria, armin.rosteck@fraunhofer.at

[2] Department of Factory Planning and Factory Management, Chemnitz University of Technology, D-09107 Chemnitz, Germany, ralph.riedel@mb.tu-chemnitz.de

Abstract

The importance of services and product service systems is constantly rising. Internationalization makes it especially for small companies increasingly difficult to meet the service requirements of their customers. Co-operation by combining various competences of all involved partners into a service-network is an option for a flexible solution for this problem. This paper answers some of the conceptual questions with regard to the configuration and operation of service Competence Cells. The presented approach, based on the Competence-Cell-based networking approach, is to date primarily used in manufacturing settings. The paper investigates the advantages of this approach and how its potential can be used for service networks.

Keywords

product service systems, service networks, Competence-Cell-based networks

1 INTRODUCTION

The economical impact of small and medium-sized enterprises (SME) is evident on a broad basis. With their high proportion of gross value added, these enterprises will also in the future constitute the backbone of economies, acting as employers and innovators. In Austria more than 60% of the jobs are created by SME. [1] In the European Union the share of the SME in total value added is about 58% in the non-financial sector. [2]

Apart from their specific core competencies, small enterprises command only limited resources. Therefore, they can only partially execute sequences of process chains. In order to acquire the ability to supply complex and innovative products and services or product service systems (PSS) in a holistic and customer oriented manner, they have to either integrate deficient competencies or recruit these by co-operation.

Services and PSS are constantly gaining importance for the manufacturing industry. On average, service products achieve higher returns than the tangible product "machine" or "plant" and thus make a substantial contribution to ensure a company's long-term success and competitiveness. [3]

The rising demand for integrated offerings and comprehensive solutions to multi-faceted problems as well as stringent requirements concerning quality and availability of services, are increasingly challenging for SME, especially with respect to international markets. For many SME, the only way of providing services and PSS on international markets is by employing co-operative networks.

Present day co-operational organization is set on hierarchical structures in and between enterprises. These co-operational relations are frequently dominated by major enterprises with respect to technical, organizational and economic aspects therefore creating dependencies, especially for SME. The benefit of relative stability corresponds to the disadvantage of unilateral dominance. While these dependencies act restricting on enterprises which are regionally established, they work as considerable market entrance barrier for start-ups, small and smallest enterprises.

As a result, existing competencies are not thoroughly accessed. Additionally, small enterprises are obstructed in the founding and their development and it is necessary to aim future efforts towards the organization of non-hierarchical production and organizational structures. This is supported by studies which consider autonomous, elementary business units [4], co-operating in temporary networks [5, 6] also called 'nanocorps' [7], as a form of enterprise organization of the future. Recent research projects [8, 9] follow the idea of collaboration of smallest business units. Due to this development in manufacturing organization, which in recent years has been lastingly influenced by the phenomena of elementarization and networking, a specific vision aimed at small and medium-sized industry has been developed. [10]

Autonomous, elementary units of production, co-operating in temporary networks, are considered as an efficient organizational form of enterprises for the 21st century. A scientific approach for this concept is provided by networks based on customer-oriented, directly linked, smallest autonomous business units – called Competence Cells. The concept researched at the Collaborative Research Centre 457 (CRC 457) 'Non-hierarchical Regional Production Networks' at Chemnitz University of Technology has pointed out perspectives for present-day small and medium sized enterprises and among them particularly micro firms to face ever-changing economic conditions. [11]

This article is intended to evaluate the applicability of the Competence-Cell-based approach for the configuration of service networks, especially for networks of SME.

2 STATE OF THE ART

2.1 Services and product service systems

Services are distinguished from physical products through the following properties:

- intangibility,
- simultaneous production and consumption
- non-storable and heterogeneous results.

Although there is not a broadly accepted definition for service, there is a variety of attempts for a comprehensive

definition for service [12]. In literature various approaches for finding a definition are described [12, 13]: definition by enumeration (e.g. in [14, 15]), negative definition [16] and definition by constitutive attributes [17].

Contemporary research in the field of service and PSS (the combination of physical products with services [18, 19]) is multi-faceted and covers the area from developing new services to their marketing as well as new business models and encompasses the whole life cycle. Especially product service systems are object of current research [20-22], which deals amongst other issues with the internal and network related demands, the organizational requirements to the providing company, its entrepreneurial strategy and the integrated development and delivery of product service systems.

Service Networks

The necessity of co-operation in networks in order to provide services, especially for SME, is the subject of various research projects. The definition of the participating partners and their respective roles and relationships are described in [23] and [24].

Operator or contracting models are co-operative arrangements between producers and users of capital goods and are a special form of a service or product service system. This co-operative arrangement between primarily two partners with its opportunities and risks has been already discussed by Harms & Famulla and Meier & Zuther [25, 26]. However, the notion of network building is covered insufficiently.

The necessary close collaboration between manufacturers and providers of services resp. product service systems and their customers leads to increased requirements concerning the structures of the service networks in comparison to the manufacturing networks [27]. New scientific contributions, such as the one of Zhang et al. [28], deal with the differences between classical engineering networks and service networks and the transition from one into the other.

A detailed configuration of service networks under consideration of the competences of the single partners is neither subject of any broader research activities in general, nor is the Competence-Cell-based approach in particular.

2.2 Networks and networking

The scientific approach of Competence Cells cooperating in non-hierarchical networks and its systematic robust implementation has been exclusively researched at Chemnitz University of Technology in the research projects "Non-hierarchical Regional Production Networks" (Collaborative Research Centre 457) [29] and "Competence-Cell-based Production Networks" (Project Cluster 196) [30].

The research on Competence-Cell-based production networks is rather unique. Usually, strategic, hierarchical corporate networks are the object of research. In the European scientific landscape, there has been an increasing concentration on "Virtual Organisations" (starting with [31]) and "Collaborative Business Networks" (e.g. [32]) for several years now. In most cases, similar basic assumptions are made compared to the vision of non-hierarchical networks, which confirms the approach. All of the research projects share the ambition to find new organizational forms. But the characteristics of the analysed Competence-Cell-based networking approach are not considered explicitly.

The vision of the Competence-Cell-based networking approach (Figure 1) is the following:

Elementary business units – called Competence Cells – are co-operating in Non-hierarchical Regional Production Networks in a customer-oriented manner and thus are capable of facing global competition.

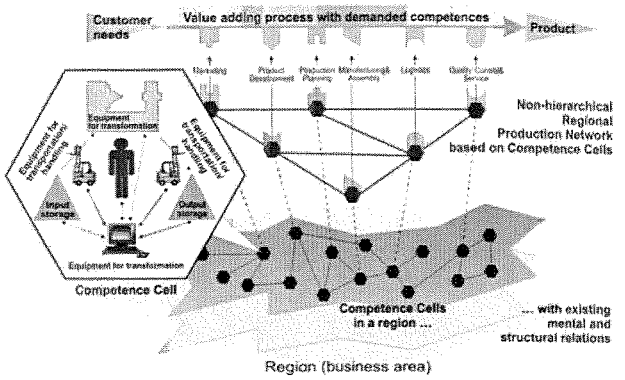

Figure 1: Conception of Non-hierarchical Regional Production Networks (see [11])

In order to substantiate the vision of Competence-Cell-based networking a model for the Competence Cell (Figure 2) and a procedure model for the networking (Figure 3) as well as an operationalized concept of organization (Figure 4) were developed.

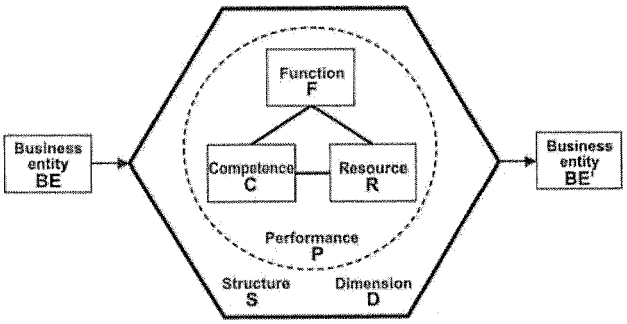

Figure 2: Conception of the Competence Cell (see [11])

A Competence Cell (see Figure 2) is considered as the smallest autonomous indivisible business unit of value adding, being able to exist independently. The model of the Competence Cell consists of

1 the human with his competencies, arranged according to professional, methodical, social and personnel competencies [33],
2 available resources as well as
3 the fulfilled task or executed function; with this function a business entity can be transformed and a certain yield can be achieved.

The aspects of dimension and structure were supplemented to obtain a complete technical description.

The procedure model (Figure 3) comprises three levels and seven phases. From loose infrastructural and mental relations present in a regional network (Level I) there initially emerges an institutionalized competence network, based on Competence Cells (Level II, phase Competence Network Composition). Institutionalization takes place via the co-ordination of behaviour (e.g. agreements on offer generation, agreements on cost allocation) and via the pooling of capacity (e.g. common servers and data bases). These facilitate an efficient acting towards the customer and avoid internal discrepancies. Institutionalization thereby creates the basis on which autonomous Competence Cells join to find to a collective creation of value. In order to hold fixed expenses down,

the institutionalization is to be limited to the necessary amount. The actual creation of value takes place in a production network (Level III, phase Production Network composition), i.e. a temporary linking of selected Competence Cells, initiated by a customer's request. In order to select and cross-link Competence Cells and to operate the network, co-ordinated ways of behaviour and pre-installed structures are available in the Competence Network.

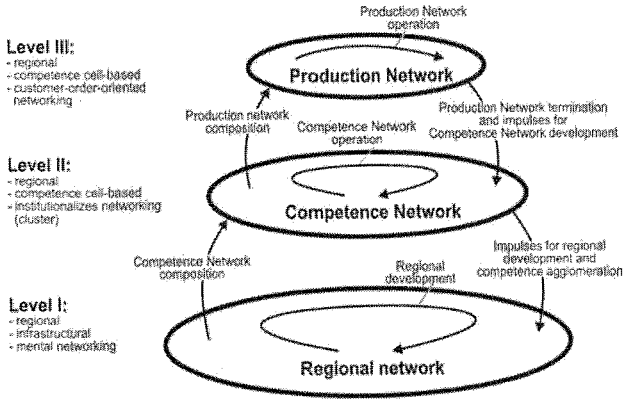

Figure 3: Procedure model of competence cell-based networking (see [11])

For running the innovative type of co-operation "Non-hierarchical Regional Production Networks" an operationalized concept of organization is needed. Such a concept was developed with the "holistic integration method" (HIM). HIM marks a comprehensive instruction as a kind of organizational manual for the Competence Cells. It is based on the levels and phases of the procedure model. The general architecture of HIM consists of the levels "Portal", "Process Engine" and "Methods&Tools", see figure 4.

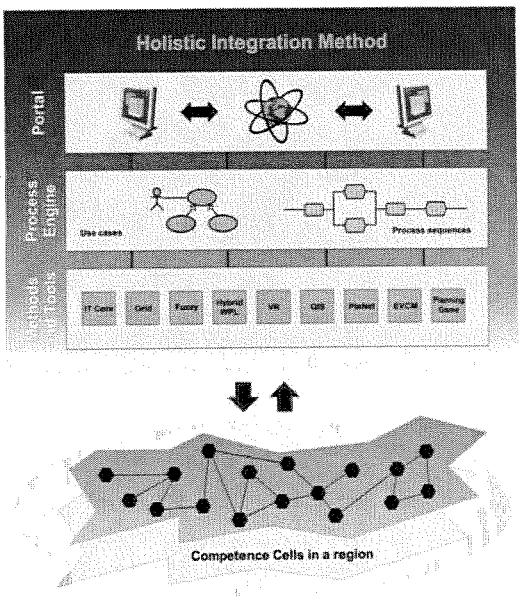

Figure 4: Holistic integration method (see [11])

The Competence Cells as users access the functions of HIM through a web-based portal. The portal is linked to the Process Engine. On the highest level of the Process Engine typical co-operative use cases respectively procedures inside the levels and phases of the procedure model are defined. On the lowest level the different methods are described in an application-driven form and, if applicable, linked to supporting software tools.

3 CONCEPT

3.1 Objectives

So far the Competence-Cell-based approach has mainly been studied for the field of production. For this purpose Competence Cells have prototypically been formed and their networking has been analysed.

The objective is now to enhance this approach and to test its transferability and adaptability on production-related services in networks. As a result, potentials of this approach for services in networks are to be identified and also prepared to become operative (see Figure 5).

The aimed enlargement of this field of research is not only of practical importance. Also an enormous gain of scientific insight concerning Competence-Cell-based networks can be assumed. The competitiveness of European small and medium sized enterprises, which maintain service networks due to their involvement in international business and in order to provide services, has to be strengthened regarding production and service. However, the configuration and management effort will be particularly high in these SME networks.

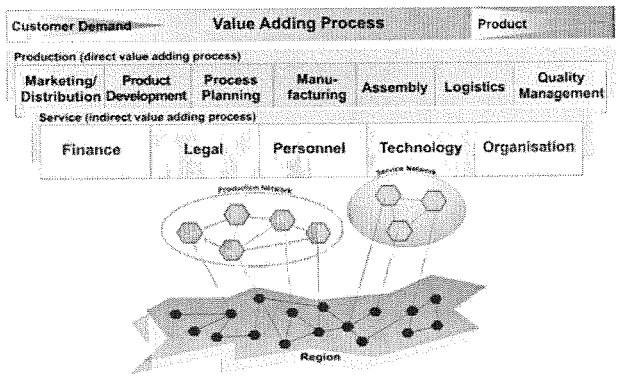

Figure 5: Production and service networks (e.g. [34])

The following assumption supports the objective of transferring the presented approach: The Competence-Cell-based approach is predestinated for an application in service networks (see definition of Competence Cells: autonomous, elementary business units acting in self-controlling, non-hierarchical networks). In contrast to manufacturing, services by tendency require a lower input of resources (immateriality), which facilitates the configuration of smallest business units. Compared to manufacturing, services rather demand high flexibility (customer as external factor, heterogeneity, non-storability – uno actu principle), which encourages the application of Competence-Cell-based networks.

In addition to testing the transferability and to assessing the potentials, there is the need to develop models, methods and tools on the basis of the Competence-Cell-based approach for a systematic generation and operation of customer value-driven service networks. For this purpose, appropriate basics have to be compiled in the first place.

Objectives of the Competence-Cell-based approach:

A first objective is to create the preconditions for the transferability and adaptability of production-related services in networks. The theoretical basics of both, Competence-Cell-based networking and services in networks have to be reviewed and adapted. Furthermore, the phenomenon has to be substantiated by identification of essential characteristics (including their specification) and their systematization in a descriptive framework. An assessment of characteristical forms of Competence-Cell-

based service networks can be achieved by an evaluation framework, which still has to be developed.

A second objective is to identify and to review empirical basics, again with respect to both Competence-Cell-based networks and services in networks. As a deduction from the empirical basis a research framework is defined, which will be the template for the following detailed explorative proceeding.

As a conjoint result of the two above mentioned objectives the evident area of research is defined. A basic set of conclusive case studies is available.

A third objective is now to integrate typical profiles of Competence-Cell-based service networks in a framework on the basis of a descriptive (morphologic characteristics) and an evaluation (potential and ratio system) framework.

Ideally, the results can be examined in explorative case studies by analyzing typical applications of this approach for services in networks.

All these efforts result in a rough framework which includes a requirement and design profile, questions, hypothesizes and working principles.

The implementation of a pilot solution represents another objective of the Competence-Cell-based approach. By means of scenarios within the pilot, frameworks regarding description, evaluation and configuration are to be substantiated and specified in detail. The hypothesis, that the Competence-Cell-based approach is particularly meeting requirements in the service sector must be verified or, respectively, falsified. A benefit analysis has to take into account on the one hand the descriptiveness as well as the assessment and configuration potential of Competence-Cell-based service networks and on the other hand the instantiated Competence Cells and their cross-linking for certain services and business processes.

As a result the descriptive, assessment and configuration frameworks are elaborated. Benefit cost analysis is then available for Competence Cells and network configurations are established for selected services and business processes. The operation of the phenomenon Competence-Cell-based service networks will be understood.

A further objective consists in evaluating the pilot solution and developing a generalization concept. The evaluation has to show how stable the transferability will be. Besides that, its limits need to be defined.

Finally potentials of application of the Competence-Cell-based approach on services in the network will be proven and further research issues will be derived.

3.2 Approach

Deduced from the mentioned objectives above, the proceeding, consisting of five work packages, is as follows:

Step 1: Development of theoretical basics in order to transfer the Competence-Cell-based networking approach to production-related services, aiming to make available existing approaches from both areas, i.e. Competence Cells and service/service networks.

The research domain "Competence Cells" provides concepts regarding description, evaluation and configuration for production (see Collaborative Research Centre 457 [29] and Project Cluster 196 [30]). These concepts are to be scrutinized and transferred to the service sector. Thus the concept as a general modeling paradigm and the Competence-Cell-based approach as a specific descriptive concept will have to be researched and, respectively, adjusted. Also strategies of decomposition and composition of Competence Cells and their cross-linking need verification and, respectively, modification.

The research domain "service" asks for a characteristic of services including appropriate characteristic values, which will have to be identified and classified (e.g. immateriality, customer integration, networkability of services). This will result in a descriptive and evaluation framework being refined and evaluated through continuous feedback discussions in the following work packages. The focus lies on production-related (industrial) services. However, the descriptive framework will have a design that allows comparison to other branches. Generalization of the outcomes is possible. Methodical components could be for example the morphological box or performance measurement systems.

Bringing these aspects together, general organizational concepts (amongst others specific production and logistics concepts, such as supplier parks) and networks (amongst others intra-organizational, worldwide F&E networks or, respectively, production networks, existing service networks) will be analyzed regarding their ability for developing and producing services. Consequently the reasonable object domain of research, e.g. branches and branch mix, will be defined.

Step 2: Definition of the evident area of research and deduction of the profile requirements within the relevant area of application. The descriptive and evaluation framework, worked out in Step 1, represents the basis and will at first be advanced and then be substantiated by means of empirical studies and surveys.

The objective of this work step is to limit the defined solution space of the evaluation framework to practice-relevant characteristics. Furthermore, controlling features regarding competence approach and services will be defined within the solution space. For this, relevant areas of application need to be identified within the basically evident area of research, such as branches (amongst others automotive industry including supplier and logistics industry, architecture, consultancy, small scale manufacturing, engineering services, maintenance; also branch mix) or spatial dimensions/cultures (regional networks) and inter-regional networks. Then, further topics have to be worked upon within the relevant areas of application, such as the statistical distribution of occurring sizes of enterprise, number and duration of established co-operation for the competence approach as well as the existing service portfolio, specificity of services or networkability in the service sector. In addition, general conditions (also with regard to the configuration), such as competitiveness, overall economic environment, flexibility or social aspects for the producing of services have to be identified and their specific characteristics have to be worked out.

A research on other selected services networks from different business sectors, not belonging to the industrial sector, will suit the development and deduction of analogies.

Finally, these field inquiries will lead to conclusions on how appropriate the areas of application, with regard to the Competence-Cell-based networking approach, are. Thus, the evident area of research is focused on. Through this, a basic set of relevant case studies can be provided. The empirically confirmed research framework will serve as model for following detailed research. Theoretical basics as well as the empirical research will help to define the profile requirements for explorative case studies.

Step 3: Specifying the concept by forming prominent profiles from the descriptive and evaluation framework via the morphologic box and then describing and abstracting these in a configuration framework. The profiles consist of

theoretically possible and, with regard to the data analysis, reasonable combinations of features, which can be mutually dependent or exclusive. The adjustment of the configuration framework to practice relevant types will result in a basic set of solutions, which can be evaluated by criteria defined in the evaluation framework. As a result a set of preferential solutions can be presented.

Transferring the results from the sector of industrial services to other business sectors and analyzing existing services in those business sectors will allow for comparability of outcomes and a further refinement of the defined descriptive and configuration framework.

From the above mentioned set of preferential solutions a pilot solution, which is available from industrial practice, will be chosen. This is achieved on the one side by considering the outcome of the evaluation framework and on the other side by appropriate qualitative evaluation methods, e.g. the provided database for a subsequent benchmark and an access to the providing service network. The choice of a pilot solution and its advantages will be backed up by interviews with experts from the network. In result, a pilot solution is selected in order to verify the adaptability and successful application of the Competence-Cell-based approach within the subsequent work packages.

Step 4: Conception and configuration of a pilot solution and application by means of the Competence-Cell-based approach on the basis of the preliminary work (Step 1-3). The pilot solution is a selected, especially qualified by explorative case studies, service network in a production-related area, which will primarily consist of SME. The analysis of the pilot solution will be carried out by means of scenarios.

Descriptive, evaluation and configuration frameworks are applied to the pilot solution and then substantiated and specified in detail. Intensive benefit cost analysis is done for the pilot in order to answer the following question: When does networking based on the Competence-Cell-based approach have a favorable effect and under which circumstances is this approach disadvantageous?

According to the Competence-Cell-based approach the proceeding is structured as follows:

1. Data acquisition, processing and description

Firstly, the database for the pilot solution has to be provided. For this, a comprehensive data acquisition has to be exercised in an existing network, which has been chosen as demonstrator network. This data must be compressed and transferred into the appropriate description format. Alternatively, the demonstrator network can be created synthetically. Descriptions of relevant services, business processes, enterprises (range of products and services, technology, competence and resources) represent important data categories.

2. Decomposition

Within the decomposition the described benefits, technologies, competencies and resources are being separated into their elementary parts, i.e. basic benefits, basic functions, components of competencies and minimum resources (see Figure 6).

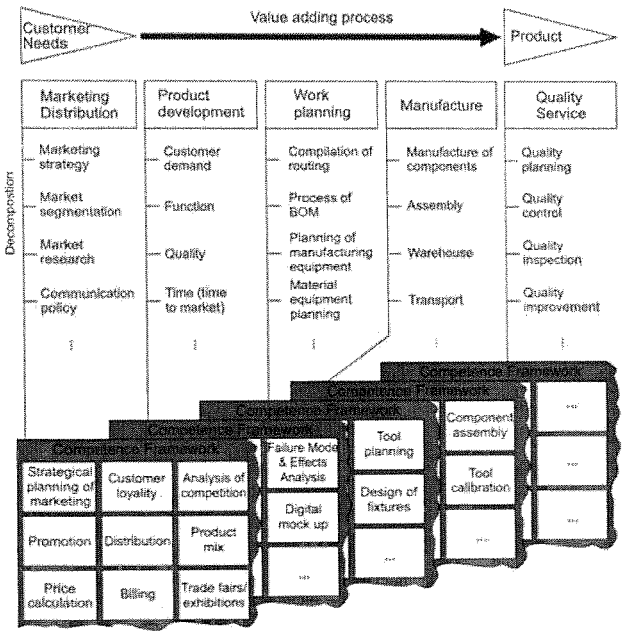

Figure 6: Decomposition of business processes into Competence Components (e.g. [34])

3. Composition

In the end the fundamental components form adequate Competence Cells as organizational units (see (Figure 7).

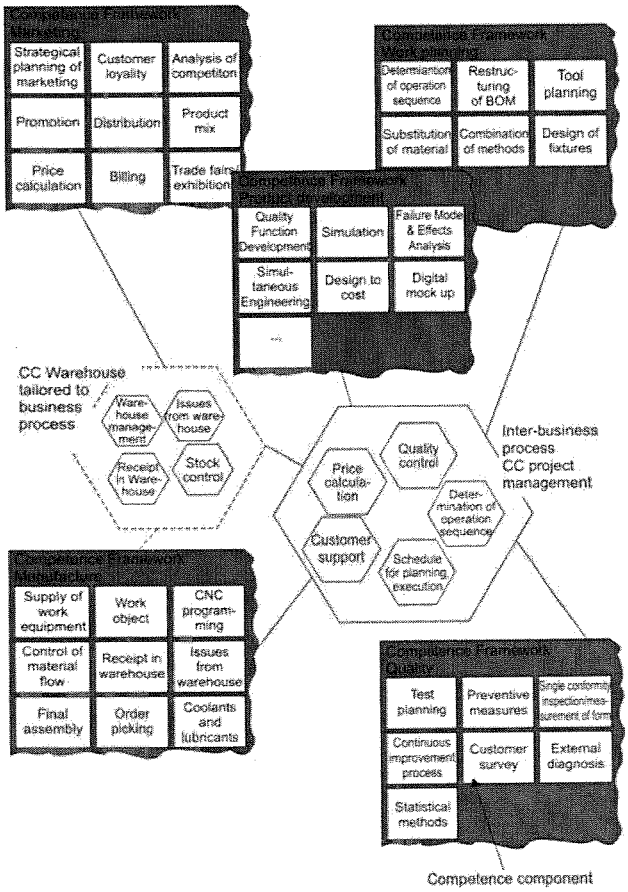

Figure 7: Composition of Competence Components to Competence cells (e.g. [34])

On the basis of precast (real/virtual) service portfolios and process chains and the created Competence Cells, scenarios of networking can be developed. These scenarios can then be researched on laboratory scale.

Step 5: Evaluation of the pilot solution in the form of an analysis of potentials by means of the pilot-based proven criteria of evaluation and evaluation of the adaptability of the methodology. In addition to the analysis of potentials, a benefit analysis is conducted. Hypotheses will then be verified or falsified and identified mechanisms will be explained. Potential, utility value and SWOT analysis are methods applied in this step. That broad analysis allows highlighting the limits of the application of the approach. Consequently, knowing the limits allows sound conclusions on the transferability of the Competence-Cell-based approach to the defined areas of application in service networks.

The research of an innovative, but for this research project atypical, services network from a non-production-related field is the basis for further conclusions about the adaptability and the possibility of generalization of the Competence-Cell-based approach in the field of service networks.

Finally, the further need for research will be documented in a research roadmap. Amongst others, it will contain areas of research that remain interesting for further research, such as certain branches. The further need for research will also address rising scientific issues and objectives as well as requirements on necessary models (e.g. descriptive, process and explanatory models), methods (educational and management methods) and tools (e.g. co-operation platform).

4 CONCLUSION AND OUTLOOK

The Competence-Cell-based approach for co-operation in non-hierarchical networks appears to be a very promising approach when it comes to innovation in service networks, especially for networks of SME. Therefore, the applicability of this for service networks has to be evaluated. The evaluation is based on both the advancement of the theoretical basis on Competence-Cell-based networks and service networks, as well as empirical studies on existing service network.

The objectives of the evaluation and the work program are presented and first hypotheses are discussed. However, the presented work program should assist in the transition to make the presented concepts applicable for pilot implementations.

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