DEVELOPMENT AND EMPIRICAL EVALUATION OF A COMPREHENSIVE SERVICE PRODUCTIVITY MODEL FOR KNOWLEDGE INTENSIVE SERVICES

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Abstract

Purpose

Knowledge intensive services play a crucial role in developing and developed countries. In order to raise service profitability, increasing service productivity as well as identifying influencing factors of service productivity is prerequisite. This paper aims to bridge the gap between traditional, manufacturing oriented productivity and service productivity by presenting a comprehensive knowledge intensive service productivity model and by identifying relevant influencing factors on service success.

Design/Methodology/Approach

The paper presents the evaluation of a novel service productivity model. The comprehensive model proposed by the authors considers the service system from two relevant points of views: 1) from the customer's perspective and 2) from the provider's perspective over all three dimensions of service provision (the potential, the process and the outcome). Service dimension specific value drivers and success criteria were defined and specified by influencing factors resulting from two explorative studies investigating engineering companies in Germany.

Furthermore, a broad empirical study was carried out and analyzed by second generation multivariate data analysis methods. The partial least square (PLS) path modeling technique was used in order to statistically analyze the results. Therefore, a measurement model with exogenous and endogenous variables based on the identified influencing factors as well as the structural model of the hypothesized relationships between value drivers and service success was modeled and evaluated. The measurement and the structural model were analyzed by using the smartpls analysis software tool.

Findings

The reflective measurement of service success was found to be highly reliable and valid. Some other formative measured constructs were nonsignificant. The majority of the hypothesized relationships proved to be significant. The phase specific efficiency and

effectiveness latent constructs explained more than 50% of the variance of service success.

Research limitations/implications

Due to the complexity of the productivity model merely a partial validation was possible. The research focuses on the service provider's perspective.

Practical implications

Relevant leverage factors and relationships were empirically identified and proved to be significant. Based on a valid and comprehensive productivity model, knowledge intensive service providers are able to assess and improve their services.

Originality/value

The paper presents a novel comprehensive service productivity model which identifies relevant influencing factors and also proves the relationships between different constructs statistically.

Keywords: Service productivity model, service effectiveness and efficiency, partial least square structural equation modeling.

Paper type

Research paper

1. Introduction

Especially knowledge intensive (engineering) service (KIS) providers have to analyze, evaluate and adapt their business continuously in order to achieve sustained competitive advantage in an increasingly changing business environment. For fostering economic performance of a company, increasing productivity on an operational level is a major challenge. After a thorough literature review and field study it became apparent that productivity measuring and improvement in the service field is quite a challenge.

In contrast to productivity management in manufacturing, service productivity is a fuzzy concept. Among others, this is due to the heterogeneity of input as well as output factors. Furthermore, the customer involvement in the service process is also a major influencing factor of service productivity, which is not part of the manufacturing environment. Thus, a comprehensive service productivity definition is needed. Therefore, the following elementary questions need to be answered:

What to measure?

Where to measure?

How to measure?

First, a definition of knowledge intensive services is given. The generic productivity and service specific productivity concept is also discussed. Based on the findings from literature and explorative interviews with service managers and employees of two major companies from the chemical process engineering and electrical sector in Germany, a comprehensive service productivity model is presented.

Second, for validating the proposed service productivity model a quantitative study in the field of knowledge intensive services is executed. The study is designed as an online survey. The constructs of the productivity model were developed and measured by using items assessing the identified influencing factors. For validating the model structural equation modelling (SEM) technique was employed. The two step approach first evaluates the measurement model by assessing reliability and validity of the items. Second, the structural model representing the hypothesized relationships is analyzed by evaluating the relevance and overall predictability of the model.

Third, the results are interpreted and discussed. Limitations that arise due to the study design and further research possibilities conclude the paper.

2. Literature Review

For the purpose of the current research defining the subject of the analysis for the assessment of service productivity is necessary.

2.1. *Knowledge Intensive (Business) Services*

Services can be viewed from many different perspectives. Thus, no generally accepted definition exists. This paper focuses on service productivity on an operational level, the value production and exchange on the "shop floor".

For this purpose the traditional service definition based on the research of Donabedian (1980) and Hilke (1989) is considered. Donabedian (1980) uses a phase based approach to assess quality of medical care. Hilke (1989) enhances the phase based division of service provision in order to comprehensively define services from three different perspectives:

1. The *service potential phase* as the provider's ability and willingness to provide a specific service. It encompasses the resources as well as the organizational structure of the service system.

2. The *service process phase* as the sum of activities of service provision.

3. The *service outcome phase* as the procedural end point of service provision comprising the service output as well as long term impact.

Services are marketable goods based on the provider's ability to combine internal and external factors (of the customer) in order to achieve value for the customer (and the service provider).

In order to further differentiate between goods and services, researchers defined four specific characteristics of services: *intangibility, heterogeneity, inseparability and perishability* (Fitzsimmons & Fitzsimmons, 2011; Haischer, Bullinger, & Fähnrich, 2007; Sasser, Olsen, & Wyckoff, 1978).

Intangibility is considered to be the predominant service specific characteristic as it describes either the immaterial nature of the service factors (input as well as output) in contrast to traditional physical goods or the difficulty of evaluation during the proposal phase caused by uncertainty of the service delivery and outcome (Haischer et al., 2007; Lovelock & Gummesson, 2004; Möller, 2008; Shostack, 1977). Heterogeneity is seen as an effect of customer specific service rendering. Even standardized services may differ in many aspects because of customer expectations and involvement. Inseparability or simultaneity in service provision and consumption is determined by the tied costumer/provider interaction. In contrast to the closed system of manufacturing goods, service rendering is an open system where the service is co-created and consumed simultaneously. Perishability can be regarded from two points of view: the input and the

output. According to the output, researchers argue about the exclusive service specific characteristic of perishability, since physical objects may also decay. From the input's point of view, there is strong evidence of service perishability focusing service capacity. Thus, service potential cannot be stored because it is usually dependent on time and space.

Although researchers argue that these fundamental characteristics apply only in special cases, specific service reference elements exhibiting these characteristics are considered to exist (Lovelock & Gummesson, 2004; Möller, 2008). Furthermore, Lovelock and Gummesson (2004) state that IHIP characteristics do apply to some degree to specific service categories (see also Lovelock (1983)). Thus, focusing on specific service subfields like information processing or high-contact and low-contact with the customer seems a viable approach for analyzing and defining service productivity.

Therefore, the process matrix proposed by Schmenner (1995) and validated by a field study in Germany by Fähnrich et al. (1999) in an adapted form is considered.

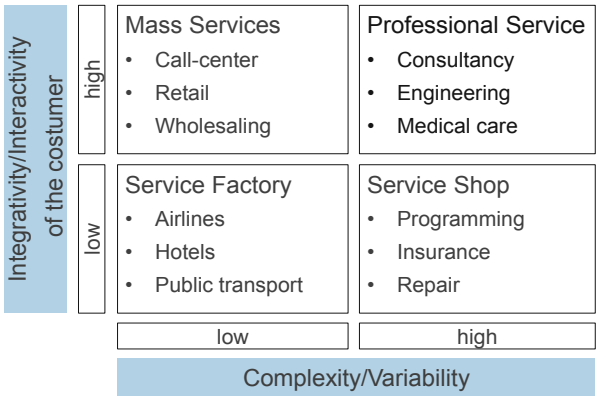

Fig. 1. Service Typology Matrix adapted from Schmenner (1995) and Fähnrich et al. (1999).

Services are classified in a two-by-two matrix by the dimensions *degree of customer integration* and *complexity by means of variability* of the service provision. According to this classification depicted in Figure 1, services with low complexity and integrativity are rather standardized, e.g. transportation or leisure services. On the contrary, there are professional services like consultancy and engineering services.

Following this differentiation and considering the statistical classification of economic activities in the European Community (Eurostat, 2009, 2013), knowledge intensive services are assigned to the cluster of professional services thus showing a high degree of customer integrativity and complexity. Comparable services are mostly customer driven and highly innovative. The service system elements build a dynamic network with an emergent character.

For further analysis it is prerequisite to consider the impact of complexity of knowledge intensive services as well as the high degree of customer integrativity in all stages of service provision. Thus, the influence of the costumer, the resource allocation efficiency and effectiveness as well as the variability of the service offering should be regarded as important.

2.2. *Service Productivity*

"*The single greatest challenge facing managers in the developed countries of the world is to raise the productivity of knowledge and service workers."* (Drucker, 1991).

The traditional, goods based definition of productivity dates back to the early stages of industrialization. Productivity is defined as the ratio of the performance achieved by a specific effort (output/input). It measures the yield of the operational factor combination (Corsten & Gössinger, 2007; Gutenberg, 1958). Productivity considers only the volumes of input and output from the technical point of view, whereas the economic view defines productivity by the profitability (revenue/cost of production) of the firm (Corsten & Gössinger, 2007; Gutenberg, 1958; Ojasalo, 1999).

According to Drucker (1974) the optimization of the working system has to consider cost reduction by means of efficiency as well as the revenue opportunities by focusing on effectiveness. He poses that doing the right things (effectiveness) is the foundation of success, thus more important than doing things right (efficiency). Furthermore, knowledge workers productivity is not a matter of the quantity of output, quality is at least as important (Drucker, 1999).

Following the characteristics of goods manufacturing systems, the traditional productivity definition does not comprehensively consider heterogeneous factors as well as the costumer's influence. Because of the closed system of manufacturing, the quality of resources as well as of the process does not influence the customer perception and thus profitability. Furthermore, due to separate and sequential stages of production and sales as well as consumption, the production process and the products are easier to assess, control and steer. Thus, many researchers proposed alternative concepts for service specific productivity assessment and design.

In contrast to productivity, the linkage between service quality and profitability received more attention in the early stages of service science. Grönroos (1984) developed a service quality model centered upon an evaluation process of the service by the customer. Furthermore, he distinguishes between a technical and functional quality dimension with impact on the perceived service quality. Following this, Parasuraman, Zeithaml, and Berry (1985) further enhanced the conceptual model of service quality based on an extensive exploratory investigation. They found a set of "gaps" between service provider and costumer forming a chain around the major discrepancy between expected and perceived (delivered by the provider) service by the customer. In his later work, Parasuraman (2002) broadens his view by integrating service quality and productivity in

a framework of service provider and customer interaction enabling to leverage the potential synergy between service quality and productivity without defining productivity in detail. A similar approach is proposed by Gummesson (1998). According to Gummesson, the customer plays an important role and is influenced by quality and influences productivity and profitability of the company. Nevertheless, the traditional productivity definition as a ratio of output to input is still utilized.

In context of services, the technocratic (production) oriented definition of productivity goes back to Levitt (1972) and Jones (1988). Levitt proposed to use management methods from manufacturing to improve service productivity by standardization and automation. In contrast to him, Jones defined a three stage model of service operations where the traditional productivity is managed only in the "back office". Capacity and quality management are discussed and considered to be much more important in the stages of service rendering and with respect to the impact of the service outcome on long term productivity.

Corsten (1994) proposed a similar technocratic approach. He used a phase based differentiation alike Jones (1988) to define two partial productivities quantitatively: the productivity of the pre-combination and the productivity of the end-combination. In the pre-combination phase the provider prepared solely an intermediate output as service (capacity) proposal. Based on the intermediate output as well as the customer's contribution and/or his production factors take part of the service provision process in the end-combination phase. He also defined the usage grade of the service capacity as the ratio between utilized and available capacity as part of the productivity measure of the pre-combination.

A more holistic view was taken by Johnston and Jones (2004) and Gronroos and Ojasalo (2004). Johnston and Jones (2004) considered productivity from two mutual complementing perspectives: operational and customer productivity. Nevertheless, the traditional definition of productivity is still used. In addition, the relationship between operational and customer productivity was examined in detail by counterintuitive examples. Furthermore, service quality was considered as a part of the productivity concept. Managing the customer is regarded to be a key lever for managing service productivity.

According to Gronroos and Ojasalo (2004), service productivity is a function of internal efficiency, external efficiency and capacity efficiency. In this respect, service productivity is considered to be a measure of how effectively input resources are transformed to output by the service process, how well the quality of the service process and the outcome is perceived by the customer and even how well the capacity is utilized. Furthermore, some hints for development of a measurement model are given.

Summarizing these findings, an evolution from a solely quality or productivity centered service management to a symbiosis of both is given. Two main directions of perception can be identified, the qualitative and the quantitative perspective. The interrelation between the points of view is obvious, but hard to concretize in a comprehensive manner.

The conceptual models on quality are more customer-centered, whilst productivity models are more provider-oriented. The latest conceptual proposals try to bridge the gap by presenting descriptive models that link productivity and quality without a quantitative validation of the hypothesized interrelations. Nevertheless, in order to specify a method to raise productivity research is needed for identifying relevant relationships between quality, productivity and profitability as well as influencing factors on the specified construct. Therefore, a comprehensive productivity model for services is proposed next.

3. A Comprehensive Service Productivity Modell

Findings from the literature and qualitative interviews with experts from the chemical and electrical industry (Petz, Duckwitz, & Schmalz, 2012) lay the foundation of the novel service productivity model.

Service Productivity of KIS is defined as the efficiency and effectiveness of the service provider and customer in all three phases of service provision from a quantitative as well as qualitative point of view. The core of the conceptual model consists of the value chain of service provision defined by value drivers and the partial productivity measures operationalized by success criteria depicted in Figure 2. This distinction is made for defining the object and place of measurement. Thus, value drivers are abstract constructs describing the service lifecycle across all three phases of service provision. They have direct impact on service productivity, but represent a cluster of success factors like competence of employee, organization, etc. Success criteria define what and how to measure service productivity. They are operationalized by key figures not represented in Figure 2.

Following Drucker (1999) and Vuorinen, Jarvinen, and Lehtinen (1998) the main objective of management is to assure that the job is being done well, namely doing the right things in the right way. Therefore, the main objective of a comprehensive service productivity model should be the assessment of efficiency and effectiveness. Hereby, efficiency is defined as the traditional output/input relationship considering also the direction of improvement: doing the same or more with less or with the same input. Thus, efficiency is a time span dependent success criterion. It is measured between directly related value drivers along the sequential stages of service rendering (e.g. between provider input and willingness to perform).

The second and at least as important criterion is effectiveness, defined as the discrepancy between a specific goal and the achieved result. It evaluates the ability to attain a purpose (Vuorinen et al., 1998). Success criteria related to the effectiveness are positioned between unconnected value drivers in the conceptual model representing a single point of time oriented measures (e.g. between quantitatively agreed service and provided service).

In the *potential phase* the service provider as well as the customer is considered. In this initial phase both are willing to introduce material or immaterial belongings (factors) or physical or mental involvement in order to render the service more or less jointly. The

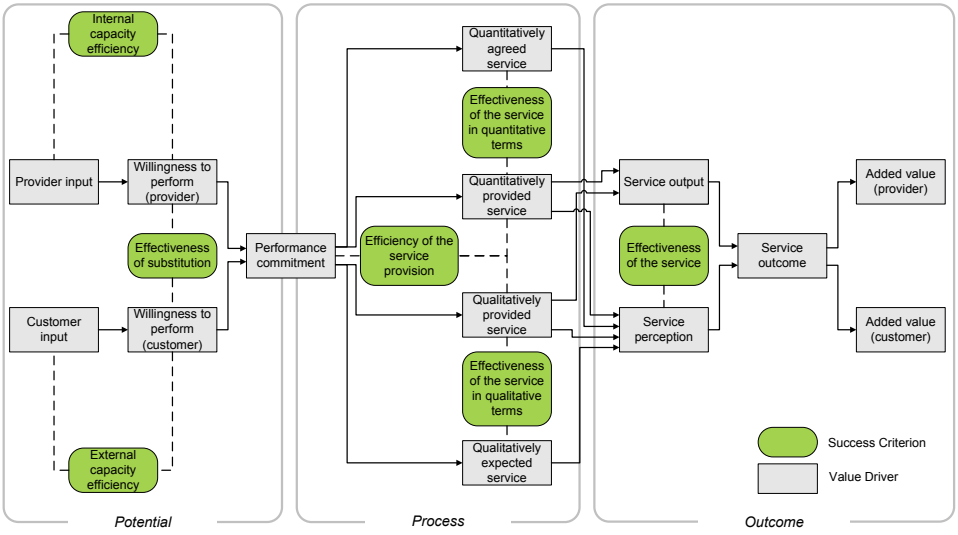

Fig. 2. Knowledge Intensive Service Productivity Model.

degree to which input factors are transformed to intermediate willingness to perform a service (e.g. availability, competence) is assessed by the internal/external capacity efficiency. Furthermore, the effectiveness of the substitution evaluates the conformance of the proposal to the requirements of the customer as well as the division of work between customer and service provider.

In the *process phase*, the service provision is evaluated from a quantitative as well as a qualitative perspective. The quantitative assessment addresses objective, technical and direct measurable factors like meeting deadline and budget. In contrast, the qualitative assessment addresses subjective, functional and indirect measures like responsiveness and motivation. These success factors are regarded to belong to the single point of time evaluation by the effectiveness of the service process. Efficiency of the service process is evaluated in terms of the overall service provision efficacy based on the planned target from a possible service level agreement (e.g. cost, duration and communication effort).

The *outcome phase* encompasses the service output and long term outcome and evaluates the overall service success in terms of the effectiveness of the service. The overall service perception is confronted with the quantitative and qualitative service outcome considering the synergistic effect of the substitution of quantitative by qualitative perceptions of the service outcome. For example, the service is fulfilled as agreed by meeting the deadline, but the collaboration with the service provider is unsatisfactory from the customer perspective. The combination determines an overall mediocre service performance. Furthermore, the service outcome can be divided in an added value for the

customer as well as for the service provider, perpetuating (reinforcing or balancing) service success or failure.

4. Research Method

4.1. *Study design*

For the statistical analysis of the service productivity model the structural equation modeling method (SEM) is used. The data for testing the hypothesized relationships were gathered by an online questionnaire survey from participants working in the knowledge intensive service industry in Germany. In order to analyze the findings, the variance based method of partial least square (PLS) is preferred over the covariance based method of structural equation modeling (CBSEM). This is due to the explorative character of the research, mainly predicting the success factors on service productivity. Furthermore, the hypotheses presented next are not yet considered to be general applicable and due to the limitation of the study, rather explorative than confirmatory (Hair, Hult, Ringle, & Sarstedt, 2013; Vinzi, Chin, Henseler, & Wang, 2010). The data is analyzed using the smartPLS 3 software application (Ringle, Wende, & Becker, 2014).

The structural equation modeling approach is also used because of the necessity to consider latent, not directly measurable variables in the model. The value drivers in the model are such specific constructs. First, the relationships between the latent variables will be defined in a structural model based on the developed service productivity model. Second, a measurement model based on the findings from the exploratory in depth interviews and the literature is proposed. Third, the validity and reliability of the measurement model is assessed. Fourth, the magnitude and significance of the structural model and its predictive relevance is assessed.

4.2. *Questionnaire survey – Measurement model specification*

The online questionnaire was structured in three parts. First, the respondents had to answer some questions about their affiliation and position within the company for classification purpose. Second, the respondents had to evaluate the potential of the company. Finally, for the main part of the questionnaire, the participants were divided equally and in a random order in two groups. In accordance with the allocation to a group, they had to think about the last successful or unsuccessful individual project while rating. For the responses a 6 point Likert-scale was used. The participants could choose between “I fully agree” (1) and “I completely disagree” (6) and “no response” (multiple responses were not allowed). The main part of the survey was structured according to the phase oriented differentiation in potential, process and outcome.

The explorative study in the electrical and chemical engineering sector was the starting point for the development of the items (Petz et al., 2012). Besides, offering some insights in defining service productivity, specific influencing factors were identified. The

influencing factors were clustered to five categories: 1.) work organization, 2.) competencies of the customer and service provider, 3.) motivation and trust, 4.) tools and procedures, 5.) communication and cooperation. These categories are considered to be relevant for knowledge intensive service productivity management. Thus, the latent variables are formed by one or more of these categories according to a phase based assignment and fit. Furthermore, all except one variable were measured by formative constructs; only the service success was defined with reflective items.

The *potential phase* considers the input of the service provider and customer as well as their willingness to perform as value drivers. The service provider input consists of the competency of employees (9 items), work organization (4 items) and tools and procedures (3 items). The participants were asked to evaluate the manifestation of these influence factors in their companies. For example, in order to evaluate the work organization, one item was specified as: "In general, in my company the instruction and decision-making authorities are clearly defined". The input of the customer was evaluated accordingly, but only by the (from the provider's point of view) visible competencies, tools and procedures (3 items). Likewise, the willingness to perform of the customer was measured by the same influencing factors. In order to define the willingness to perform of the service provider, 11 items were formulated. The respondents had to evaluate the readiness of the company in assuring a proper level of needed resource (type and extent) to fulfill the given service. The proper level of the competencies of the employees, the work organization with focus on planning as well as the tools and procedures were evaluated.

The success of the allocation of the proper input as well as methods and tools for a given service were assessed by the internal capacity efficiency. The participants were asked to evaluate the performance of the service systems with regard to the ability to optimally plan the given service. It considers especially a realistic estimation of schedule and costs as well as resource allocation, before providing the service. Furthermore, the effectiveness of substitution is regarded to arbitrate the effort and fit of provider's offering and customer's demand. Thus, three items were formulated to assess the optimality of work division and offering.

The productivity in the *process phase* assesses effectiveness from a quantitative and a qualitative perspective as well as overall efficiency. Therefore, a differentiation between agreed, provided and expected service is considered.

From the quantitative point of view, directly measurable factors from three relevant categories were considered. For evaluating the quantitative agreed and provided service factors which belong to the work organization, tools/procedures and communication /cooperation were asked to be assessed by the respondents. For example, the participants had to respond to the following statement for the agreed service: "Before service provision we agreed [with the customer] to use specific software and hardware" (12 items). Likewise, for the provided service the respondents had to give a statement "During the provision of the service we used the specified software and hardware" (11 items).

In contrast, from the qualitative point of view, competencies, communication and cooperation as well as motivation and trust are considered to have a significant influence on service effectiveness and efficiency. Thus, the qualitatively expected service was captured by 21 items. The respondents answered statements like: "From service provision I expect activities to be transparent and understandable for the customer". Likewise, 22 items were adapted to measure the qualitatively provided service: "Activities were transparent and understandable during service provision." For logical reasons not all questions have been adapted to reflect agreed, provided and expected service, but were included in the model for reasons of integrity.

The service productivity measures of the quantitative and qualitative effectiveness were also measured by statements evaluating the degree of meeting agreed or expected objectives (10 items). The efficiency of the service provision conceived as the optimality of the service operations with regard to the usage of resources, tools, methods etc. contained statements for evaluation of costs, duration as well as communication and cooperation effort (6 items).

The overall service success represents the objective and outcome of the service provision. It is assessed by the only reflective measure in the model following findings from Lechler (1997) in the field of project management. The four items evaluate the service success from different perspectives: the customer, the service provider as well as the employee. Besides, the service outcome is compared to an ideal service by using the statement "From my point of view and compared to an optimal service, the service was a real success".

4.3. *Hypotheses – Structural model specification*

Because of the complexity of the proposed productivity model and the exploratory character of the study, a dyadic survey was not considered to be feasible. Thus, the relationships from the productivity model are specified focusing on the service provider's point of view. The relationships are presented in Figure 3.

In the *potential phase* willingness, ability as well as commitment to perform a certain service is confirmed by an agreement between service provider and customer. Both dispose upon material and immaterial resources as input factors and have the possibility to hold physical objects or oneself available for a given service. Thus, a positive relationship between provider/customer input and willingness to perform is hypothesized ($H_{1,2}$).

The internal capacity efficiency evaluates the optimality of resource configuration and utilization in order to enable a specific service provision from the service provider point of view. It's a companywide measure evaluating the capabilities of the firm. Thus, a positive relationship between the input (quality of resources, competence of the employee

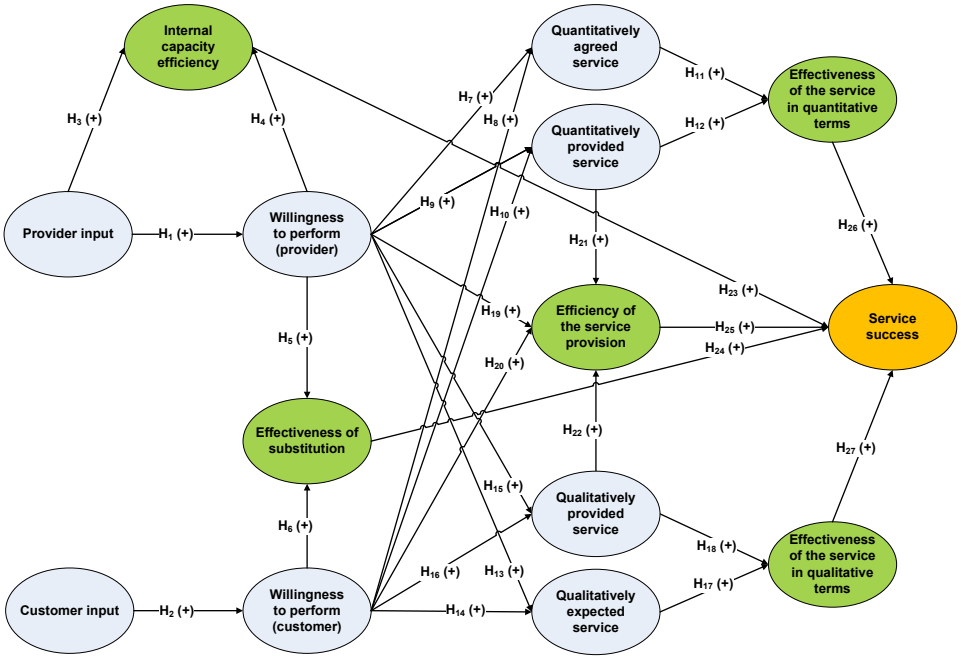

Fig. 3. Hypothesized relationship in the structural equation model of knowledge intensive service productivity.

etc.) and the capacity efficiency is hypothesized (H_3). Furthermore, there is also a positive relationship between the possibility and willingness to perform and internal capacity efficiency (H_4).

The effectiveness of substitution assesses the degree and the benefit to which activities of the service provider are substituted with activities of the customer. Furthermore, it evaluates also the degree to which customer requirements or necessities are met (value proposition). The effectiveness of substitution increases only if both – the value for customer and service provider - increases. Thus, the willingness to perform of service provider and customer has a positive impact on the effectiveness of the substitution ($H_{5,6}$).

In the *process phase* the service is rendered by the service provider and customer. The model distinguishes between quantitative and qualitative perspectives. The quantitative perspective focuses on directly measurable, technical factors of influence. A positive

influence is posed to exist between the service provider's/customer's willingness to perform and the quantitatively agreed ($H_{7,8}$) and provided ($H_{9,10}$) service. The effectiveness of the service in quantitative terms evaluates the degree to which the service process goals are achieved by the service provider. For example, suppose there is an agreement about using specific tools to provide the service or specific tools are used (without agreement), the effectiveness in meeting the objective will most likely be positive. Thus, the quantitatively agreed and provided service is hypothesized to have a positive effect on service effectiveness from the quantitative point of view ($H_{11,12}$).

The subjective, qualitative point of view considers only indirect measurable and valuable factors of influence (e.g. motivation, trust). Likewise, a positive influence is hypothesized between the service provider's/customer's willingness to perform and the qualitatively expected ($H_{13,14}$) and provided ($H_{15,16}$) service. The service effectiveness in qualitative terms evaluates the functional degree of reliability and conformance with implicit and explicit customer requirements. It is assumed that high expectations of the customer will most likely raise effectiveness of the service provision as well as internal and external cooperation (quality). Thus, a positive influence is posed to exist between the qualitatively expected/provided service and the effectiveness of the service in qualitative terms ($H_{17,18}$).

The efficiency of service provision is also considered to have a significant influence on service success. It evaluates the efficacy of the service provision process with regard to the nature and extent of the used resources (as agreed). There is no distinction between quantitative and qualitative dimensions since it is a more internal, service provider oriented measure. The efficiency of the service provision is posed to be positively influenced by the willingness of the parties ($H_{19,20}$) and of the quantitative and qualitative service output ($H_{21,22}$).

In the outcome phase the overall service success for service provider and customer is considered. The effectiveness of the service evaluates the overall service success as the discrepancy between the overall service perception and the objective service output. Thus, all the success criteria are posed to have a positive influence upon the overall service success forming the service productivity concept. The internal capacity efficiency, the effectiveness of the substitution, the efficiency of the service provision, the quantitative and qualitative effectiveness are hypothesized to have a positive impact on the overall service success ($H_{23,24,25,26,27}$).

4.4. *Sample data*

In total, 1233 persons participated in the cross-sectional online study. The participants were acquired from an online panel of a specific group of people who attend surveys repeatedly. Furthermore, they all were working in project oriented organizations, since this was the first disqualifying question. Further disqualifying criteria were used to eliminate unrepresentative data during the analysis. First, 648 persons who dropped the survey to any time were excluded. This high drop-out of 52.6% is quite typical for online

surveys (Birnbaum, 2004), because the participants visit the first page and reverse their decision to take part in the survey.

Another important aspect is the time to complete the survey which serves as a control variable. This variable indicates whether the questionnaire was answered seriously (Thielsch & Weltzin, 2012). The average time to answer all needed items was 14.48 minutes (SD=12.04). Persons who completed the survey under five minutes (<2,3 seconds per item) were sorted out due to the fact that a meaningful answer does not seem to be feasible in that time. For that reason, 70 participants were eliminated. Moreover, 19 persons were sorted out as well, because they took over 45 minutes to respond the survey (three times the amount of the average time). Such a long time to complete the survey supposes that the participant interrupted the survey and consequently did not answer in accordance to the formulated assignment.

Afterwards, participants were excluded from the analysis who answered the questionnaire mainly with the same characteristic. This indicates a conspicuous unreflecting answer pattern. In order to identify these patterns, a filtering variable was selected which included positive as well as negative poled items. Answering these items in the same way is regarded to be antithetic and senseless. The identified cases showed this pattern among different scales; these participants were also excluded from further analysis.

The remaining data set to this time comprised 425 participants. With aid of the procedure "Anomaly detection" of SPSS (v. 21) unusual cases were detected by using an algorithm based upon deviations from similar cases. Thereby, 17 persons were excluded from the analysis. The remaining persons were classified according to NACE Rev.2 into knowledge intensive services. 33 Participants could not be assigned to a knowledge intensive category, thus they were also excluded from further analysis. In the final analysis the data set contained 375 valid data sets.

The remaining 375 participants were matched to an industrial sector according to NACE Rev.2. As you can see in Figure 4, more than 40% were assigned to the knowledge-intensive market service which comprises architectural and engineering offices, business consultants, academic or technical freelancer etc. One third of the participants belonged to the high- tech knowledge-intensive service which includes especially research and development or IT-services. 19% of the participants were assigned to other knowledge-intensive services, e.g. publishing or healthcare. Merely six percent were assigned to financial and insurance services like reinsurances or pension funds.

53.1% of the remaining 375 participants answered the survey on the basis of their experiences in a successful project, while 46.9 % of the participants considered an unsuccessful project. Male participants were in the majority (63.7 %). More than half of

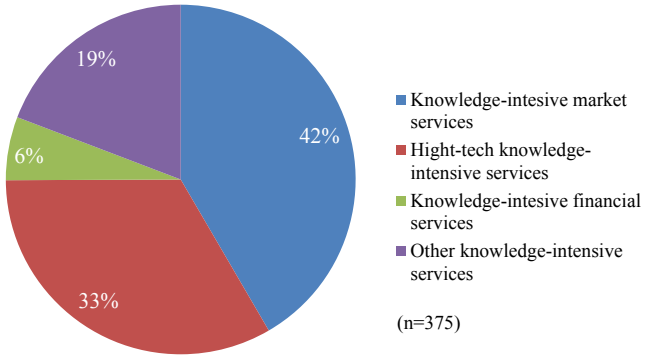

Fig. 4. Classification of the survey participants in % according to NACE Rev.2.

the participants were older than 40 years (57.1 %). Almost a quarter of the attenders worked in the top management or as managing director as well as an employee in a technical domain (multiple responses allowed). Other positions were e. g. project or department manager (15.7 %) as well as employees in the commercial sector (12.0 %). About one quarter of the participants worked in an organization up to 10 employees, while more than a half (56.5 %) served in a business up to 1000 employees. Over 70 % of the participants stated that the service share in their organization amounts over 50%.

5. Reflective and Formative Measurement Model Evaluation

For a systematic evaluation empirical measures of the relationships between the proposed indicators and constructs as well as between the constructs are presented. The measurement model is evaluated by means of reliability and validity.

First, the single reflective measured variable service success is evaluated. Therefore, the composite reliability to evaluate internal consistency, individual indicator reliability, convergent validity by the average variance extracted as well as the predictive relevance is considered (Hair et al., 2013). Discriminant validity has not been assessed due to the fact that the latent variable service success is the only reflective operationalized construct in the model, so a comparison to other variables is not possible.

Usually, internal consistency reliability is measured by Cronbach's alpha. Due to using PLS-SEM, the assumption that holds for the usage of Cronbach's alpha (equal outer loadings of the indicators) is not applicable. Thus, a more appropriate measure is used:

the composite reliability (ρ_c). The composite reliability can vary between zero and one, a high value indicates a high reliability. An acceptable level of .6 to .7 in exploratory research is regarded to be satisfactory (Hair et al., 2013). The composite reliability of service success is .951, well above the required .7. This states a strong internal consistency (measuring the same construct) of the proposed indicators of service success.

The individual indicator reliability is evaluated by the indicators' outer loadings. The outer loadings should be .7 or higher (Hair et al., 2013). In this study all the four loadings are well above .8, thus exposing a high individual reliability and are retained in the model.

For the convergent validity, the average variance extracted (AVE) is considered. The AVE evaluates analogous to the individual indicator reliability the communality, not for a single item but for the whole construct. An AVE of .5 indicates that the construct explains more than a half of the variance of the indicators. The AVE accounts for service success .830, so the construct explains more than 80% of variance and thus it is regarded to be suitable for the given purpose.

Finally, the predictive relevance (Q^2) is evaluated as well. The Stone-Geissers Q^2 assessed the fitness to rebuild the latent variable out of the associated indicators. Therefore, a value above zero is required. This final assessment criterion is also fulfilled with a value of .704 for the service success variable.

The bulk of the latent variables were operationalized by formative indicators. Usually success factors are considered to be of formative nature since they comprise drivers of success. Compared to reflective indicators, formative indicators define the latent variable as a whole. The content of the construct is described and specified by the indicators according to the underlying theory in a logical manner. Formative indicators are the source of the latent construct and therefore are not necessarily correlating with each other. They complement each other within the construct and form a self-contained variable. Thus, reliability measures are inappropriate for evaluating the goodness of the formative measurement model. Instead, content validity is evaluated by collinearity, significance and relevance of the indicators as well as discriminant validity on the construct level (Hair et al., 2013; Huber, 2007).

In contrast to reflective indicators, where high levels of collinearity between indicators are important, in case of formative indicators it is contra productive because they increase standard errors and influence weight estimation negatively. In order to evaluate collinearity, the variance inflation factor (VIF) is considered. The square root of the VIF is defined as the degree to which extent the standard error increases due to collinearity. Removing indicators should be considered in case of a VIF value higher than 5. All the indicators analyzed manifest an acceptable degree of collinearity (VIF<5). Thus, all items were considered for further analysis.

For evaluating the relevance of formative measures the outer weights of the indicators are considered first. In the proposed measurement model, 72 out of 126 items have a

significant weight. Second, the significance of the outer loadings is also evaluated. After analyzing the outer loadings, only 4 out of 126 indicators proved to be non-significant. After revising the items and considering the acceptable degree of collinearity, the items were retained in the model in order to preserve the logical, content oriented composition of the constructs.

On the construct level the discriminant validity is considered by evaluating the correlations between the latent variables. The score should be below .9 in order to ensure that no substantial relationship between different constructs exist (Huber, 2007). All latent variables are below the given limit. The highest score between qualitatively and quantitatively provided service (.85) is reasonable and in respect with the content. A highly selective specification of the constructs is desirable, but not practicable because of the complexity of the considered (model) relationships.

6. Structural Model Evaluation and Results

After the measurement model is evaluated as reliable and valid, the structural model can be assessed accordingly. The structural model is evaluated by the relevance and significance of the path coefficients, the coefficient of determination (R^2), the effect size (f^2) as well as the predictive relevance (Q^2) (Hair et al., 2013; Huber, 2007).

Before the relationship and the predictive relevance of the model are analyzed, the collinearity of the latent variables is evaluated. The path coefficient might be biased if predictor constructs show a high degree of collinearity. The VIF is considered analogue to the inner variable collinearity assessment. Fortunately, all constructs exhibit a VIF below 5, thus collinearity is not an issue.

By analyzing the path coefficient the hypothesized relationships are considered. The posed relationships are assessed according to the magnitude, significance and direction of the effect. The results are depicted in Figure 5. The path coefficients can take standardized values between -1 and 1, values close to ±1 represent a strong positive/negative relationship and values close or equal to 0 indicate no relationship. In addition, the significance is obtained by computing *t*-values with the help of the bootstrapping procedure. Out of the *t*-value the probability of error is calculated, *t*-values of 1.65 (10% probability of error) and above are considered significant.

Finally, 24 out of 27 postulated relationships were significant. Thus, the model comprehensively considers complex relationships between value drivers (built of relevant influencing factors) and service productivity measures. Furthermore, some measures and relationships are regarded to be more important than other with respect to the magnitude of the specific relationship. All significant relationships are positive by their nature.

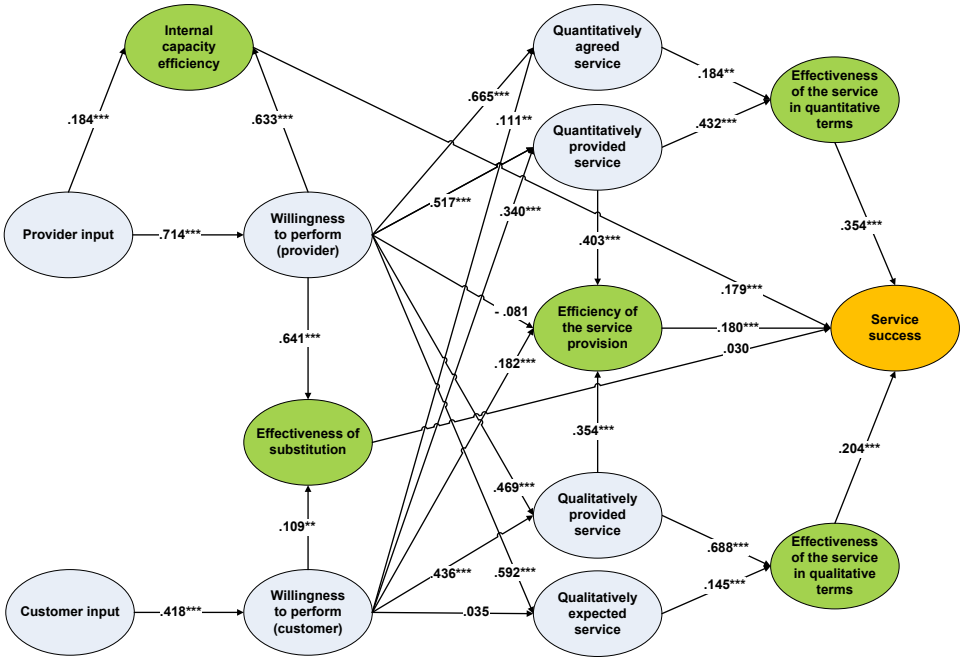

Fig. 5. Path coefficients and probability of error of the structural equation model of knowledge intensive service productivity. *** p<.01; ** p<.05;* p<.1

Although no significant influence from the provider's willingness to perform on the efficiency of the service provision was found (H_{19}), the mediation relationship by the quantitatively provided service will be examined in the future. Likewise, the hypothesized relationship between the customer's willingness to perform and the qualitatively expected service showed no significance (H_{14}). It turns out that the expectation as seen from the service provider's point of view are much stronger influenced by the service provider than by the customer himself. This is plausible if previous (before service engagement), exogenous influencing factors are neglected. Last but not least, the effectiveness of substitution shows no significant relationship to the overall service success (H_{23}). This result is surprising and not fully explainable. However, like in H_{14}, a specific transition between potential and process is observable, thus further analysis especially regarding the moderating effects of the constructs will be carried out.

The model's predictive accuracy is evaluated by the coefficient of determination (R^2). It is defined as the squared correlation between a specific endogenous construct's actual and predicted values representing the amount of variance explained by all of the exogenous constructs ranging from 0 to 1, the higher the better. In Table I, all R^2 values analyzed in the model are comprised. There are no general acceptable intervals for good coefficients of determination since it is research discipline specific. Thus, the definition of Chin (1998) is considered appropriate. The limit starts at .190, values above this limit are considered to have a weak predictive accuracy, values above .330 a moderate predictive accuracy and values above .670 very high predictive accuracy.

Table I. Coefficients of determination (R^2) of the latent variables.

Latent Variable	R^2
Service success	.610
Effectiveness of the service in quantitative terms	.320
Effectiveness of the service in qualitative terms	.603
Effectiveness of substitution	.491
Efficiency of the service provision	.644
Internal capacity efficiency	.601
Willingness to perform (provider)	.509
Willingness to perform (customer)	.175
Quantitatively agreed service	.526
Quantitatively provided service	.554
Qualitatively provided service	.610
Qualitatively expected service	.372

Almost all latent variables show a moderate predictive accuracy and are thus considered to be explained adequately by the exogenous constructs linked with them. The limitation arises only due to the single sided survey. For this reason, the customer's willingness to perform is regarded to be weakly predicted.

The f^2 effect size of the exogenous constructs is regarded to be another measure for evaluating the predictive accuracy. The limits for a small, medium and large effect are given by .02, .15 and .35 respectively. The exogenous variables of the provider input is found to have a large effect on the willingness to provide the service, but only a small effect on the internal capacity efficiency. This is in concordance with the rather low magnitude of the respective path coefficient (H3 - .184; $p<.01$). Furthermore, the input of the customer shows to have a medium effect size on the willingness to perform of the customer.

Stone-Geisser's Q^2 is the last measure for assessing predictive accuracy. Unfortunately this measure can only be applied for reflective indicators of the latent variable, thus only for the service success construct. A value above zero confirms the predictive relevance of the construct. The measure is computed by the blindfolding procedure. In the proposed model the Q^2 value of service success is .499, thus showing predictive relevance.

7. Findings and Discussion

Following the positive evaluation of the measurement and the structural model, the proposed service productivity concept is considered to be valid. The majority of the hypothesized relationships were not rejected.

From the potential perspective, a relationship between the service provider's input and the internal capacity efficiency through the mediating variable of the willingness to perform was found to be significant. The willingness of the provider to perform a specific service is also influencing the effectivity of substitution, even though no direct relationship to overall service success was found. This unexpected result may hold on the operational level, because the effectivity of substitution may have an impact on a higher (strategic) level, on the overall company profitability. This will be subject of further analysis. Thus, the management of a knowledge intensive service company should not only look at the profitability and fulfilling customer requirements, but also at the organizational and resource oriented capability of the firm.

In the process phase strong and significant relationships between the provider's willingness to perform and the value driver could be found. This also holds for the willingness to perform of the customer, except for the influence on the qualitatively expected service provision. Thus, from service provider's as well as from the costumer's point of view, the two different perspectives (qualitative and quantitative) as well as the three different stages (agreed, provided and expected service provision) are considered to be important for evaluating service productivity.

Finally, from the outcome, the impact of the success criteria on the overall service success was investigated. The results indicate that the conformance with the agreed service (quantitative effectiveness) is more important than with the expected service (qualitative effectiveness). Compared to the effectiveness, the efficiency of service provision has an inferior impact on service success. Thus, improving effectiveness is more important than improving efficiency.

In contrast to more generic models on service productivity the proposed service productivity concept provides a detailed view on success factors as well as a phase based measurement approach. Thus, the model assists service managers to consider service productivity from a holistic point of view defining leading (potential) as well as lagging (outcome) indicators for measuring service success. Furthermore, the validated relationships between value drivers enable the simultaneous study of the impact of

influencing factors on different service success criteria (e.g. influence of raising capacity utilization on service process efficiency and effectiveness).

8. Conclusions and Limitations

The study focuses on the research of relevant measures and influencing factors on service productivity. By using the structural equation modeling method the overall quality of the complex model could be assessed comprehensively. The proposed productivity model for knowledge intensive services was validated accordingly.

Therefore, a quantitative online study in the German knowledge intensive service industry was conducted. Almost 70% of the sample belonged to the field of market oriented and high-tech knowledge intensive services, thus the productivity model is regarded for being generalizable predominant for this category of complex services.

A limitation arises due to the single sided survey of the service provider. This holds especially for questions regarded the customer perspective. Therefore, this is the subjective perception of the customer by the service provider. Nevertheless, this approach was chosen because of the model's novelty and of the great effort for dyadic surveys.

Another limitation is given by the SEM method and the smartPLS software used for the statistical analysis. They only consider linear relationships between the proposed latent variables. The presumed relationships are not necessarily linear in reality, thus further in depth research is needed.

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