Increase Accuracy of Service Costing using Customer Involvement
An Application Scenario based on Service System Analytics

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Abstract

A service provider is interested in precise service cost calculations. Reliable cost information is required for sound economic decisions and provides valuable input for human resource management. But, without accounting for customer involvement, service costing is not accurate. Existing costing methods like Activity-Based Costing (ABC) have paid too less attention on customer introduced uncertainty. To overcome this problem and to increase reliability we measure a customer's individuality e.g. (experience, company size or speed of internet connection) and integrate it into cost accounting. We have developed a three layered approach based on customer factors, customer factor classes and Time-Driven Activity-Based Costing (TDABC) to compute a customer's influence on service costs. Our approach is used to compute customer factors to forecast service activity time. In this paper we describe our approach and demonstrate that it increases accuracy of service costing. The approach was evaluated using data from an international software provider.

INTRODUCTION

Services have contributed significantly to the economic growth in the last years. This brings new challenges for service providers in B2B and B2C service scenarios. In this context, we focus on the mandatory customer involvement in the process of service co-creation. A service provider is forced to integrate a service customer into service provision with positive or negative consequences on service costs. During co-creation both partners participate in a service system and invest resources e.g. knowledge, human resources or infrastructure capabilities (Spohrer, Maglio, Bailey, & Gruhl, 2007).

Customer involvement requires a service provider to extend the process view to the customer domain to consider the impact of customer factors, because they define the necessary resources for co-creation. Customer factors are all the tangible and intangible artifacts which influence co-creation e.g. information, experience, technical capabilities or commitment.

Since "the customer is a coproducer of service" (Vargo & Lusch, 2004), the concept of Service-Dominant (S-D) Logic also demands to include customer factors into investigations concerning qualitative and quantitative measurements. In S-D Logic the most important resources are knowledge and competencies of the provider and customer.

We motivate our approach based on the fact that a company needs methods to achieve pre-defined goals of the corporate strategy (Morris & Ashley, 2004). This includes solid information to decide about leadership based on costs or differentiation. We treat costs and the associated corporate strategy of cost leadership as a quantitative measurement and differentiation as qualitative measurement. With cost leadership a company tries to gain higher margins compared to competitors by lowering production and distribution costs (Reimann, Schilke, & Thomas, 2010). With solid information about the required level of customer involvement, cost accounting of a service provider is more accurate. This enables the service provider to include a customer's individuality into economic decisions, e.g. market price considerations.

Our research target is to increase the accuracy of service cost calculations by including a customer's individuality into cost accounting. A reason for imprecise service cost calculations is the uncertainty induced by customers on the process of co-creation. In our study, we have analyzed services from an international software provider. We have selected the service requirements engineering which is part of complex software integration projects. Such projects have a duration that ranges 3 to 24 months and a budget up to 2 million Euros. The complexity of requirements engineering depends on what the customer "wants" and the target is to prepare a requirements description document which can be implemented within the forecasted time. Project managers and software developers confirm that it is difficult to estimate the activity time and associated costs for this service. The current practice is to implicitly consider different customer factors, like experience, contact persons or company size without a systematic process.

This paper is organized as follows. In section two we describe the related work associated to service co-creation. Section three is used for our customer factor approach. Section four describes our evaluation process based on the service scenario requirements engineering. Finally, we draw our conclusions and give an outlook to our on-going research activities.

RELATED WORK

In this section we focus on the different roles a customer can assume during the service co-creation with a provider. Furthermore, we want to discuss production factors for a successful service co-creation as well as quantitative effects – the service costs.

From a provider's perspective, customers can contribute to the service creation in different roles. As discussed in scientific papers about customer integration (e.g. (Bitner, Faranda, Hubbert, & Zeithaml, 1997) and (Srivastava, Shervani, & Fahey, 1999)), it depends on the customer's qualification and the internal processes of the provider, how well the relationship succeeds. In (Straub, Kohler, Hottum, Arrass, & Welter, 2013) several different customer functions based on the work of (Büttgen, 2009), (Schneider & Bowen, 1995), (Lengnick-Hall, 1996), (Bettencourt, 1997), (Prahalad & Ramaswamy, 2000), (Wind & Rangaswamy, 2001), (Chervonnaya, 2003), (Graf, 2007), such as 'co-designer', 'service-specifier', 'co-marketer', 'quality-controller', or 'co-producer', have been identified. For a direct integration of the customer into the provision of a service, the roles 'co-producer' and 'quality controller' are of particular interest, as there, the interaction between the provider and the customer is focused directly on the service provision. For the provider as the party, which is responsible for the success of the co-creation, the integration of customers always entails both - a risk and an opportunity. In the following we will have a closer look at the identified customer roles and their valuation in former scientific work.

Customers can be involved in service co-creation as co-producers. Lengnick-Hall (1996) focuses on customer orientation of service providers and aspects of quality management. The customer is discussed in different roles – from a resource or product, to a user and a buyer. Furthermore customers are examined as co-producers, with "influence […] on quality resulting from [their] work activities" (Lengnick-Hall, 1996). Wilson, Zeithaml, Bitner, & Gremler, (2012) emphasize the alignment of providers towards their customer, by describing service marketing supporting the "uniqueness of services, keeping the customer at the centre". Customers may be seen as "assets to be valued, developed and retained", for enabling them to act as "one-time revenue producers" (Wilson, Zeithaml, Bitner, & Gremler, 2012). Customer involvement is often associated with product development (Lagrosen, 2005) during different stages (initial, final or continuously).

With their expectations, customers can function as quality controller of the estimated service result. By being integrated trough the provider into the service co-creation, customers are able to force decisions by giving their feedback about their service experience. Customers "judge quality based on multiple factors relevant to the context" (Wilson, Zeithaml, Bitner, & Gremler, 2012). Setting high customer satisfaction as success criteria, forces providers to integrate the customer and react directly on his quality assumption. The customer then acts as an "organizational consultant", who "is in a unique position to offer guidance to the service firm" (Bettencourt, 1997). By giving his feedback, the customer is able to cause changes in the provider's performance.

In production theory a concept called 'production factors' (internal and external) exists (Flandel & Blaga, 2004). Internal factors are entities that are provided by the producer. The customer supplies the external factors. The provider cannot produce or buy external factors on the market. Also the associated explicit knowledge is under control of the service customer. The producer is forced to integrate internal and external factors into production processes where so called factor combination occurs. This implies that both sides have to provide resources during co-creation (Frisch, 2009). In contrast to production factors, we present a concept extended to the customer domain. Using customer factors we demonstrate its applicability on services. In contrast to the concept of 'service system' (Spohrer, Maglio, Bailey, & Gruhl, 2007), we take a provider's perspective. Therefore, the contribution of the customer is of special interest. Furthermore, we describe the customer's input with dedicated customer factors.

To measure the quantitative effects (service costs) of customer involvement we rely on time. Conventional Activity-Based Costing (ABC) (Cooper & Kaplan, 1988) and the further development of Time-Driven Activity-Based Costing (TDABC) (Anderson & Kaplan, 2007) are well-known approaches to account for service costs. Due to the similarity between overhead costs and service costs, the ABC is applicable for service costing. In both cases the activity time required for the involved business processes is identified and used for cost calculations. Overhead costs are indirect costs with a weak relation to the costs of a product and are associated to a company's overhead departments (marketing or sales). In TDABC, it is easier to maintain the underlying costing data compared to ABC and a change in a business process requires only updating the time equation for activity time consumption. In TDABC, time is the leading cost driver to compute consumed resources (human resources and employees and machines).

CUSTOMER FACTOR CONCEPT

To describe the impact of customers on co-creation we developed the concept of customer factors. Customer factors can vary per customer and service scenario. Potential customer factors, which influence the process of co-creation and the associated activities, are the number of contact persons, the number of production sites or the experience of a customer. A high number of contact persons and production sites make it difficult for a service provider to standardize co-creation and to calculate service costs. An experienced customer can make co-creation more efficient and support scheduling of human resource.

Based on a literature review, we have tried to find which type and how detailed customer factors are described. In all selected articles we found a detailed, or at least a brief, description about the correlation between customer involvement and costs. The type of customer factors range from not precisely specified to concrete values (Bergholtz, Johannesson, & Andersson, 2011), e.g. health care information (Moll, 2010), project complexity, company size, experience (Sioukas, 1995), commitment, information (Lu & Wei, 2011), co-creation activities (Xiang, Guo-xing, Jingchang, & Yanqiu, 2008) or knowledge about customer profiles (Furstner & Anisic, 2010). Based on this input we argue that each customer provides individual customer factors and it is necessary to consider them for cost accounting. Additionally, it is necessary to have a concept that allows the comparison between different customers with changing individuality and also the applicability on different service scenarios (e.g. healthcare, IT, manufacturing or tourism). To obtain an expressive indicator for customer involvement we developed a three layered approach composed of customer factors, customer factor classes and TDABC, (see Figure 1). From activity time, the monetary service costs can be calculated based on the salaries of the involved employees.

Customer Factors (Layer 1)

To calculate a customer's contribution we first use customer factors CF_i, with i is the number of different CF_i of a service S_i, and map them on customer factor classes CFC (co-creation, information, technology and experience). For comprehensive cost accounting and to enable the benchmarking of customers and services, a value indicating a customer's contribution must remain comparable, between customers and service scenarios, also when number of CF_i changes. To achieve this, we map the values of CF_i first on CFC and from CFC on TDABC. To calculate CF_i, we define metrics based on the service use case and calculate values based on operational data. If there are no operational data available, then expert interviews can be used as data source. For example the number of contact persons or production sites can be determined using data from an Enterprise-Resource-Planning (ERP) System. In an ERP-System a company stores operational data about customers, suppliers, offers, orders and invoices.

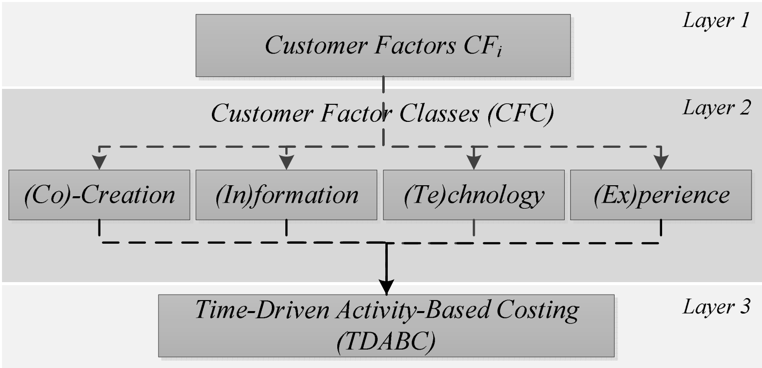

Figure 1: Three layered customer factors approach

Customer Factor Classes (Layer 2)

Based on our literature study and service use cases, we derived four general customer factor classes. They are always present in a service scenario, are aggregated values based on CF_i, and indicate the level and quality of provided customer factors. To get comparable values between customer factor classes, we use a pre-defined range and scale the computed CF_i to it. In Following we describe the customer factor classes and raise questions to explain their semantics associated to our service use case.

Co-Creation (Co): Describes the level of co-creation. A high co-creation level indicates a high customer involvement level. The more activities are performed by the customer, the higher the level of co-creation is. Questions associated with *Co* are: (1) What is the role of the customer during co-creation? (2) How active or passive is the customer participating in the process of co-creation? (3) During which process steps is the customer required? If the customer is motivated to provide detailed requirements, he can invest more time than agreed which influences resource consumption on the provider side.

Information (In): For a provider, *In* measures the degree of dependency on external information. Questions related to *In* are: (1) Which information is required and who can provide it? (2) How high is the level of externalization? (3) How and in which granularity is the information provided? Questions related to our service use case are: How detailed are requirements documented and how complex are they?

Technology (Te): Indicates the importance of technology during co-creation. Questions associated with *Te* are: (1) Which specific technologies are necessary during service provision (2) Is a technology replaceable by another one? (3) In which quantity and quality are technologies necessary? (4) How mature must be a technology? Related questions to our service scenario are: How many different technologies (internet, telephone, mobile phones, remote desktop sessions,…) are required during co-creation? Which internet bandwidth is required? How much time is required to establish a remote session?

Experience (Ex): Indicates the degree of experience and kind of competencies required for co-creation. The time required for co-creation is influenced by the involved employees. Consequently, a provider is interested that the customer provides experienced employees. Including experience supports the provider and customer to find out which levels of experience and competencies are required to reach the agreed activity time consumption. Questions associated with *Ex* are: (1) Which level of experience (expert or novice) is at least required during co-creation? (2) Are special competencies (programming, mathematic or chemical) necessary to participate in co-creation? (3) Is a special education (medical, legally or civil engineering) a necessary qualification? Questions related to our service use case are: How experienced is the customer in requirements analysis? How mature is the current project? Is the customer a reference customer?

Time-Driven Activity-Based Costing (TDABC) (Layer 3)

The third layer is set for the quantitative measurement. The goal is to measure the impact of customer involvement on activity time consumption. Co-creation is a process between provider and customer. This requires analyzing and modeling the activities which are relevant to compute CF_i, i.e. activities which are part of the commitment between provider and customer. We call them service activities and they: (1a) are required for co-creation; (1b) have a direct relation to the service offered; and (1c) a provider or a customer is responsible partially or entirely for them. Service activities provide a suitable fundament for customer factor calculations, because they are required for co-creation and support customer individual service scenarios. We exclude for customer factor calculation so called overhead activities. Overhead activities (2a) are performed independent on both domains, (2b) are not always directly related to a specific service and (2c) are involved into the processing of different services. To calculate the activity time for service activities, TDABC is suitable. We selected TDABC because it relies on time, which is the most important resource for cost accounting in the context of services. Additionally the calculation process of TDABC facilitates the integration of our customer factor approach.

Formalizing Customer Factor Calculation

To calculate a customer's impact for an individual service activity A_i, all four customer factor classes are required and extended by a weighting factor, see (1). We use the variables *Iw*, *Tw* and *Ew* to weight the impact of the CFC. This enables to change the importance of a CFC for different business scenarios. Co-creation is excluded from the weighting, because the level of co-creation and its impact is fixed by the agreed service activities between service provider and service customer. A Service-Level-Agreement (SLA) contract can be used to document for which service activities the customer is responsible. Service activities which are included into cost calculations have a $Co_{A_i} = 1$. The level of co-creation for a service S_i is the ratio between the number of A_i which are part of S_i and S_i performed by the customer. Only *Ai* where $Co_{A_i} = 1$ can result in $CF_{Ai} > 0$. Consequently, we use no additional service factors to calculate co-creation and weight the impact.

$$CF_{Ai} = Co_{A_i} * (In_{A_i} * I_w + Te_{A_i} * T_w + Ex_{A_i} * E_w), \text{ with } (I_w + T_w + E_w) = 1 \quad (1)$$

The values of In_{A_i}, Te_{A_i} and Ex_{A_i} are calculated for each co-creation $\mathrm{CC_t}$, at time period t, from which we obtain $\mathrm{CF_{Ai}}$. This allows a comparison between forecasted and actual weighing and to re-adjust it. To obtain values for In_{A_i}, Te_{A_i} and Ex_{A_i}, we first identify and calculate customer factors. To map a CF_i to a CFC we use an injective function $f: CF_i \rightarrow CFC$. This means each CF_i can only be mapped to one CFC. Each CF_i is scaled e.g. to $CF_i \in [0; 10] \in R$ and on each CFC a different number of customer factors CF_i can be mapped. The usage of a scaling value different from 10 is also possible. The output for Si is a parameter indicating the quality of customer involvement during co-creation, which is subsequently integrated into TDABC. The formula in (2) shows how. We have merged our customer factor approach with TDABC, where m is the number of different service activities A_i. CD_{A_i} is the cost driver and AT_{A_i} the activity time for activity A_i. A CD_{A_i} is something that drives the required time of an activity. For our service use case a cost driver is the number of different requirements.

$$SC_{S_i} = \sum_{j=1}^{m} CF_{A_i} * \left(CD_{A_i} * AT_{A_i}\right), \qquad (2)$$

EXPONENTIAL SMOOTHING AND CUSTOMER FACTORS

In this section we describe our method to increase the economic accuracy of service activity time calculations. A costing approach can increase economic accuracy, when it supports economic decisions by providing more precise information. We demonstrate this by extending exponential smoothing (ES) with our customer factor approach. Exponential smoothing is a standard forecasting method. Forecasting is a technique to predict future values and is associated with operations research to provide input for decision making (Jensen, 2002). To monitor the forecast accuracy we use statistical standard methods: the cumulative sum of forecast error (CFE), the mean forecast error (MFE), mean squared error (MSE), mean absolute deviation (MAD), root mean squared error (RMSE) and the mean absolute percentage error (MAPE) (Goetschalckx, 2011). The standard formula for ES calculate applied on a service co-creation is:

$$\boldsymbol{ES_{CC_{t+1}}} = \boldsymbol{\alpha} * \boldsymbol{CC_t} + (\mathbf{1} - \boldsymbol{\alpha}) * \boldsymbol{CC_{t-1}} \quad (3)$$

The smoothing factor α $(0 \leq \alpha \leq 1)$ is used to change focus more on past observations or current values. To integrate the customer factor approach we use the adjusted formula (4). With the independent smoothing factor β which is $0 \leq \beta \leq 1$. The customer factor weight (CFW) is $-1 \leq CFW \leq 1$. The proportional forecast error $PFE_t = \frac{100}{CC_{t-1}} * CC_t$ is a parameter to limit the forecasted value between CC_t and CC_{t+1}. CFW and PFE are necessary to limit the impact of computed customer factors and not to over forecast. The adapted formula (4) is our adapted exponential smoothing method ES_{cf} to calculated

$$EScf_{CC_{t+1}} = (\alpha * CC_t + (1 - \alpha) * CC_{t-1}) * \left((\beta * CF_t + (1 - \beta) * CF_{t-1}) * CFW\right) * PFE_t \qquad (4)$$

Evaluation Setting

We use the following hypotheses to test the adapted forecasting method, see (4). H_0: $ES = ES_{cf}$ where ES (compare to (3)) is the standard exponential smoothing method and $EScf$ (compare to (4)) is the adapted method. H_1: $EScf$ prevents forecasting too less human resources. H_2: The total sum of forecasted activity time with $EScf$ is higher compared to ES. To obtain results we made the steps: (a) Select the service activities from our service use case, (b) identify customer factors and map them on customer factors classes, (c) calculate CF_i for each co-creation based on the provided operative data, (d) apply forecasting formulas ES and $EScf$ (e) and use selected forecast error metrics. The results of one parameter combination are illustrated in Table 1.

Accuracy metric	ES	$EScf$	Used Parameters are: $\alpha = \beta = 0.5$, $CFW = 0.5$, $PFE = 250$
CFE	0.0328	-14.1858	
MAD	0.9453	0.9687	Analyzed 1537 co-creations for 149 customers
MSE	5.2516	5.8361	
RMS	2.2916	2.4158	
MAPE	5.0953	5.5273	
MFE	0	-0.0092	
SAT in h	506.8384	713.3862	
AFE	41.54 %	58.46 %	

Table 1. Comparison of forecast accuracy

Results

The H_0 is not valid because of PFE the results of ES and $EScf$ are always different. Because of H_1, we intentionally want our $EScf$ to over-forecast. A forecast model is over-forecasting with $MFE < 0$. With a $MFE > 0$, the model is said to under-forecast. In general an ideal forecast model has a $MFE = 0$. We can answer H_1 positive because of the $MFE = -0.0092$. Also H_2 is valid because the Sum of Activity Time (SAT) of $EScf$ is higher. Also positive is that the Absolute Forecast Error (AFE) is higher with 58.46% for $EScf$. This implies that the financial loss with $EScf$ is smaller and more accurate for service costing.

CONCLUSIONS

The presented customer factor approach enables a service provider to compute more accurate service costs. Based on our service use case we computed results that support our assumptions. In about 60% of 1537 investigated co-creations, the customer factor approach provided more accurate results compared to a standard forecasting method. Also the risk to under forecast was lower with our approach.

Based on the results a service provider can derive detailed information about the required level of customer involvement and activity time consumption. This information can be used to plan required human resources and associated competencies.

In this paper we have demonstrated the applicability on one service scenario. To confirm our results, and to show the applicability using different type of services, we are currently applying our approach to additional services (software engineering and maintenance of manufacturer of medical devices). In our further research activities, we want to find out, if a high customer factor level increases the probability to reach forecasted activity time consumption. Another activity is the application of regression analysis to analyze the dependency between customer factors and activity time consumption.

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