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## **A cost calculation model for determining the cost of business process modelling projects**

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*Abstract:*

*Business process management projects in general and modelling projects in particular still have a lack of practical and scientifically sound method of cost accounting. In this work, an integrated cost model is presented, which provides a method to determine project modelling cost ex-ante and ex-post respectively..*

*Key Words: business process modelling; cost model; cost accounting; business process management*

## 1 Introduction and Motivation

For many companies, gaining competitive advantages through a differentiation at the product level is increasingly difficult due to their homogeneity. This entails the need to reduce costs by streamlining work processes and organizational structures. According to the Gartner Group, "Hype Cycle for Business Process Management" [DiJo11] business process management (BPM) and the related modelling of the processes are core areas of enterprise management. A process is defined, according to Rosemann [Ro96, 9] as a self-contained temporal and logical sequence of the proper functions to be executed to process a business-relevant object.

According to a study by Minonne in 2011 [Mi11], the uncertainty about the financial benefits of BPM is still a major obstacle to its introduction. Assessing the usefulness, the cost factor of modelling as one of the phases of business process management plays a prominent role [Ga10, 2]. To this date, however, no stringent or integrated scientific approach exists for cost and performance accounting in process modelling [BeSc04, 128].

The absence of such an approach is particularly essential in light of the principles of proper modelling (PPM) [BeRo+95], since in the principle of efficiency it is implied that also the modelling should follow this general maxim [BeRo+95, 438]. This principle, which reflects on the model related costs, determines in essence the intensity of the modelling and, thus, at least partly the quality and validity of the models for BPM. Although Heinrich, Heinzl and Roithmayr noted that the principles of proper modelling have no significant importance in practice [HeHe+07, 238], however, the need to evaluate the cost of modelling projects is not debatable (e.g. [KO10, Wo08]). In previous modelling and BPM projects, the cost calculation for modelling is based on an often overly optimistic estimate, which frequently shows strong deviations later on towards the actual costs. Thus, we suggest that the costs of business process modelling projects should be pre-estimated on the basis of an adequate cost calculation model which we outline in the remainder of this paper. To lay the foundations, the next section summarizes some basics of accounting.

## 2 Methods of cost accounting

For a better understanding of the cost model proposed in this paper, some basics of cost accounting are briefly summarized below, provided they are relevant in the development of a model to determine the overall cost of business process modelling projects (BPMP). The following discussion refers primarily to the work of Wöhe and Döring [WöDö10] and Peemöller [PE05].

Part of cost accounting is controlling costs and providing data for operational planning (e.g. for the calculation) amongst others. The basis for this is the complete recording of all costs incurred in the financial accounting, which usually resorts to common chart of accounts (or industry-standard chart of accounts). Through the separation of the costs in different groups cost types are created (in a modelling context e.g. costs for meta modelling and modelling experts personnel costs). Direct and overhead costs, fixed and variable costs are amongst the most important cost groupings. Variable costs are dependent on application rate, while fixed costs - regardless of the amount of output (also at a level of zero) will always occur at the same level and will arise due to the establishment of operational readiness of a system [WöDö10, 936 et seq.].

In order to determine the calculation for the cost of a product, it is necessary to distribute the total costs incurred as they reflect the individual products (cost units). This among other things makes it possible to determine the exact cost drivers, for instance for a BPMP, in order to optionally influence it. The direct costs that are incurred only with a particular product can be attributed perfectly. The overhead costs cannot be explicitly attributed to a particular cost unit, therefore these must first be organized according to cost centres (operating locations where the costs arise), summarized and with the help of overhead rates again charged to the cost units (cost centre accounting). In summary, the task of cost accounting consists of the acquisition (cost type accounting), the distribution (cost centre accounting) and accountability (cost unit accounting) of the costs incurred by entrepreneurial activity.

In full cost accounting, both fixed and variable costs are charged to the cost units. Variable cost accounting omits the allocation of fixed costs (e.g. infrastructure costs) to the cost units, on the grounds that they cannot be attributed unambiguously.

Target cost accounting represents a future-oriented approach in contrast to actual costing, which specifically refers to costs incurred, and is used to forecast potential costs incurred and include future expectations (e.g., price developments).

A root cause analysis in terms of cost differences in conjunction with the actual cost can be administered later [PE05, 268 et seq.]. Both the actual and target cost calculation can be performed as a full or variable cost accounting. In target costing one further distinguishes between the rigid (with a fixed level of employment) and the flexible approach (with a time-adjusted level of employment, such as varying number of modelling experts in a BPMP).

As indirect service areas, such as planning and controlling activities, gain more importance in companies through the usage of modern technology, it proves more and more difficult to charge the costs of these areas fairly to single cost units. Moreso, a change takes place towards consideration of processes, which a product or services uses. The resulting process

cost calculation is based on one hand on the need for the service delivery chain of activities (process) and also on cost factors (cost drivers) and finally on all costs, which can be attributed to the execution of a process (process costs ) [e.g. HO09, 489 et seq., PE05, 304 et seq.].

Basis of process costing is a process analysis and design of a process hierarchy which is mapped according to main and sub-processes. Then the related cost drivers are determined, which serve as a measure of the actual cost causation and the place of performance of the main processes. With the help of determined quantities of the cost drivers and primary processes and the specific process costs, one can determine cost rates (the average target cost for a single execution of a (modelling) process) which are applied on further allocation to the individual costing items, according to their respective individual consumption [Wo10, 1010].

The designed costing model (target costs on a full cost basis) below refers to the presented cost accounting procedures and adapts them to the specifics of BPMP.

### 3 The cost model

The matter of the presented work is to develop an integrated cost model for the specific identification of costs of BPMP, which in the detailing and specification does not exist yet in literature. Related work (see e.g. [Wo08]) deals with specific aspects, such as cost type of modelling, but is not a practicable model for total cost accounting in BPMP. This fact is taken into account in the following approach. A costing model for BPMP should permit the determination of the modelling costs before the project starts (ex ante) or after project implementation (ex post). By application before the project begins, several alternative executions or the offer of an external service provider can be compared. An application after project completion enables the evaluation of implemented BPMP and can build the basis for subsequent ex-ante considerations for future BPMP. Thanks to constructed know-how in this particular way, the costing and budgeting in the BPMP can be constantly improved and thus contribute to the economy of the organization.

"Cost models are computational approaches to estimate the effort of production of (software) products, financially" [ChSc+11, 378]. A transfer to the context of BPMP shows that cost models are computational approaches in order to estimate the cost of such projects. A costing model for the purposes of this article aims to determine the total cost of a BPMP. Splitting or classifying costs into groups is necessary to develop such a cost model. After determining the individual costs, the results can be aggregated to the total cost.

In literature there are various approaches (see, for example. [Ti06, 292; Wo08, 41 et seq.] Tiemeyer [Ti06, 291 et seq.] refers in his remarks to more of a general IT project costing.

The backgrounds of a BPMP can be very diverse and can lie in - besides questions of application system design - in the field of organizational design as well [Ro11], [AL05, 28]. Anyway, BPMP is not traditional IT projects at its core. Wolff [Wo08, 41 et seq.] takes this particular fact into account, by going into more detail on the specifics of the cost of modelling. He refers to Maier [MA96, 292, MA04, 318 et seq.] and Krcmar [Kr05, 403] and splits the cost of enterprise modelling into the categories of investment, running costs, direct modelling costs and other costs of modelling.

Category	Cost Type	Personnel costs	Material Costs
Investment costs	Designing the modelling method	x	x
	Hardware costs	-	x
	Software license costs	-	x
	Training costs (methods, tools)	x	x
	Other setup costs	x	x
Running costs	Cost of maintenance and care	-	x
	Modelling support costs	x	x
	Cost of the system is running	x	x
	Cost of using a regular technical infrastructure	-	x
Direct costs of modelling	Overall personnel costs	x	x
	Personnel costs of specialists (modelling)	x	-
	Personnel costs for quality assurance	x	x
Other costs	Cost of intra- and extra-company exchange of information	x	x
	Costs of negative productivity effects	-	-

Table 1: Costs of modelling (based on [Wo08, 42]).

Wolff considers, in the context of modelling, investments as acquired or internally generated resources for long-term use. The running costs of the system operation and provision of technical infrastructure for the modelling should be distinguished from one-time costs. A significant share of the costs falls to, according to Wolff, the direct modelling costs, which include the personnel costs of internal employees and external consultants. All other costs incurred in connection with the modelling, are assigned to the category "Other Costs". The intra-company and inter-company exchange of information or the so-called "negative effect on productivity" is an example for this category of costs [Wo08, 41 et seq.]. Among the negative productivity effects are, according to Wolff [Wo08, 42], as described with re-



spect to [Kr05, 403], effects caused by some poorly understood process models or poorly coordinated user activity. In a further step, Wolff extended the categories of costs to cost types and adds the distinction between material and personnel costs. This extension is shown in Table 1.

Due to modelling reference of these cost categories, the proposals of Wolff [Wo08, 42] are used as the basis for the construction of our cost accounting model. However, as Wolff gives no information on the identification of the individual types of costs or any more concrete details, calculation variants and further refinement of each cost category and type are hereafter presented. Based on the cost categories, the total cost equation of the cost model for BPMP is derived in Formula 1:

$  \begin{aligned}  \text{Total cost} &= \text{Investment costs} \\  &+ \text{Running costs} \\  &+ \text{Direct costs of modelling} \\  &+ \text{Other costs}  \end{aligned}  $
--

Formula 1: Total cost of BPMP and business process models (based on [Wo08, 42])

Using various calculation proposals the individual cost categories are determined. This is, unless otherwise noted, based on rigid target cost calculation<sup>1</sup>, which may be developed as needed by adapting to fluctuations in employment. The advantage is the ease of use in the determination of nominal quantities and nominal prices, which multiplied constitute the target costs. If the cost model is implemented after the project has been completed, actual prices and actual quantities are to be used to calculate the actual cost.

#### 4 Determination of investment costs

According to Wolff [Wo08, 42] the investment costs are determined by the cost of the design of the modelling method, one-time costs for the purchase of hardware and software licenses, training and other set up costs (see formula 2). Normally, these are one-time costs that can be used for future BPMP based on a compensation key.

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<sup>1</sup> Rigid target costing is based on a single level of employment during the settlement or calculation [PE05, 273].

$$\begin{aligned} \text{Investment cost} = & \text{the cost of designing the modelling method} \\ & + \text{Hardware costs} \\ & + \text{Software license costs} \\ & + \text{Training Costs} \\ & + \text{Other set up costs} \end{aligned}$$

Formula 2: Determination of the investment costs

Using a defined method, the cost of the design of the modelling method can be neglected. Otherwise, it must be implemented as a single project in the organization and their project costs are charged here. One-time hardware costs can be divided in client hardware costs (e.g., notebook, tablet, etc.), server hardware costs, network hardware and other costs. Depending on the particular BPMP, costs are to be determined depending on the cost of procurement or internal transfer prices for IT services.

As a rule, available resources are used; therefore no significant investment in hardware for BPMP is expected. The software license costs can be determined by analysing the required software features, the number of users and the technical environment. The software license models in Table 2 are basically a starting point for the licensing fee in practice [KR10, 181]:

For optimal usage of modelling method as well as modelling tools by project employees of BPMP, it is necessary to execute training courses, the cost of which are determined by course and hourly trainer rates or internal transfer prices respectively [JA05, 90, SC09, 64]. According to Löffelmann [Lö07, 64], in addition to these costs there are expected staff costs during the training (through absenteeism) and any further expenses for the follow-up ("practical testing") as well. Furthermore, additional costs for rooms, travel, accommodation, information and organizational and administrative costs may incur [ME08, 263F]. These can be determined by e.g. internal transfer prices (such as rooms and administrative costs) or by obtaining quotations (e.g. for accommodation costs).

<b>Licence model</b>	<b>Cost driver</b>	<b>Provision of the software license costs</b>
Primarily user-based models	for example, the number of users	- Number of user licenses - price
primarily time-based models	for example, the duration of use	- Time - costs per unit of time
primarily value-oriented models	for example, number of models	- Number of models cost - cost per model
Primarily infrastructure-related models	for example, the extent of use of the infrastructure	- solicitation of quotations

Table 2: Determination of the software license costs (based on [KR10, 181]).

The last part of the investment is made through the introduction of other setup costs. This includes the costs of adaptation or of customizing and configuring the software, hardware and any modelling method (e.g.: modelling handbook) [We12].

## 5 Determination of running costs

The determination of the BPMP running costs is defined by the cost components in Formula 3. The costs incurred by the modelling in the strict sense (e.g., personnel costs of the modelling experts) are not part of the running costs, but are mapped into the direct cost modelling.

<p>Running cost = the cost of software maintenance and care</p> <p>+ Modelling support costs</p> <p>+ Ongoing modelling system operation cost</p> <p>+ Cost of using a regular technical infrastructure</p>
---

Formula 3: Calculation of the running costs

The software maintenance and care of the modelling environment includes various cost components which are to be determined: firstly, the costs for maintenance contracts and updates [BR09, 76] and the cost of maintenance [Kr05, 403]. The cost of maintenance, for example, includes the necessary personnel and material costs for software support and maintenance, which cannot be assigned to the direct modelling costs. The calculation of these costs may be based on offers made by the software vendor and invoice prices of the internal service catalogs, respectively.

Costs to support such modelling incur through the extra effort in the modelling of processes for the creation, reuse and maintenance of convention manuals or for example through the modelling of technical terms [AbHi+02, 119]. The calculation of these costs is proving difficult due to project-specific expression. Therefore, an estimate for a new BPMP should be carried out by experts due to their individual experience and subsequently evaluated for future projects. The estimated costs can then be recognized as modelling support costs. However, this method proves to be prone to errors and not very accurate [BeSc+08, 149].

The modelling environment operating system is another ongoing expense item within a BPMP. Because the technical infrastructure and the software maintenance and care form an individual cost point, the operation of information systems such as software systems and hardware systems without consideration of the networks and communication equipment and software maintenance and care, is the presumed operating system, based on Kurbel and Datsenka [KD10]. According to Brugger [BR09, 76] and Krcmar [Kr05, 403] the cost factors for cost of computing power, data storage costs, or costs for archiving can be subsumed under this category, amongst others. The cost of operating the modelling environment can be determined by tenders, existing projects or internal transfer prices in catalogs for each relevant cost factor.

The ongoing operation of the technical infrastructure and the network is the final cost within the running costs. A collaboration in modelling is not possible without the use of such an infrastructure. Costs thereby incurred include amongst others, LAN and WAN costs (for pipes, equipment, data security) and costs for network monitoring, which shall be determined by internal transfer prices or tenders [BR09, 76].

## 6 Determination of direct modelling costs

Usually the direct modelling costs represent a very significant part of the costs and therefore receive a level of special attention in determining the overall costs [Wo08, 41 et seq.]. Wolff divides these costs into the overall personnel costs, personnel costs of specialists (modelling) and the personnel costs for quality assurance.

The determination of direct modelling costs can be done in different ways: by an application of process costing, on expert estimation methods or customized parametric methods (e.g. based on COCOMO II or Function Point [BA00, 91 et seq.]).

Determination is based on process cost accounting in the following comments. This option is only applicable if information about previous BPMP and modelling activities are available. If this is not the case, the use of an expert estimation method (cf. [BSH08]) is advisable, despite all its weaknesses. According to Horvath [HO09, 492], the areas to be included and the objective of the project must first be defined in process cost accounting. Below is

an example for the inductive process designed to illustrate, what must be adapted to the circumstances of each organisation.

The modelling department in the example represents the area of the organization to be included. The objective of this project will be to determine the process costs for modelling business processes.

In a second step, Horváth [HO09, 492] suggests the definition of the main hypotheses about the main processes and the cost drivers of process modelling. For the sake of simplicity, one can assume that the main processes in the business process modelling department are business process modelling and process model reviews. The number of considered business processes is the respective cost driver in both cases.

A process analysis to identify sub-process [HO09, 492] follows afterwards. These are the sub-processes of modelling actual and target processes and the process "lead department" in the main process of business process modelling, for example. The process "lead department" includes a proportion of overhead costs of the area to be included. For simplicity, the "Process Model Review" process is not broken down further into sub-processes. For each process model a review must be conducted. Furthermore, this example assumes that for each business process an actual and a target model are to be constructed.

In the fourth step of the process cost accounting a capacity and cost allocation is performed according to Horváth [HO09, 492 et seq.]. The process amount of the last period of time, the last month for example, or the proposed process quantity is used as capacity. Within the allocation of costs, planned staff resources of the sub-processes, are taken as the basis in their respective expense rates. Furthermore, a distinction is made between the volume-induced ( $v_i$ ) and volume-neutral ( $v_n$ ) processes. This is done to allow an appropriate cost allocation later on. Table 3 shows the corresponding steps with sample quantities and costs by person-months carried out.

In this example, the cost for a month's labour of a person is assumed at 6.500 €. The cost of a month's labour of the head of department is 10.000 €. This results in subsequent process costs and cost rates, as shown in Table 4.

These calculations were performed based on the suggestions of Horváth [HO09, 492 et seq.]. By multiplying the person-months with the cost per man-month in formula 4, the vi-process costs are as follows:

Process costs $v_i = \textit{person months}$ • staff costs $v_i\text{-one month of work}$
--

Formula 4: Determination of vi-process costs

Main process	Sub-process	Cost drivers	Amount models	Person-months	Process type
Business process modelling	Modelling actual process	Number of business processes	20	3	vi
	Modelling target process	Number of business processes	20	3.5	vi
	Lead department	-	-	0.75	vn
Process model review	Review process model	Number of business processes	40	3	vi
	Lead department	-	-	0.25	vn

Table 3: Capacity and cost allocation for business processes of the modelling department.

Main process	Sub-process	Amount	Person-months	Process cost (€)			Process cost rates (€)	
				vi	vn	Total	vi	Total
Business process modelling	Modelling actual process	20	3	19,500	4,125	23,625	975	1,181
	Modelling target process	20	3.5	22,750	3,375	26,125	1,137	1,306
	Lead department	-	0.75	-	7,500	-	-	-
Process model review	Review process model	40	3	19,500	2,500	22,000	488	550
	Lead department	-	0.25	-	2,500	-	-	-

Table 4: Process cost and process cost rates for basic business processes in the modelling department.

The vn-process costs can be calculated analogously as shown in equation 5.

Process costs  $_{vn} = \textit{person months}$

- staff costs  $_{vn-one\ month\ of\ work}$

Formula 5: Determination of vn-process costs

To distribute the overhead costs on a fair basis according to processes, an allocation takes place. The specific charge of the vn-process costs is used in proportion to the costs of the vi-processes [PR07, 185]. This results in the contribution rate based on formula 6.

$$\text{Contribution rate}_{vn} = \frac{\text{Process cost}_{vn}}{\text{Process cost}_{vi}} \cdot \text{Process cost rate}_{vi}$$

Formula 6: Determination of the contribution rate of the vn-process costs (according to [PR07, 185])

A previous calculation of the proportions of the vn-processes to the respective sub-processes must be carried out, because not every vi process usually claims the same share of vn processes. In the example shown, it is assumed that 55% of department management costs (amounting to € 4,125) refers to modelling actual processes and 45% (in the amount of 3,375 €) to modelling target processes. This results in a contribution rate of the vn-costs of € 206.25 for the portion of modelling actual processes. This represents approximately 21.15% of vi-process costs as a surcharge. For modelling target processes a contribution rate of the amount of € 168.68 is calculated. The (total) cost rate of a process, that defines the cost of a singular process execution, results from the vi-process cost, with the contribution rate added in accordance with Formula 7 [PR07, 185].

$$\begin{aligned} \text{Process cost rate} &= \text{process cost rate}_{vi} \\ &+ \text{contribution rate}_{vn} \end{aligned}$$

Formula 7: Determination of the total process cost rate (according to [PR07, 185])

Finally, an aggregation step is performed, where the individual sub-processes with their properties and costs are associated with the main processes. The process costs for the respective main process result from the sum of the process costs of the associated sub-processes. The process cost rate is the cost incurred on average when running through a process once and is derived by dividing the total process costs by the respective process amount [HO09, 492 et seq.], as shown in Table 5.

As a result, personnel costs for the modelling of a business processes can be determined. In the previous example, both the process-cost rate for the modelling process as well as the

process of model review are relevant. Therefore, a sum of both process costs must be formed and multiplied in a second step with the number of business process models, the cost driver, as shown in formula 8.

Main process	Cost driver	Amount	Process cost	Process cost rate
Business process modelling	Number of business processes	20	49,750 €	2,487 €

Table 5: Cost aggregation to main processes.

$$\text{Direct costs of modelling} = \text{number of business process models} \cdot \sum \text{process cost rate}$$

Formula 8: Determination of direct modelling costs based on process costing

In this example, for a business process direct costs of € 3,587 (2,487 € + 2 • 550, - €) are derived. All cost categories can be covered within process cost accounting. Personnel costs are accounted for in the process of business process modelling and the costs of quality assurance can be found in the process model review. The costs of specialists, if not already included in calculated positions could be added as a surcharge or via individual treatment within the costs of a man-month.

## 7 Determination of other costs

Aside from the already identified costs, any arising costs will be included in the “other costs” category.

Wolff [Wo08, 42] proposes the cost of intra-and extra-company exchange of information and the costs of negative productivity effects, which arise, for example by poorly understood models, as cost types. The collection of the costs can be difficult due to heterogeneity of the individual cases. Therefore, experienced project managers should estimate the costs for new projects and evaluate completed projects. The cost of intra-and extra-company information exchange, for example due to the participation of project staff at conferences, etc. [MA04, 319], should also be appreciated by experienced project managers. Other costs in this area, which may need a determining depending on the case, if not already included in other cost categories are cost of insurance, office supplies, facilities, in-



terest expense, depreciation, taxes and special administrative costs (based on [Ti06, 292]). Therefore, the additional costs are defined as a sum of the respective drawn on additional costs, as illustrated in formula 9.

$$\textit{Other costs} = \sum \textit{not otherwise covered cost categories}$$

Formula 9: Determination of direct modelling costs based on process costing

## 8 Conclusion

In this article the design of a costing model has been demonstrated for business process modelling projects. A structured calculation of modelling costs was not previously addressed in the available literature. Starting from the basic cost categories according to Wolff [Wo08, 42], these were refined and methods for their respective calculation were proposed. This makes it possible to calculate the cost of modelling projects in advance to support the tendering process and help evaluating completed projects. This addresses a major gap in the field of controlling of business process management.

Furthermore, the cost categories and the refinement proposed could serve as the basis for statistical forecasting models, such as regression models, with the goal of providing a cost estimate for modelling projects in advance. However, when a new modelling project exceeds known references in terms of total effort or capacity requirements, it is still a difficult task to forecast certain cost categories such as the direct modelling costs. Estimation methods can be a useful measure to circumvent these problems. Moreover, many dynamic factors, dependencies and risks influence the overall costs of BPMP on different levels (i.e. the likeliness of social differences, communication problems, different skill levels of modellers). These factors have not been considered here because they are rather hard to quantify.

In future research, empirical testing and, if necessary, industry-specific customization should be performed based on these theoretical considerations. First, the correctness of the procedure must generally be proven by empirical verification. This must be determined primarily by the weight of the individual cost categories and types, dependencies between them must be identified and entered into future calculations. Furthermore, it is assumed that this distribution is dependent on other determinants such as the project objective, process structure, industry, context dependency of processes, etc.

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