TOWARDS A VALUE-ORIENTED APPROACH TO BUSINESS PROCESS MODELLING

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Abstract: To date, typical process modelling approaches put a strong emphasis on behavioural aspects of business operations. However, they often neglect value-related information. Yet, such information is of key importance to strategic decision-making, for instance in the context of process re-engineering. In this paper we propose a value-oriented approach to business process modelling that facilitates managerial decision-making in the context of process re-design based on concepts and metrics from financial and operations management.

1 INTRODUCTION

Over recent decades, business process management (BPM) has emerged as a popular management approach in information systems and business management practice. BPM has over the last three years continuously been identified as a top business priority and building business process capability continues to be a major challenge for senior executives in the coming years (Gartner Group, 2007). Most notably, BPM practices are employed to improve, re-design or re-engineer existing business operations so as to improve overall effectiveness or efficiency of an enterprise. In fact, a recent survey on BPM initiatives confirmed that 75% of active BPM projects are concerned with process improvement (Palmer, 2007).

A key challenge in process improvement projects is the initial discovery and description of the business operations in a manner that is conducive to process improvement (Burlton, 2001). In this context, process modelling as an approach to graphically articulate the activities, events or states, and control flow logic that constitute a business process is typically employed to discover existing processes, and document them in a way that helps managers making improvement or change decisions (Recker, 2007; Rosemann, 2006).

However, the graphical description of events, tasks, control flow logic and the like does actually little in helping managers making change decisions. What is missing in process modelling practice is a focus on business value considerations. More precisely, popular process modelling approaches, such as ARIS (Scheer, 2000), provide a reasonably good understanding of what is happening in the process – but reveal only little about the financial consequences of the operations, and how changes to these operations would contribute – or not – to corporate success. Surprisingly, also existing apporaches in process simulation, e. g., Greasley (2000), or process mining, e. g., van der Aalst (2005) hardly consider financial information.

The question then is how to leverage process modelling for the assessment of the business value of processes (or process changes). In particular, long-term monetary consequences which are influenced by market and resource-related stimuli, should be taken into account for process improvement. In order to assess the value of a process with regard to long-term economic consequences, decisions on the process design have to be considered as an investment (Devaraij and Kohli, 2002).

Accordingly, the imperative of our research is to identify and to describe the different aspects that contribute to the long-term financial value of a

process design. In particular, we propose a framework that distinguishes three levels of evaluation, *viz.*, the operational, the budgeting, and the corporate level. Furthermore, we show how these different financial dimensions can be identified by the help of a process model, and how this financial data relates to process change decisions. Overall, we call this approach *value-oriented process modelling*.

We proceed as follows. First, we give an example of a typical process design scenario and highlight how and why existing approaches fail to provide adequate information for process change decision-making. Then, in Section 3 we introduce our framework of financial dimensions of a business process design. In Section 4, we describe in detail our approach for identifying different financial aspects in business process models by means of exemplary methods. We conclude in Section 5 with an outlook to future work.

2 A MOTIVATING EXAMPLE

Figure 1 depicts a garage fabrication process described in Anupindi et al. (1999) as an Event-driven Process Chain (EPC) (Scheer, 2000). The EPC is a modelling technique for the representation of temporal and logical dependencies of activities in a business process. The EPC denotes one of the most popular approaches to process modelling and are heavily used in practice (Davies et al., 2006), which is why we use them for illustration purpose. EPCs include function type elements that can be used to capture activities of a process and event type elements that describe pre- and post-conditions of these functions. Furthermore, there are three kinds of connector types in EPCs to specify the control flow logic of a process. For details refer to Mendling and van der Aalst (2007).

In essence, the garage fabrication process shown in Figure 1 starts when a garage has to be assembled. In concurrency (AND-split), the purchased parts have to be taken out of the warehouse and the roof has to be fabricated in two steps. Both these inputs are required for the assembly of the garage. Only then, the assembled garage can be put into the warehouse. For each of the EPC functions there are two operations metrics annotated: first, the flow time (i.e., the number of garages or parts required for a garage per week), and second, the flow rate (i.e., the number of units in dollar that flow through a specific function per week).
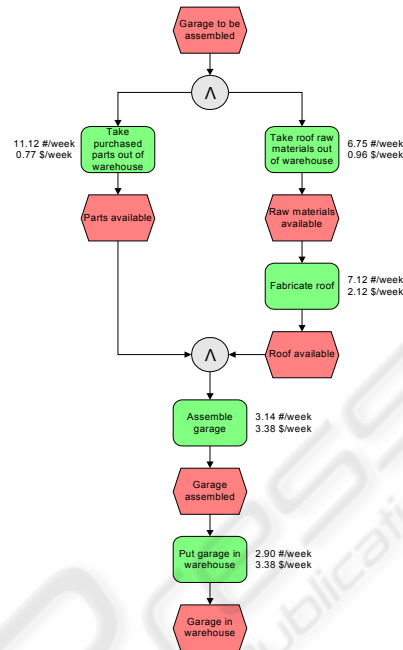

Figure 1: EPC of a garage fabrication process.

It should be noted, however, that in many contemporary business process modelling projects neither of these two flow metrics are actually measured let alone described in a process model. At best, flow times are collected. Consider now a procedure to business process improvement that takes flow times into account. In a naive and ad-hoc approach, one might argue to focus improvement efforts on the function that takes the longest time. Assume that this way the flow time of, let's say, the 'purchase parts' function can be reduced from 11.12 units per week to 10 units per week. As Figure 1 shows, however, the flow time reduction does not improve the cycle time of the overall process since the purchase parts function is not on the so-called critical path – the reason is that the roof fabrication takes longer (6.75+7.12 units per week). And indeed, operations management (Anupindi et al., 1999) informs us that such an approach takes too narrow a stance. Instead, the appropriate criterion to check would be the inventory of each activity. The average inventory can be calculated according to Little's law as the product of average flow rate multiplied with the average flow time. Accordingly, in the garage fabrication process the function 'fabricate roof' has the highest inventory with 7.12 #/week * 2.12 $/# = 15.1 $/ week. But even if we follow this operations management approach, we still miss investments in the business process infrastructure and tax aspects. Changing the process design might impact these dimensions as well.

This small example illustrates the need for taking financial data into account when making decisions on business process change. While several authors in operations management and investment theory (e. g., Anupindi, et al., 1999) discuss the financial impact of changing business processes, these insights are hardly reflected in recent research let alone practice on business process modelling. Accordingly, in the next section, we sketch the integral parts of a system intended to lend better support.

3 A GENERAL FRAMEWORK

The measurement system presented in this paper distinguishes three levels of evaluation: the operational level, the budgeting level, and the corporate level (see Figure 2). The operational level serves to collect payments relevant to a specific process design. The economic value of these payments referring to a company's situation is subsequently evaluated, first on the budgeting, and then on the corporate level. The budgeting level aggregates payments of process designs over time and the corporate level condenses the data to key performance indicators that can form the basis for decision-making.

On the operational level payments (out-payments) and receivables (in-payments) are calculated. They can be directly assigned to decisions on the process design (consider, for instance, payments driven by the process performance). Obviously, these payments considered to be relevant in a specific situation may vary according to a specific decision situation. Research in the field of value-based business process management focuses on the analysis of typical situations in order to derive sets of payments representative for certain application areas.

On the budgeting level, additional parameters are taken into account for establishing the economic value created by respective series of payments. Relevant parameters are derived from specific conditions of funding and tax obligations that a company has to meet. These series of payments are consolidated over time by applying methods of capital budgeting (Grob, 1993; Seitz and Ellison, 2004; Shapiro, 2004). That way, a survey of financial consequences is created.

Finally, on the corporate level, the profitability of a process design and operation has to be judged by condensing the aggregated economic process data into key performance indicators. Measures like the Total Cost of Ownership (TCO) and the Return on Investment (ROI) help to consider relevant parame-

ters for this purpose (Seitz and Ellison, 2004; Shapiro, 2004; Gartner Group, 2003).

As for the budgeting and corporate level, well-established measurement systems already exist (Grob, 1993; Shapiro, 2004). Our framework is designed to integrate these methods from financial management into the context of process re-design. This allows measuring the financial implications of a process design. In doing so, however, the challenge is to find relevant in- and out-payments on the operational level. One promising approach in this context could be the use of Activity-based Costing, (Sapp, Crawford and Rebishcke, 1998), which is a method to decompose cost measures alongside the activities of a business process to identify critical cost drivers.
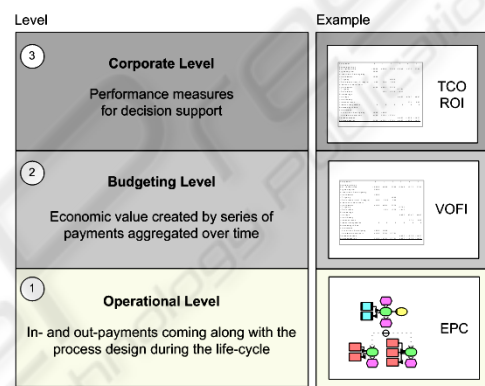

Figure 2: Framework for Measuring the Economic Process Value (EPV).

Still, we have to note that the notion of 'corporate success' typically transcends beyond financial measures. The Balanced Scorecard approach, for instance, takes multiple perspectives into consideration (Kaplan and Norton, 1992). It distinguishes four perspectives of performance measurement, including 'Financial', 'Customer', 'Internal Business Processes', and 'Learning & Growth'. Of these, we focus on the financial perspective, which measures the economic value generated within the other perspectives, in particular by improvements to business processes.

4 METHODICAL SUPPORT

4.1 Preliminaries

This section discusses the systematic consideration of relevant process payments. Our approach is based on the observation that in every process, each and every function brings about *payments* (out-

payments) and *receivables* (in-payments). The approach we propose is to estimate these and aggregate them based on the overall process structure.

The method provided in this chapter sets certain assumptions for covering this task:

- Costs lead to in- and out-payments. The reason for this is that multiple time periods are considered. Accordingly, factor input and/or creation has long term consequences on capital costs. Capital costs are dependent on capital stock that is influenced by means of payments (and not by means of costs and performances).

- Costs have to be allocated to a process. Calculating the value of a single process implies that relations to various other processes have to be taken into account. Here, payments are calculated in relation to the process they are caused by.

Against the background of these preliminaries, exemplary methods for the value assessment of business processes on each layer shall now be presented.

4.2 Measurement on the Operational Level

Payments can be calculated according to different schemas. In this section, basic operations for calculating out-payments are presented. Factors serving as input in the process are identified and assessed. As to the apportionment, factors for both consumption and usage have to be distinguished. Factors of consumption are objects that are consumed by functions. Factors of usage, however, are objects of input that serve as resources for processing a function. They can either be calculated fully or partitioned according to certain keys. The concept of the prevailing calculation is shown in Figure 3.

Out-payments of a function are assembled by payments for the required objects of usage as well as the objects of input that were consumed in the execution of the function. We assume that the payments are aggregated per period such that they capture the operational inventory. In order to calculate objects of input, the amount (and type) of the objects applied in the function have to be accounted for. In order to assess out-payments, the amounts have to be multiplied by the cost per unit. The payment for objects of usage is calculated according to the frequency-of-utilisation principle. This procedure is similar in application to the procedure of activity-based costing. That is, the percentage of resource-utilisation of a function is calculated. For this calculation, resource units that are used by a certain function are proportional to the total sum of all units provided by this resource (see Figure 3).

$$[Payment.Inputobject]_i$$
$$= \sum_{p=1}^{n} [Inputobject.Amount]_{i,p} \cdot [Inputobject.Price]_p$$

$$[Payment.Ressourceobject]_i$$
$$= \sum_{j=1}^{m} [Ressourceobject.Usage]_{i,j} \cdot [Ressourceobject.Cost]_j$$

$$[Payment]_i$$
$$= [Payment.Inputobject]_i + [Payment.Ressourceobject]_i$$

Symbols
i   Index for Functions
p   Index for Objects of Input
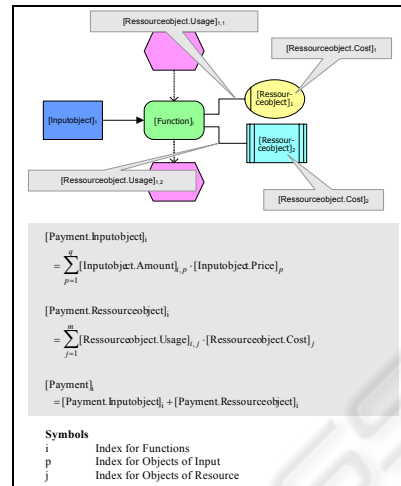j   Index for Objects of Resource

Figure 3: Calculating out-payments.

Payments related to functions now need to be aggregated for each specific process and each period within the planning-horizon. Generally, payments of all functions have to be added. In case of process branches in which an alternative processing takes place, the probability of branches has to be considered (see figure 4).
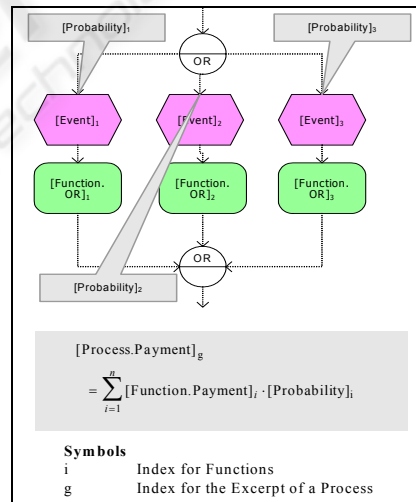

$$[Process.Payment]_g$$
$$= \sum_{i=1}^{n} [Function.Payment]_i \cdot [Probability]_i$$

Symbols
i   Index for Functions
g   Index for the Excerpt of a Process

Figure 4: Aggregating Payments.

In order to investigate the probability, relative frequencies can be estimated in which events reoccur when instantiating the process multiple times. While probabilities of all events related to a branch clearly have to sum up to one in case of an XOR connector, the sum of rates can differ from 100% in the case of OR connectors.

In order to partition both in- and out-payments on various periods during the phase of operation,

constant trend rates can be applied. In addition, special payments can also be planned explicitly and included in the calculation.

4.3 Measurement on the Budgeting Level

On the budget-level, the financial consequences are measured that are derived by the payments on the operational level. For that purpose, the method of ´Visualisation Of Financial Implications´ (VOFI) can be applied (Grob, 1993). Using VOFI, the financial consequences of long-term decisions are structured and calculated by means of spreadsheets that serve as a database for further analysis. Compared to formulas applied by conventional methods of capital budgeting (e.g., Present Value or Annuity of an Investment Project), calculating the investment on the basis of a spreadsheet offers greater transparency and adaptability (vom Brocke and Lindner, 2004). A template of an appropriate VOFI is illustrated in Figure 5.

VOFI for Profitability of Business Processes				
Point in Time	0	1	...n...	h
Series of Payments				
Internal Funds				
– Withdrawals				
+ Deposits				
Instalment Loan				
+ Credit Intake				
– Redemption				
– Debitor Interest				
Annuity Loan				
+ Credit Intake				
– Redemption				
– Debitor Interest				
– Creditor Interest				
Loan in Current Account				
+ Credit Inatake				
– Redemption				
– Creditor Interest				
Financial Investment				
– Reinvestment				
+ Disinvestment				
– Debitor Interest				
Tax Payments				
– Out-Payment				
+ In-Payment				
Accounting Balance	0	0	0	0
Balance on				
instalment loan				
annuity loan				
current account				
financial investment				
Net Balance				[Final Value]

Figure 5: Template for Calculating the Financial Consequences of Processes.

The calculation shown in Figure 5 is to be repeated for each considered period. With this algorithm, the value of an investment in the implementation of a to-be model of a process can be monitored across its life-cycle by observing the net balance in each relevant period. The net balance of period t=n is then the final value of the investment.

4.4 Measurement on the Corporate Level

Apart from general measures provided by capital budgeting, other measures can be calculated associated with specific aspects or relevance to process management. We cannot detail these measures at

this stage and instead refer the reader to the discussion in (vom Brocke, 2007).

The approach described here is not restricted to the assessment of single business processes. Rather, it can be used to facilitate decision-making between different process designs. And indeed, economic process value in a narrow sense can only be assessed properly when at least two alternatives are compared: taking a certain decision or not taking this decision – or in more practical terms: sticking to the as-is state or implementing a to-be model.

In comparing alternative process designs, two different approaches can be applied: a total and a differential calculation (see Figure 6 in contrast to Figure 2). According to a *total calculation scheme*, each process is measured independently. The comparison takes place on the corporate level by evaluating the performance measures for each design. This approach gives a high flexibility, as numerous alternatives can be compared. However, the effort of establishing precise value measurements for each design alternative is substantial.
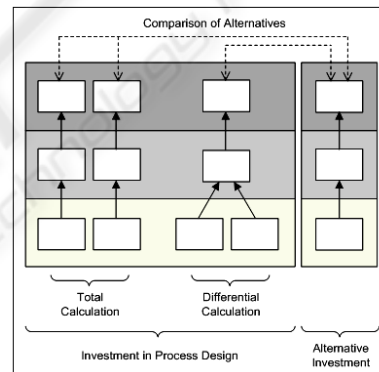

Figure 6: Comparing alternative Process Designs.

Under the *differential calculation scheme*, the idea is to focus only on those additional payments relevant to the comparison of two alternatives (e. g., not the total but only the *additional* expenditure for the implementation of a to-be model, compared to the current state). Accordingly, the comparison is based on measures collected on the operational level, whereby only one financial plan and set of measures is calculated on the corporate level that represents the added value of one alternative compared to the other. The differential approach, however, is limited to pair-wise design comparisons. When comparing more than two alternatives, the effort related to pair-wise comparisons to be assessed grows exponentially.

Following either of the two approaches, the resulting measures should be compared with those re-

sulting for alternative investments (the 'opportunity', Grob, 1993). This way, the return of investments in a process design is compared to the return on investments in further fields (similar to a financial investment). Only in comparison, the value of a process design can be assessed considering the specific situation of a company.

5 CONCLUSIONS

In this paper we presented and discussed an approach to extend typical process modelling approaches with value-related information. This way, managerial decision-making in the context of process management, most notably process improvement, can better be supported. In turn, our approach presents a stronger business case for process modelling. We showed how process modelling can be leveraged to more cohesively and comprehensively provide stakeholders with financial information required to assist process change management.

The presented research findings have to be contextualised in light of some limitations. Most notably, our elaborations have been of analytical and conceptual nature and lack empirical testing. However, our endeavour was to amalgamate existing, proven practices from both process management and financial management practice. Nevertheless, we do consider empirical evaluation an essential aspect of our work, and look to validate our approach in the future by means of case studies with companies engaging in process improvement initiatives and we look forward to present initial results at ICEIS 2008. Second, we have not considered other, potentially relevant, non-monetary measures of process change. Clearly, values of culture, training, people, governance, knowledge, resistance to change, leadership and the like also display pertinence to the success of process improvement projects.

We do not consider our research complete. We do hope, however, that we made a case towards long-needed extensions of process modelling practice so as to be able to better leverage the graphical articulation of processes for various types of decision-making scenarios.

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