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An Integrated Model for Business Process Measurement

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Abstract

Business process management has been a very active subject in practice, software industry and research for the last ten years. Many important contributions are in the business process modeling and its software implementation. Development of Business process modeling software and its ability of using Web Services are key factors for the popularity of the subject. Now businesses are increasingly capable of designing and redesigning business processes to improving business operations and reap benefits, even gaining a competitive advantage. However, research in the evaluation of business processes is lacking behind those of modeling techniques. Past studies have been either on the internal quantitative performance measures or on the satisfaction of customers using qualitative measures. In this paper an attempt is made to combine all relevant measures (with respect to the goals of the business process) into one overall measure. The overall measure is to reflect all stakeholders' perspective and importance on the goals of business process in question. The conceptual model is believed to be a promising tool. Some issues of the model are highlighted and briefly discussed for future research.

Keywords

Business process measure

1. Introduction

Business process (BP) management has been a very active area in recent years. It is without doubt that core business processes are always being scrutinized for possible improvements in order to stay competitive. Information technology holds the best opportunity for realizing new levels of efficiency in business processes. Since business processes change from time to time due to new or modified company and government policies, requirements, and regulations, and also due to advances in information technology. Some well designed innovative business process could contribute paramount value because of the potential for gaining business competitiveness. In the 1990's the concept of business process re-engineering led by Hammer & Champy (1993) call upon businesses to total overhaul or even abandoning existing business processes and replace them with carefully designed new processes. Unfortunately, the BPR movement in the 90's was not successful because, it lacked the support of credible measurement for business process effectiveness, among many reasons. Management needs concrete or tangible evidence from business process implementations. Specifically, they need to know "what is the contribution of business process?" To answer this question some measurement or evaluation mechanism must be institutionalized and relevant data collected. In this paper, the main proposal is to discuss a concept or approach to measuring business process. First we provide a brief literature review.

2. Factors that Influence the Selection of Business Process Measures

Measuring a business process could be a very hard proposition because there is no one single approach, if existed, fits all types of applications. Its difficulty stems from a variety of factors, some of them are briefly discussed below.

- Business goals. It is a common principle that business processes must be aligned with business strategies of a firm. For strategies to be achievable, each should be transformed into explicit goals if possible. Business processes are setup to achieve the derived goals from the firm's strategies. Following the goal setting stage, each goal should be represented by a set of metrics that measure the effectiveness of business process. Different business goals will likely lead to different set of metrics.

- Type of business processes. Classifying business processes into types help making the study of processes easier because of similarities within the class of processes. It is generally the case that the goals of each process within the same class share some common requirements while processes from different classes may exhibit unique differences. According to Alonso, et al, (1997) business processes may be classified into four types: *production workflow, administrative workflow, ad hoc workflow, and collaborative process.* Consider the order fulfillment process, a production workflow type, one of its main goals is to maximize customer satisfaction which may be measured by the "on time delivery". This process is in sharp contrast to the product development process, a collaborative process, whose main goal is to develop new products that will receive market acceptance. A measure for such a process is the number of successful products developed over a fixed period of time which is quite different from the notion of "on time delivery".

- Business process perspectives. Different business process perspective leads to different measures. For each business process, Franken, Jonkers and Weger (1999) propose an evaluation that is based on five different perspectives. Each perspective must be definable by a set of performance indicators/metrics. The five perspectives and their related measure which is given in parenthesis are: customer perspective (response time), process perspective (completion time), product perspective (processing time), system perspective (throughput) and resource perspective (utilization rate). The set of measures defined under each perspective, however, are neither mutually exclusive nor independent. In addition, simultaneous optimization in all perspectives may not be possible because of conflicts among perspectives; e.g., high resource utilization may slow down services to customers. Other business process perspectives can be found in Kwan, and Balasubramanian (1997).

- Process Complexity. High process complexity could increase the difficulty of identifying tasks/sub-processes that generating faults and/or making contributions to the process. In terms of quantitative methods for measuring performance, many methods (e.g., queuing networks) would be too difficult to apply. Thus, the selection of measures for the business process could be influenced by the complexity level of the process. Rolón et al (2006) use FMESP – a framework for the modeling and evaluation of software processes – as a base, they develop a set of indicators for the evaluation of the complexity of business process models represented by BPMN (http://www.bpmn.org/) diagrams. Their procedure may aid

in determining more appropriate methods for performance evaluation of a given business process.

3. Measurement and Analysis Techniques

There are many measurement techniques that have been used for evaluating business processes. Because of differences in goals, types, complexity and perspectives with business processes discussed above, some techniques may be better suited than others in a given application. A broad range of techniques are available, a brief review of some techniques found in the literature follows.

Questionnaires. Generally, the first step in the measurement of a goal is to define what to be measured. Choenni, Bakker, and Baets (2003) propose a generic set of key parameters/attributes in the measure of business processes; they are speed/time, cost, quality, flexibility, and reliability. They assumed that all attributes could be quantified in terms of costs. Their measurement model is an additive cost model from each attribute. The meaning of each attribute must be clearly defined, for example, "speed/time" means the total time (or throughput time) it takes from the beginning of the process to the completion of the process. To obtain such data they use survey questionnaires. They conducted two surveys: one is before and the other is after the implementation of a business process. The difference from the two survey results is then converted to costs. Obviously, their approach will not generate reliable results because firstly their survey is not easy to answer by respondents with accuracy and secondly it is difficult to convert what is measured to cost units. The evaluation framework/desgn based on "before and after" (or pre/post) implementation of the business process is common among the literature. The framework relies upon an important assumption in that the difference between "before and after" measures can be attributable to the new process. The advantage of using survey questionnaires is that it could overcome the difficulties caused by certain subjective parameters that are not easily quantifiable, e.g., user satisfaction.

Critical path analysis. Traditional critical path analysis (in terms of throughput times) has been extended to the analysis of completion times of business processes with choice and iteration constructs (Jonkers, Boekhoudt, Rougoor, & Wierstra, 1999).

Black box views. In this approach the business process itself is viewed as a black box which is invisible, the system properties and behavior are studied through data collected from many inputs and their corresponding outputs.

Markov chain modeling. To use this technique, a business process has to be modeled in the form of states. States of a process undergo changes as activities advance. This phenomenon is modeled by a state transition probability matrix. A successful execution of a business process is when the process reaches its goal states from the initial states. An example of its application is in the calculation of expected completion time for each workflow case.

Queuing theory. A business process is designed to handle "cases". Each case is equivalent to a customer and each activity in a business process acts like a server in a queuing system. So a business process may be viewed as a queuing network and thus results from queuing network

theory may be applicable (Franken, Jonkers, & de Weger 1999). However, queuing theory is complicated by the fact that not only one needs to identify appropriate probability distribution for the arrival process and service time distribution of servers but also one needs specify the so called service discipline, e.g., first come first serve (FCFS). So in most cases application of queuing theory is limited to simpler workflow systems.

Computer simulations. This is a more flexible technique for complex processes because it requires little work from analytic modeling. Assumptions and probability distributions can be changed whenever one sees fit. However, strong statistical knowledge is required to analyze data and validate simulation results. An example is in Weyland & Engiles (2003).

Direct Measures. Votlins (2004) proposes a way of measuring the cost and time of a business process by calculating the time and cost of each activity and then sum over the entire process. Figure 1 is reproduced from Votlins (2004). If one is interested in studying the efficiency of business processes then Votlins's approach is preferred because measurements made at the activity level could help detecting which part/activity of the process revealing exceptional performance, bottlenecks and excessive idle time. In an all e-business process data collection from each activity could be automated; this will produce good source of data for analysis. On the other hand, if data could not be collected from some activities then a manual data collection is required; this may be much slower and produce less accurate data.

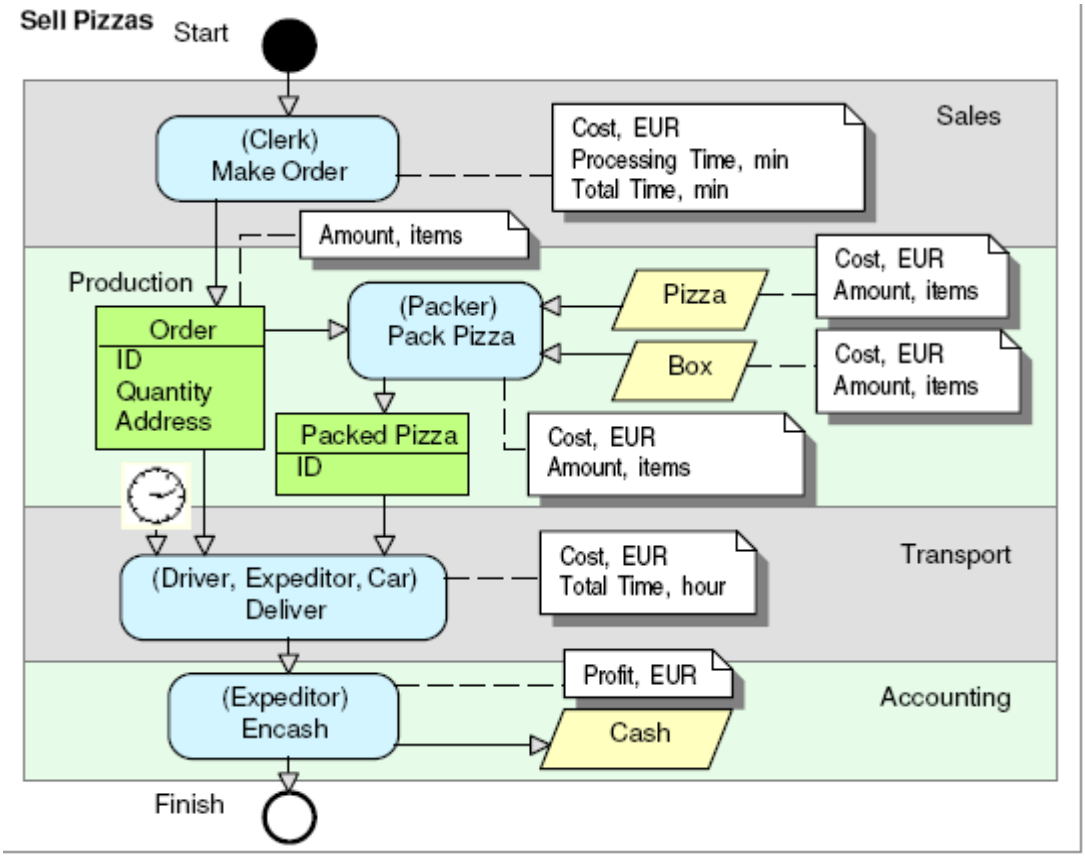

Figure 1. A Business Process for Selling Pizzas. (Source: Fig.1 of Vitolins, 2004.)

4. An Integrated Model of Measures

As stated in the beginning of this paper, the success of a business process is determined by the degree of achievement of pre-set goals. Goals of a business process are in general set forth on behalf of stakeholders who consist of customers, employees, stockholders, to name a few. So the measurement problem in hand is a multi-criteria one. In essence, we are faced with a design issue for the set of measures of business process that reflects all stakeholders' interests. Obviously the idea can be very difficult to carry it out in practice. So far, measurement techniques discussed above only serve a limited purpose because, in most cases, they focus on internal process performance and often limited to certain outcomes, e.g., completion time, costs; also, these measurement methods often belong to the quantitative category. In this paper, a new and simple approach to tackle the problem just described. The proposed approach is to developing an integrated measure that would be more representative of the interests of stakeholders (and therefore satisfying goals better); for simplicity and illustration, two important classes of stakeholders will be considered: customers and employees of the organization.

4.1 Ordinal Scale Measures

Generally, performance measures used for evaluating business processes are either quantitative or qualitative. As an example, a *patient clinical service process* (a business process) has the goal to provide prompt and quality service at low cost. An example of a quantitative measure for such a process is "mean completion time (MCT)"; this is the expected time from the entry point to the exit point of a case processing. Notice that the goal of the business process is stated in a multi-criteria form. To evaluate the success of the process involves use of different measures. To simplify the discussion, we limit our consideration to two stakeholders: management and patients. From the managerial stand point of view, the goal is to achieve the lowest MCT or close to a pre-defined targeted MCT level as possible. However, this may not be the same from the customer/patient perspective. It is because patients are more concerned with receiving the necessary treatments (/quality) of the service (may be measured in qualitative terms such as degree of satisfaction) than the amount of time spent in the service. But the value of MCT is still relevant to the patient; it is simply not the top priority. In order to take both measurement perspectives into account, our approach is to convert and transform any measure into a common ordinal scale in terms of the degree of satisfaction, e.g., very unsatisfied, fairly unsatisfied, neural, fairly satisfied, very satisfied. Equivalently, a 5-point Liker scale can be used to represent the degree of satisfaction. Thus, for a business process, the first step is to identify all important measures that are perceived necessary from each stakeholder class perspective. Next, data are collected and results are calculated as defined by each measure. Then each of these calculated results is rated on the degree of satisfaction using a 5-point Liker scale by groups each consists a sample of members from a category of stakeholders. In the next section we discuss a way to combine them into one score; this score is defined to be the final performance score of the business process under study. The reason for converting all quantitative measures to a 5-point Liker scale is that it facilitates the composition of multiple measures to a single overall measure. For what follows it is assumed that that all quantitative measures could be mapped to a 5-point Liker scale. If a measure involves a qualitative variable it is assumed to be measured by the same 5-point Liker scale.

4.2 Composition of Measures and Issues

In this section the composition of measures is described. Starting from a business process, the steps are: a) define business process goals, b) define critical measures, c) determine the weight of each measure by considering the order of importance among all measures, d) evaluate the outcome of each measure and convert it into a 5-point Liker scale per section 4.1., e) the final step is to calculate the composite measure by applying the weight to step d) and sum. The proposed composite score/measure is an additive weighted model. Weights are used to reflect the relative importance in contributing to the business process goals as perceived by different groups of stakeholders. Several issues arise from this model. 1) Overlapping relationships between measures. For example, the measure MCT completely overlaps with the mean throughput measure which defines the mean number of cases completed in a fixed amount of time. Another example is that the mean number of cases waiting for processing in a business process could be related to the MCT. 2) Setting the Weights for each measure. As afore mentioned in 1) measures may overlap that may cause weighted scores in favor of certain goals. Also, different stakeholders may use the same measure for measuring a goal of interest. For example in a customer survey it may contain the question whether the customer is satisfied with the speed of service she/he receives. The question may use the same MCT measure used by the managers of the company. When this situation arises one would assign more weights in accordance with the importance of the stakeholders. Obviously there are many factors should be considered in determining the set of meaningful weights that corresponds to the set of measures of the business process. This paper will not discuss further on methods for weights determination and assignment. However, when it comes to applications of the additive model one should ensure that the set of measures be in a state of close to the mutually independent (non-overlapped) condition if possible.

5. Conclusions

In designing and implementing a new business process it is important to ensure that pre-set business process goals will be met. This implies that a reasonable set of measures that represents the goals of the business process should be identified and used. Since the goals of a business process are to satisfy all stakeholders in question, such a goal is necessarily of multi-criteria in nature. In this paper, a linear weighted additive model is proposed to serve as a composite measure and a conceptual process of how to apply it is described. Because of possible inflated weighting results from the overlapped member measures in the composite measure, it is recommended that the set of all member measures should be only those that are close to mutually independent measures as possible before entering the computation of composite scores.

In this paper, the assignment of weights and the concept of independence of measures are used in an ad-hoc manner. To formalize such concepts along with a real world application to validate its applicability is one of future research topics.

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