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The Temporal Dimension of Business Processes - Dealing with Time Constraints

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Abstract

The execution of business processes has a temporal dimension and many times there is a set of time constraints that processes have to comply with. Unfortunately, both in terms of process modeling languages as well as systems used to manage business processes, the support for the time dimension is still very poor. In this paper, we describe the main time constraints that need to be considered in the management of business processes and process modeling languages need to incorporate. Furthermore, we point out some avenues for future research.

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Keywords: Business processes; business process modeling languages; BPMS; time constraints; temporal dimension.

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1. Introduction

The temporal dimension is of critical importance in the management of business processes, because its execution is often temporally conditioned. Of course, dealing with time in the business processes domain is not new. Since the early days of BPM (*Business Process Management*), process improvement efforts have dealt, predominantly, with the reduction of cycle times [1]. However, dealing with waiting times and task execution times have mainly been considered goals of the process simulation domain, rather than a process analysis and design concern [2].

Today, even languages such as BPMN (*Business Process Model and Notation*), which is considered the standard *de facto* for process modeling [3][4], only offer basic features regarding time. Indeed, besides the capability to define task deadlines in process models, which trigger when a specific time has elapsed, there is not much more. Although a BPMN model represents dependencies between tasks, the absence of relevant temporal data does not allow BPMS (*Business Process Management Systems*) to offer the visualization of critical paths and timelines during process execution. Regarding the temporal dimension, present BPMS features are limited to the management of "schedules" and sequences of personal activities, monitoring of deadlines and durations of activities and processes, generating notification events (alerts), and handling exceptions in situations where deadlines are not met.

When considering the temporal dimension of organizational processes, Project Management stands out as an influential area of study, since it offers widely accepted and standardized temporal representations, as well as well-known planning tools, such as PERT (*Program Evaluation and Review Technique*) diagrams, Gantt charts and CPM (*Critical Path Method*) [5]. Although one can see some similarities between business processes and projects, in practice the application of these concepts can be very different. Processes (workflows) differ significantly from projects and, therefore, require a specific temporal management [6],[7], being time a major facet [8].

Regarding the structure of the article, in the next section we present a survey of the types of temporal constraints that may appear in a business process model. In section 3, we present an example of the definition of time constraints in a business process model (work-in-progress). In the last section we draw some conclusions and present some avenues for future research.

2. Temporal Requirements of Business Processes

The specification of a business process is accomplished through a model. The model should be able to represent different aspects of business process, including its structure (e.g. order of execution of activities, concurrent activities), manipulated data, technological and human resources involved, etc. In addition to these, a process model may also need to incorporate temporal aspects. Although some time-related process features have been incorporated into the commercially available BPMS, as discussed above, these are usually very limited and therefore tend not to fully satisfy the temporal modeling requirements of business processes.

Regarding the temporal dimension, the rules that govern the execution of business processes may be called *time constraints*. From the perspective of organizations, time constraints depend on business policies, internal regulations, legal constraints, common practices, as well as mutual agreements and expectations related to the efficiency and productivity of the work performed. A process model, of course, should represent these constraints.

The time constraints commonly mentioned in the literature include [9],[10],[11],[12],[13]:

- *Activity duration*

  Given a process model, one may assign execution durations to activities. These durations are assigned by process analysts, based on estimates, projections or derived from past executions of these processes. The expected value of the duration of an activity might be calculated in the same way as in the PERT method, that is, by a weighted average of three time estimates (optimistic time **a**, pessimistic time **b** and most probable time **m**). The calculation of the average or expected time of an activity is thus obtained by the formula: (a + 4m + b) / 6.

- *Process duration*

The duration of a process is calculated by the temporal distance between its initial activity and its final activity. A minimum duration and/or maximum duration might be assigned to the process. For example: "*Each loan application should be processed in no more than two days (maximum duration). However, to ensure the quality of the executed process, the processing of each loan application should take, at least, one full day (minimum duration)*".

- *Deadlines*

Given a process model, one may assign deadlines to the activities and/or the entire process. A deadline might be specified in terms of absolute time limits, at the initial time or in the final time of carrying out an activity, that is, during the execution of a process it can be assigned a certain period within which an activity should start or end. A deadline may be specific to an activity or may be interdependent. The specific deadline of an activity does not depend on other activities in the process, i.e. we can simply specify that activity A should end at a given point in time. On the other hand, the interdependent deadline introduces temporal dependencies between activities. For example, we can specify that activity B should end at a specific time after the start or end of activity A, and there may be other activities between activities A and B.

- *Minimum limit*

The minimum limit defines that the time interval between activities A and B must be greater than or equal to a certain amount. This restriction limits when an activity should start/end in relation to another activity. For example: activity B should start no earlier than N times after activity A is finished. An example of a minimum limit is the invitation to a meeting that must be sent to participants at least one week before the meeting.

- *Maximum limit*

The maximum limit defines that the time interval between activities A and B must be less than or equal to a certain amount. This restriction limits when an activity should start/end in relation to the begin/end of another activity. For example: activity B should start no later than N times after activity A is finished. An example of a maximum limit is a project proposal that must be completed no later than seven days prior to the meeting.

- *Fixed date(s)*

Specifies the date(s) on which an activity can be performed, i.e. a certain activity can only occur on certain (fixed) dates. This time constraint is used to express the fact that an activity can only occur on specific dates. For example: payment to suppliers is only carried out after the 15th of each month.

- *Waiting time*

In specific phases of the execution of a process, there may be a need to wait a certain amount of time before proceeding. As with deadlines, the waiting time constraint may be activity-specific or may be interdependent. The specific waiting time for an activity determines the time an activity should wait before it starts to run. On the other hand, the interdependent waiting time introduces temporal dependencies between activities. For example, it may be specified that activity B should not begin or end before a specific time after the start or end of activity A.

- *Negative information*

Represents a date or date interval where an activity may not be performed. The concept of negative information of an activity is completely opposite to the concept of a fixed date, since the fixed date represents the date(s) in which an activity can be performed. An example of negative information may be: activity A may not be performed on holidays, vacations, etc.

3. Business Processes Temporal Management

In order to manage the time dimension, it is needed to create a temporal process model. As an example, Fig. 1 represents a process model (for the sake of generality, we have decided not to use any of the most common process modeling languages) with six activities which incorporates some of the previously defined time constraints: *minimum limit*, *maximum limit*, *process deadline* and *negative information*. The temporal constraints on activities are represented in the process model through additional elements - *time links*.

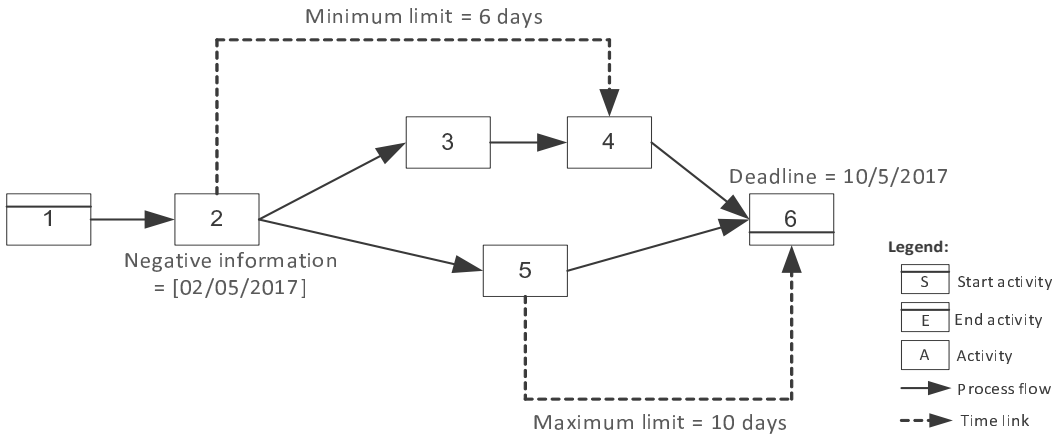

Fig. 1 Definition of time constraints in a business process model

After defining a process model that incorporates temporal aspects, it is required to check if the defined time constraints do not contradict themselves (if they are coherent with each other) and if the set of time constraints is feasible and correct. That is, if it is possible to find some execution scenario (instance of the model) that satisfies all the temporal constraints. In other words, it is necessary to verify if the model has *temporal integrity*.

As this is a work-in-progress, these aspects will be detailed in further studies.

4. Conclusions

Business processes have temporal aspects. The temporal management of business processes is therefore crucial. However, it only has practical feasibility if supported by suitable tools. If BPMS intend to be the right platform to support the definition and execution of business processes, then they have to properly consider the temporal dimension of processes. Unfortunately, present BPMS offer a very limited support for the temporal modeling and management of processes. Indeed, of the various time constraints described in this paper, the BPMS available in the market basically support the definition of dates and durations of the activities. This is extremely poor. BPMS have to evolve in order to provide the needed mechanisms for the effective temporal management of business processes, being this an important avenue for future research.

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