On the Notion of Flexibility in Business Processes

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Abstract. Business process flexibility, while very much desired, bears a rather vague meaning. The paper aims at discussing the meaning of flexibility in business processes. The discussion applies concepts taken from two theoretical frameworks: the Generic Process Model (GPM) and the theory of coordination. Two forms of flexibility are discussed: Short-term flexibility, which is the ability to deviate temporarily from a standard way of working, and long-term flexibility, which is the ability to easily change the standard way of working.

1. Introduction

In the dynamic and fast changing business world of today, organizations must change constantly in adaptation to changes in the environment. Consequently, flexibility has become a holy grail to be sought. However, the term "flexibility" is often used for expressing terms of different meaning, thus its essence is not always clear.

Different disciplines address flexibility from different points of view. In the workflow literature, flexibility is usually associated with exception handling capability (e.g., [1]). Attempts are made either towards an efficient mechanism for handling run-time exceptions [1] or towards an "exception-free" workflow model (e.g., [3, 4]).

Flexibility has been widely addressed with respect to manufacturing systems, focusing on production capacity. As reviewed by [6], many definitions and classifications were suggested. Basically, flexibility is described as capability to react to uncertainty by adaptation. Relevant factors addressed are the range of possible configurations (or products) a system can adopt, cost and time of migrating to new configurations or products, the level and magnitude of changes a system can handle without having to change and while keeping normal operation, and others. Concluding from this survey, [6] defines e-business flexibility as the ability to react to changes by taking advantage of IT through collaboration and cooperation.

Virtual organizations are described as means for achieving flexibility [2], in the sense that the organization and its business processes are formed ad-hoc for a specific task or goal achievement. This satisfies the need to change constantly rather than maintain a fixed structure.

It is evident that "flexibility", while very much desired, bears a rather vague meaning. The aim of this paper is to provide insights into the meaning of flexibility of business processes. By gaining an understanding of what flexibility is, it should be possible to

establish ways of achieving it. Specifically, we distinguish two forms of business process flexibility, namely short-term flexibility, which is the ability to deviate temporarily from a standard way of working (e.g., exception handling), and long-term flexibility, which is the ability to easily change the standard way of working.

The discussion of flexibility in its two forms shall establish a close relationship between the concept of flexibility and the concept of goal. The discussion shall also be based on the theory of coordination [5], and relate to dependency types defined by this theory. We shall first provide some theoretical background for the discussion, introducing key concepts of the Generic Process Model (GPM) [7, 8] and the theory of coordination; then present and analyze the two forms of business process flexibility.

2. Theoretical Background

This section introduces two key concepts which form the basis for the discussion of flexibility, namely process goals and coordination.

The term goal, frequently used in the process modeling literature, is used for expressing concepts of different meanings. In particular, there is often no distinction between *operational goals*, defining a desired state to be reached by a process (e.g. "complete an order"), and *strategic goals*, which are more abstract objectives the organization is striving to achieve (e.g. "being responsive to market demand"). The former type can be accomplished via a given process, while the latter type of goal cannot usually be achieved by a specific process, yet it is important for the organization. In this paper the term goal relates to an operational goal, while strategic goals are referred to as soft-goals (see details in [8]). The goal definition relies on the Generic Process Model (GPM) [7, 8], which is a formal, ontology-based framework. Here we shall informally outline its relevant concepts.

A process model in GPM specifies a set of allowed transitions between subsets of states, starting at an initial subset of unstable states on which a process is triggered, and ending on a subset of stable states, which is the goal set. Each subset of states is specified by a condition it satisfies. The transitions are governed by a law that specifies mappings from a source subset to a target subset.

A process goal is, therefore, a subset of states that satisfy a condition (which denotes what the process is intended to achieve). Existing constraints that restrict the states and transitions the process can go through are specified by the law.

The second key concept to our discussion is coordination. Coordination, according to Malone [6], is the management of dependencies among activities.

Three basic types of dependencies are distinguished: (a) Flow dependency, where one activity (process) produces a resource that is used by another activity. (b) Sharing dependency, where multiple activities (processes) use the same resource. (c) Fit dependency, where multiple activities (processes) produce a single resource.

While in sharing dependency the resource is usually physical and clearly of a limited capacity (otherwise no dependency exists), we may extend the meaning of "resource"

in flow and fit dependency, and use it for any result of a process or an activity, be it a thing of substance or a state of the domain.

Note, while flow dependency and sharing dependency relate to conditions for initiating an activity or a process (part of the GPM law concept), fit dependency relates to its goal. It can be perceived as a set of sub-processes, each having a goal which is a step on the way to achieving a mutual goal of an overall process. The sub-processes may be concurrent or sequential. This view allows us to address fit relationship as part of the process law, similarly to flow and sharing dependency.

The notion of process goal together with the dependency types defined by the theory of coordination shall serve as a basis for the discussion of flexibility in the next section.

3. Flexibility of business processes

This section applies the theoretical concepts in order to discuss the two types of flexibility: short-term flexibility, which is the ability to deviate temporarily from a standard way of working, and long-term flexibility, which is the ability to easily change the standard way of working.

While it is clear that flexibility in general is some kind of capability, it would be interesting to find out whether the two types of flexibility are two independent sets of capabilities, whether they are correlated to each other, or whether they are just different forms of a single set of capabilities.

Using GPM concepts, short-term flexibility is the ability to reach the goal of the process from a state which is not the "normal" state of affairs. This means that the law includes a *minimal set of essential constraints* on the course of the process. In other words, the conditions defined by the law are "looser", and the sets of states in each step of the process are larger than the ones in rigid processes.

In order to identify what an essential set of constraints is, the sources of constraints formed by organizations on their business processes should be examined. These constraints can be classified as follows:

(1) Constraints posed by the environment (e.g., government regulations).
(2) Constraints that are designed to guarantee that all related processes shall achieve their goals.
(3) Constraints imposed by the BPS system as a result of its particular design.
(4) Sharing dependency-related constraints.
(5) Constraints aimed at achieving certain levels of measures related to soft-goals.

In what follows, we shall discuss each of these constraint types and its implication on short-term flexibility. Specifically, we will try to identify which constraint types can be considered essential.

Environmental constraints – constraints of this type are imposed on the organization and cannot be eliminated in the short term. The organization may initiate a move for

changing the environment to release these constraints (e.g., by lobbying), or may discover in time that they no longer exist (e.g., in case of technology constraints). However, as long as they exist, they belong to the set of essential constraints.

Goal reachability constraints – It is reasonable to believe that every process is designed so as to attain its goal. However, this is not always guaranteed. [7] used GPM as a basis for analyzing process validity, namely the ability to reach the process goal, and identified three possible causes for invalidity. In particular, two of the three were related to events which are external to the process, and may result from interaction between processes. Interaction is when one process requires a state that is reached by another process. It may mean that the process is triggered or reactivated (after being temporarily stable) by such state, or that it simply uses it. Invalidity is caused when a failure in an expected event prevents the process from reaching its goal. For example, a production process requires the availability of materials in inventory in order to be executed and achieve its goal. The availability of the materials is achieved by a purchasing process, whose failure will lead to failure in the production process too. Another example is a sales process, where the customer's credit must be checked before an order is placed. The state of the customer's credit is determined by the process of accounts management, and is required for the sales process to proceed towards its goal.

In terms of the coordination theory, such interaction between processes is a flow dependency. The interaction forms constraints on processes, requiring them to reach the states needed for other processes to achieve their goals. Relating to the above examples, the production process poses constraints on the purchasing process, and the sales process poses constraints on the accounts management process. These constraints are essential, since the result of not meeting them is that goals will not be achieved.

Constraints imposed by the BPS system – BPS systems are designed to support a certain way of working. They do not necessarily support each and every possible way of attaining the goals. Once operating, they may not allow actions they were not designed to support, even if these may lead to achieving the process goal. As an example, consider a process of municipal tax collection, where payment can be made for a predefined time period only. Assume the ownership of an estate has changed in the middle of the payment period, and the seller wishes to pay for the time until that specific date. The current process does not allow it, as no partial payment can be made. However, this constraint is not related to the goal of the tax collection process (since the buyer can pay for the rest of the time), nor does it contribute to the achievement of any other process goal. The constraint is clearly imposed by the BPS system, whose design followed an easy-to apply rationale.

Constraints of this type are not essential. They introduce rigidity to the business processes, and this rigidity is not necessary in terms of achieving the process goal.

Sharing dependency-related constraints – in a sharing dependency, multiple activities require a single resource. The effect of such dependency on the business processes is usually the existence of coordination mechanisms that allocate the resource(s) to the activities. However, if the resource capacity is not sufficient, or if the number of

activities competing for the resource is high, coordination may be hard to achieve. In such cases, organizations may form simple rules to regulate the use of the resource, transforming sharing dependency into flow dependency. As an example, consider the process of assigning computer classes to courses in a university. If the capacity of the computer classes is sufficient, then each course can be assigned to a class as it requires. If the capacity is not sufficient, the university may decide that courses that require large classes will be assigned first, and smaller courses afterwards. In order to address the sharing dependency, a flow dependency was created, so small courses cannot be assigned to a class before all the large courses are. The result is a constraint on the course of the business process.

To answer the question whether constraints of this type are essential – obviously, increasing the capacity would eliminate the need for these constraints. However, this is not always possible. Nevertheless, it is important to be able to distinguish constraints of this type, since they may sometimes remain long after capacity has been increased, as their origin was forgotten.

Soft-goal related constraints – soft-goals stand for business objectives the organization is striving to achieve. They can sometimes be operationalized through measures that serve for evaluating the specific goal state achieved by a process. Different paths of a process may yield different values of these measures. In order to avoid undesired values, the organization may form constraints that restrict the possible paths to be taken and do not allow the process to reach a goal state whose soft-goal performance is very poor (e.g., producing an item using a machine that incurs very high cost will be avoided). Should constraints of this type be considered essential? Path priority rules can be defined instead, leaving a possibility to still take the path in case there is no other way the process can reach its goal. For example, if all other machines are unavailable, an item will be produced by the high-cost machine, since there is no other way it can be produced. Under normal circumstances, of course, this path would not be taken.

Concluding the above discussion, the constraints that should clearly be considered essential are environmental constraints and goal reachability constraints. Other types of constraints can theoretically be eliminated (although in practice it may require effort). Leaving only the essential constraints would enable a relatively high number of paths to be taken each time the process is executed, hence achieve short-term flexibility.

Regarding long-term flexibility, which is the ability to easily change the standard way of working, our discussion shall focus on change and some of its facilitators.

Software engineering advocates modularity as a means for locally administering change. The essence of modularity in this context is that constraints posed by one module on another are limited and well-defined. Relating this to business processes brings us back to the essential constraints discussed above. The question is whether a set of essential constraints resulting in a short-term flexibility would also yield long-term flexibility.

A change in the business processes can be a change in the goals (adding, modifying, or omitting goals) or in the constraints (adding, modifying, or releasing constraints).

Any of these changes may lead to a chain of changes, both in goals and in constraints, due to interaction among processes. The chain of changes results in a new set of interacting processes, which must comply to environmental constraints and to (newly defined) goal-reachabilty constraints to be valid. The ability to clearly identify interaction among processes and its resulting constraints is, therefore, one of the facilitators of change.

BPS system imposed constraints – a BPS that is designed to support an existing set of processes, even if it is goal-oriented and imposes only the essential constraints, does not necessarily support a different set of goals and constraints. Hence, a BPS system that provides short-term flexibility in a given situation does not necessarily provide long-term flexibility. In the other direction, a BPS system that supports long-term flexibility is one that allows processes to be easily changed. This does not mean that once the new standard processes are supported, deviations from these standards are easily handled.

Sharing dependency constraints – the role of these is similar with respect to both types of flexibility. Flow constraints that serve as coordination mechanism should not be considered as constraints when designing business process change, since the real constraint they reflect is of resource capacity.

Soft-goal related constraints – these constraints, while not necessarily imposed in the short term, cannot be ignored in the long term. When a deviation from the normal course occurs, it may be treated as an exception, and a compromise on a soft-goal can be considered for the process to reach its goal. However, when the standard way of working is changed, the new standard should be designed according to the defined soft-goals. For example, a high-cost special delivery to the customer can be considered when an order is late. This is not the standard way of working, but the organization may be willing to pay more in order to deliver the order on time. This will not become the standard way of working if the costs are too high, and may cause the organization to loose money.

In summary, although short-term and long-term flexibility are closely related, they do not necessarily appear together. Still, the ability to classify constraints and identify an essential set contributes to both flexibility forms.

4. Conclusion

This paper discussed the notion of flexibility in business processes, using concepts of two theoretical frameworks – the GPM framework and the theory of coordination.

This combination, and in particular, the representation of processes in terms of goals and constraints, and analyzing constraints in terms of dependency types, has proved to be useful.

Two types of flexibility were discussed, namely short-term flexibility and long-term flexibility. These two, while closely related, are not necessarily achieved at the same time.

The understanding gained here can form a basis for designing methods and tools for achieving flexibility. Future research may address both short-term and long-term flexibility. Regarding short-term flexibility, the issues to be addressed are

identification and classification of constraints, and designing the BPS system accordingly. Regarding the long-term flexibility, the main issue seems to be impact analysis of changes in goals and constraints of a set of business processes.

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