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Planning of business process execution in Business Process Management environments

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ABSTRACT

Efficient management of business processes is a key element of enterprise information systems for organizations operating in a competitive business environment. Despite methodology introduced to enhance the effectiveness of Business Process Management, research on the initial phase of system implementation has typically focused on the accurate execution of processes, not efficiency. The enhancement of process efficiency in various manufacturing applications, however, has received much attention over the past several decades. Unfortunately, due to the dissimilarities between business and manufacturing processes, optimized manufacturing processes cannot be applied directly to business processes. This study introduces a methodology for incorporating business process semantics and alternative paths in the Business Process Management structure. The approach entails mixed integer programming (MIP) formulation for a business-process execution plan and a meta-heuristic algorithm to obtain good solutions for multi-activity processes.

1. Introduction

The increasingly competitive business environment is impelling firms to pursue various innovative means to reduce costs and satisfy customer demands. Recently, companies have recognized the importance of Business Process (BP) innovation to survive and accordingly have adopted various methodologies entailing primarily process-oriented reconfigurations of enterprise information systems [4,7,8,15,31,36]. At the core of the new structure, the Business Process Management System (BPMS), comprised of integrated software, designs BP models, manages the execution of them, and facilitates process improvement [11,18]. Thus far, the BPMS has been applied to a variety of areas such as precise modeling, control, and execution of complex business processes [1,23,26]. Moreover, as more companies adopt the BPMS and as the number of processes managed by the system increases, the efficiency aspect of BP execution is garnering more attention. Despite the importance of BP efficiency, optimization methods have rarely been studied, and only scheduling techniques have been extensively investigated.

For over several decades, process efficiency enhancement has been a topic of interest in various manufacturing applications [6,21,27,29,37,43]. These methods, however, have not been applied to BPs, which are different than those used in manufacturing. Most of the differences reflect the human element inherent in BPs, which generates uncontrollable variances and uncertainties as knowledge must be considered in performance evaluations. Applications of the manufacturing methodology

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to service systems consisting of business process have been recently reported [2,39]. This indirectly shows the necessity of applying the scheduling methodology to BP planning. This paper provides a mathematical formulation and solutions to the BP execution plan by using scheduling algorithms developed for manufacturing systems.

By applying BPMS, companies can solve BP problems with the aid of a mathematical formulation. First, a formal BP model is developed with a specific design tool, and then potential performers for each BP task are determined, much like resource assignments are made in a manufacturing process. Second, due to the automated process flow using a BPMS, the delay between tasks can be reduced significantly during BP execution. This introduced efficiency reduces uncontrollable variance in processing time due to poor task performance by human workers. Third, a process modeling tool in the BPMS provides an interface requesting a user to input expected processing times for each BP activity. By utilizing a BPMS, firms treat the BP like a complicated manufacturing process.

The problem of executing a BPMS is similar to those involved in scheduling manufacturing processes: The objective is to find an optimal assignment that yields the most efficient performance under resource limitations. Efficiency measures commonly used in manufacturing scheduling, such as makespan, cycle time, and flow time, can be directly utilized for enhancing BP efficiency. However, optimization techniques of manufacturing cannot be directly applied to BPs, which allow for alternative paths. Despite the difference between the manufacturing and business environments, by modifying existing scheduling optimization techniques, a good plan of BP execution can be obtained.

This paper is organized as follows. In Section 2, the BP and related execution plan are outlined and compared with a manufacturing process, and existing literature is reviewed. Section 3 offers a definition of a formal BP model along with a mathematical formulation for optimizing a BP execution plan. Section 4 introduces a Genetic Algorithm (GA) effective for finding a solution to the problem. Section 5 discusses the experimentation conducted, and Section 6 draws conclusions.

2. Background and literature review

2.1. Business process execution plan

In an environment where a BPMS is employed, two phases characterize the BP process; build-time for modeling and run-time for execution. During the build-time phase, activities in a process are defined and precedence relationships among the activities are designed with a graph notation [40]. Many BP modeling standards have been suggested to support the build-time phase [24]. In process models, attributes for each activity, such as name, expected execution time, and candidate performer (s) are also specified. During the run-time phase, the values of the attributes are determined as results of process execution. For instance, even though the expected execution time is predicted, actual execution time of the activity is fixed during the run-time phase. Completion times of all activities and the whole process are influenced by the assignment of performers to tasks. In this paper, we call this assignment "the BP execution plan".

Comparing a BP execution problem with a production scheduling problem, one expects the activity execution time to provide a solution for minimizing the completion time of a process. Build-time modules of most commercial BPMSs provide a Graphic User Interface (GUI) in which users input the expected execution time of activities. Using a GUI for the BPMS process, activity, and task performer (i.e., human or software agent), firms can map the BP to the job concept, operation, and machine (of the manufacturing domain), respectively, as shown in Table 1. This mapping has already been introduced in [5], and we added the mapping of execution time to processing time in the table. Even though BP factors are utilized similarly to those characterizing a manufacturing problem, the alternative activity performers and possible paths in a BP execution plan must be considered. Recent models have allowed for alternative machines in the manufacturing problem, which legitimizes the use of scheduling techniques in BP environments. Consideration of alternative paths in process network structures using a mathematical formulation, however, is a unique contribution of this paper; this approach has not been tried in previously published research.

If BPs are automated and managed by a BPMS, the problems are similar to those of manufacturing processes. Therefore, the following reasons explain that a BP execution plan can be developed using the scheduling approach for manufacturing processes:

- The BPMS enforces the use of a formal process model. In a conventional scheduling problem, an operation sequence is given. Where a BPMS is employed, the structure provided in the model clearly depicts the order of precedence among process activities. For each activity, a user (or other expert) can provide an expected processing time, which is used as an input value for scheduling.

Table 1
Mapping between BP execution plans and manufacturing scheduling.

BP execution plan	Manufacturing scheduling
Process (instance)	Job
Activity	Operation
Human/software agent	Machine
Execution time	Processing time