P-graph based workflow modeling with fuzzy extension

PhD Thesis

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2007
1. The problem, research demand, goals and objectives

The cost effective and error free management solution of the complex operation management processes as well as the solution’s efficiency rate are corner points in the life of profit- and non-profit- oriented organizations and institutions, since the optimal efficiency of the complicated business, office-automation processes is of primary economic interest. The optimization of processes greatly depends on the good modeling tool and on the fact that the tool system necessary to find fast and systematically the optimal solution should be available.

Workflow is the most widespread modeling technique application in the field of business and office information systems. At present, there is no such process-based methodology amongst the workflow based modeling techniques applied for workflow formulation, modeling and optimization that would provide a systematically guaranteed optimal workflow-network structure. The structure optimization in this field is not scientifically based but realized on an empirical way.

This fact made this research necessary in this field. The application of methodologies elaborated and used in the PNS field of system network synthesis enables resource-critical structure optimization.

As a result of my research I aimed at elaborating such a methodology in workflow modeling whose background is mathematically justified, the optimal workflow structure algorithmically leads to an optimal solution, while considering more properties than in the traditional way.

I also aimed at working out such a new model that apart from the handling of the process-structure enables the handling of the input-, temporary-, and output documents, is capable of the quantitative and qualitative consideration of the necessary and available resources, as well as the management of the resource- and other type constraints and other bottlenecks. Furthermore, my goal was to introduce such a methodology that enables to achieve a better modeling of real processes, a better handling of the life-like, ambiguous, non-exactly definable situations, by applying fuzzy solutions.
2. **New scientific results**

The summary of the new scientific results in theses of the dissertation:

1. I have developed a concept for a new network-structure oriented, P-graph based workflow model that enables, in contrast to the traditional workflow models, a more suitable modeling for workflow synthesis.
   1.1. I have outlined and given a criticism to the traditional solution methodologies of workflow modeling. I have pointed out the shortcomings of the existing solutions and highlighted the necessity of the introduction of workflow synthesis (WFS).
   1.2. I have introduced the P-graph based workflow model, the concepts and the management of documents and activities in the new model.

2. I have developed the WFS model with P-graph based workflow model extension and with the introduction of time and capacity constraints. In order to describe real problems and tasks I have worked out a more adaptable system than the already existing ones for the methodology of the PNS based optimization of network structure.
   2.1. I have worked out such a P-graph based workflow model that enables the determination of the optimal structure of work processes through the novel approach.
   2.2. I have provided a methodology, how the impacts of the constraints – resource and time constraints, bottlenecks, - that reduce the efficiency of the work processes can be analyzed in the model.
   2.3. I have provided the adequate mathematical model in the P-graph based structural model of work processes, whose solution provides the optimal structure of the given work process-network.

3. I have elaborated a tool in order to achieve a more precise modeling of reality that extends the traditional process-synthesis model in a way that it would make the handling of the uncertain elements in the system possible.
   3.1. I have introduced an operation activity with fuzzy properties in order to describe the activities including uncertainty in the P-graph based workflow model.
   3.2. I have worked out an algorithm in order to determine the optimal structure of the extended model.
3.3. I have developed a new parametric t-norm for the realization of the fuzzy operation activities, with the help of which the real task can be approximated a lot better during the system-tuning process.

3. Implementation

The theoretical solution for the P-graph based extended workflow modeling presented as a result of the research meets the requirements given in the objectives. The methodology has been examined in application. In a case study I have solved a real task, i.e. modeling the work process of the state administration procedure of speeding motoring offence carried out in the Budapest XI. District Policy Headquarters and I have carried out the resource-critical structure optimization.
4. Publications in the last five years

Publications in the PhD research theme

Reviewed articles in international journals:


Publications in reviewed international conference proceedings:


Seven independent references have been published in reviewed international conference proceedings.

**Publications in other research themes published in reviewed international conference proceedings:**


Sixteen independent references have been published in refereed international conference proceedings.