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A Model of Workflow Composition for Emergency Management

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Abstract

The common-used workflow technology is not flexible enough in dealing with concurrent emergency situations. The paper proposes a novel model for defining emergency plans, in which workflow segments appear as a constituent part. A formal abstraction, which contains four operations, is defined to compose workflow segments under constraint rule. The software system of the business process resources construction and composition is implemented and integrated into Emergency Plan Management Application System.

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Keywords: Business process; Resource; Composition; Emergency

1. Introduction

In the field of emergency management, governments, enterprises and institutions have formulated many emergency pre-arranged planning, in which different response levels are defined according to all different situation. Every response level defines the tasks needed to be accomplished by all the participant units and the relationship among different tasks. When emergent event occurs decision-makers must give effective response in the shortest time and coordinate all the respective staff. At the present time, most integrated emergency response information systems are lack of the management of emergency pre-arranged plans, or only focus on the documents management of plans without formal model. When complicated emergent event occurs, departments in charge usually have to consult several pre-arranged plans and make organizing and integration. How to make emergency pre-arranged planning be really helpful to decision-maker? This article defines business process source, formalizes emergency plan into business process source, defines algebra system which includes several operations, achieves the business process source construction and assembling suitable for final users, and applies it in emergency response information systems.

Business process modeling [1] is an intensive study field at present, which can refer to Petri, UML etc. in aspect of workflow modeling. While in workflow modeling there are rigor requirement to control flow as implemented [2], in emergency response field, when implement process, user should have the ability to define business process flexibly. Different users define different process, rules, data resource and etc., which are written integrated. On one hand, users need to manage resource separately and emergency response processes defined by themselves. Sometimes, data need to be isolated for the reason of confidence. On the other hand, these business processes need to work coordinately, make kinds of complicated logic assembling and collective presence, which requires data source sharing in process. So business process is a kind of resource which includes not only business logic but also data. This paper concerns how to consider above factor in process modeling and management.

In the field of emergency management, emergency plans is managed by the ontology technology, and from the starting, formal description of the individual plan is studied [3][4]. The relationship between emergency pre-arranged plans on the respect of macro point is studied in [5]. Flexible workflow research the agility of workflow modeling and executing. The logical relationship among tasks of Web Services is defined by Web Services composition [6]. The task of Web Services is different from task what emergency plans are formatted. To solve the issue of modeling for loosely coupled inter-organizational workflows (LCIOWF), based on the colored Petri nets, the colored multi-dimension inter-organizational workflow (CMD/IOWF) Nets is proposed through importing color-set, colored function, resource places, waiting places, busy places, begin transitions, end transitions, roles, organizations, time functions, resource functions and transition functions into IOWF [7]. However, the work is lack of Web system background. SOEDA [8], an approach that unifies EDA and SOA by introducing a development method takes advantage of the unique properties of both architectures. The method reaches from abstract process specification over event and process implementation to the final execution phase-described in an abstract manner. The work is not involved with labor, and can not solve the problem completely in emergency information system.

2. Business process resource abstractions to support emergency plans modeling

2.1. Emergency Plans modeling

Modeling emergency plans is a formal procession from documental emergency plan text to a structured data. In emergency information system, the emergency event is one of the key research objects. The information of event contains time, place, characters, task, and consumption of resources, which is 5W principle: when, where, who, what, how. The pre-arranged emergency plans contain these 5 kinds of information, which is formulated by all kinds of emergency response units. All have their own industry or self-management features. Emergency management information system has to meet the problem of data abstraction definition, which reflects the special nature of all emergency units. Each emergency plan, formulated by each emergency unit, is considered severities of a certain kind of emergency event. Each severity correspond a response level, and each response level correspond an emergency business process. When an emergency event happens, the emergency response process is complicated and involves multiple departments and plans. How to organize these response processes rationally is a problem which this article mainly mentioned. We formulate emergency plan into business process resources. The modeling and composition of business process resources is deeply discussed in this article.

2.2. Definition of business process management

In business process management, workflow is one of the core technologies. Workflow concerns business process is definition strictly and execution reliability, and data flow and control flow in workflow is separated. We propose business process resource, which is considered control logic and data corresponding and linking. The definition of business process resource is as follows.

Definition 1: The model of business process resource.

Business process resource is a four-tuples. It is a recursive definition.

business process resource (Role, Task, Rule, Relation)

Role is the set of role in business process resource.

Task is the set of elemental task in business process resource.

Relation is the set of relation between business process resource and elemental task. It includes sequence, concurrency, xor. That is a set as below.

Relation operator={sequence, concurrency, xor}.

Rule is conjunctive normal form of expression, which contains the description of emergency event properties.

Rule= $r_1 \ r_2 \ r_3 \ \dots \ r_n, n \in \mathbb{N}$.

r_n is a three-tuple (event property, comparison operator, data). Event property is two-tuple (property name, data type). Data is constant, which type is same as event property. Data type is kinds of numeric and character.

Rule expression is the premise of the execution of elemental task and business process resource.

For example, No.1 emergency response of a certain emergency plan of traffic accident on speedway is formalized as p(role, task, rule, relation).

role={department of health, transportation department, department of first aid},

task={'dispatch ambulance', 'cure and treat the wounded', 'accident responsible affirm', 'remove danger and rescue people'},

rule=(death number \geq 10) (accident vehicle='bus') (property loss degree='great'),

property ={(death number, numeric), (wounded number, numeric), (property loss degree, character), (accident vehicle, character)}

relation= ('dispatch ambulance' sequence 'cure and treat the wounded' concurrency 'accident responsible affirm' concurrency 'remove danger and rescue people').

2.3. Business process resource composition

As a management unit, business process resource is edited and stored by each business unit and each business unit is grouped to be a management domain. Further more, business process resources are involved in algebraic computation. After algebraic computation, the task information in business process resources is separated as easy as before. We define 4 operations in the set of business process resource, such as sequence, concurrency, XOR selection, and quote, which is indicted with <,+,*,Linking. The algebraic system on the set and operations is a lattice.

A business process resource is created by business users without linking any other business process resources, which we call elemental business process resource, while we call a complex one which quotes other business process resources. The advantage of operation in the set of business process resource is that both elemental and complex business process resource can be stored in a unified data table and the unified management data program is available. However, user operation is random, not any business process resource can be composed. The problem is not discussed in this article. The mainly work in this article is how to deal with the information after two or more business process resources composition. Role, Task, Rule and Relation are four parts of business process resource. During composition, on the one hand, Rules composition is most difficult, and conflict and redundancy must be solved firstly, on the other hand, a link table is needed, if users use quote operation, a record is added into the linking table.

3. System design and application

3.1. Emergency Plan Management Application System

We have developed Emergency Plan Management System (ab. EPMS). The system platform aims to build, storage, and manage cross-domain plans, which is abstract to be business process resources. Cross-domain business users refer to all kinds of rescuers. All kinds of rescuer units add, delete, edit and query emergency process, and manage emergency plans themselves. After fundamental data are collected,

leader can make use of them at the time of emergency scene or simulation training. On one hand, system helps decision makers to certain the response level about an emergency event to open to the public. On the other hand, system mainly helps emergency decision-maker to schedule rescuers, their tasks, and emergency resources. Decision-maker needs a global view, which can get information simple and clear, and information contains responsible person, rescue resource, and task which are defined in plans.

In function of building business process resources, the platform uses visualization to present business processes resources by means of lines and nodes. The platform is a Web application system, whose structure is B/S. business users use dragging and dropping, clicking and other easy way to add business process resources in their own business management unit. Further more, decision-makers compose many business process resources from different units to a complex one, which has a global perspective. In editing interface of the platform, 6 kinds of nodes defined, which are start node, end node, task node, plan node, choose branch node and concurrent node. Lines indict relationship of task nodes, which are sequence, concurrency, XOR selection, and quote. Task node contains properties which descript role and task information. All the business process resources from the different management domains are stored on the platform. Both elemental and complex business process resources are controlled be identical application program, which reduce the difficulty of platform maintenance. The business process resources are treated with XML data. A process engine is in charge of analyzing XML data, and separate role, task and other data to business unit.

Each emergency rescue departments maintain their plan data daily. At the time of emergency scene or simulation training, decision-makers choose suitable plans and compose them to a new plan using tools on process panel. The plan composition interface for users is shown as Fig.1 .

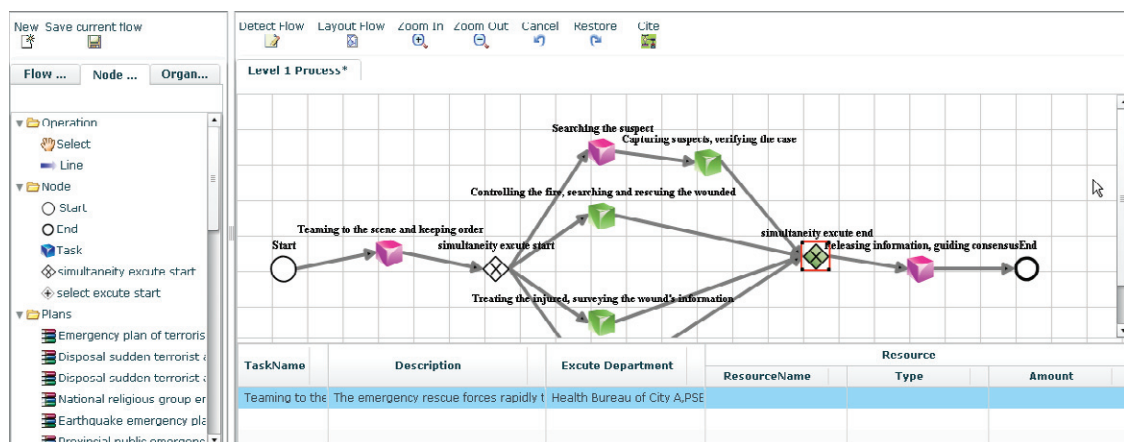


Fig 1. Building Plan interface





3.2. An example

In emergency management, one event may be accompanied by other secondary disasters. A single plan often aims to a sole event without predicting secondary disasters, which corresponds to other plans.

For example, on speedway, a serious traffic happened. A bus and a dangerous chemicals trunk clashed firstly, and then 3 car rear-end collision happened. At event scene, there were more than 50 persons injured, and chemicals leakage in the trunk has serious danger to pollute environment around the site. Because the incident site is far away from city, many specific vehicles are needed. But, the problem is that if all emergency vehicles arrive at the site simultaneously, the rescue efficiency will not be promoted but be reduced for the reason of possible jam or traffic chaos [9]. Department of Transportation starts the secondary response of "city traffic contingency plan". Hospitals start the secondary response of "city public emergency medical and rescue emergency plan". Environmental Protection Bureau launched the secondary

response of "a city environmental pollution and ecological damage emergency plan". Highway Bureau starts the secondary level of "highway emergency plan".

According to real-time information, emergency response levels mentioned above are filtered out. Decision maker chooses 4 of them, as Tab.1 shown.

Plan Description	Plan presentation	Roles
First-aid wounded		Health Bureau of City A
Chemical leakage environmental rescue		Environmental Protection Agency of City A
Fire Fighter rescue		Fire Fighter Bureau of City A
Maintenance of road		Road Administration of City A

Tab.1. Optional emergency plans and part of resource type and amount

Decision maker use 4 plans to compose a business process. 3 among these plans, "First-aid wounded", "Chemical leakage environmental rescue" and "Fire Fighter rescue" are composed to be executed simultaneously and "Maintenance of road" is the subsequence task. A process completed is shown as Fig 2.

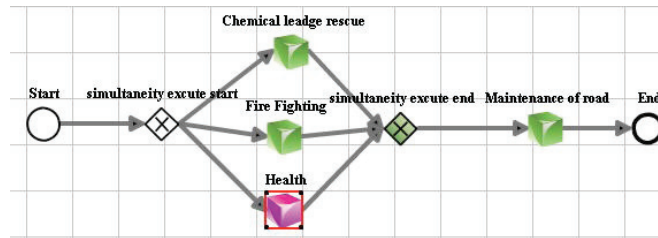


Fig 2. Emergency plans composition

4. Conclusion

With all levels of government and enterprises paying attention to improve the ability of emergency response, emergency management becomes one of the hot research spots. Formal abstract and process modeling of documental plan text is different from workflow modeling. The system is focus on ease of use and decision support function. A business process resource is proposed in this article. Business process resources through a visual method to build, and decision-makers can combine business processes flexibly to provide decision support services. There are still some problems worthy of our further study. For example, the composing business process resources may create redundant rules to be eliminated, and the departments need to manage user access control, storage management, business processes, resources, scheduling of resources for emergency management issues, and so on.

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References

- [1] Wil van Aalst, Kees van Hee, Workflow management—Models, Methods, and Systems. The MIT Press, Cambridge, Massachusetts, London England. 2002. P15-25.
- [2] ZHOU Jiantao, SHI Meilin, YE Xinming, State of arts & trends on flexible workflow technology[J], Computer Integrated Manufacturing Systems, 2005, 11(11), P1501-1503(Ch).
- [3] WANG Wenjun, LIU Xinpeng, LUO Yingwei, WANG Xiaolin, XU Zhuoqun, Study of Ontology and Application for Emergency Event Model[J], Computer Engineering, 2005, 31(10), P10-12(Ch).
- [4] Lee C H, Lee H B, Ng G W, et al. Plan ontology and its application[C], 7th Int Conference on Information Fusion. Stockholm: JAIF, Sweden, 2004, P455-460.
- [5] DONG Cun-xiang, WANG Wen-jun, YANG Peng, Emergency plan system ontology and its application, Computer Engineering and Applications, 2010, 46(10), P235-238(Ch).
- [6] OASIS. 2007. Web services business process execution language version 2.0. OASIS.
- [7] CHENG Shao-Wu, XU Xiao-Fei, WANG Gang, LI Quan-Long, A Simulation Model of Loosely Coupled Inter-Organizational Workflows, Journal of Software, 2006, (17)12, P2461-2470(Ch).
- [8] M. Wieland, D. Martin, O. Kopp, et al., SOEDA: A Method for Specification and Implementation of Applications on a Service-Oriented Event-Driven Architecture, in Business Information Systems. vol. 21, ed Heidelberg: Springer Berlin, 2009, P193-200.
- [9] Xin Chen, Feng Zhang, Bin-ge Cui, Yong-shan Wei, A User-centered Approach to Recommending Business Process Slices, WISA 2011, China.