International Journal of Innovative Computing, Information and Control
Volume **6**, Number **9**, September **2010**
ICIC International ©2010 ISSN 1349-4198
pp. 4145–4156

KNOWLEDGE REPRESENTATION FOR DISRUPTION MANAGEMENT PROBLEMS IN URBAN DISTRIBUTION SYSTEMS

Lijun Sun, Xiangpei Hu, Yan Fang and Minfang Huang
School of Management
Dalian University of Technology
Dalian 116023, P. R. China
lena-sun@hotmail.com

Received April 2009; revised September 2009

Abstract. *An integrated knowledge representation method, named ESR, for disruption management problems in urban distribution systems is presented. It aims to support the real-time decision-making processes of disruption management when an unexpected event emerges. The method comprises three components, E, S and R. In the E component, the ⟨Source—Type—Value⟩ Tree-like structure is created to represent the knowledge for identifying an unexpected Event. In the S component, the ⟨Object—State—Set⟩ Tree-like structure is invented to represent the distribution system's State. In the R component, Production Rules are used to represent the Rules for judging if an event can result in a disturbance. Examples show the efficiency and effectiveness of the proposed method in real-time decision-making support. The research result can support real-time reasoning and modeling for disruption management problems in urban distribution systems.*
Keywords: Knowledge representation, Disruption management, Decision Support System (DSS), Tree-like structure, Production rules, Urban distribution

1. **Introduction.** Unexpected events constantly occur during the process of urban distribution, including customer demand changes, time window changes, vehicle breakdowns, road breakdowns, etc. Once a change exceeds some limits, a disruption occurs. Hence the vehicle-routing plan being executed will be disrupted and infeasible, which results in the failure of order fulfillment and consequent negative effects in distribution service. A new tactic used to handle disruptions is disruption management, which has been defined by Yu and Qi [1]. Disruption management aims to get a feasible solution deviating from the original solution as little as possible in order to respond to unexpected events in real time. In urban distribution systems, static Vehicle Routing Problems (VRPs) have proved NP-hard. Therefore, it's more difficult to generate a policy in real time in order to adjust the current vehicle-routing plan. In practice, the policy is usually made by human experts. Human experts can respond to different kinds of events quickly, so the method is suitable for simple problems. However, since human experts often employ common sense and past experiences that are blended in a fuzzy, sometimes inconsistent, and not well-understood way [2], the method is often accompanied by inaccuracies and not suitable for large scale problems. Another method is model-and-algorithm method, which can get more precise and scientific results when solving large scale problems. However, the method has limitations too. Researches focusing on mathematical models and algorithms [3-7] had to predefine a specific event type or a specific system's state in order to construct a model and algorithm. Moreover, it takes a long time to construct the model and algorithm. Since unexpected events are diversified and distribution system's states change constantly with the plan-executing process in practice, the method lacks flexibility and adaptability. Hence automated or semi-automated modeling by computers,