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METHOD FOR THE DESCRIPTION OF ACTIONS IN WHOLESALE LOGISTICS NETWORKS AND THEIR IMPLEMENTATION IN SIMULATION MODELS

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ABSTRACT

Decision-makers are continuously facing the challenge of maintaining logistics networks in a competitive condition by implementing actions, e.g., changing the transport structure within the network. Therefore, logistics assistance systems are increasingly being used to support the decision-making process, e.g., by identifying and proposing promising actions. A typical feature of this type of assistance system is, however, that possible actions are predefined by the system. Adaptations to existing actions or the implementation of new actions is regularly a problem. To solve this problem, the author has developed a new method for the formal description and modelling of user-generated actions and their transformation in changes to simulation models. The method is based on a semantic model for mapping these actions, which are parameterized by a novel domain-specific language.

1 INTRODUCTION

Wholesale logistics networks are highly complex systems that are subject to constantly changing requirements due to globalization. In order to improve the performance of these networks and, thus, ensure competitiveness, it is necessary to continuously adapt the network's configuration or structure. The performance of logistics networks is usually determined by KPIs, such as total costs or service level. Adjustments to logistics networks are carried out by decision-makers applying actions to the networks. Such actions are, for example, increasing a route's frequency or decreasing the stock of a stock keeping unit (SKU) at a site.

However, actions can be highly complex, for example if an action influences different areas or elements of the logistics network at the same time. For instance, an action to close a site can affect inventory, personnel, network or transportation structures. In addition, actions can have interdependencies with each other. If the inventory of an SKU is increased, this may lead to a better service level, but at the same time to higher inventory costs. Thus, finding the most promising actions combination for increasing the overall performance of the logistics networks is a difficult task.

In order to support the decision-making process, the author has developed a logistics assistance system (LAS) for identifying the most promising combinations of actions, which are then made available to the decision-maker. Basis of the LAS is a simheuristic framework consisting of a heuristic algorithm and a data-driven discrete-event simulation (DES). The heuristic is used to search for promising actions which are then evaluated by DES. The identification and evaluation of actions can be carried out iteratively until termination, for example if a previously defined number of iterations has been reached. A detailed description of the LAS can be found in Rabe et al. (2019) and Rabe and Schmitt (2019). Characteristic for this LAS and similar systems is that the available actions are predefined by the system itself.

In order to increase the flexibility of the LAS, a method for modelling actions and their implementation in changes to simulation models was developed. The method is based on a semantic model for the formal description of actions in wholesale logistics networks, which is described in Section 2. By using a newly developed domain-specific language (DSL), the semantic model can be parameterized to represent individual actions, see Section 3. These action can then be selected by the heuristic of the LAS and transformed into changes to the simulation model.

2 SEMANTIC MODEL FOR REPRESENTING ACTIONS

For the formal description of actions in wholesale logistics networks, a semantic model has been created. With this model, all possible actions can be mapped generically. Differences between actions are realized by different parameterizations of the semantic model's attributes.

The semantic model consists of a large number of attributes that have been divided into different classes, depending on the attributes' semantic. For identifying an action and its purpose, attributes with an informative character are used, such as the ID, the name, or the description of an action. Furthermore, meta information can be stored in the model, such as the status of an action. The specific changes to a logistics network, represented by an action, are modeled by using functional attributes. For instance, when applying an action "change stock" the functional attributes the affected entities of the logistics network, e.g., specific stock keeping units in a specific site. In addition, the semantic model contains attributes with which strategic information can be represented, such as the duration of the implementation of an action or the associated costs. In another class of attributes, domain-specific knowledge is mapped, such as information about the correlation between different actions. A complete description of the semantic model and its attributes can be found in Rabe and Schmitt (2019).

3 DOMAIN-SPECIFIC LANGUAGE FOR MODELING ACTIONS

A novel DSL is used to model actions in wholesale logistics networks. This language, specially developed for this purpose, is used to parameterize the underlying semantic model.

Since the semantic model consists of various attributes in order to map all possible actions, the DSL consists of different language constructs. These constructs are known in part from general languages, e.g. loops or case distinctions. In addition, some constructs were developed based on existing data manipulation languages (DML), e.g. the corresponding DML-part of SQL. In addition, new data types were developed with which relevant information for the implementation of actions can be mapped. Furthermore, new language constructs have been developed to model the changes in the logistics network that an action has brought about. For a detailed description of the DSL and its underlying grammar, please refer to Rabe and Schmitt (2019).

Access to the language is realized via a specially developed IDE. This interface is specially tailored to the DSL and, thus, supports the modeling process of actions, for example through auto-completion or syntax highlighting.

4 CONCLUSION AND OUTLOOK

The author presented a method for modeling actions in wholesale logistics networks. The method is based on a semantic model for mapping these actions. A newly developed DSL is used to parameterize the model. An extension of the language, for example with language constructs for planning relevant boundary conditions, or the use of the method in other domains of supply chain design are candidates for further research.

REFERENCES

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