SOFTWARE MODULE FOR THE VISUALIZATION AND PLANNING OF MARSHALLING YARD OPERATIONS

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Abstract: Software solutions applied for the management of the marshaling yards are important elements of today’s freight transport. There are various software applications developed for real time management of marshalling yard, and, usually, module for the visualization and planning of yard operations and infrastructure, is included. This module enables yard operators to perform wagon classification and other operations, by using supplied software tools. Generally, the process is not fully automated, and it requires a lot of experience from the users of the system. In order to propose a new approach to the visualization and planning of marshalling yard operations, novel software solution was developed. This solution includes optimization, and visualization and planning modules for automatic wagon classification in marshalling yard. The main idea is to create one smart and responsive automated system, which will improve yard operations, minimize user engagement, and therefore enable better freight transport.

Key words: Software, Marshalling yard, Visualization, UML, Database

1. INTRODUCTION

Marshalling Yard (MY) is a complex system, and it contains many processes, which should be properly performed. The main processes in marshalling yard are: Pre-notification of incoming and outgoing trains, Arriving and checking incoming trains, Disaggregating/aggregating trains; Wagon shunting within the yard; Throwing wagon using the hump and/or the locomotive; Checking and departure outgoing trains. All processes mentioned above are standard processes and part of the standard and usual daily data flow [1,2]. The standard processes are automated on satisfaction level with various IT applications [2]. Regarding to that, the focus of research and innovation activities is on the providing adequate response on deviations from standard processes. The special attention is given to deviations of decision-making processes in marshalling yard. Different types of deviations are presented in [3,4] and can be summarized as the following: Deviations of the incoming train – later (delay) or earlier than timetable plan; Deviations of the outgoing train - later (delay) or earlier than timetable plan; Deviations in personal resources – lack of train driver or other staff for operations in MY; Deviations in individual wagons modification; Unexpected repair or breakage of sections of rail line; Unexpected repair or breakage of wagons; Deviations or incorrect weight of incoming trains or wagons; Priorities in cases of congested infrastructure or other priority policies; Extraordinary requests; Not defined deviations

All deviations can be grouped related to four factors: time, the present state of infrastructure, personal resources and additional cargo operators’ demands. The main factor is time and that is the reason why first two above deviations are also one of the consequences of all other deviations.

Each of these deviations has some own causes, consequences of deviations, decisions needed to be realized and consequences of selected decisions. There have to exist the list of criteria for deviations because not all deviations should be taken into account as trigger inputs for SMART Real Time Management System (RTMY) starting and giving some optimal solution. Inputs can be inserted manually or automatically from existing IT system. In that sense, inputs and outputs are stored and exported in XML and JSON format. These formats allow easy adaptation for standard rail formats (e.g. RailML).

Fig.1 The role and position of SMART RTMY system regarding existing IT system in MY

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In general, developed software solution SMART Real Time Management System (RTMY) would give real time response to deviations, decrease time for making adequate decision by providing advisory system with optimal optional solutions based on selected criteria and optimization objectives. It will be beyond state of the art solution. In that sense, the role and the position of the SMART RTMY system regarding to existing IT applications, can be presented in Fig 1.

2. DEVELOPED SOFTWARE SOLUTION

SMART RTMY is currently in development stage. Some features are created, and others are in the process of development. SMART RTMY in general, is composed of visualization and optimization module.

Visualization module (presented in this paper) is used for data presentation, and optimization module is used for data processing. In order to properly define functional and technical requirements of the SMART RTMY, Unified Modeling Language (UML) is used. UML diagrams are created for all specific software requirements, and used for the development of visualization software module. As it has already stated, there are nine selected types of deviations in decision making processes in marshalling yards, and they can be described as use cases in UML. They are modelled and presented in Fig.2. There are many responsibilities of yard staff and they play significant role in the entire system. In order to demonstrate roles and responsibilities, some of them are modelled as Use case diagram and presented in Fig.3.

In order to properly model deviations and data included in marshalling yard management systems, relational database was created. Database structure was defined with separate tables for trains, wagons, sidings, timetable, traffic directions and users. Database is defined according to established static and dynamic parameters, presented in Fig 4 and described in [5]. The database was created and its logical schema is presented in Fig 5.
This schema defines the structure of a Marshalling yard data model on which object model depends. Database structure and its logical schema includes all requirements and limitations that are restricting the use of freight transport in the marshalling yard as well as freight transport that is going to be processed in the marshalling yard. The defined composition of database, allow input and processing of all the described deviations and inputs or outputs. Static and real data from different marshalling yards was inserted to database, for further manipulation and processing.

2.1. Visualization and planning module

Visualization and planning module is currently in the last phase of development and it can display potential status of the marshalling yard to the user, based on data entered manually by the user, or acquired automatically from a railway information system. This module will also be able to display the future state (advisory proposition) of the marshalling yard based on input data and the outputs of the optimization module for specific occurred deviation. The methods used for modelling marshalling yards and inbound and outbound traffic information, as well as methods implementing the algorithm for optimal marshalling process planning will be extracted and encapsulated into a publicly available software library. This library will enable users to model their own marshalling simulation scenarios and perform marshalling process planning using the developed optimization algorithm outside of the information system for supervision and management of marshalling yards. Visual representation will be available for different kind of users, e.g. dispatchers. Visualization and planning process is shown in Fig. 6.

Based on the defined requirements, and module specifications, class diagram which defines module objects is shown in Fig. 7.

The module was developed by using following technologies: Front End – JQuery (standard, generally known JavaScript library) and D3.js (Data-Driven Documents); Back End – Currently php is used as main platform. The first version of RTMY Visualization module has already done and next three figures show some aspects of user interface of RTMY Visualization module. In Fig. 8 image of Popovac marshalling yard with defined infrastructure is presented. One solution for wagons classification in a case of time deviation is shown. Some aspects of visualisation module are presented in Fig. 9 and 10.
3. CONCLUSION

This software module presented in this paper is used for modelling input and output requirements, and for visualization and planning of marshalling yards operations. The special attention was dedicated to UML modelling of the visualization and planning processes and theirs realization. It can be concluded that modelled processes are complex, and that final claim about developed module can be made after the completion and integration with optimization module, which will be the next step in the SMART RTMY software system development.

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REFERENCES