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MODEL OF MANAGEMENT, IMPLEMENTATION AND PLANNING OF BUSINESS PROCESSES IN A RAILWAY COMPANY BASED ON ARTIFICIAL INTELLIGENCE

Zoran G. Pavlović, Ana Savić
zoran.pavlovic@vzs.edu.rs, ana.savic@atuss.edu.rs
ORCID 0000-0001-6076-1811, 0000-0002-8099-1136

Academy of Technical and Art Applied Studies ATAAS, Belgrade, SERBIA

Abstract: *Realization of regular business processes in large and complex economic sectors requires safety, security and functionality that are in accordance with the mission and vision that was foreseen in advance. The above basic criteria directly and indirectly affect the quality of the service or product. A large number of business tasks are performed by employees directly or indirectly, where an unplanned action can occur that negatively affects the functioning of the entire system. The solution for such situations can be the implementation and application of advanced Internet technologies. This paper presents the basis for improving the mentioned criteria in the railway company in traffic and transport, where at the same time the existing computer system is modernized. The role of the employee is reduced or abolished in order to reduce the consequences of fatigue, lack of knowledge or incompetence. Applying artificial intelligence (AI) technologies to the existing infrastructure computing system can address the gap that needs to be addressed. AI is increasingly represented in the transformation of digital processes, where agents are created for the management, organization, and implementation and planning of autonomous computer systems in intelligent transport systems (ITS). It covers the basic concepts of AI and presents the advantages and disadvantages (anomalies) specifically on the example of application in railway traffic and transport. The paper presents a theoretical and practical framework that can be implemented in the railway company in order to increase all segments of quality in the near future.*

Key words: *advanced internet technologies, artificial intelligence, intelligent agents, rail traffic and transport, service or product quality*

1. INTRODUCTION

One of the priorities of railway companies is to increase the quality of transport services in all segments of electronic business. The solution may lie in the application of advanced internet technologies that have the prerequisites for improving operations in line with the vision and mission of the railway company [1]. Railway traffic and transport based on available computer systems can more efficiently organize, regulate and plan business activities related to safety and security to increase overall quality [2], [3]. In the engineering and academic community, a large number of scientific approaches are applied that have shown and so far provided good results in passenger and goods traffic and transport [4], [5].

This paper covers the basic guidelines for the application of artificial intelligence with an emphasis on the advantages and disadvantages that can be an obstacle for implementation in the railway company. On the basis of related literature, a model of the application of AI in the electronic business of a railway company is presented.

2. RELATED literature

In this paper, for the purposes of research, certain literary references were selected to make it easier for the reader to accept the application of AI in all business process activities in railway traffic and transport.

Artificial Intelligence (AI) is becoming ubiquitous in most engineering fields, and rail transport is no exception. However, due to the multitude of different new terms and meanings associated with them, there is a risk that rail professionals, as well as several other categories, will get lost in these ambiguities and unclear boundaries, and therefore fail to grasp the real possibilities and potential of machine learning, computer vision and big data analytics, to name just a few of the most promising approaches related to AI. The aim is to introduce the basic concepts and possible applications of AI to rail academics and practitioners. To this end, it presents a structured taxonomy that will guide researchers and practitioners to understand AI techniques, research areas, disciplines and applications, both generally speaking and in close relation to rail applications such as autonomous driving, maintenance and traffic management [6].

The centralized intelligent railway traffic management system plays a vital role in implementing railway dispatching service, improving transportation efficiency and ensuring train safety. However, with the development of high-speed railways, the construction of new lines and the upgrading of existing equipment have become increasingly widespread, which poses significant challenges to the safety and reliability of the system. To address these challenges, a scenario-driven parallel system testing method is proposed. We use divisible and combined scenarios to describe the functionality and testing processes. Based on the scenario representation, a virtual-real interactive testing method is adopted, where virtual testing is used to generate a large number of scenarios simultaneously, thereby accelerating the system testing process while ensuring comprehensive testing coverage. Field testing is carried out to verify the reliability of the system in real operating environments, especially in critical scenarios [7].

The application of artificial intelligence (AI)-based techniques has a strong potential to improve safety and efficiency in data-driven intelligent transport systems (ITS), as well as in emerging Internet of Vehicles (IoV) services. It is covered by a practical implementation of deep learning methods to increase safety in a specific ITS scenario: railway crossings. It presents a system called Artificial Intelligence-Based Railway Traffic Surveillance System that is based on a combination of detection and classification methods focused on different image processing inputs: vehicle presence, pedestrian presence, vehicle path tracking, and railway barriers at railway crossings, railway warnings and light signaling systems. The designed system uses cameras that are conveniently positioned to capture the entire crossing area at a given railway crossing. Using GPU-accelerated image processing techniques and deep neural networks, the system autonomously detects risky and dangerous situations at the railway crossing in real time. In addition, the camera modules send data to a central server for further processing, as well as for notifying interested parties (police, emergency services, railway operators) [8].

Digital transformation has been prioritized in the railway industry to automate railway operations. Digital twin (DT) technology has recently attracted attention in the railway industry to fulfill this goal. Contemporary researchers argue that DT can be an advantage in railway production logistics for planning and scheduling. Although the basic technologies of DT, e.g. modeling, computer vision and Internet of Things, have been studied for various applications in the railway industry, DT has been least explored in the railway context. Therefore, the aim is to understand the state-of-the-art DT for Railway (DTR) for advanced railway systems. In addition, the research clarifies how DT can serve designers and developers of railway twin systems. Since DTR is still in the early stages of adoption, there is almost no clear direction for identifying technologies for specific DTR applications [9].

In railway systems, station safety is a critical aspect of the overall structure, yet station accidents continue to occur. It is time to learn from these mistakes and improve conventional methods by using the latest technology, such as machine learning (ML), to analyze accidents and improve safety systems. ML is used in many areas, including engineering systems, and interacts with us in our daily lives. Therefore, we need to consider the available technology in general and ML in particular in the context of safety in the railway industry. This paper investigates the use of decision tree (DD) in safety classification and accident analysis in railway stations to predict the characteristics of passengers affected by accidents [10].

Unexpected train delays can cause a series of negative consequences in a high-speed rail system. In such cases, the train schedule must be rescheduled. However, timely and efficient rescheduled train running is still a challenging problem due to modeling difficulties and low optimization efficiency. A macroscopic transformer-based control approach is presented, which consists of two stages, including

transformer-based modeling and policy-based decision making. First, the relationship between different train schedules and operations is described by creating a macroscopic model using transformers, providing a better understanding of the overall operation in a high-speed rail system. Then, the policy-based approach is used to solve the continuous decision problem after the macro model for fast convergence. Extensive experiments are conducted on different delay scenarios. The results show the effectiveness of the proposed method compared with other popular methods [11].

Building Information Modeling (BIM) has long been used in various industries. The railway system is another industry where BIM plays an important role. Since BIM can contain information about a project at different stages, a set of information is included and included in BIM. In order to use this information effectively, machine learning, as a branch of artificial intelligence, is one of the tools that is widely applied today. However, the integration of BIM and machine learning in the railway system is new. This study is therefore the first in the world to integrate BIM and machine learning for defect localization in railway infrastructure. In this study, “burnt wheels” are used as a case study. The machine learning techniques used for defect localization are deep neural networks (DNN), convolutional neural networks (CNN) and recurrent neural networks (RNN). The study shows that the developed BIM model can be fully integrated with machine learning for defect localization in railway infrastructure using the developed workflow. It is found that the CNN model provides the best result when the mean absolute error (MAE) is used as the main indicator. The MAE of the CNN model is 0.03 m and the maximum error (ME) is 0.3 m [12].

In order to realize the reliable and safe operation of smart railways and provide high-quality information transmission services to passengers, the railway system must develop an innovative communication network and advanced communication technology to meet the gradually increasing demand for multi-dimensional comprehensive information resource services. The Space-Air-Ground Integrated Network (SAGIN) can provide seamless information services for land, sea, air and space users and is an effective solution to the challenge posed by future smart railways for permanent, omnidirectional, airborne, high-reliability and high-throughput communication. First, we analyze the development of SAGIN and the mobile communication network of HSR, and comprehensively discuss the unified network architecture of space, air and ground networks, as well as the integrated network, and discuss the application scenario and network structure of the combination of integrated networks. At the same time, the communication services, existing problems and key technologies of space, air and ground networks are discussed, and the application trend of SAGIN in high-speed rail vehicles (HSR) is introduced. In addition, the application scenarios of artificial intelligence (AI) technologies in solving the efficient use of resources of smart rail communication and SAGIN are studied. Based on these technologies, we point out the research direction for the future development of AI technologies in SAGIN in HSR communications [13].

The study is limited to road vehicle-train collisions at unmanned level crossings on single-track rail-road sections. The first objective of the study is to assess the risk of rail-train collisions by developing models to predict the frequency and severity of road vehicle-train collisions using Poisson and Gamma-log regression techniques, respectively. Another objective of the study is to implement crash modification factors on the predicted risk factors, in order to reduce the risk of road vehicle-train collisions at level crossings. The crash risk is predicted to be 3.52 times higher and 77% lower in one direction, while in the other directions it is 2.95 times higher and 80% lower than the average risk at all unmanned level crossings. By applying crash modification factors to factors that contribute to higher risk, i.e. "crossing angle" and "train visibility", it is predicted to reduce the risk of collisions between road vehicles and trains by approximately 85% [14].

3. BASIC COMPONENTS OF AN INNOVATIVE MODEL BASED ON ADVANCED INTERNET TECHNOLOGIES

3.1. Basics of advanced internet technologies

The main task in this paper includes the application of AI in solving tasks in management, regulation, planning and increasing safety in railway traffic and transport. At the beginning, it must be explained what the advanced internet technology called artificial intelligence (AI) is. There are various definitions in the professional literature, and for the purposes of this work, the following was chosen: "Artificial intelligence is a branch of computing that deals with the development of software systems and technologies that enable computers on the infrastructure network to perform business tasks that

usually require human intelligence, education, expertise, expert abilities such as decision-making, learning from experience and solving problems in railway traffic and transport.

The application of advanced internet technologies of artificial intelligence includes the following branches:

- **Machine learning**: A technique that allows computers to learn from data and improve their performance.
- **Deep learning**: A specific type of machine learning that uses deep neural networks.
- **Natural Language Processing**: A technique that enables computers to understand, analyze and generate human language.
- **Computing with constraints**: Using rules and logic to solve problems.
- **Cognitive computing**: Modelling human cognition processes to create intelligent systems.

A representation of the branches covered by the application of artificial intelligence is shown in Figure 1.

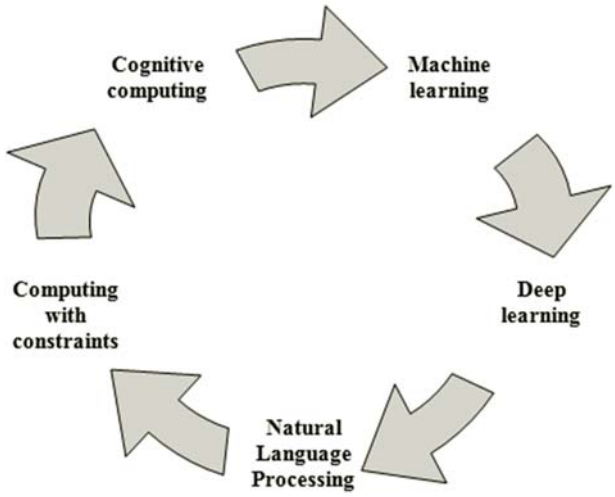

Fig. 1. Branches of artificial intelligence

The following table shows the advantages and disadvantages of applying AI:

Table 1. Advantages and disadvantages of applying artificial intelligence

Benefits of implementing AI		**Disadvantages of AI implementation**	
1. Technological progress	AI has the potential for revolutionary technical progress, to solve many complex problems, in the railway company	1. Job loss	People fear that artificial intelligence will take over many jobs, which could lead to unemployment and economic instability
2. Improving efficiency	Artificial systems can increase efficiency, enhancing transformed digital transactions.	2. Lack of control	The question is what will happen if artificial intelligences become super intelligent and lose control of their actions.
3. Fulfillment of human needs	AI can meet the specific needs of employees and users, including care for the elderly, assistance to people with disabilities, and the like.	3. Loss of humanity	There are concerns that over-reliance on artificial beings will lead to a loss of human empathy and communication skills.
4. Scientific research	AI can speed up the process of scientific research, enabling faster analysis of huge data sets.	4. Privacy and security	Fear of misuse of data and possible infiltration of systems that manage artificial beings,
5. Education and creativity	Artificial systems can improve educational processes and encourage creativity	5. Misuse	Applying AI unethically against other people

3.2. Steps required to implement an AI model

The process of implementing an AI model for implementation must include the following steps: defining the project, data management, machine learning development, model launch, and model maintenance and monitoring as follows:

- **Defining the project** It is necessary to determine the feasibility of the project, computer infrastructure capacities, possible technical limitations, cooperation and willingness of employees, as well as the availability of necessary data (rules, instructions, orders, legal provisions, etc.);
- **Data management** Collection of relevant data in digital form, storage and regular updating by authorized people;
- **Development of machine learning** Selecting the appropriate algorithm with the ability to learn based on the relevant created database;
- **Running the model** The process of adding the selected algorithm to an application located on the infrastructure computing server on the railway;
- **Model maintenance and monitoring** At the beginning, it is necessary to follow the procedure for loading data contained in the database and current decisions for events that are an integral part of business processes.

3.3. Development of an AI-based model in a railway company

In this model, given that a computer infrastructure network has been developed throughout the entire territory of the railway carrier, it is necessary to install an application on the railway carrier's server. computers distributed at official locations can be accessed by employees who are currently performing their business tasks. The application contains an artificial intelligence algorithm designed to find a solution that will be applied in a newly created situation. Regardless of whether there are employees in that official location or the business facility is not under supervision. The solution can be in an existing database that includes procedures and actions or based on similar situations that the AI has acquired through learning.

The database contains legal provisions, regulations and instructions that are currently in force and regularly updated. As part of the database, there are also technical and operational characteristics of the railway infrastructure network in the territory of the carrier where the traffic and transport take place. Based on the location, place of occurrence of the event and the environment, measures are taken to facilitate the functioning of traffic when it comes to regularity. In addition to the above, the application automatically accesses the changes and additions made, but only by the authorized administrator. This predetermined method of data access prevents the algorithm in the application from using other similar internet sources that are not in accordance with the applicable regulations, but is only oriented towards application in rail transport. Based on machine learning, forms are created that are applied when receiving information about the event. The artificial intelligence application has the task of simultaneously informing all relevant employees in the area what they need to do and what activities will be automatically carried out. At the same time, the competent railway emergency committee, the police and the emergency medical service are notified. The model is shown in Figure 2.

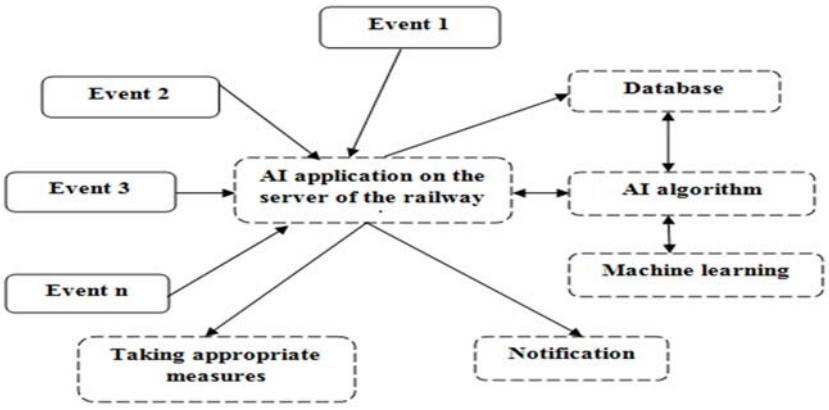

Fig. 2. AI-based process of interrelationships in a railway company

CONCLUSION

The application of artificial intelligence in rail transport offers significant advantages in terms of efficiency, economy and safety. When it comes to timetable management, train and staff scheduling, traffic flow simulation, signalling management, incident detection and resolution, investment planning and network expansion, demand assessment and passenger flow modeling, monitoring the behavior of staff and service users, emergency management and the like. By integrating AI systems into the organization, regulation, planning and safety of rail transport, it is possible to significantly improve the quality and reliability of rail transport, both in the passenger and freight segments. Future research must be directed towards the development of innovative sustainable models. Special attention should be paid to the environment and the green agenda, which is currently gaining increasing interest among researchers and companies that want to implement international standards. Accordingly, it is necessary to apply innovative technologies based on AI.

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