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### **The use of simulators in the training process of train drivers and train and station dispatchers**

**Abstract:** The article explores the possibility of using railway vehicle simulators and train traffic management station simulators for training Warsaw metro employees. The great benefits of using simulators are pointed out. On the basis of experience, positive opinions of candidates and employees who already have qualifications in terms of the possibility of practicing many incidental situations rarely occurring in reality have been observed. The use of simulators allows for the repetition of the same exercises for all employees and the initial verification of the trainee's predisposition to perform given activities.

**Keywords:** Training; Simulator; Metro

A properly conducted training process is one of the key elements of preparing an employee to perform activities at a given position. In the case of employees directly related to the operation and safety of railway traffic and the operation of railway vehicles, professional preparation takes on additional importance. Persons driving railway vehicles and persons controlling railway traffic perform responsible work for the benefit of sometimes several thousand passengers at the same time. The safe transfer of passengers from point A to point B depends on their knowledge and skills. Knowledge and professional experience are gained throughout professional practice, however, at the very beginning, during the first training, it is important to provide students with knowledge in the field related to railway traffic, in an accessible, professional, and greatest extent possible. For this purpose, it is advisable to use all teaching aids facilitating the understanding of issues, in particular, allowing to practice important situations, especially emergencies that may occur in reality and the production of which in real conditions is difficult and expensive. Electronic solutions in the form of various types of simulators come in handy here. Two types of simulators are used in the Warsaw metro in the process of training employees driving metro rail vehicles (engine drivers) and employees controlling train traffic (traffic and station duty officers) using two types of simulators: a cabin simulator of a metro vehicle and a simulator.

The metro network in Warsaw consists of two lines, M1 and M2, with lengths of 22.7 km and 18.6 km, respectively. There are 21 stations on the M1 line and 18 stations on the M2 line. There are plans to build three more M2 line stations shortly. According to the data of the Public Transport Authority in Warsaw, in 2021, 180.6 million passengers used the metro services [1]. The presented volume of transport was carried out with the simultaneous use of 54 metro trains running during rush hours with a time sequence of 2 min 20 sec on the M1 line and 2 min 50 sec on the M2 line.

Metro Warszawskie Sp. z o. o. employs 2,786 employees (as of September 2022). Among all occupational groups, the drivers of underground railway vehicles are the most numerous—over 300 employees. Traffic and station supervisors, with 110 employees, control the movement of trains on the metro lines and at the Kabaty Technical and Parking Station. From the perspective of the expansion of the metro in Warsaw, the stated employment figures will also increase.

Training for the above professional groups is conducted based on internal regulations specifying the subjects of theoretical and practical training. Part of the training program takes place in the Metro Training Center with the use of simulators.

The first simulator was delivered to the Warsaw Metro with the delivery of Siemens Inspiro vehicles in 2013. It is a simulator consisting of a cabin equipped with an Inspiro vehicle dashboard and an instructor's station operating a training and simulation system with active control of the activities performed by the trainee, setting driving parameters, unusual situations, and registration of performed activities.



1. The interior of the Siemens Inspiro vehicle simulator cabin

The simulator contains the complete subway track system that existed at the time of delivery, i.e., both metro lines (M2 line from the Rondo Daszyńskiego station to the Dworzec Wileński station) and the track system of the Kabaty Technical and Parking Station. The first contact with the simulator showed the great potential of this training tool. Both trainees and instructors passing on knowledge to future train drivers pointed out its numerous advantages. First of all, the opportunity to get acquainted with the workplace—the train cabin and its most frequently used element, the driver's desk—without the need to physically provide the train. Checking the operation of the buttons, getting to know the operation logic of the driving controller, active dead man's switch, or vehicle-driver interface (HMI) without the limitations and restrictions that occur in reality were quickly appreciated by both sides of the simulator users—the instructor and the trainee. It is worth noting that the use of a simulator of a specific type of vehicle allows you to train the use of functions specific to a given vehicle.



2. Siemens Inspiro vehicle simulator, visible cabin, and instructor's station

Training with the use of the simulator has become a permanent part of the professional preparation program for metro drivers. The current training program allows you to perform activities on the simulator for up to 30% of the hours provided in the program related to the operation and driving of a subway rail vehicle. Regardless of the classes on the simulator carried out at the stage of professional preparation, the simulator is also used in current instructions and periodic training.

Over several years of operation of the Inspiro vehicle simulator, the experience gained allows us to indicate the following advantages of using the vehicle simulator in the training process:

- the possibility of practicing unusual situations, the simulation of which in real conditions is difficult or requires intentional lowering of safety, including the simulation of faults and alarm states of the vehicle displayed on the driver's desktop,
- the ability to repeat activities many times without a negative impact on the traffic situation on the line (interference with the traffic of other vehicles),
- before actually driving the vehicle, full familiarization with the operation of the vehicle's functions performed from the driver's cabin, from the basic and most important, such as starting, service braking, emergency braking, and others, e.g. sending messages, operating the interface for the driver,
- the possibility of practicing communication between the train driver and the person in charge of train traffic,
- the possibility of initial familiarization of the trainee with the track system of the metro line without physically entering the tunnel with limited access temporarily (specificity of the metro),
- operation of subway-specific systems - the SOP automatic speed limitation system in every possible mode of its operation, including learning about the vehicle's behavior (displayed messages) when exceeding the allowed speed on the route in the speed range controlled by the SOP,

Simulating various emergency situations on the simulator gives the trainee the opportunity to know and learn how to react in those situations that occur very rarely on a daily basis, which in turn increases their effectiveness while actually driving the train as a full-fledged train driver.

After several years of using the Siemens Inspiro vehicle simulator, the Warsaw Metro decided to expand the training center with another simulator, this time for a group of employees managing train traffic on metro lines. In 2019, a metro train traffic simulator was launched, representing the operation and operation of SRP devices in the control area of the Kabaty station, which, after two years of operation and gathering experience, was expanded by another control area - the Kabaty Technical and Parking Station (STP Kabaty).

Training with the use of a simulator is one of the most important points in the professional preparation program for candidates for the position of traffic and station dispatcher. As is the case with the metro vehicle simulator, the traffic management simulator is also used in current instructions and periodic training for traffic and station dispatchers.



3. The room of the traffic control station simulator. A view of two positions - traffic and station dispatcher and the instructor's position

The traffic management simulator consists of an instructor's station and two traffic controller stations, which, in terms of interface and operation logic, fully reflect the traffic controller's station and the A1 Kabaty and STP Kabaty stations. Traffic management stations can work independently or cooperate as adjacent control posts. Cooperation can take place in the normal traffic management mode, but it is also possible to practice the procedure with limited traffic management, e.g., by announcing trains by telephone. All setting commands issued at the stands are recorded and controlled by the instructor, which allows you to react and discuss the situation on an ongoing basis or return to a given event at a later date. In addition to setting normal traffic control, the instructor can simulate several emergency states, obliging the traffic dispatcher and the station to react appropriately to a given situation. All practiced commands and emergencies do not require any interference with real SRP devices or rolling stock operated on metro lines. The simulator allows, without any risk to devices or people, to practice issuing all commands that are possible to implement on real traffic control devices. Starting from the simplest and most frequently used setting commands, such as setting the routes (including automatic repeating of the routes for the passage and turning of the train at the station), slowing down the routes, issuing commands to specific semaphores, controlling the setting voltage, to special commands - important for traffic safety. The ability

to simulate and practice behavior in situations requiring the use of special commands is an undoubted advantage of the simulator. During training on the simulator, the staff has the opportunity to improve their behavior in situations such as: the occurrence of apparent occupancy of a track or point section (switch without vacancy control), signaling of a point break, lack of control of the position of the point, temporary takeover of control by the traffic and station supervisor, axle counter reset or release of the course with a time delay.



4. Electronic control panel at the driving simulator station



5. The position of the traffic simulator training instructor

At the station of the traffic simulator, in addition to the functions strictly performed by the simulator, traffic, and station dispatchers perform other activities characteristic of their workstation. Completing the workplace documentation, issuing special orders, or communicating via telephone with the vehicle driver (simulated communication with the training instructor) are complementary to the on-the-job training of traffic and station duty officers. Theoretical lectures and classes in real conditions at the setting posts, operation of point drives "on the ground", including the use of the needle shoe and the lock, form a comprehensive preparation of the employee to take up the position of traffic supervisor and station.

The simulator, which has been in operation since 2019, allowed the trainees, the training instructor, and Metro Warszawskie Sp. z o.o. The trainees were allowed to act freely, without the mental burden that usually accompanies training in real-world conditions, and had the opportunity to practice the procedure for practically any emergency. Both employees training at the train dispatcher and the station, as well as people already authorized to operate traffic, can train in specific traffic situations without any restrictions in real-world conditions, according to their own needs. Training instructors gained a tool that allows them to set different scenarios of traffic situations. Thanks to the recorded course of lessons, instructors can return to given situations many times, discuss them with students and use them in subsequent training. Saved scenarios of events allow you to set the desired traffic situation without the need to adapt to the current traffic situation in a given control circle. And finally, the Warsaw metro as a railway operator in public transport, has raised the level of employee training, which translates into a negligible number of undesirable events resulting from employee errors. It is gratifying that trainees and already working traffic and station dispatchers report their willingness to control and practice traffic situations much more often than in the period before the implementation of the simulator. Over a dozen months of operation, the simulator brought positive opinions from people training for the position of traffic and station supervisors, as well as from employees who already have traffic management licenses. This allows us to evaluate the project positively and from the perspective of further development of the metro as necessary.

The simulators operating in the metro training center do not close this area of activity. Along with the delivery of a new type of rolling stock for the metro, where, as a result of a tender procedure, Škoda Transportation is delivering passenger trains, another train simulator has appeared in the metro training center.



6. The interior of the Škoda Varsovia vehicle simulator cabin



7. Stand of the Škoda Varsovia simulator training instructor

### Summary

Device simulators, software simulators, and simulators that represent entire workstations are commonly used tools today to improve the quality of employee training. Purchasing them on the Polish market is not a problem, apart from the obvious issue of having the appropriate financial resources. However, the purchase of a simulator can quickly pay off, not necessarily in the economic sense, but in the form of easier verification of professional predispositions, and an increased level of employee training and qualifications, which should ultimately translate into traffic safety. Exercises conducted on a simulator, supplementing practical training at a real workplace, generate added value for each party - the trainee, the instructor, and the employer interested in acquiring well-trained staff. From a practical point of view, the simulator has only advantages. It allows the trainee to familiarize himself with the basic work tool, perform activities without affecting safety, repeat them many times, and improve areas that require increased effort for a given employee. The instructor conducting the training gains a tool that allows for a more accurate check of the candidate and his predispositions to perform a given profession; he can repeat the required activities many times and set the desired action scenarios without affecting the actual traffic on the metro line. Finally, the employer can verify the candidate at the initial stage of training and, in the case of his disqualifying characteristics, avoid wasting time and costs. After successful completion of the entire training, he gains a better-trained employee than in the absence of classes on a vehicle simulator or driving simulator.

Among the most important benefits that have been observed over several years of using simulators in the training process should be mentioned:

- positive opinions of candidates and employees who already have qualifications (periodic training) regarding the possibility of practicing situations that rarely occur in reality or situations that cause problems for employees - employees themselves report their willingness to practice given situations on a simulator,
- practicing reactions to unusual events on the metro line, which are difficult, costly, and time-consuming to simulate in real conditions,
- repeatability of the same exercises for all employees (training uniformity),
- initial verification of the student's predisposition to perform given activities,

Keeping in mind the benefits of using simulators, Metro Warszawskie invests in the development of the training area through the use of modern tools. There are plans to expand the existing Metro Training Center with new devices and to cover the entire metro network with the traffic simulator. As part of expanding the group of employees whose training could also be carried out with the use of a simulator, coupling the simulator of the electronic setting panel with the real switch drive is being considered, which would also enrich the training of SPR fitters.

**Source materials**

- [1] Raport Roczny ZTM Warszawa: <https://www.ztm.waw.pl/wp-content/uploads/2022/05/Raport-Roczny-ZTM-za-rok-2021.pdf>