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IMPACT OF THE IMPLEMENTATION OF DIGITAL AUTOMATIC COUPLING ON WORKING CONDITIONS OF SHUNTING STAFF

POSLJEDICE IMPLEMENTACIJE DIGITALNO AUTOMATSKO KVAČILO NA UVJETE RADA MANEVARSKOG OSOBLJA

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SUMMARY:

The requirements for supply chains have changed significantly in the last decades, due to demands or challenges in competition. However, not only the requirements but also the technologies underwent a change. If we consider rail freight transport, digital systems for wagon data admission or route planning system are currently implemented. The freight wagons themselves, however, have remained in basic principles of the 19th century. For example, they do not have a power supply or a continuous data line to ensure the train integrity or supply sensors on the wagons with power. It is also necessary to couple and uncouple the screw couplings manually. Today coupling and uncoupling wagons is a physically demanding work and not without danger. Here, the use of a Digital Automatic Coupling (DAC) could have a positive impact of the operating procedure and reduce occupational risks. In the context of this work it is examined, how the implementation of the DAC influences the staff. For this purpose, conventional processes are analyzed and the effects of the DAC are examined. It is shown, how the various tasks and the responsibilities are shifted between different workers, like shunting staff and train drivers.
Key words: Shunting, Digital Automatic Coupling, work environment, Freight traffic

REZIME:

Zahtjevi prema opskrbnim lancima značajno su se promijenili u posljednjim desetljećima, kao rezultat promjena na području tršišnog natjecanja. Međutim, nisu se promijenili samo zahtjevi, već i tehnologije. Ako promatramo željeznički teretni promet, trenutno su implementirani digitalni sustavi za prijem podataka o vagonima i sustav planiranja ruta. Teretni vagoni, i dalje su utemeljeni na načelima 19. stoljeća. npr., nemaju napajanje ili kontinuiranu podatkovnu liniju koja bi osigurala cjelovitost vlaka ili opskrbu senzora na vagonima strujom. Nadalje, potrebno je ručno spajati i odvajati vijčane spojnice. Spajanje i odvajanje vagona je fizički zahtjevan i opasan posao. Uporaba digitalno automatskog kvačila (DAC) mogla bi imati pozitivan učinak na radni postupak i smanjiti profesionalne rizike. U kontekstu ovog rada ispituje se kako implementacija DAC-a utječe na osoblje. U tu svrhu analiziraju se konvencionalni procesi i ispituju se učinci DAC-a. Prikazuje se kako se različiti zadaci i odgovornosti prebacuju između različitih radnika, poput manevarskog osoblja i strojovođa.
Key words: Manevriranje, digitalna automatska spojka, radno okruženje, teretni saobraćaj

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1. INTRODUCTION

Currently the freight transport sector needs to react in order to achieve the Green Deal targets for emissions caps in the transport sector. It is necessary to drastically reduce emissions in land-based transport. This can be achieved by reducing emissions in the individual modes of transport or by shifting to more climate-friendly modes of transport. (CER (on behalf of Rail Freight Forward), 2020a)

For example, it is planned to increase the modal split in rail freight transport to 30 % by 2030. However, in order to achieve this goal, corresponding optimizations in rail transport are necessary. Many rail freight corridors (RFC) are already well utilized today. In urban centers, some of the rail networks are at their capacity limits. (CER (on behalf of Rail Freight Forward), 2020b)

In addition, although technical systems are already being used in rail freight transport to handle traffic, for example software solutions for recording wagon data, the freight wagons are largely in their original condition. This means that they are only mechanically coupled and braked via a main air line. For coupling and uncoupling, it is necessary for a shunter to enter the track area and perform this activity manually. This operation is not only time consuming but also dangerous. In addition, the manual UIC screw coupling is an obstacle to completely automating shunting in marshalling yards. There are approaches here, for example, research has been carried out in Austria in recent years on a prototype uncoupling robot. However, this could only be used locally at large stations and could not bring any improvements in small area stations. (Egger et al., 2019)

Currently, various European projects are working on the implementation of a Digital Automatic Coupling (DAC) system. In the course of international projects (e.g. European DAC Delivery Programme / Europe's Rail Joint Undertaking) and national projects, this idea is being implemented. This paper presents considerations that have been developed in part in the Digital Automatic Coupling in Infrastructure Operations (DACIO) Project. (FH St. Pölten Forschungs GmbH, 2021)

For this purpose, a process from as-built shunting is analyzed. This will then be looked at using a DAC and the improvements for employees will be identified.

1.1. Digital Automatic Coupling

The DAC is a center buffer coupling system which, in addition to a mechanical and air coupling, also ensures the power supply and data supply. Several center buffer coupling systems already exist worldwide. For example, the SA3 type coupling, which is mainly used in Russia, and the AAR type, which is used in America. Whereas with the UIC screw coupling all coupling and uncoupling operations have to be carried out manually, with the center buffer coupling systems at least the coupling operations are automated. The DAC would therefore be an innovation in this sector and would enable corresponding technical functionalities. (Rilo Cañás et al., 2022)

Table 1 shows the different technical levels of the DAC with their functionalities.

The power and data line can, for example, optimize train preparation, brake tests and, through sensor technology, wagon technical inspection. However, these are so-called enabler functions that require further adaptations to the freight cars and traction units, but the DAC makes them possible in the first place.

As a coupling type the Scharfenberg coupling type is chosen as a coupling design:

Table 1: Different DAC Levels Source: (Hecht et al., 2020)

Functionality	AK-1	AK-2	Level 3	Level 4	Level 5
Automatic mechanic coupling	Yes	Yes	Yes	Yes	Yes
Automatic main air-pipe coupling	Yes	Yes	Yes	Yes	Yes
Automatic power coupling	No	No	Yes	Yes	Yes
Automatic data coupling	No	No	No	Yes	Yes
Automatic Decoupling	No	No	No	No	Yes

Figure 1: DAC Type Scharfenberg from Voith. Source: (Voith GmbH & Co. KGaA, 2022)

2. METHODS

Methodologically this paper can be divided into two parts. The first one is an analysis of the existing processes and the second part consists the considerations of the implementation of the DAC. Basically, freight transport can be divided into four sub-areas: Shunting preparation, shunting execution, train preparation and train running. In the course of this work, the focus is on shunting preparation and shunting execution. Although these activities are comparable throughout Europe, Austria is chosen as the region to be studied. In particular, the infrastructure of the Austrian Federal Railways (ÖBB). For this purpose, a rulebook and process analysis is carried out at the beginning, which leads to initial findings on the processes. Based on these findings, a schematic overview of the respective activities could already be created. An analysis of the processes in operation on site brought further refinements for this part of the work. Based on this, the respective target states are considered with the DAC. For this purpose, the DAC is implemented in the fine-ranking process. In doing so, not only the process components are examined, but also the respective activities for the staff. It will be deduced how this changes the work environment.

3. RESULTS

As mentioned, the first part is to analyse the shunting process in general. In this stage, the different tasks involved in the process of assembling and disassembling train formations are identified. On the other hand, categories are established to group these activities according to their main objective: Uncoupling of wagons, Shunting movements, Coupling, Inspection of wagons, departure arrangements. Thus, it is possible to obtain a process diagram based on these two initial dimensions.

Two important distinctions have been taken into account in the rail shunting operations performed in the freight yards, which do not have a hump: Flying shunting (pushing off) and displace shunting (pushed and pulled by a shunting locomotive). In the first case, special attention is focused on the preparation and shunting activities for those wagons that must be pushed in a controlled manner.

3.1. Detailed Shunting Process

Based on the most common shunting operations needed to modify the train formations, the seven most representative operational cases were then defined, excluding the case of Marshalling yards with Hump-yard systems (classification yards). They are the change of direction of a train, which means that the locomotive has to be shunted to the other train side. But not only the position of the locomotive can be changed. Also, the position of freight wagons within the train can be changed. Therefore, a fine row or reordering is needed. Also there can be wagons added to a train or taken from a train. It is also considered as an extra case if wagons are stabled on a loading track within the station area. For industrial sidings there are also assumed two additional cases. One for picking up freight wagons in an industrial siding and the second for delivering wagons to an industrial siding.

3.2. Current situation

Based on the definitions described above and on the analysis of real cases by professionals in the operation, it was possible to structure a process diagram for each case, identifying the main activities and the personnel involved (Dispatcher, Train driver, Shunting stuff and Wagon inspector) in the different stages.

The driver concentrates on the activities related to the movement of the train and shunting operations with the different groups of wagons, whether with a line locomotive or a shunting locomotive. All the checks emanating from both the Shunter and the Dispatcher are also added before proceeding to move the train. (ÖBB Infrastruktur AG, 2021)

The activities associated with the coupling and uncoupling of wagons are performed by the shunting Staff in-between two wagons, coupling them. The activities include the physical coupling and uncoupling of the UIC screw coupling and main air pipe. Before or after that the opening and/or closing of valves as well

as the partial or total testing of the brake system has to be done. Other activities are related to the wagons: Verify the correct information of the transported cargo (freight documents), add or remove the end of train signal if it corresponds to the end wagon, add or remove the drag shoes in case the wagon must be secured or not. Finally, there are the operational support activities: Assisting the driver in pull situations (because the driver cannot see the line ahead), request, check, and steering manual turnouts on the route. (ÖBB Infrastruktur AG, 2021) In bigger railway stations a Wagon inspector carries out a technical examination of the wagons. In industrial sidings a simplified wagon inspection is made by the shunting staff. (Wagner et al., 2021)

The corresponding components of the fine-series process can be seen in Figure 2, whereby the shunter activities, which will be affected by the DAC are marked yellow:

3.3. Adapted situation

While the driver's activities are largely unaffected by the implementation, there are improvements in all activities that relate to the checks that emanate from both the Shunter and the dispatcher before proceeding to move the train.

In the case of the activities associated with the Shunter, those are associated to the coupling and uncoupling of the wagons are of great relevance. The big change has to do with the fact that the Shunter's workplace, between the wagons. The shunting staff don't has to be in between two freight wagons, and also the time on the track in general can be reduced. It should be noted that for uncoupling of the DAC Level 4, although it requires manual operation, it is possible to operate it from the side of the train. Other activities related to the wagons that have to do with verifying the correct information can be assisted

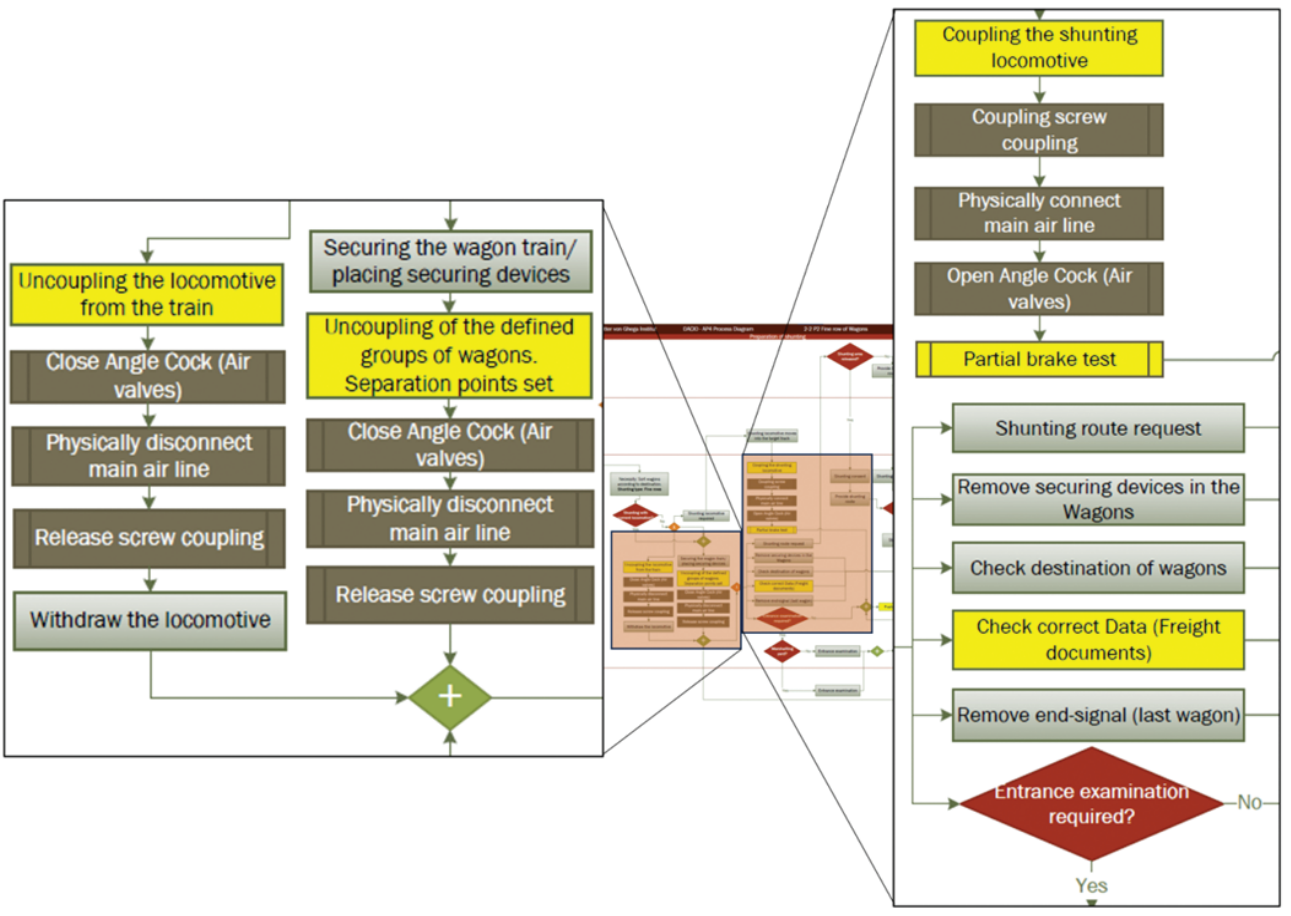

Figure 2: Conventional process of fine row of wagons

thanks to the digital information flow between the wagons. Finally, operational support activities remain unchanged. Figure The corresponding components of the fine-series process with the DAC Level 4 or Level 5 can be seen in Figure 3. The changed steps are marked green.

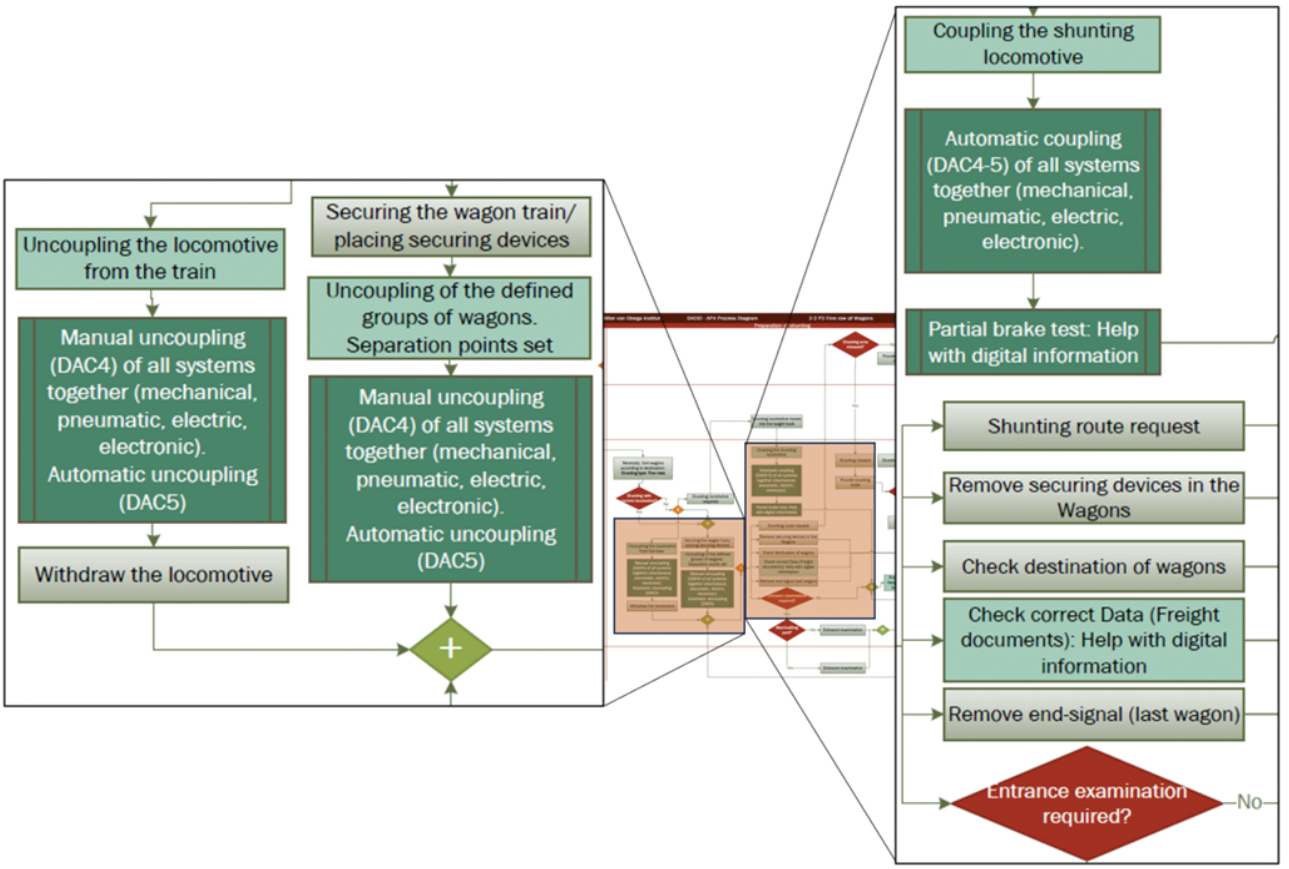

Figure 3: Adapted process of fine row of wagons

3.4. Impact on professional profile

The new modifications due to the DAC in the processes of assembling and disassembling train formations have consequently a rethinking in the definition of the required professional profile, mainly due to the following three aspects. Data Utilization: Possibility of performing remote tasks, in a shorter period and a higher data quality. This accelerates the planning, preparation, document inspection and follow-up processes. Automation: The new designs ensure automation throughout much of the process. In others where it is not possible (decoupling at level 4) there is a substantial improvement in working conditions (less risky). For both cases, partial or permanent supervision by personnel is required in case of failures. Data and control: The project will allow each car to report information related to the systems and even the ability to perform diagnostics and thus detect certain deficiencies. Another possibility that is still under study is to reinforce the control of the braking systems and thus cover the functionality of partially or totally securing the wagons. It is therefore proposed that the changes in the professional profiles will finally focus on the inspection, supervision and troubleshooting. For this purpose, a greater specialization related to the previous aspects is required for the personnel. Especially to the new coupling system functionalities, diagnostics, preventive and corrective activities, risks, etc. Although if the total occupational risk decrease significantly due to reduced exposure, there has to be further investigation, if new occupational risks also arise due to technological change. (Alay et al., 2023)

Therefore, it is possible to address a strategy of reassigning personnel, so that those roles that disappear do not result in the reduction of personnel, but rather cover the new needs and thus the new roles demanded. This requires a strong transition program that allows people to be trained and thus provides more attractive and secure job opportunities with great projection. (Alay et al., 2023)

4. DISCUSSION

The implementation of the DAC is expected to be gradual and with it come dynamic scenarios, which we must consider in all areas when thinking about implementation process. The level of coupling

automation (type 4 - type 5) is therefore a significant criteria, which is triggering the activities and functions to be performed by the trained personnel. It leads to a dynamic and prolonged change management. The technological changes will be made gradually. Especially if there is not a transition phase there will situations where trains with the new coupling systems deliver data, but other trains do not deliver data. To this end, it is important to think about the necessary interfaces as well as the requirements and functionalities to be integrated. (Tyrinopoulos & Milioti, 2022)

Finally, one of the most relevant aspects of the DAC project has to do with the overall impact of digitization on the workforce. This is not trivial, but it can be generally identified, that there are opportunities, remaining gaps and barriers and mixed conditions. As a barrier it can be seen, that there has to be a scepsis from the workers. Therefore the staff should be integrated, in adapting their new job roll, because there are fundamental changes from a simple mechanical system to a system with electrical components, which is more complex and offers more functions (supervision and breakdown/maintenance services). There has to be an appropriate training on the new functions. Which leads not only to new function in existing job roles but also to new professions (platform workers, IT). Also, the harmonization of rules and procedures but also the legal framework has to be done. The reduced occupational risk can also improve the possibility to find more workers, especially young people. On the other hand there should be mentioned, that also if new employees are needed, they cannot be found so easily so automation and the change process can attract these jobs. That can be reached by a reduction of manual activities and the redeployment of functions between different positions. But also for the transition phase there should be considerations of the mixed scenarios. (Tyrinopoulos & Milioti, 2022)

5. CONCLUSION

It can be concluded, that the development of the DAC will bring improvements in operational efficiency and safety. On the other hand, digitization also brings in the railroad field new functions to support in the operation, collecting online information and thus improving the management of other stakeholder processes.

Of great importance is the training of the personnel involved and the redefinition of roles and functions in change management, which will not be immediate. Hybrid operating scenarios are to be expected in which high-tech trains and conventional (non-equipped) trains coexist. It is therefore important to prepare personnel not only for the future scenario, but also for the transition scenario.

Finally, automation brings with it new technologies that require greater specialization of operating personnel, a greater effort in personnel training processes and complex change management in processes and protocols, both operational and risk prevention. The presence of more technology also means the opportunity to attract new highly qualified professionals, especially women and young people.

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