Journal of Automation, Electronics and Electrical Engineering

Optimisation of the Production Line for Safety Equipment in Rail Traffic Using the RHR-95 Drive as an Example

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DOI: https://doi.org/10.24136/jeee.2024.007

Abstract - The article presents the optimisation of the production process proposed by the authors on the basis of the production process of the RHR-95 type drive optimised according to LEAN standards. This is a safety infrastructure element which is part of the system for securing railway and road crossings manufactured by ZA KOMBUD S.A. The final result is a presentation of the tangible benefits of optimising the production line according to LEAN assumptions and the impact on product quality after making changes to the production process.

Key words - railway automation, signalling systems, safety

1. Introduction

Every day, we carry out a variety of transport tasks that have become part and parcel of our lives, such as commuting to work or shopping for daily necessities. We are users of various modes of transport carrying out our daily transport activities in a safe manner without thinking about how extensive and extensive the safety infrastructure in transport systems is. One of the elements that take care of the safety of users are horn drives, including the RHR-95 type, which is used to for securing level crossings. They allow safe crossing of level crossings by informatively blocking the crossing with a horn when a train is approaching. However, those devices that affect the correct stopping of the car represent a sophisticated engineering mechanism based of various component parts. The drive is created during the relevant manufacturing process in man-made assembly steps. This inseparable element of the crossing systems we encounter every day is the result of the work of many people: designers, engineers and installers. The whole is a manufacturing and engineering process, the final result of which is a finished product in the form of a horn drive, in this case the RHR-95 drive. Each production process is a sequence of activities comprising so-called technological processes of various kinds, together with auxiliary activities that are ancillary to the whole, such as warehousing and inventory management together with the supply of raw materials from both the warehouse and production lines. [1] Another of the ancillary elements is the quality control of the component sub-assemblies of the finished product and of the product itself after completion of the production operations, together with maintenance. Instead, this technological process is the assembly element of the individual components of the production process, which are, among other things, the assembly of sub-assemblies, materials and parts, together with secondary machining.

1 BASICS OF THE RHR-95 DRIVE PRODUCTION PROCESS

The traffic control devices (srk) serve to ensure the safety of the movement of vehicles on the network and the required performance in a technically and economically feasible manner. in a technically and economically feasible manner. [2-4] Particularly sensitive locations on the railways are level crossings, i.e. junctions in one level between a rail road and a wheeled road, where significant property damage and often human casualties can occur. This is particularly important due to the quantities that characterise the movement of rail vehicles, such as speed, weight, braking distance they have priority at a level crossing over vehicles on the road.Polish legislation on securing single level crossings of railway lines with roads is based on the Regulation of the Minister of Transport and Maritime Economy on the technical conditions to be met by crossings of railway lines with public roads and their location of 26.02.1996, which allows such crossings on railway lines with a maximum train speed of up to 160km/h and distinguishes 6 categories of crossings: railway line crossings with a maximum speed of up to 160km/h, and railway line crossings with a maximum speed of up to 160km/h. trains up to 160km/h and distinguishes 6 categories of crossings:

- category A - level crossing with or without turnpikes where traffic on the road is controlled by signals given by railway workers, on lines with a maximum speed of 160 km/h,
- category B - level crossing with automatic traffic lights and with semi-collars, on lines with the maximum speed of 160 km/h,
- category C - level crossing with automatic traffic lights or activated by railway workers on lines with a maximum speed of 160 km/h. activated by railway staff, on lines with a maximum speed of up to 140 km/h,
- category D - level crossing without horns or semi-traffic barriers, without automatic traffic lights, on lines with a maximum speed of up to 120 km/h,
- category E - public level crossings,
- category F - crossings and road crossings of non-public use.

Self-acting crossing signal (ssp) devices are used to protect traffic at single level crossings of vehicular roads with railway lines. These devices are activated by a train approaching the crossing by means of track sensors (or electrical overlapping circuits). [5-7] The crossing is equipped with warning devices consisting of: traffic lights (2÷4 pieces) supplemented by an acoustic signal and one or two pairs of semi-crossings. The signalling is activated a minimum of 30 seconds before the head of the train enters the level crossing and switched off approximately 5 seconds after the last axle has left the level crossing. The automatic crossing signals level crossing signals comprise the following devices:

- sensors (detecting an approaching train, e.g. track sensors),
- command and control (apparatus and power supply cabinets with PLCs),
- warning (traffic signals, bells, horn drives, crossing warning lights),
- auxiliary for the visualisation of the operation of ssp,

- diagnostics (remote control devices, portable diagnostic panels and, in exceptional cases, diagnostic modules).

The way in which the production process is carried out, both for the overall finished product and for the individual components that make up the product during assembly, has a significant impact on the time it takes to carry out assembly work and on the quality and reliability of the final product. Any type of activity that improves the production process, while benefiting the quality and reliability of the equipment, also reduces the real and indirect production costs that are incurred by the manufacturer at various stages of product creation. The application of the LEAN philosophy in the production process allows for the optimisation of assembly operations as well as secondary operations accompanying production. Through better organisation of work, it reduces the time needed to manufacture a finished product and, at the same time, by simplifying the work method, prevents mistakes that the assembler may make during the work, guaranteeing a higher level of quality and reliability of the device.

The basic and first element in the application of LEAN methods to optimise the production process is the correct organisation of the work nest, where all kinds of assembling work are carried out. The person assembling the individual components should have convenient access to the place where he or she is currently carrying out the assembly operations. The body of the RHR-95 drive has a height of one metre, of which the opening allowing the motor to be mounted together with the other goods included in the drive has a maximum opening height of 75cm. A view of the said drive and the internal appearance can be seen in the following figure 1, where the problems that the assembler may encounter in the operations can be analysed. The use of a lift truck as an assembly point allows the drive to be assembled in a convenient manner at a height allowing the assembly to be performed in a comfortable manner. This allows the worker, through convenient and clear access, to perform the work in a comfortable manner, resulting in a more meticulous execution of the consolidation of the RHR-95 drive components. At the same time, better and more comfortable working conditions allow for avoiding mistakes resulting from human error during assembly. It is also worth noting that the correct position of the fitter at the workstation also has a significant impact on health, as incorrect body posture during work can cause health damage, spinal defects and other posture-related diseases. It also helps to increase the safety of workers, as it eliminates the possibility of many work-related accidents. The trolley that is used in this optimisation procedure can be seen in figure 2.

This is a standard lift truck with a lifting capacity of up to 500 kg, which meets the requirements for the analyzed RHR-95 barrier drive.

Fig. 1 Drive type RHR-95

2 THE PROCESS OF SUPPLYING COMPONENTS

As another of the optimisation steps, it is necessary to analyse the process of supplying raw materials and components to the production nest, which are necessary for the assembly activities on the production order. The proposed method is to separate raw materials into three material categories such as general cargo, fixed goods and goods on demand. The first group of materials defined as smallgoods are low-value goods that are permanently used during production activities, these goods can be lost, destroyed or used in a non-standard way. It contains various types of screws, washers, nuts, electrical clamps and other goods necessary for production.

They are permanently placed in the production nest on shelves or in trolleys that contain containers with a specific product and quantity. An example of a workshop trolley that can ideally fulfil this role is shown in Figure 3. Thanks to its mobile design, it allows the assembler to move it to a convenient location where he or she is currently carrying out assembly operations on a production order.

Fig. 2 Lift truck [8]

Fig. 3 Workshop trolley for materials [9]

The goods on such a trolley, in order to ensure the continuity of the available materials is continuously replenished by the warehouse when the container is emptying the container. Such a trolley should contain two containers with the same goods, because when one container runs out of goods, the assembler uses the other one, while the warehouse has time to refill the container. This ensures production continuity, avoiding the lack of goods at the work bay, while allowing the person performing the consolidation of the drive to concentrate fully on the task at hand, without having to worry about possible material shortages that may occur in any type of production process. At the same time, these goods are constantly in production departments, even when a production task is not being carried out in a given nest at a given time. Another of the material subdirectories are fixed materials. These are higher-value goods or goods that do not need to be on the work nest all the time. An example of such a product in the aforementioned barrier drive is the drive body, which is the entire external casing. This is a semi-finished product that should not be in production all the time but should be a warehouse element. When the assembler starts work, the fixed goods specified in the technology, such as the above-mentioned barrier body, are delivered to the work center by warehouse workers. Thanks to this, the assembler does not have to make unnecessary movements related to providing himself with the goods necessary to complete the production order entrusted to him, but can fully devote himself to the work he is doing. The last proposed assortment group assortment group are goods on demand. This is a group of goods not needed the assembler at the initial stage of the production process, so that on delivered at the start, they would occupy most of the assembler's time only space. Goods on demand are specified in the third stage of technology and are supplied when the goods needed at a given production stage are called up. To facilitate this procedure, 'kanban' cards are used, which are lined up by the production worker in a specific, clearly visible place when he approaches the moment where he will need the goods specified on the card. Then a warehouse employee seeing a card lined up collects it and delivers the goods to the work slot instead, within the time specified for the warehouse's response to the card. In this way, the assembler has the goods required for the production operations available at all times. An example of such a commodity could be a hydraulic motor, which is not required as soon as production begins, but only after the preparatory activities for the next stage of assembly performed on a production order have been completed. An example of a 'kanban' card is shown in Figure 4, but it is worth noting that the data it should contain can be selected according to the characteristics of different production processes. It can be expanded to include the number of pieces to be delivered or information for the warehouse on which work slot the goods are to be delivered..

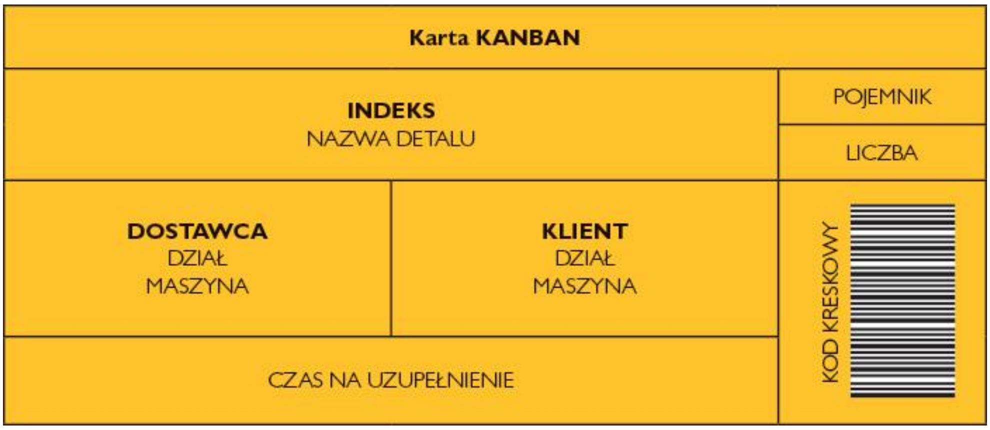

Fig. 4 Example of a kanban card [10]

3 LEAN'S IMPACT ON COST REDUCTION AND WORK TIME

Thanks to the optimization of production processes according to the LEAN philosophy, it is possible to implement production processes faster, which allows for a significant reduction of working time and the costs of manufacturing the final product. [11-14] Chapters one and two present topics related to the possibility of optimising the production nest and the system for supplying raw materials to the assembly station. It is worth noting that, thanks to the optimal design of the work slot, installation can be significantly shortened through better accessibility to the areas where it is carried out, which has a real impact on the time in which activities are carried out. Thanks to the efficient supply of raw materials, the fitter does not have to go to the warehouse or organise the supply of raw materials himself, which has a significant impact on time, as he can then focus solely on production. It eliminates ro unnecessary movements that are not direct production movements and are only indirect production movements. However, according to these assumptions, intermediate production tasks are eliminated for the assembler and transferred to employees who only deal with intermediate production work, such as warehouse staff. This has a real impact on reducing the time spent working on a single production order. Reducing the time it takes to complete a single order makes it possible to better manage assembly time, with the end result being greater productivity on the production line. Increasing the efficiency of a production line results in a reduction of costs in a single-shift operation, as the greater efficiency of the work carried out on a single production line spreads the indirect production costs such as electricity, water, gas, wear and tear on lines, tools and machinery over a greater number of finished products made. At the same time, the optimisation of deliveries from the warehouse into three technological categories avoids damage to high-value products such as the engine, for example, where the risk of damage at the initial production stage by the fitter or production factor is eliminated, which also reduces the overall costs of the production line and individual workplaces while eliminating the waste of raw materials.

4 CONCLUSIONS

The article discusses the application of LEAN methods in the organisation of the production process and its optimisation. At the same time, a methodology for the optimisation of the production process was presented, which can be used not only in the production of RHR-95 drives, which are a product of the Automation Machinery Plant KOMBUD S.A. located in Radom, but also in other various production processes. The solutions presented have a significant impact on the overall process as well as on the final result, as the facilities provided give the fitter time to work in a comfortable environment with uninterrupted access to the material. This eliminates the possibility of error resulting from human work. It is a significant element in ensuring the correct operation of the entire system for securing a level crossing, with the end result being the provision of an appropriate, high level of safety in land traffic. The production process, which is a set of activities that make up the overall technological process and the ancillary activities such as storage management, including the procedure for supplying raw materials to workstations, as well as inspection and maintenance and the transport process. This set of tasks, which are often overlooked, has a significant impact on the effect of the final product which, in the case under consideration, is a critical element of the land-based safety infrastructure that can be improved by applying the LEAN philosophy to production processes.

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