International Journal of Advance Scientific Research
(ISSN – 2750-1396)
VOLUME 03 ISSUE 02 Pages: 07-17
SJIF IMPACT FACTOR (2021: 5.478) (2022: 5.636) (2023: 6.741)
OCLC – 1368736135

Journal Website: http://sciencebring.com/index.php/ijasr

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Research Article

THE CURRENT STATE AND DEVELOPMENT OF METHODS FOR ASSESSING THE TECHNICAL AND OPERATIONAL PERFORMANCE OF SORTING STATION

Submission Date: February 05, 2023, **Accepted Date:** February 10, 2023,
Published Date: February 15, 2023
Crossref doi: https://doi.org/10.37547/ijasr-03-02-02

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ABSTRACT

The purpose of the work is to analyze the performance of the main work indicators of the sorting station and to analyze the modern state and stages of development of assessment methods. In this case, all methods were divided into two categories, the advantages and disadvantages of which were studied. Through this case, proposals and recommendations were developed on the application of methods of management theory in the work activities of the sorting station. As a result, the advantages of the most optimal methods for analyzing and assessing the level of implementation of the most basic operating indicator of the qualifying station – the technical standards "wagon standing time" were indicated.

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Crossref doi Google Scholar WorldCat MENDELEY

ISSN-2750-1396

KEYWORDS

Sorting station, analytical method, graphic modeling, simulation modeling, management, time spent by wagons at the station, unproductive loss.

INTRODUCTION

The operation of the railways of each country largely depends on the efficient operation of sorting station. The competitiveness of railways, and in turn, also important operational indicators depend on their precise operation, namely in conditions of increasing wagon traffic volumes.

The operational performance of the sorting station is divided into two groups (fig. 1) [1-19, 21].

Operational indicators are used for planning and analyzing the operation of the station, as well as for technical and operational evaluation of the organization and management of wagon traffic at sorting station. They are calculated for a certain period of time, then, comparing the results obtained with the results of work in previous years, a conclusion is drawn about the nature and trends of changes in the quality of operational activities.

The system of indicators for all types of sorting station is determined depending on the category of wagon traffic processed at this station.

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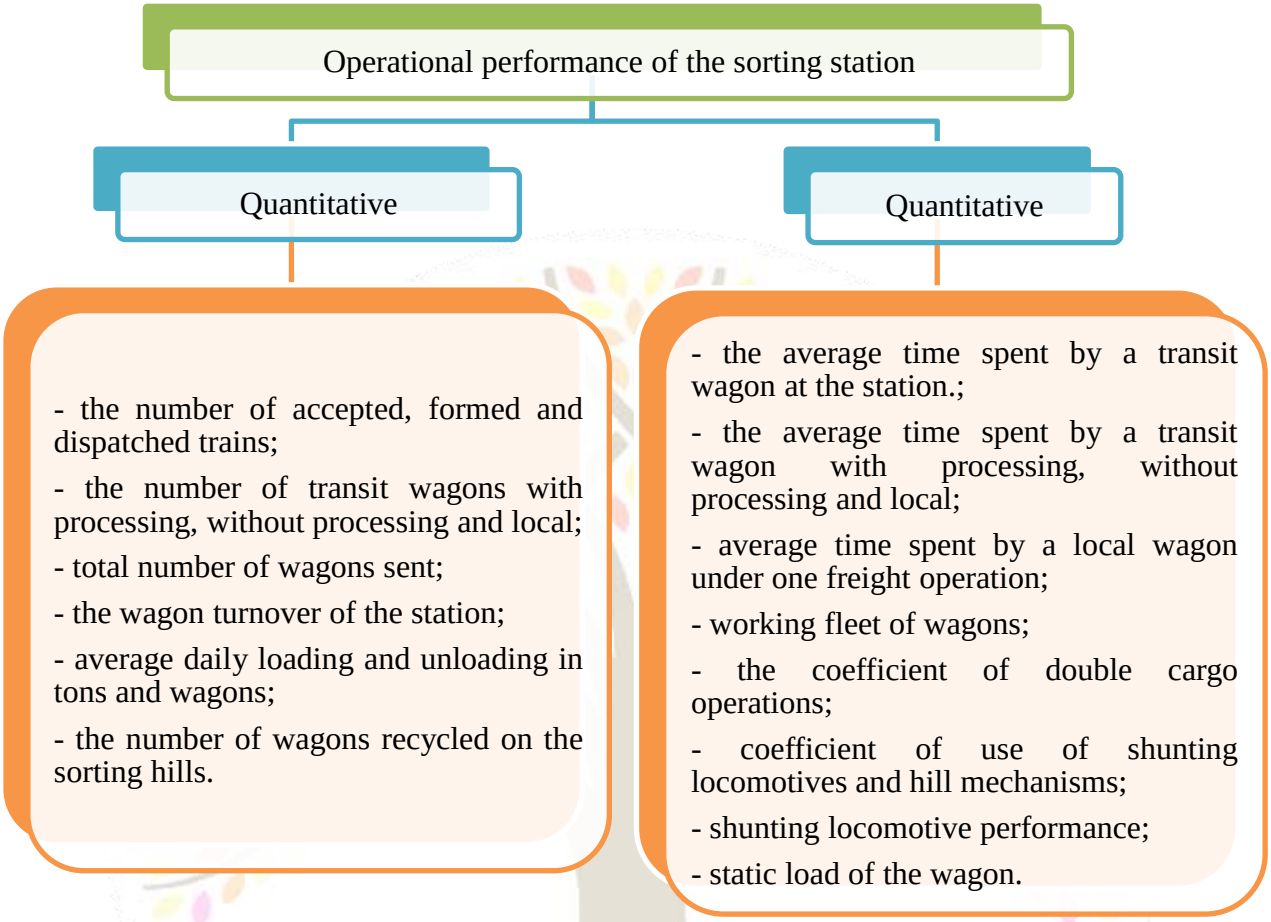

Figure 1. The system of operational indicators of the sorting station

METHODS

To assess the technical and operational performance of the sorting station, the following methods are used: theory management and operation [1, 2].

In the theory of management within the framework of lean manufacturing, the technical and operational performance of the sorting station, including the time spent on wagons and unproductive time losses, are evaluated by various methods: kanban; kaizen; Ishikawa diagram; value stream mapping; "just-in-time" system, etc.

Kanban (Pulling production). The principle of the pulling method within the framework of the lean manufacturing concept means that the required quantity of products produced at each stage of the process determines the technological link that is at a subsequent stage in the course of this process [1, 17-20].

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Pulling for railway transport means that the main link in the transportation process is the delivery "just in time", for this, unproductive losses in all parts of the transportation process at the sorting station must be reduced. [1, 2, 7-16].

Figure 2 shows an example of pulling in the work of a sorting station for the final result "just in time".

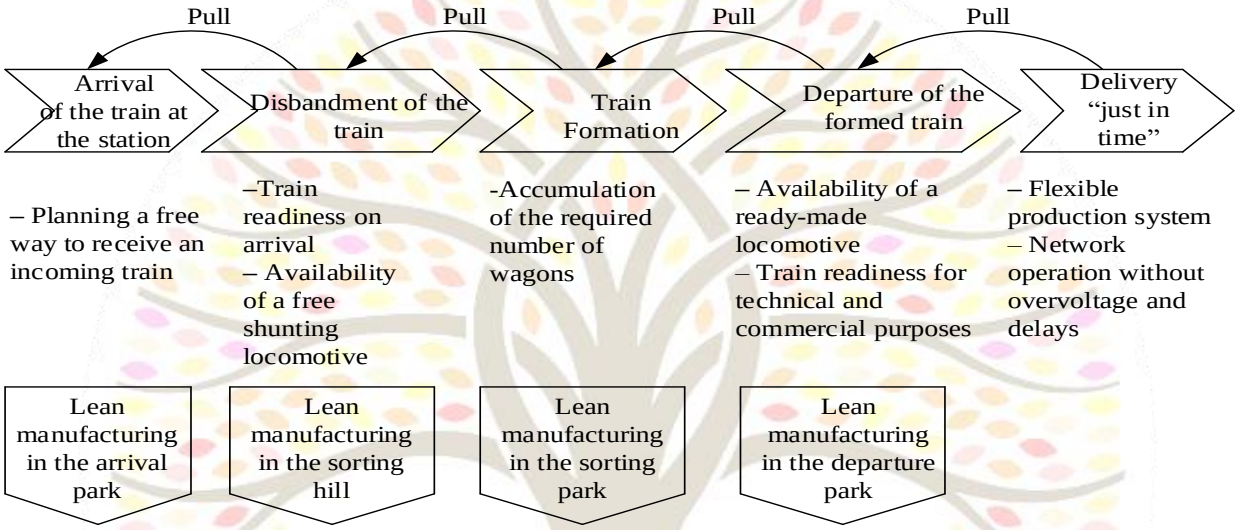

Figure 2. Pulling in the operation of the sorting station

Kaizen (constant improvement) is a derivative of two hieroglyphs – "change" and "good" – usually translated as "changes for the better" or "constant improvement" [1].

The Kaizen method can be implemented to improve the inspection of trains in the departure park of the sorting station.

Figure 3 shows the cycles of continuous improvement of the inspection of trains in the departure fleet, when trains depart from the station to the scheduled schedule lines.

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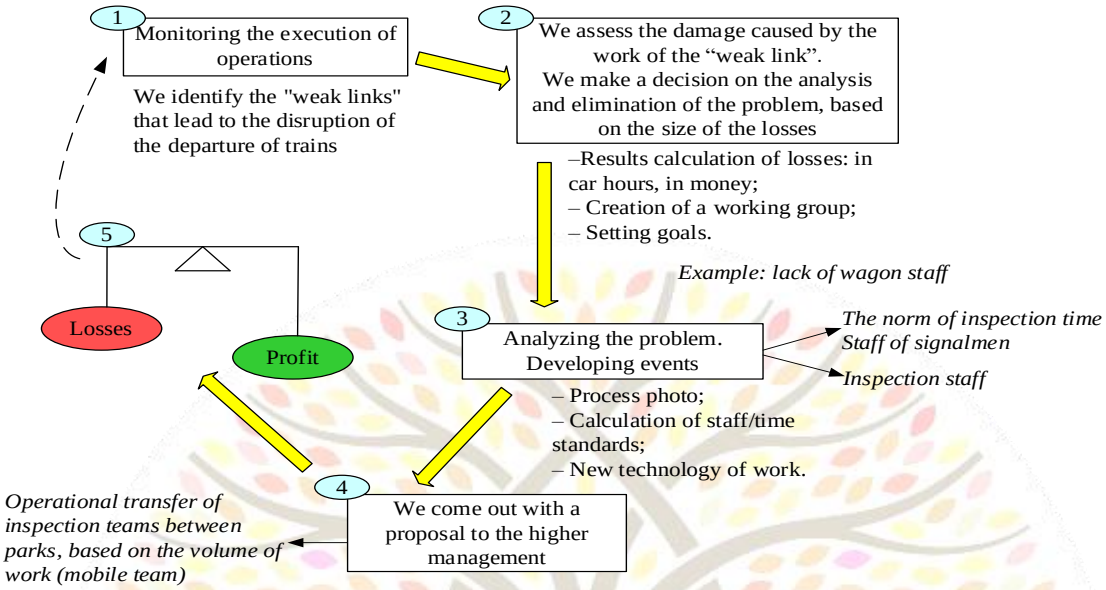

Figure 3. The cycle of continuous improvement of the inspection of trains when trains depart from the station to the scheduled lines of the schedule

The Ishikawa diagram is the key to solving emerging problems [1].

This method studies, displays and provides technology for finding the true causes of the problem in question in the operation of the station for their effective solution, i.e. to determine the causes affecting all levels of the technological process.

Its main advantage is that it provides a visual representation not only of the factors influencing the analyzed object, but also of the causal relationships of these factors, which is the key to solving emerging problems.

In the work, using the Ishikawa diagram, the reasons for non-compliance with the standards for the time spent at the station for transit cars being processed and without it are considered (Fig. 4)

The works of many scientists are devoted to the issues of accounting and analysis of unproductive losses and the development of lean production methods, however, most of the works reveal certain aspects of the problem without offering a universal evaluation mechanism [1, 2, 20].

For example, in [20], the use of methods for mapping the value stream is proposed. Using the example of the introduction of lean manufacturing at the Moskovka station of the West Siberian Railway in order to reduce time losses affecting the time spent by wagons in the station's fleets, [20] maps of the value creation flows of the process during the processing of the train in the marshalling yard reception park were

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formed, before the application of measures to reduce the time of technical maintenance of rolling stock and commercial inspection wagons and after (fig. 5).

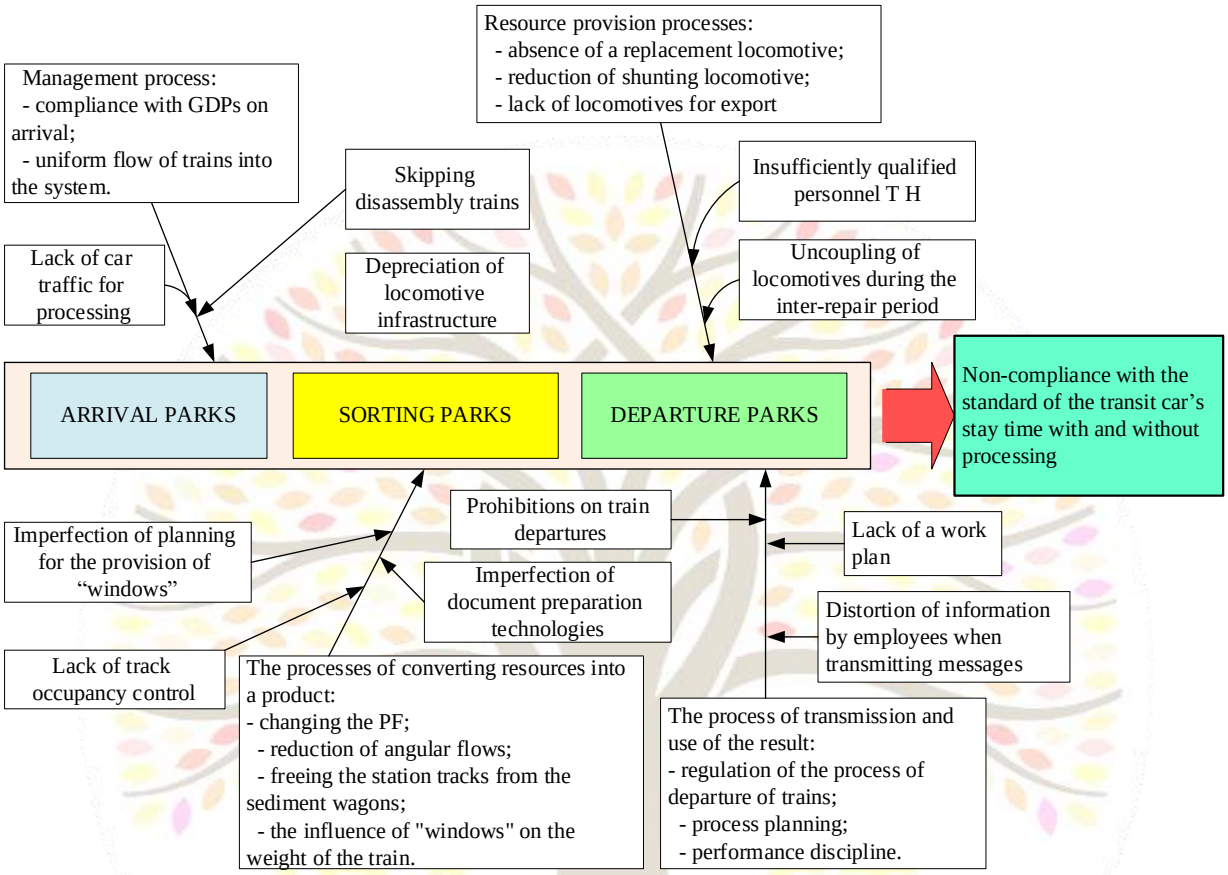

Figure 4. Diagram of "Ishikawa" on non-compliance with the standard of time spent by a transit wagons at a sorting station

It follows from [20] that an increase in value is possible only by reducing the time for inspection of the composition in technical and commercial terms (Fig. 5), but no specific mechanism for such reduction is indicated.

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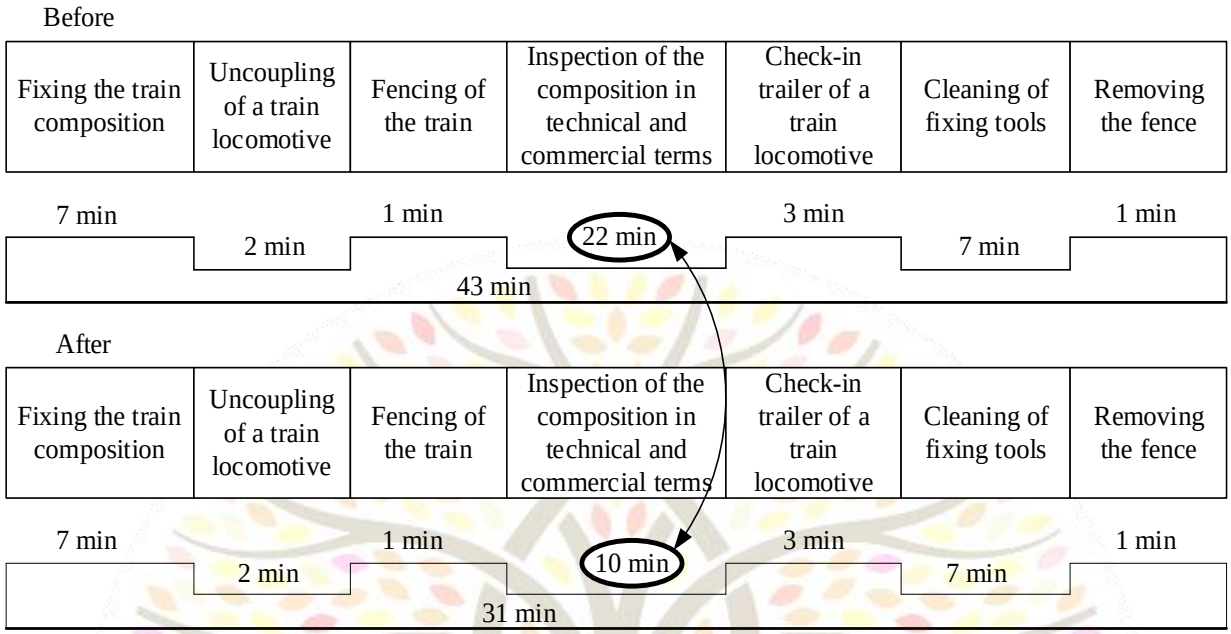

Figure 5. Map of the value stream of the process during the processing of the train in the receiving park of the sorting station

In the theory of operational work, methods are used that can be combined into two groups – analytical methods and modeling methods (graphical, tabular, simulation, etc.) [1, 2, 21]

In the group of analytical methods, two subgroups of methods can be distinguished aimed at calculating the time spent by wagons at stations. The first is based on the use of the mathematical apparatus of queuing theory and the second is based on statistical dependencies. The proposed formulas are used in all cases to determine the average time spent by wagons only in the subsystems of the station. The disadvantage of analytical methods is the lack of consideration of the influence of subsystems on each other, and they are also complex and require additional time-consuming processing of actual materials to obtain initial data [4, 6-8, 10-12]. However, the use of analytical methods is very convenient for evaluating design solutions when conducting scientific research [15-19]. The percentage of errors is on the order of up to 50% [1-3, 5, 9, 13, 14].

The standard technological process [1, 2] recommends determining the norms of the time spent by the wagon at the station using either tabular modeling or graphical methods based on the construction of a daily schedule (CDS) of the station operation. Despite the fact that the calculation of the time spent at the station by these methods is approximate and time-

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consuming, these approaches are widely used in practice.

The graphical model of the daily operation of the station is a graphical representation of the station's work on processing wagon traffic per day.

CDS is considered a regulatory document that defines the main performance indicators of the device. For two third-party stations, each system is compiled separately. At CDS, the arrival and departure of trains is accepted in accordance with the train schedule, the processing time in the parks is according to the norms of the technological process. The work of the locomotive maintenance point and the provision of locomotives and crews is not specified. The advantage of CDS is in the clarity and convenience of evaluating the operation of the station, taking into account the mutual influence of the elements on each other, but the determination of time according to it is due to the conditionality of the nature of the initial data, fluctuations in the time of technological operations, the absence of accounting for the operation of the system for providing trains with locomotives.

On the basis of CDS, the norms of the time spent by wagons, as a rule, are significantly underestimated, and unproductive losses are overestimated.

The method of tabular modeling is characterized by a sequential comparison of the intensity of the arrival of trains (wagons) in the parks with the intensity of their output after processing over the billing period. As a result of calculations, the probabilities of the states of the wagons and the time they are under operations are determined. The advantage of this method is to take into account the unevenness of the receipt of compositions and processing in parks, as well as the possibility of modeling for any period of time. The disadvantage of the method is, although it is less than in the case of using graphical modeling, but still a large complexity of calculations. In addition, the requirements of the system approach are violated – the calculation subsystems are considered as independently functioning technological subsystems, which does not allow to correctly take into account the employment of tracks, the work of locomotives, opposition in the throats, etc.

As a result, the norms of the time spent by the wagons are quite approximate. The losses calculated for these groups often do not correspond to reality. The percentage of errors when using graphical and tabular modeling is approximately 20% [1-3, 5, 9, 13, 14].

Currently, simulation modeling is an effective means of analyzing and evaluating the performance of stations.

The method of simulation modeling is in a repeatedly repeated calculation on a computer of technological processes with a greater or lesser level of their detail. To do this, statistical data is collected on the parameters of interest.

The disadvantages of simulation modeling include the complexity of developing modeling tools, debugging and verifying them, as well as using them to obtain results. At the same time,

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simulation modeling is considered to be the main method of analysis and calculation of large systems [1-3, 5, 9, 13, 14].

At work [1-3, 5, 9, 13, 14] it is noted that the percentage of errors when using simulation modeling methods varies at the level of 5-10%, which is significantly better than the methods listed above.

CONCLUSION

The advantages and disadvantages of the above existing methods for analyzing the time spent by wagons at the sorting station show that an effective method for analyzing and evaluating the operational performance of the sorting station is the simulation of station processes using modern computer technology. The use of these models in the operation of sorting station makes it possible to make the most effective decisions aimed at minimizing time and costs during the processing of wagons.

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