Selected Aspects of the Train Timetable Construction of Passenger Trains with the Consideration of Platform Edges and Stabling Tracks Allocation Problem

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The aim of the article is to present a method concerning the problem of the construction of timetable from the point of view of the assignment of platform edges and stabling tracks. Taking into account these two issues in the method is extremely important from the point of view of the fluency of railway traffic, as well as minimizing railway undertaking costs related to access to the infrastructure offered by the manager in terms of occupying the platform edge above the set time. The paper describes the issues of allocating platform edges and stabling tracks in operating offices, with particular consideration of the costs related to this. The formulation of the problem of the train timetable construction was presented, including the allocation of edges and stabling tracks in a mathematical manner. In the model those parts were specified that are relevant to the research problem considered in the article. In addition, the algorithm of the construction method with the use of a block diagram was discussed.

Keywords: organization of railway traffic, construction of graphic train timetable, allocation of platform edges, allocation of stabling tracksexamples of identification of mezo-logistics systems in the economy at the sectoral and territorial levels are given, which allows further selection of management methods.

1. INTRODUCTION

Transport of people and goods [2], [34], [40] must be carried out in a timely, fast, reliable and, above all, safe way [6]. This applies to each of the transport modes. Otherwise, it is ordered in the case of road transport, and differently in the case of, for example, railway and air transport, where the minimum threat to the level of safety can have very serious consequences. Therefore, it is necessary to look for methods that allow the introduction of an appropriate traffic organization [21].

The organization of railway traffic [4], [10], [18], [19], [33], [38], [42], [44] is a complex decision-making process that consists of many problems [1], [17], [20], [22], [29] and which is influenced by many factors. One of the problems concerning the organization of railway traffic is the construction of the train timetable [35]. It consists of two stages [13], [18], [19]: shaping the transport offer [14], [41] and the construction of the graphic timetable. The effect of the process of shaping the transport offer is searching for rational routes of communication lines, allocating the right size of the traffic flow to be transported over the selected lines and assigning to the line the type of the train's set to service and its frequency of running. In addition, train numbers are generated as well as the proposed time of their start from a specific operating office on the network. The second stage of the timetable construction process is the development of a graphic train timetable, the effect of which is the deployment of train paths in time and space. In a word, train hours of individual trains are finally obtained. It is worth noting that in the literature many types of timetables can be distinguished [3], [8], [28], [30], [31].

Because IT and optimization methods are developing very strongly, they should also be introduced into the railway transport area [7], [15], [24], [27]. One example is the optimization of train

timetables. For its needs, mathematical models are developed, which are then algorithmized and programmed. Decision support systems are being created in which it should be emphasized that person plays a very important role all the time [36]. The basic models do not take into account a number of factors that affect the process of timetable construction. They should be expanded to make the prepared timetable more flexible [10], [11], stable [12], [16], [39], resistant [9] to all kinds of disturbances and effective [25], [32], [37]. One of the possible actions is to take into account in the process of the construction of the timetable the problem of allocation of platform edges [5] and stabling tracks.

The aim of the article is to present a method concerning the problem of the construction of timetable from the point of view of the assignment of platform edges and stabling tracks. Taking into account these two issues in the method is extremely important from the point of view of the fluency of railway traffic [43], as well as minimizing railway undertaking costs related to access to the infrastructure offered by the manager in terms of occupying the platform edge above the set time. The paper describes the issues of allocating platform edges and stabling tracks in operating offices, with particular consideration of the costs related to this. The formulation of the problem of the train timetable construction was presented, including the allocation of edges and stabling tracks in a mathematical manner. In the model specified those parts that are relevant to the research problem considered in the article. In addition, the algorithm of the construction method with the use of a block diagram was discussed.

2. THE PROBLEM OF THE ALLOCATION OF PLATFORM EDGES AND STABLING TRACKS ON THE RAILWAY NETWORK

A passenger train stop, during which passenger exchange takes place (boarding and getting out of passengers), can only be carried out on the platform track. This principle is primarily related to passenger safety. Therefore, at each operating office for individual trains that have a designated trade stop, a place to stop at the platform should be provided. This limits capacity of given operating office from the point of view of passenger railway

traffic operation. It should be noted that this problem is particularly important for railway stations, for which number of platform edges was designed for a completely different volume of passenger flows.

Therefore, when constructing the timetable of passenger trains, the problem of allocating platform edges for individual trains should be taken into account. In a word, the problem is to assign the number of the platform and the track number on which the train stop for a given operating office. Assigning this from the point of view of the problem of the construction of the train timetable is associated the need to estimate the time of occupation of the platform edge by a particular train. It consists of:

- time which elapses from the moment when the signal allowing the entry to the station on the semaphore is displayed to the moment when the route is released by the entering train,
- time of the train stop at the platform planned by the railway undertaking,
- time needed to release the track at the platform by the outgoing train (time that passes to the point where it will be possible to re-arrange the entry route on the same track at the same platform - e.g. time to slow down the route going to the stabling tracks).

Before the train goes into stabling tracks, the train manager is obliged to check the entire train to see if all travellers have left it. This takes a reasonable time during which train takes up the platform edge all the time. In addition, all stabling tracks can be occupied at any given time. Both factors result in the fact that another train approaching a given station cannot occupy the track at platform. Failure to take into account the appropriate time reserve may result in delays of trains, and hence costs arising from rules for allocating train paths and using available railway infrastructure.

Therefore, it is necessary to take into account the problems of allocating platform edges and stabling tracks for passenger trains already at the stage of constructing the timetable. Today, this problem is taken into account only by the timetable constructor at the second stage of construction. The railway undertaking only assigns edges and tracks after receiving the timetable proposal from the manager. In the event of problems, proposed timetable is corrected.

3. FORMULATING THE PROBLEM IN MATHEMATICAL WAY

3. 1. DATA TO FORMULATE THE PROBLEM

In order to construct a train timetable it is necessary to know [13]: the structure of the railway network **GK** located in the analysed area and its characteristics **FK**, data on the transport needs **ZP**, division into categories of trains **KPC** and periods of day **T**, types of train's sets **TP** possible to use, transport offer **OP** and graphic train timetable **WR**. Thus, the mathematical model [23], [26] of train timetable construction can be presented in form of ordered eight [13]:

$$\boldsymbol{LKRP}\left(wk\right)=\left\{1,...,lkrp\left(wk\right),...,LKRP\left(wk\right)\right\}$$
(1)

The most important element of the model of the train timetable construction (**MKRJ**) from the point of view of the problem of allocation of platform edges and stabling tracks is the graphic train timetable (**WR**) – in the formula (1) marked in grey. The use of this tool allows you to analyse the collisions of train paths in an analytical manner related to the lack of station capacity and adjust the hours of running. We should endeavour to ensure that the elimination of collisions is carried out not only by human but with the support of IT tools using optimization techniques or only by optimization tools.

In connection with the above, it is necessary to formulate the optimization task of the construction of the graphic timetable, which will take into account the problem of allocation of platform edges and stabling tracks. Thus, the formulation of the problem can be presented as follows.

For the data:

matrices:

FWK – characteristics of operating offices,

FNOLK – characteristics of sections of railway lines,

FSZL – characteristics of open lines,

vectors:

NOLK(nlk) – sections forming the railway line with the number nlk ($nlk \in$ **NLK**), **TLK**(lk) – sections forming the route of the communication line with the number lk ($lk \in$ **LK**), **LKOMSS** – communication lines, containing between operating offices where trains can start and finish their run,

sets:

WK – operating offices, **NLK** – railway lines, **OLK** – sections of railway lines, **SZL** – open lines, **LK** – communication lines, **T** – periods for which the day was divided, **KPC** – segments of transport needs, **TP** – segments of transport needs, **CZAS** – moments, **POC**(a) – proposed train numbers, **GR**(a) – graphic timetable structure prepared for communication lines a ($a \in$ **A**), **WR**(a) – graph nodes representing the graphic timetable for the communication line a ($a \in$ **A**), **LR**(a) – connections on the graphic timetable prepared for communication line a ($a \in$ **A**),

parameters:

α(wk) –function of the operating office wk ($wk \in$ **WK**), χ(wk,wk') – there is a direct railway connection between a pair of neighbouring operating offices wk and wk' (where: $wk \neq wk'$) or no, β((wk,wk'),nlk) – affiliation of the segment between the vertices wk and wk' to the railway line nlk ($nlk \in$ **NLK**), γ((wk,wk'),nlk,szl) – affiliation of the segment between the vertices wk and wk' on the railway line nlk to the open line szl ($szl \in$ **SZL**), δ((wk,wk'),lk) – affiliation of the segment between the vertices wk and wk' to the communication line lk ($lk \in$ **LK**), $ss(wk)$ – possibility of finishing and starting the run of trains at the operating office wk, $tkr(wk)$ – station time spacing values at the operating office wk, station values of intervals of nonuniastity at the operating office wk: $tnp(wk)$, $tno(wk)$, $tnpo(wk)$, $tnop(wk)$, $tnst(wk)$ – value of the station time interval of trains at the operating office wk, $tsk(wk)$ – minimum time necessary to connect trains at the operating office wk, $vmax(nolk)$ – maximum speed on the section of the railway line $nolk$, $l(nolk)$ – length of the section of the railway line $nolk$, $ltorow(nolk)$ – number of tracks on the railway line $nolk$, $kier(nolk)$ – direction of traffic on the railway line $nolk$, $ruch(nolk)$ – type of traffic on the railway line $nolk$, $lodst(nolk)$ – number of intervals on which the section of the railway line number $nolk$ is divided, $tj(nolk,tp)$ – time passage of the train tp ($tp \in$ **TP**) after the railway line $nolk$, time of occupation of the open line: $tpsI(szl)$, $tpsII(szl)$, $tpsIII(szl)$, $tszlI(szl)$, $tszlII(szl)$, $tdb(t)$ – number of

minutes of the period of the day with the number t ($t \in T$), $prio(kpc)$ – priority of a given category of trains kpc ($kpc \in \boldsymbol{KPC}$) in the construction of timetable, $a1(tp)$ – acceleration of trains type tp ($tp \in \boldsymbol{TP}$), $a2(tp)$ – delay of trains type tp, $vdop(tp)$ – maximum speeds of train type tp, $gw(poc(a),wk)$ – proposed start time of train $poc(a)$ ($poc(a) \in \boldsymbol{POC}(a)$) in operating office wk, $wr(wk,czas,poc(a))$ – vertices on the graphic timetable referring to transport nodes wk, moments of time $czas$ ($czas \in \boldsymbol{CZAS}$) and trains with numbers $poc(a)$, $lr(poc(a))$ – numbers of arcs on graphic timetable referring to states of trains with the numbers $poc(a)$, $tjlr(lr(poc(a)))$ – duration of states of trains with numbers $poc(a)$ described by displacements $lr(poc(a))$,

in addition, data relevant from the point of view of the problem of platform edge and stabling tracks allocation:

- $tpost(wk,poc(a))$ – stop time of train $poc(a)$ ($poc(a) \in \boldsymbol{POC}(a)$) in operating office wk,
- $\boldsymbol{LKRP}(wk)$ – set of platform edges located at the operating office wk ($wk \in \boldsymbol{WK}$):

$$\boldsymbol{LKRP}(wk) = \{1,...,lkrp(wk),...,LKRP(wk)\} \tag{2}$$

where: $lkrp(wk)$ – number of platform edge located in the operating office wk, $LKRP(wk)$ – number of platform edges located in the operating office wk; it should be noted that $lkrp(wk) \in \mathbb{N} \cup 0$.

- $tzwkp(wk,poc(a))$ – time of freeing the platform edge at the operating office wk ($wk \in \boldsymbol{WK}$) by train $poc(a)$ ($poc(a) \in \boldsymbol{POC}(a)$), which leaves the point,
- $tzakp(wk,poc(a))$ – time of attachment of the platform edge at the operating office wk ($wk \in \boldsymbol{WK}$) by train $poc(a)$ ($poc(a) \in \boldsymbol{POC}(a)$), which enters the point,
- $\boldsymbol{LTODS}(wk)$ – set of stabling tracks located at the operating office wk ($wk \in \boldsymbol{WK}$):

$$\boldsymbol{LTODS}(wk) = \{1,...,ltods(wk),...,LTODS(wk)\} \tag{3}$$

where: $ltods(wk)$ – number of stabling track located in the operating office wk, $LTODS(wk)$ – number of stabling tracks located in the operating office wk; it should be noted that $ltods(wk) \in \mathbb{N} \cup 0$.

- $tzwto(wk,poc(a))$ – time of freeing the stabling track at the operating office wk ($wk \in \boldsymbol{WK}$) by train $poc(a)$ ($poc(a) \in \boldsymbol{POC}(a)$), which leaves the tracks,
- $tzato(wk,poc(a))$ – time of attachment of the stabling track at the operating office wk ($wk \in \boldsymbol{WK}$) by train $poc(a)$ ($poc(a) \in \boldsymbol{POC}(a)$), which enters the tracks.

3. 2. DECISION VARIABLES

The problem is to determine the value of decision variables:

- $y(lr(poc(a)))$ on the interpretation of compliance with the principles of safe and smooth railway traffic operation and maximum meeting the needs of participants of the transport process placing on the graphic timetable connection $lr(poc(a))$ related to train $poc(a)$ enrolled in form of the matrix $\boldsymbol{Y}$,
- $rj(poc(a))$ on the interpretation of the timetable for the train developed for a communication line a ($a \in A$),

as well as the values of decision variables that are particularly important from the point of view of the problem of platform edges and stabling tracks allocation:

- $kp(poc(a),lkrp(wk))$ with the interpretation of the assignment to a particular train $poc(a)$ ($poc(a) \in \boldsymbol{POC}(a)$) of the platform edge $lkrp(wk)$ ($lkrp(wk) \in \boldsymbol{LKRP}(wk)$) in the form of a binary matrix $\boldsymbol{KP}(wk)$:

$$\boldsymbol{KP}(wk) = \Big[kp\big(poc(a),lkrp(wk)\big)$$
$$kp\big(poc(a),lkrp(wk)\big) \in \{0,1\} \Big] \tag{4}$$

where if $kp(poc(a),lkrp(wk)) = 1$ then for train $poc(a)$ in operating office wk is allocated platform edge $lkrp(wk)$, otherwise $kp(poc(a),lkrp(wk)) = 0$,

- $to(poc(a),ltods(wk))$ with the interpretation of the assignment to a particular train $poc(a)$ ($poc(a) \in \boldsymbol{POC}(a)$) stabling track $ltods(wk)$ ($ltods(wk) \in \boldsymbol{LTODS}(wk)$) in the form of a binary matrix $\boldsymbol{TO}(wk)$:

$$\mathbf{TO}\left(wk\right)=\Big[\,to\left(poc\left(a\right),ltods\left(wk\right)\right):$$

$$to\left(poc\left(a\right),ltods\left(wk\right)\right)\in\left\{0,1\right\}\Big] \tag{5}$$

where

if $to(poc(a),ltods(wk)) = 1$ then for train $poc(a)$ in operating office wk is allocated stabling track $ltods(wk)$, otherwise $to(poc(a),ltods(wk)) = 0$; $\mathbf{TO}(wk)$ matrix is developed only for such operating office, where it is possible to finish and start the running of passenger trains.

3. 3. BOUNDARY CONDITIONS

The solution to the problem is sought after the following limitations and boundary conditions:

- initial node on the graphic timetable (symbolizing the moment when the train appears on the graphic timetable) for a given train can have only one outgoing state,
- for the intermediate node on the graphic timetable (symbolizing the moment when the train state change on the graphic timetable) for a given train, the number of incoming states must be equal to the number of outgoing states,

$$\forall wk \in \boldsymbol{WK} \quad \begin{array}{c} kp\left(poc\left(a\right)',lkrp\left(wk\right)\right)\cdot tzakp\left(wk,poc\left(a\right)'\right)> \\ > kp\left(poc\left(a\right),lkrp\left(wk\right)\right)\cdot\left(tzakp\left(wk,poc\left(a\right)\right)+tpost\left(wk,poc\left(a\right)\right)+tzwkp\left(wk,poc\left(a\right)\right)\right) \end{array} \tag{6}$$

- end node on the graphic timetable (symbolizing the moment when the train disappears on the graphic timetable) for a given train may have only one incoming state,

- for each vertex, the moment of departure of the next train must be greater than or equal to the departure of the train, increased by the length of open line time spacing,
- for each vertex being a place where trains can end and start running, the difference between the departure of the next train and the arrival of the train should be greater than or equal to the time of communication for the node,
- number of trains on the open line should not exceed the sum of the number of intervals to which the sections constituting this open line are divided,

also in the case of limitations and boundary conditions relevant to the problem of platform edges and stabling tracks allocation:

- number of platform edges assigned for a given operating office at a given moment should not be greater than the number of edges available at the office,
- number of stabling tracks assigned for a given operating office at a given moment should not be greater than the number of tracks available at the office,
- time of attachment of the platform edge by the next entering train should be greater than the time of attachment of the edge by the preceding train, its time of stopping and the time of release of the edge by its:

- time of attachment of the stabling track by the next entering train, if there is no free track, should be greater than the time of releasing track by the entering preceding train:

$$\forall wk \in \boldsymbol{WK} \quad \begin{array}{c} to\left(poc\left(a\right)',ltods\left(wk\right)\right)\cdot tzato\left(wk,poc\left(a\right)'\right)> \\ > to\left(poc\left(a\right),ltods\left(wk\right)\right)\cdot tzwto\left(wk,poc\left(a\right)\right) \end{array} \tag{7}$$

- for each vertex the difference between the arrival of the next train and the departure of the train must be greater than or equal to the length of the station time spacing,

3. 4. CRITERIA FUNCTIONS

The solution of the problem is sought in such a way that the criterion function:

- $F(\mathbf{Y})$ – criterion function describing the total duration of train states for a given communication line,

and that the criterion functions relevant to the problem of the allocation of platform edges and stabling tracks:

- $F(\mathbf{KO}(wk))$ – criterion function describing the minimization of the waiting time of the next trains for releasing of the platform edge by previous trains:

$$F\big(\mathbf{KO}(wk)\big) = \begin{array}{c} \displaystyle\sum_{poc(a)'\in POC(a)} kp\Big(poc(a)',lkrp(wk)\Big)\cdot tzakp\Big(wk,poc(a)'\Big)- \\ -\displaystyle\sum_{poc(a)\in POC(a)} kp\Big(poc(a),lkrp(wk)\Big)\cdot\big(tzakp\big(wk,poc(a)\big)+tpost\big(wk,poc(a)\big)+tzwkp\big(wk,poc(a)\big)\big) \end{array} \longrightarrow \min \quad (8)$$

- $F(\mathbf{TO}(wk))$ – criterion function describing the minimization of the waiting time of the next train for releasing the stabling track:

$$F\big(\mathbf{TO}(wk)\big) = \begin{array}{c} \displaystyle\sum_{poc(a)'\in POC(a)} to\Big(poc(a)',ltods(wk)\Big)\cdot tzato\Big(wk,poc(a)'\Big)- \\ -\displaystyle\sum_{poc(a)\in POC(a)} to\Big(poc(a),ltods(wk)\Big)\cdot tzwto\big(wk,poc(a)\big) \end{array} \longrightarrow \min \quad (9)$$

reached minimum values.

4. THE ALGORITHM OF THE METHOD OF TIMETABLE CONSTRUCTING FROM THE POINT OF VIEW OF THE PROBLEM OF PLATFORM EDGE AND STABLING TRACKS ALLOCATION

The algorithm of the method of timetable constructing from the point of view of the problem of platform edge and stabling tracks allocation is shown in Fig. 1. The algorithm can be described as follows:

- **STEP 1** – includes parameterization of the railway network in the field of technical aspects of railway traffic. Parameters are obtained by railway undertakings from documents developed by the infrastructure manager.

- **STEP 2** – includes checking that the values identified in step 1 are adequate and sufficient. If not then return to step 1, otherwise go to step 3.

- **STEP 3** – includes generating the right number of graphic timetables. The canvas consists of a graphic timetable grid containing a time division and a list of operating offices.

- **STEP 4** – includes checking if the prepared canvas for graphic timetable are appropriate. If not then return to step 3, otherwise go to step 5.

- **STEP 5** – includes applying to the canvas of the graphic timetable model train paths, i.e. paths created on the basis of the proposed start time (obtained at the stage of shaping the transport offer) and the use of the A * algorithm to search for the shortest path in the graph. Obtained paths are those for which the principles of safe and smooth running of railway traffic are not maintained. The search for paths is carried out using the criterion of minimizing the train driving time in a given area of the railway network.

- **STEP 6** – includes checking if on the graphic timetable prepared in step 5 there are collisions of train paths (by means of a collision it is understood, among others, that the path system is actually driving from opposite directions of two trains on a single-track line). Collision detection is carried out using the Axis Alignment Bounding Box (AABB) algorithm. If collisions do not occur then go to step 8, otherwise go to step 7.

- **STEP 7** – includes elimination of train paths collisions by shifting them on timetable in order to obtain the smallest possible differences from the standard condition. After completing the collision, return to step 6 to check if the

STEP 1:
PARAMETERIZATION OF THE RAILWAY NETWORK
IN THE SCOPE OF GRAPHIC TIMETABLE

STEP 2:
ARE ALL THE DATA
IDENTIFIED?   NO

YES

STEP 3:
GENERATING OF GRAPHIC TIMETABLE CANVAS
FOR SPECIFIC COMMUNICATION LINES

STEP 4:
ARE CANVAS ACCEPTABLE?   NO

STEP 5:   YES
APPLYING TO CANVAS REFERENCE TRAIN PATHS

STEP 6:
ARE ON CANVAS PATHS
COLLISIONS?   NO

STEP 7:   YES
LIQUIDATION OF TRAIN PATHS COLLISIONS
ON GRAPHIC TIMETABLE

STEP 8:
OBTAINING ON THE GRAPHIC TIMETABLE
REAL TRAIN PATHS

STEP 9:
NO   IS THE NEED FOR PATHS
CORRECTION?

STEP 10:   YES
MANUAL CORRECTION OF REAL TRAIN PATHS
ON GRAPHIC TIMETABLE

STEP 11:
ARE ON CANVAS PATHS
COLLISIONS?   YES

STEP 12:   NO
ALLOCATION FOR TRAINS
PLATFORM EDGES AND STABLING TRACKS

STEP 13:
YES   IS THE ALLOCATION
RATIONAL?

STEP 14:   NO
CORRECTION OF ALLOCATION
OF PLATFORM EDGES AND STABLING TRACKS

STEP 15:
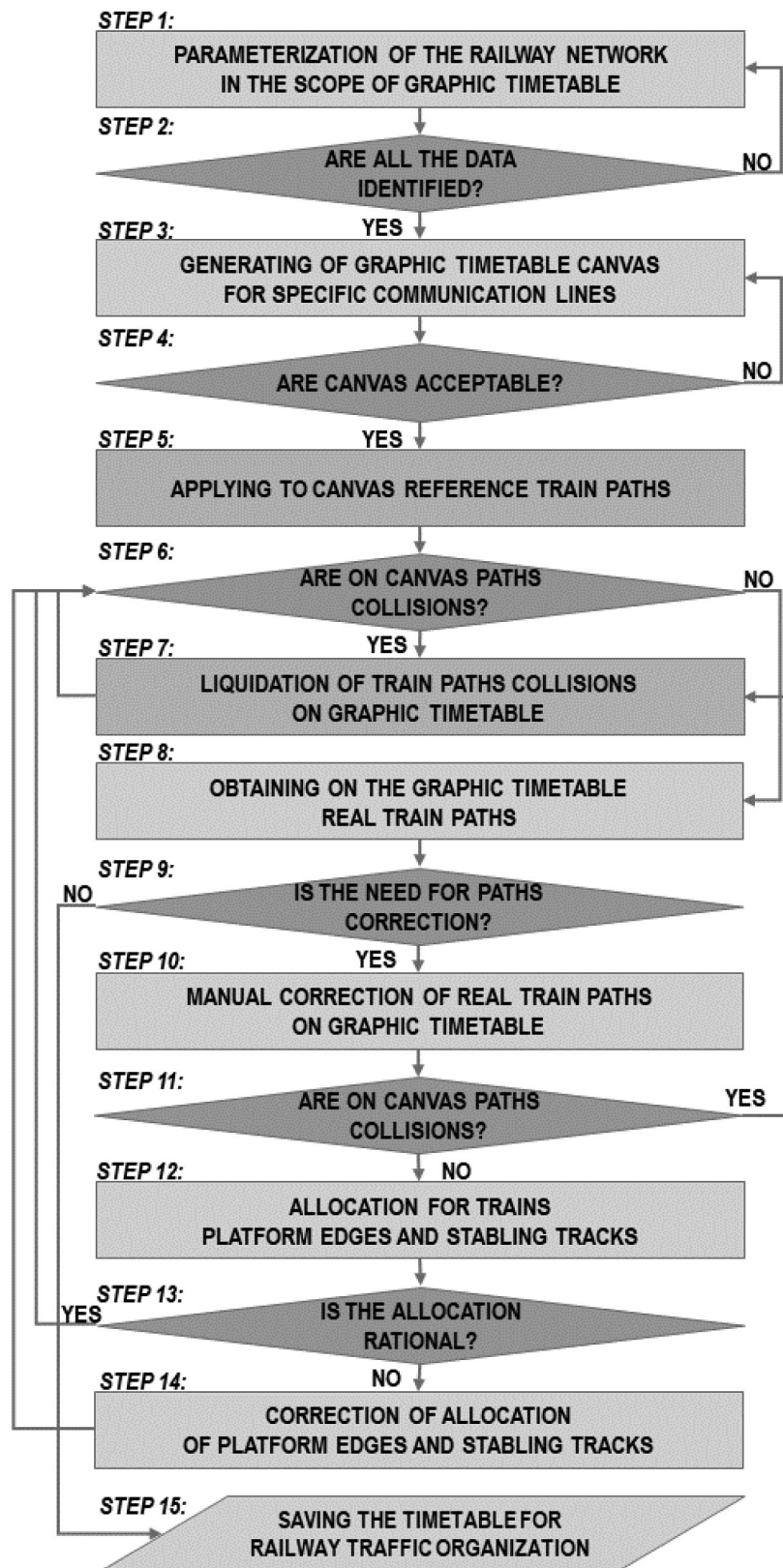SAVING THE TIMETABLE FOR
RAILWAY TRAFFIC ORGANIZATION

Fig. 1. Algorithm of the method of timetable constructing from the point of view of the problem of platform edge and stabling tracks allocation (source: own work)

collisions have been removed. If, after re-checking, collisions do not occur, go to step 8, otherwise step 7 should be performed again.

- **STEP 8** – includes getting of a system of real train paths on a graphic timetable, i.e. one that allows for railway traffic operation in safely and smoothly way.

- **STEP 9** – includes checking if there is a need to make additional corrections of train paths on graphic timetable to increase the degree of their adjustment to the needs of passengers. It should be noted that real routing causes re-routing of trains on the graphic timetable. Elimination of collisions may cause changes in the assumptions that result from work at the stage of shaping the transport offer. It should be emphasized that the liquidation of collisions when creating a graphic timetable causes a specific "refining" of the results obtained in the previous steps. If so, go to step 10, otherwise go to step 15.

- **STEP 10** – includes manual correction of the location of train paths on the graphic timetable. This is done on the basis of the experience of the train timetable constructor. By analysing the obtained layout of real paths on the graphic timetable, the constructor may manually move the selected train paths to a place where they will be more able to meet transport needs.

- **STEP 11** – includes checking if collisions of train paths have occurred after the designer has made changes to the graphic timetable. If they are revealed, they will be removed using the AABB algorithm (step 7). Otherwise, go to step 12.

- **STEP 12** – includes the allocation of specific platform edges at individual operating offices to individual trains. In addition, in these operating offices, where necessary, specific stabling tracks are assigned. This assignment is implemented using the Bees algorithm according to the rules set out in item 3 of the article.

- **STEP 13** – includes checking whether the allocation of concrete platform edges and specific stabling tracks has been carried out in a reasonable manner - i.e. in such a way that adequate traffic fluidity is maintained and there are no bottlenecks in operation points. If this occurs, go to step 14. Otherwise, go to step 6 to check for collisions in the graphic timetable.

- **STEP 14** – includes the correction of the allocation of specific platform edges and specific stabling tracks. Correction is carried out manually. It may be necessary to change the hours of running certain trains. Therefore, there may be a possibility to appear a collision on the graphic timetable. It is necessary to perform step 6 and subsequent to eliminate the collision.

- **STEP 15** – includes the presentation of a timetable in the form chosen by the user. The arrival and departure times are presented for each train and for each operating office.

5. SUMMARY AND CONCLUSIONS

The subject of the article was to present a method concerning the problem of the construction of a timetable from the point of view of platform edge and stabling tracks allocation. As already mentioned in the article, these issues affect the proper organization of traffic on the railway network, and more specifically on the timetable of trains. It should be prepared in such a way as to avoid congestion due to trains having to wait for the train to release the edge, which is very common in practice. As an example, you can give a group of suburban tracks at the Warszawa Zachodnia and Warszawa Wschodnia stations.

On the other hand, the issues of platform edge and stabling track allocation are related to the requirements of the infrastructure manager regarding access to railway infrastructure and the use of allocated train paths. Delaying the moment of release platform edge by train may cause that the next train will be delayed. A minor problem is if it is the train ending the run at a given station. If, however, a given operating office is indirect to it, the generated delay may cause secondary delays of other trains. Every minute of delay is associated with the necessity of paying an appropriate fee to the victim. The same applies to the exceeded stop time at the platform edge.

As of today, the problem of allocation of platform edges and stabling tracks is only taken into account by the timetable constructor at the second stage of construction. When applying the train path to the graphic timetable, the constructor tries to keep the appropriate time buffers. There is no allocation of a specific edge to a particular train. The railway undertaking after receiving the timetable proposal from the manager only does this. If problems arise, the proposed timetable is corrected. There

is therefore a need to develop tools that will allow these issues to be taken into account as early as at the stage of the construction of the timetable.

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