# Basic Framework for Adjusting the Freight Train Schedule

Boris Davydov[1], Vyacheclav Esaulov[2], Vadim Gopkalo[1(✉)], and Kseniya Kablukova[3]

[1] Far Eastern State Transport University, Khabarovsk 680000, Russian Federation
vng@yandex.ru
[2] JST Russian Railways, Far Eastern Branch, Khabarovsk 680000, Russian Federation
[3] Computer Center FEB RAS, Khabarovsk 680000, Russian Federation

**Abstract.** Robustness of the train schedule is ensured by use of time margins. The features of each particular section and disturbing factors are not sufficiently taken into account when a master train schedule is created. The paper studies the methodology of effective scheduling the freight train traffic according to the criteria of economic efficiency and punctuality. The methods are proposed for group and individual traffic adjustments. Statistical characteristics of freight train traffic on the main railway line are investigated. The framework of finding margins to the departure headways based on statistical analysis is described. This improvement aimed increasing the punctuality and economic efficiency of freight traffic. The theoretical conclusions are confirmed by statistical data obtained on the Russian railways.

**Keywords:** Railway traffic · Freight train flow · Dispatching · Schedule · Time margins · Optimization

## 1 Introduction

Train traffic is subject to disturbing influences which causes schedule deviation as a result. These deviations weaken by adjusting the train flow dynamics which is made by traffic manager effort. For example, dispatching in the passenger segment solves the task to exclude (or decrease) train delays quantity and duration. This provides high level of passenger train punctuality including on time arrivals at intermediate stations. On the other hand, freight train traffic does not imply exact moments of services arriving and departing from the small stations. There is an large additional time which is included in the schedule to provide the freight train on time arrival just on the destination station. Time margins usually added to line sections run time without necessary argumentations. Besides that, features of specific train flow as intensity, daylight or dark hours and others are not taken during the operational planning process into account. So we can see punctuality degradation leads to wasting an infrastructure capacity and to economic losses as a result. Obviously it needs create the methodology for the schedule adjusting which reflects the real situation on the rail line sections.

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A stochastic model for the train traffic process [1] is the basis for an effective approach determining the freight train schedule parameters. The model is grounded at the statistical historical data analysis. Besides, it takes the weather conditions and the clear visibility distance into account. This information uses for prediction the probabilistic process of schedule deviations and intertrain conflicts appearance in a future.

On this basis, the main parameters of the schedule are determined, such as travel time at the each line section and departure intervals from technical stations. Timetable of train traffic at the rail link is formed by coordinating the schedule fragments created for all the sections.

This paper examines the methodological issues of operational rescheduling the freight train traffic, taking the criteria of punctuality and economic efficiency of their travel into account. Section 3 analyzes the criteria for operational decisions developing that are used to solve the optimization problem when determining adjustments to the movement of freight trains. Methods are proposed for group and individual traffic control (see Sect. 4). There is described the methodology of finding and processing an experimental data about train traffic in the Sect. 5. The regularities of formation the main indicators of actually executed schedule with the existence of random perturbations are discussed in Sect. 6. The results of the analysis obtained are used to justify the adjustments to the parameters of the schedule (see Sect. 7). There are summarizes the results of the study and outlines the direction for further work in the final section.

## 2 Literature Review

The problem of providing high quality of operational adjusting train flow finds a wide scale of discussions amid researchers (look at, e.g., 4). Nowadays, admitted that the main point of increasing the quality is a dynamic change of schedule according to the real situation. A case of providing adaptive adjusting in the passenger segment seems was researched in the [2]. At the beginning of 2000th was offered a concept of dynamic adjusting passenger trains flow by European scientists (Railway Dynamic Traffic Management- RDTM) [3]. Further the concept RDTM were designed computer's models for using this principles in complex [4–6].

Extremely fast increasing of railways freight traffic in Russia in 1970th sunk the common productivity of the main lines. This factor was the reason for new interest to the problem of adaptive adjusting. One of the firsts Klimanov [7] estimates in details circle of assignments in the field of operational changes for freight schedule. The problems of optimization train traffic by the adaptive adjusting in Russia were researched by scientists [9–12]. Besides in Europe this kind of problems were researched (see, e.g., review [13]). However, there were not tools for changes freight schedule according to the changed conditions. Taking attention on last articles we have to note [14, 15]. There is a classic way of building optimal schedule in [14]. There is a multiagent way of building optimal schedule in [15]. The particular example of using online adjusting for solving the task automatic change the schedule immediately before the maintenance gap in [16].

The key question in operational adjusting is a complex of full using the infrastructure ability and robustness train traffic, another words is a complex of the «physical top» and the «economy optimal» [17].

There are deterministic and stochastic models, described in [18, 19], for building train schedule. The first group of models allows building optimal schedule and fixing it in real time in case of dominance accurate factors. Anyway, often effectiveness of prediction operational situation would be increase by using stochastic models matched the historical information about train traffic.

Main items of the deterministic analysis of the dynamic operational situations were illuminated in [20–22]. Looking for schedule solves for minimizing delays managing by making discrete models and using methods of line soft programming [23]. The absence of taking attention on the random disturbing factors is the main flaw in modeling.

This flaw amends in significant rate by using stochastic describing of train traffic. In one of the firsts paper in this field analytical method for finding delays by integrate initial delays (on the segment's gate) and further delays was proposed [24]. The model of forming delay while following several trains one after another by using probability approach [25] consider full moving time on the line as a sum of random moving intervals segmentally.

The adjusting middle level model of freight traffic [26] took gathered segment and terminal stations as the basic units. The deep of planning is 12–24 h periods. Micro level deep of operational planning decreases time to 3 h. The simplest segment of adjusting traffic considered the dispatch part of line.

The changes freight traffic have an economy ground just with a decision support system for modeling cases and choosing optimal way of adjusting (look at the review [27]). There is only idea of estimating the results of decisions for improving train traffic by the analysis of the current losses in the [28]. There are limit articles (e.g. [29]) shows the main role energy losses in forming variable part of current losses.

There are some gaps in last researches in the field of management of train flow on main lines and measures of getting optimal traffic controllers decisions. This article gives principally new methodology for solving described difficulties.

## 3 Criteria for Determining the Operational Decisions

The process of making effective adjustments to a disrupted schedule requires adequate criteria for optimality. There are some important differences between criteria used in passenger and freight segment. Submit the model for creating economy result, oriented mainly on the freight segment, for the reason of proving measures using in modern traffic adjusting.

Train manager solve optimization task in taking adjusting decisions. There are two main measures supporting decisions. First one for the local income - improve rates of using line traffic ability. Second one for general economy result of working whole railways direction.

As were underlined, there are some differences between criteria used in passenger and freight segment. The quality for passenger trains defines by comparing fulfilled and actual schedule using summarize delays for gathered trains. Many papers estimate passenger segment by special term such as train operating reliability [30].

The punctuality in freight segment has a different meaning. There are just some points for dismiss conflicts between trains. Significant additional time in the schedule allows you to rebuild speed ways and changes the order of freight trains in the process of disturbing liquidation.

Nowadays line speed and number of followed trains are the most popular measures for characterize effectiveness of railways infrastructure. Obviously, effectiveness of these measures in the local scale does not enough. Quality of operational adjusting has to be estimated by the rate of using train operating productivity and cost-effective operating mainly. Gather of adjusting decisions which gives the top of income in the process of following freight traffic should be the result of solving optimization task.

Increasing railroad traffic denies renew specific measures for operate adjusting, e.g., there are common income on a vehicle via solving task of increasing trains weight and route distance [31].

Every adjusting decision follows the local change of the loss measure on a quantity $\Delta E_{\mathrm{i}}$. This quantity includes currant traffic losses and penalty losses in case of unpunctuality. In case of submit the optimal schedule decision there is a criteria of summarize the losses on the road line: $\sum_{\mathrm{i}} \Delta \mathrm{E_i} \rightarrow \min$.

According to [166], the simple model of traffic losses has a view:

$$E = E_{\mathrm{r}} + T \sum e_i + W_r e_w,$$

where $\mathrm{E_r}$ the component defined by the length of mileage for a vehicle

$T = L/v$ – the traffic time for a train on the line segment L;
$e_i^{\text{бр}}$ – the unitary loss rate for i-time measure;
$e^{\text{ээ}}, W^{\text{экв}}$ – the pay rate and the volume of energy power.

As a rule, traffic adjusting follows some changes of traffic time on the $\Delta T$ and rebuilds the loss measure on a quantity:

$$\Delta \mathrm{E} = \Delta \mathrm{T} \sum \mathrm{e_i} + \Delta \mathrm{We_p}$$

As an analysis shows, according to the cost rate the power component dominates in the traffic process for Russian railways.

The irrational traffic adjusting can decrease the common income $R$ in the economic result. Particularly, decreasing of the number of trains were followed is a reason of losses. So looking for the optimal decisions has to be based on the model reflected income *in* a traffic process. The clear approach to the economic estimation the freight traffic quality described in [32]. Shown that income $P$ for using a thread of timetable is

a difference between the traffic rate $R_{map}$ and the summarize loss $C$ for guiding the train on the route:

$$P = R_{map} - C$$

The objective function used for building the optimal scheme of guiding trains in common case is reaching the top of the **local economic result**: $\sum_i P_i \rightarrow \max$

In a process of building income and loss element of the economy measure using the processed approach distinguished the business processes and fragmentized it on parts (sub processes or elements), further is coming economic estimation of every single parts [33].

The economic model reflected the process of discrete coordinating trains in the space «coordinate – time - cost». The route of changing the object condition is a points gather. Every point reflected income in the moment of finished traffic or technic stopped on the station.

The changing of income in a traffic process on the route shows on the chart (see Fig. 1). Items on the time scale matched the moments of the train operation beginning and finishing. The elements of chart *AB, A'B', CD, C'D'* matched the operations of following train on the open tracks. The elements *BC, B'C'* are characterizing changing of economy result on the technic stations.

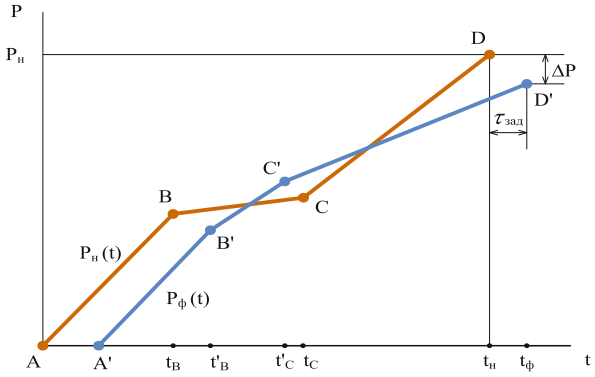


**Fig. 1.** Example of dynamic changing of economic result

The way ABCD shows the dynamic of income in case of guiding train in schedule. In case of delay (point A') the line of account income $P_{\phi}(t)$ is situated under planned income line $P_{н}(t)$. The forcing service of train follows some improving of situation as we can see the point C' is getting above the point C. However on the segment CD the conditions do not give the opportunity for realizing the staff traffic. The train arrives on the destination station with delay $\tau_{зад}$ and economy result decreased on the quantity ΔP relatively of norm.

The choice of effective adjusting decision submitting according to the expression (relatively constant components were excluded):

$$\Delta P = (\Delta R_i - \Delta R_k) - (\Delta E_i - \Delta E_k)$$

## 4 Group and Sighting Adjustments of Train Traffic

There is an absence of strict demand to the local punctuality, as a specific of freight trains managing gives a relative freedom in traffic adjusting which is aimed to disturbances liquidation. There are two significantly distinguished ways of on-line managing such as group and individual (sighting) adjustment of train traffic. The first one is oriented to prevent gathered conflicts. The second one suggests using an implicit technique which purposefully increases departure headways to create additional time reserve. This reserve can be used for improving the common economic result due to decreasing the threat of intertrain conflict happening.

The sighting adjustment of traffic does not suggest changing the headways and the speed trajectories for all trains. This kind of adjustment represents the schedule correction just for single train for the reason of solving two next tasks. The first one is realized the optimal speed profile of the train approach to the potential conflict point which allows you to dismiss unplanned delay and (or) save the economic losses. The second task is to provide minimal influence to other trains of the same or reverse moving in case of crossing occur. Needs to create a prediction model and solve the local optimization problem for the reason of planning and realizing the on-line traffic adjustments.

The group adjustment suggests choosing so regulation mode for the whole train flow as the goal of decreasing the number of unscheduled delays and energy losses. This kind of traffic adjustments creates by schedule correcting on the determined period of time with duration from one to few hours. The group adjusting of traffic shows especial effectiveness in case of decreasing the train flow intensity.

The group adjusting is in definition the schedule time segments for using intensive or economic mode of managing. The economic mode suggests increasing the departure headways and (or) additional traffic time for trains included in the package.

There are three blocks of adaptation technology used in Traffic Control Centers. The first one is definition of schedule segments in which would be used intensive or economic traffic mode. The separation problem is based on the data described real train run and delay forming at the stations.

The second block suggests finding the order of departing freight trains from the terminal stations with taking attention on the commercial or technical priority. There are two ways of solving the problem. The first one includes prediction economic result for every variant of train departure sequence. The second one considers scenario of forced train waiting on the terminal stations because of random deviations in case of different sequence of depart. The same approach has place in case of looking for the optimal regulation in the telecommunication package net [34].

The adjusting block III provides the assignment a trajectory of motion optimized according to the criteria of a local economic result or energy consumption to each individual train or group of trains. This solves the optimization problem which is similar to the problem of minimizing delays in the flow of passenger services. In this case the freight train has new parameters of technology elements (stops, traffic times).

Usually the system of organizing freight traffic uses the parallel schedule (the Fig. 2). The main operational schedule changes on the limit period of time are increasing the travel time (item c) or intertrains (item) or the sequence of trains following.

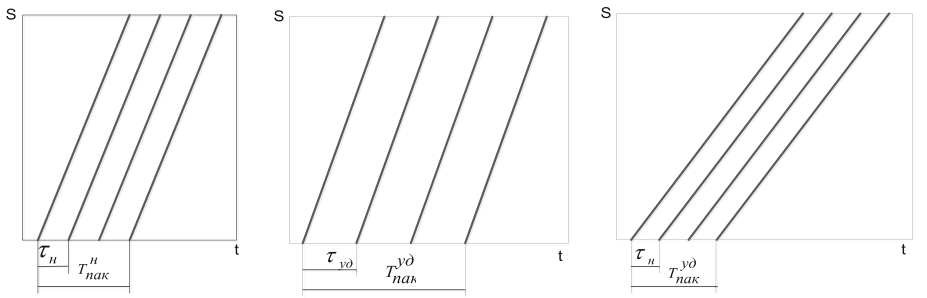


**Fig. 2.** The ways of organizing the package of trains on the railroad section (a) by schedule; (b) by rareschedule; (c) with increasing traffic time

There is a package of trains «N». The package sends on the section of line from the initial station «A» and fills the time segment $T_{pac} = (N - 1)T_s$, where $T_s$ is a departure headway. In real conditions there are periods of time characterized by decreasing of intensity of train flow. In this very periods of time there is an opportunity of increasing interval between trains to the $T_s^{'}$. In this case the line of time filled by package of trains becomes wider to the $T_{pac}^{'}$ (Fig. 2b). Increasing of headways prevents distributing further delays in case of short deviation of train from the traffic way. Decreasing the number of unscheduled delays comes dismissing of energy losses.

In the period of decreasing of intensity of trains flow the additional time would be used for organizing energy saving regime. Obviously there is way of organizing the package of trains with appointing for all trains increased travel time (Fig. 2c). The additional traffic time distributed on elementary sections of line in the way providing the top of energy economy and current losses in conclusion. The appointing increased travel time comes energy economy by using the optimal running regimes.

## 5 Methodology of Analysis Fulfilled Traffic Schedule

In case of creating effective traffic schedule needs to use the traffic parameters close to the real situation. Traditionally the count of the parameters builds on the base of so called pulled count. The reserves of traffic time included in schedule are often unproved. There are sink of punctuality and decreasing of railroad line productivity as a result.

The short-term infrastructure limits, the technic broke, the weather influence and the human factor have the random influences on an accomplishing of the schedule. The human factor shows by different reaction of train team on the same factors and situations and depends on the personal experience, skills and personal features. For the reason of increasing the quality of schedule needs to use the historic information about real train traffic. The information creates the base of stochastic model for using in definition the trains traffic time.

The main feature of suggesting methodology of correcting the train traffic time and intervals between trains is using the statistic data got to distinguished scenarios. There are some gathered scenarios researched in analysis process.

- trains moving in conditions of day and night;
- trains moving in conditions of short of wide intervals;
- trains moving in conditions of appearance of difficulties and absence of difficulties: infrastructure maintenance works, short-term speed limits and so on;
- train moving in conditions of normal weather and spoiled weather.

Obviously has to account some combinations of scenarios in further detailed analysis.

On the first step researched the statistic data about fluent train traffic on the railroad line. There were the statistic data about fluent train traffic in periods of absence of infrastructure maintenance working, technics broke and other negative factors. In the statistic gather were included trains without influence of trains moved in front of.

There were investigated that in January, 2018, in the period of minimal infrastructure maintenance closing on the segment of main line «O – Kh» (360 km by length) were followed 105 trains of odd direction and 50 trains of even direction in a fluent traffic conditions. By another hand, were investigated that in June, 2018, in the period of huge number of infrastructure maintenance works on this segment were fixed 24 trains of odd direction and 4 trains of even direction in a fluent traffic conditions.

In conclusion, absence of negative disturbing factors does not guarantee punctuality in freight segment (Table 1).

**Table 1.** The figures of accomplishing the freight train schedule

| The number of trains on line segment O-Kh: | Periods, 2018 | |
|---|---|---|
| | January | July |
| Followed fluently (in even direction) | 50 | 4 |
| Arrived on time (in even direction) | 0 | 0 |
| Followed fluently (in odd direction) | 105 | 24 |
| Arrived on time (in odd direction) | 7 | 1 |

There were fulfilled the factor analysis of data gathering for the reason of distinguishing influences that come to delays. The trains were gathered in groups on different features characterized the main kinds of influences. In particular, separating was

fulfilled by traffic direction (odd/even), time of daylight (day/night), intervals between trains in the moments of depart.

The next step is in building the bar chart of common traffic time on segment of line, defines statistic figures (value of mathematical expectation, standard deviation) and creates of approximation function. The approximation quality is estimated by using probability theories [35]. The probability of increasing the scheduled traffic time is fond by standard methodology by path of integrating matched segment of distribution density of noted figure.

The probability model of analysis the historic data allows to define the additional time to the schedule with account the different scenarios of train traffic situations. It has immediate practical significance especially in time of automatic timetable forming.

## 6 Regularities of Forming the Schedule Features When Random Disturbances Occur

There is a need to pay attention to the statistical characteristics of train run time in order to correctly determine the train schedule parameters and to adjust them online. The statistical features are various in different periods and those differences depend on the real traffic conditions. Obviously, firstly has to be researched the cases when there are no any negative factors on the rail line such as temporary speed limits, broken infrastructure or damaged rolling stock.

There were taken the historical information about real train traffic on the East region of Transsiberian main rail line. This area is characterized mainly by freight train traffic. There are heavy haul services, in the main, runs in the east direction (in the "even" direction). The overlong trains flow is observed in the west direction (the odd direction). Such a train includes until 100 freight cars. The historical data taken from the information system ASOUP which operated at the JSC «RZD» for some periods of the 2018 that characterized by different traffic conditions. According to historical data about trains that followed without delays

There were analyzed the four sets of the run time random value on the section K-O of the Eastern rail region. The first two samples collected for the odd train traffic direction that traveled in January, 2018. One of this sample matches to day time period, another – to night period. The volume of the first set includes n = 55 samples, the second set is n = 50. The second two sets gathered for "even" trains traveled in July, 2018. Here also one of the samples matches to day time, another – to night period. The volume of the third sample is n = 16, of the fourth sample – n = 8.

Let's check the following statistic hypothesis for every data samples: they were taken for gamma distribution with the density

$$l(t;\alpha_1,\beta) = I(t>0)\exp(-t/\beta)\frac{t^{\alpha_1-1}}{\Gamma(\alpha_1)\,\beta^{\alpha_1}} \tag{1}$$

with matched parameters $\alpha_1 > 0,\ \beta > 0$.

In literature we can notice the gamma distributions with other parameters and with other form (e.g. [36], p. 170)

We use the Kolmogorov criteria for approximating functions verification. The critical meaning defines by the formula $\lambda_n(\alpha) \approx \frac{\lambda_\alpha}{\sqrt{n}}$, where $\alpha$ is a level of criteria's significance, $\lambda_\alpha$ is a root of an equation

$$1 - K(\lambda) = \alpha, \tag{2}$$

$K(\lambda)$ - the Kolmogorov function, $n$- the sample's volume.

Take $\alpha = 0.1$. The root $\lambda_\alpha = 1.224$ in Eq. (2) is known ([37], p. 157, $\lambda = 1.2$). We can also find it by computer.

Let's describe the way of solving for the first sample in details.

**The sample 1:** The "odd" trains, January, 2018, the day period of time, n = 55. The conclusions of the Kolmogorov criteria based on the statistic's meaning $D_n = \sup_x |F_n(x) - F(x)|$, where $F_n(x)$ - the observational disturbance function, $F(x)$ - the hypothetical disturbance function. For the reason of finding the meaning $D_n$ by the sample, we have to find the parameters of hypothetical disturbance (1). The random figure of common traffic time sights as $\rho$. As known [100, p. 170]:

$$\mathrm{E}\rho = \alpha_1\beta, \quad \mathrm{D}\rho = \alpha_1\beta^2. \tag{3}$$

We finds by sample: sample average $\overline{\rho} = \frac{1}{55}\sum_{j=1}^{55} \rho_j = 367.3\ldots$ and sample mean-square deviation $s_0 = \sqrt{\frac{1}{54}\sum_{j=1}^{55} \left(\rho_j - \overline{\rho}\right)^2} = 14.3$. Solving the system of equations by taken (3) $\overline{\rho}$ instead $\mathrm{E}\rho$, and $s_0^2$ instead $\mathrm{D}\rho$:

$$\overline{\rho} = \alpha_1\beta, \quad s_0^2 = \alpha_1\beta^2 \tag{4}$$

relatively $\alpha_1$ и $\beta$ we have found the meanings of accurate estimations of the parameters $\alpha_1 \approx 659.8$ and $\beta \approx 0.56$.

For the reason of counting the statistic of $D_n$ has to build the set of variate values for the observational disturbance function and formula of the hypothetical disturbance function $L(x) = \int_{-\infty}^{x} l(t; \alpha_1, \beta)\, dt$, of matched condensation (1). As a result there is a $D_n = 0.088$. There is an approximate critical meaning of the criteria for this sample $\frac{\lambda_\alpha}{\sqrt{n}} = \frac{1.224}{\sqrt{55}} = 0.165\ldots$ so the conclusion is:

the checking statistic hypothesis does not controversies the sample data by the Kolmogorov criteria with level of significance 0,1, because the meaning of the statistic more less than the meaning of critical meaning.

Although there is a comparison of observational and hypothetical disturbance functions in the Kolmogorov criteria, we will show on the Fig. 3 and further the bar chart and hypothetical condensation.

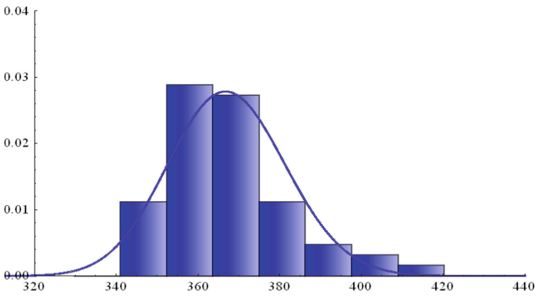


**Fig. 3.** The disturbances of common train traffic for the odd trains were followed in January, 2018, in day period of time.

**The sample 2:** The odd trains, January, 2018, the night period of time, n = 50. The approximate meaning of the sample criteria is $\frac{\lambda_\alpha}{\sqrt{n}} = \frac{1.224}{\sqrt{50}} = 0.173\ldots$ So the meaning of $\overline{\rho} = 370.1$ and $s_0 = 18.6$. We have got the $\alpha_1 \approx 395.9$, $\beta \approx 0.93$ by solving the system of Eq. (4). Afterwards the $D_n \approx 0.094$. As $D_n < \frac{\lambda_\alpha}{\sqrt{n}}$, we have taken the same conclusion as for the first sample with only one distinguish that the hypothetical disturbance has the other parameters. The bar chart and hypothetical condensation are shown on the Fig. 4.

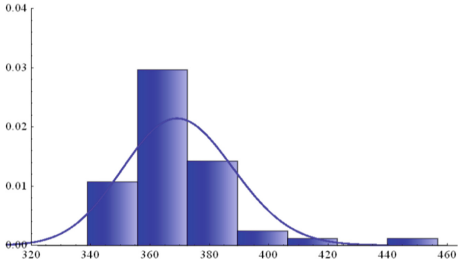


**Fig. 4.** The disturbances of common train traffic for the odd trains were followed in January, 2018, in night period of time.

**The sample 3:** The odd trains, June, 2018, the day period of time, n = 16. The approximate meaning of the sample criteria is $\frac{\lambda_\alpha}{\sqrt{n}} = \frac{1.224}{\sqrt{16}} = 0.306$. So the meaning of $\overline{\rho} = 366.2$, $s_0 = 16.4$.We have got the $\alpha_1 \approx 498.6$, $\beta = 0.734$ by solving the system of Eq. (4). Afterwards the $D_n \approx 0.132$. As $D_n < \frac{\lambda_\alpha}{\sqrt{n}}$, we have taken the same conclusion as for the last samples with only one distinguish that the hypothetical disturbance has the other parameters. The bar chart and hypothetical condensation are shown on the Fig. 5.

**The sample 4:** The odd trains, June, 2018, the night period of time, n = 8. The approximate meaning of the sample criteria is $\frac{\lambda_\alpha}{\sqrt{n}} = \frac{1.224}{\sqrt{8}} = 0.4327\ldots$ So the meaning of $\overline{\rho} = 379.4$, $s_0 = 15.5$.We have got the $\alpha_1 \approx 599.14$, $\beta = 0.63$ by solving the system

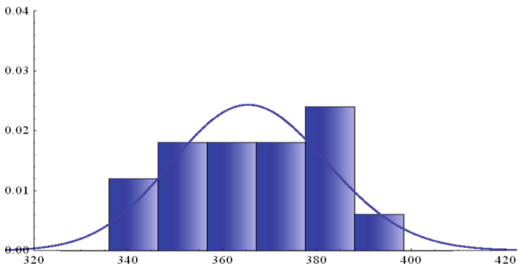


**Fig. 5.** The disturbances of common train traffic for the odd trains were followed in July, 2018, in day period of time.

of Eq. (4). Afterwards the $D_n = 0.295$. As $D_n < \frac{\lambda_\alpha}{\sqrt{n}}$, we have taken the same conclusion as for the last samples with only one distinguish that the hypothetical disturbance has the other parameters. The bar chart and hypothetical condensation are shown on the Fig. 6.

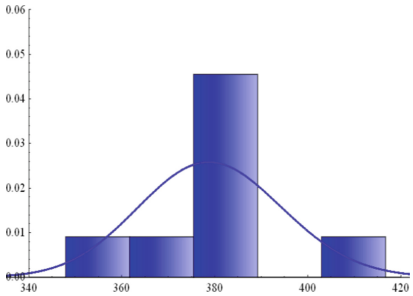


**Fig. 6.** The disturbances of common train traffic for the odd trains were followed in July, 2018, in night period of time.

## 7 The Grounding of Train Schedules Adjustments

In a process of planning and building the train schedule has to create the grounded parameters for the reason to fulfill the demands of accurate accomplishment of this schedule. First of all the parameters include the departure headway and the section run time. There is a methodology in this very article for ground the reliable figure of section run time at the determined headway interval.

There is a statistic approach in the base of the methodology. According to this approach creates the probability of fulfill the section run time in different disturbing conditions for the trains flow like speed limits, weather, excess of stations capacity and so on.

On the next step has to select the trains which followed the line in the same conditions. There is a main gather of trains characterized by absence of intensive

negative factors for grounding the basic section run time. There is absence of trains delays while move as a particular feature of conflict free following.

Further has to build the bar chart and find the parameters of function approximate the distribution of run time figures. After forming the probability $P_{rp}$ of accomplishing this parameter find the meaning of ground run time which get into the main schedule. This parameter will provide the necessary level of punctuality in arriving trains on the technic stations.

There is an example of a count the run time for the main schedule for the segment of Transsiberian main rail line shown in the paper.

## 8 Conclusions

The analysis of characteristics of probability distributions of run time and arrive delays of trains create the opportunity of grounding the schedule's demands. There is a high level of punctuality in condition of following the demands. Besides, the analysis of distribution shape helps to recognize the main factors which lead delays while adjusting the trains flow. There are most frequent negative influences as initial delays and unplanned stoppings which lead the further delays in the intensive traffic. There is also incorrect realization of technique processes on the line stations as a reason of happening unscheduled delays before the entrance signals.

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