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System of Support Logistics and Transport Control for Routes in a Distribution Network

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***Abstract*— Large manufacturing enterprises have complex logistic systems. Although they can try and employ fleet monitoring based on satellite monitoring, this approach has significant drawbacks as well. Here I present a more advanced solution to the fleet tracking and route control problem in the form of the automated transport monitoring system. This system leads to significant, measurable increase in efficiency of individual vehicles within the fleet.**

Keywords — transport; control; route; task; flight; monitoring

I. INTRODUCTION

GPS technologies or GLONASS based systems of satellite monitoring are developed with the purpose of work optimization and control of vehicle fleet, thus allowing to carry out spatio-temporal control. However there is a set of problems at large enterprises with a big product distribution network, such as MUE "Minskhlebprom" with about 500-1500 flights every day. To control transport in real time through the system of satellite monitoring becomes impossible. Thus, the decision was to create a system of support and transport control on transport routes on a strictly set route within a movement corridor, taking into account the set of sequence of target points, according to the schedule of deliveries and service time windows.

After a year of experiment on three vehicles of a bakery No. 6 the system showed strong economic benefits - to 52 % of reduction of transport run length with constant performance level.

II. SYSTEM DEVELOPMENT

Municipal unified manufacturing enterprise "Minskhlebprom" – the manufacturer of the bakery, and confectionery foods, frozen products and semi-finished foods. Each group of goods has specified conditions of warehousing, storage and transportation therefore bakeries do several distributions, depending on shipped products that in aggregate expands a transport task. The daily average number of routes varies from 500 to 1500 or more. Flights also account for the return of product containers. Process of route scheduling is carried out by the production program of our own development. Solving algorithms allow us to solve transport problems of the level of Vehicle Routing Problem with Time Windows (VRPTW), Vehicle Routing with pick-up and delivery (VRPPD) and The Multi-Depot Vehicle Routing Problem (MDVRP) [1].

The transport program creates Travelling tasks by association of shipment demands and forming routes on an assortment set and territorial accessibility of finding of target objects of customers, taking into account the schedule of deliveries (Fig. 1).

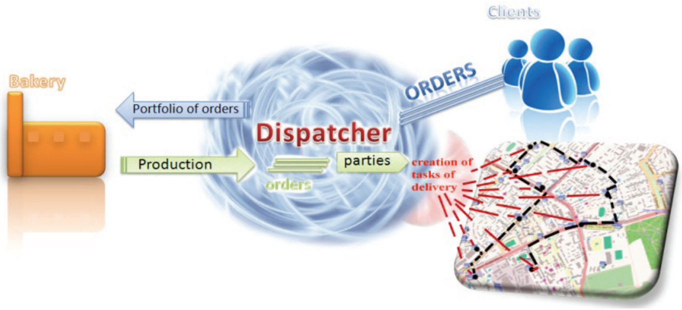

Figure 1. Scheme of the logical system.

With introduction of the satellite monitoring system on MUE "Minskhlebprom", it was necessary to integrate it with the transport program of the enterprise. Installation of system of monitoring as the separate program acted as an additional software which complicated work of the dispatcher, by bringing heterogeneity to the processes of planning, management and transport control.

The main objective of merging the system of satellite monitoring with the transport program of the enterprise was to create an effective logistic system working to achieve maximum efficiency of the system at the expense of minimization of human factor in the control. The decision was to create a system of support and transport control on the routes, consisting of a package of add-on for the system of satellite monitoring which is carrying out feedback with the vehicle.

III. SYSTEM OF SUPPORT AND TRANSPORT CONTROL

For the assistance to the dispatcher and as a replacement of minute by minute control, a system of support and route transport control was developed, created through improvement to the workflow of installations and superstructures, in particular: connecting of geozones corridors to the constructed itinerary, temporal limits, predefined fixed order of visiting locations and task visualization through a template on the map in the system. The system evaluates deviations from the transit route and visiting time of the set points, notifying the operator. Without violations and deviations the system classifies the task as "correctly executed". The developed system significantly simplifies and strengthens the process of route performance control, thus relieving system dispatchers and allowing for unbiased evaluation all deviations from the planned delivery route both on distance and in time, in so minimizing the human factor in the process of control [2].

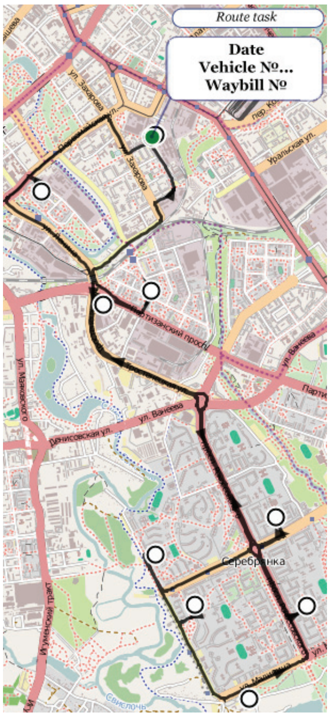

Figure 2. Route template

1. Route template.

The route constructed by the dispatcher becomes attached to a specific vehicle and driver, becoming the task for the driver. The task registered also in the waybill, in monitoring system it is displayed as a template on the card - the semi-transparent image of the assembled route (the Fig. 2). The task history and a course of completion can be seen in the system by choosing the vehicle and the working day in a program calendar, and also through waybill or route No. In the case of two and more runs they will be displayed on the map with a numerical tag. When closing a waybill the dispatcher displays a track of the given vehicle run for the date in question, which is displayed against the given route. If there are no deviations or the deviations are minimal, the run may be considered as optimal.

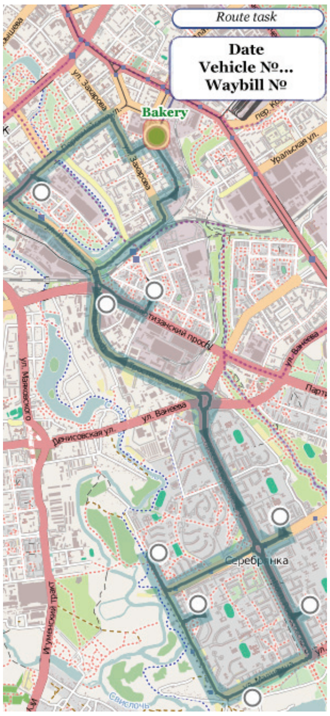

Figure 3. Route corridor

For evaluation of deviations the following additional capability is necessary – a geozone attached to a track of a route, thereby creating a route corridor.

2. Route corridor.

For tracking of vehicle accuracy on a track drawn with a routing program, the geozone is added along the track with a distance of 20-50 meters (visualization looks as a shadow along the track of the route). In case of a deviation from the tolerance on the route (aforementioned 20-50 meters) a note created in a route color, a report is made and the notice in the program is sent to the dispatcher (to the Fig. 3). The metrics of a deviation is set small to allow for possible moving of the vehicle on a track within the street.

Upon receiving report of a traveling task, the operator of the system already sees not only a run track against a track of a route, but also the assigned corridor. If the vehicle went deviated from the corridor constructed by the program when planning the route, it will be noted in the program with notice drawn. All deviations or departures from corridor limits are determined by system and displayed on the system monitor with a color label. Also in the report on a the corresponding note is created.

It is important to consider the sequence of arrival to destinations and the potential necessity to reorganize the route in case of unforeseen situations, for this purpose it is necessary to complete a functional routing program.

3. Sequence of delivery

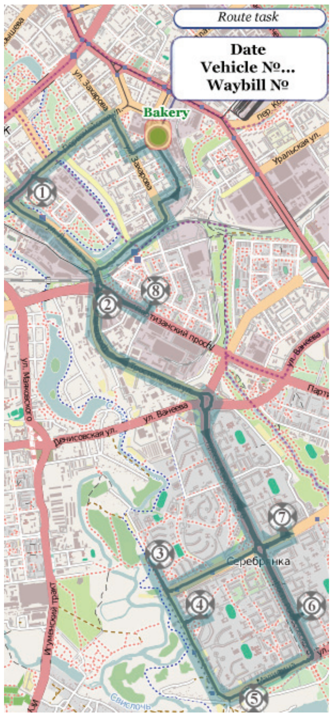

Figure 4. Sequence of delivery

Creation of a route begins with establishing of the start and end points which open and close a traveling route. Following stops on the instructions of for product delivery are numbered by serial numbers from 1. The vehicle should proceed on a the route in the order delivery stops as determined by the dispatcher since the approved schedule of delivery is considered in the final route determination (it is defined in the contract of product delivery, delay or early arrival will be considered a violation, with late arrival a more undesirable violation than early). A working principle is like in Check-Points (Control points), i.e. the system tracks vehicle passing certain points, according to the itinerary and taking into account the sequence of stops (the Fig. 4). If a point is missed – it's a strict violation: it is noted on route graphics by color, and a notice is drawn up by the system and sent to the dispatcher (the operator of system).

The program automatically makes the report on vehicle residence time at each point noted in the itinerary, allowing the dispatcher to compare the given task with performance by fast inspection of the stopping points. Visualization on the map helps to determine in a glance correctness of task performance of the driver.

Figure 5. Schedule of deliveries

4. Schedule of deliveries.

Because it is important to consider the approved schedule of product delivery in a shop, at each point of unloading the there is and established time limit . In case of not point visits in time it is marked as «failure of the schedule of delivery». Failure of the delivery schedule is noted by color on a track of a course of performance of a route, note is made in the report on a route and the system operator is notified by the notice of delay.

In addition, it is possible to control the vehicle stoppage time at destinations. For example, in the contract it is written that at the shop the vehicle may me unloaded for no more than 40 minutes. Idle time above the established time is strong violation by the shop which may cause deliveries failures to subsequent shops. Having adjusted in the system the maximum stoppage time at commercial entities to 40 minutes, we create an operative assistant notifying us on vehicles idle times (see the Fig. 5). The dispatcher will be notified and can take timely measures to resolve the situation. Protective function, in the case of complaints or claims from shop, it will be possible to create a report on excess of an admissible stoppage time. Shops can receive the stoppage time for statistical purposes for application in optimization calculations, in an algorithm for the solution of a task.

Restrictions on the maximum speed of movement and temperature of transported cargo (when a temperature sensor is present) are entered for the safety of movement and cargo transportation. In the case of violation of the established limits, a corresponding graphical indicator is created, together with the notification for the system operator.

Flexible route track – the additional function of the system allows creating points of track deviation between delivery locations with possibility of sliding, thus, forcing the program to redesign the route. This allows the system operator, having coordinated with the driver, to redirect the vehicle to a detour of the obstacle created on the road (see the Fig. 6). Departure from the route, in cases of the established detours, traffic jams or road repairs should be coordinated with the dispatcher. The dispatcher notes on the track in the system a point of the traffic jam and directs the driver to an alternate way.

With the listed set of functions in the system of satellite monitoring disappears the need of for the system operator to do real time route control and tasks performance evaluation upon closing of waybills. In the absence of violations the task is considered to have been executed correctly. It is necessary to look only through tasks with deviations and administrative measures to stop further repetition of failure in task performance.

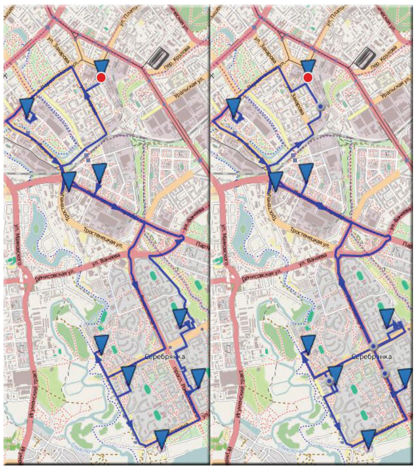

Figure 6. Flexible route track

Optimizing resolution methods will help to increase efficiency of vehicle fleet operations, reduce run numbers, reduce number manpower involved in process of transport delivery, and the system of support and transport control on routes will with in better accuracy ensure correct realization of delivery tasks.

IV. Result of Experiment

In December, 2010 MUE "Minskhlebprom" introduced a system of support and transport control on routes of 3 transport units of a bakery No. 6. Work with the system allowed to carry

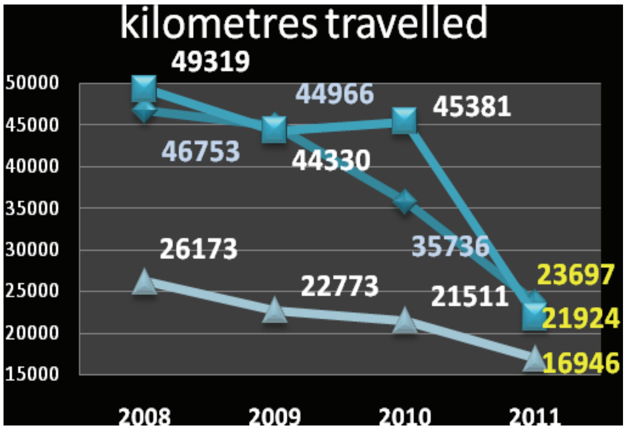

Figure 7. Decrease in run of 3 vehicles

out course performance control of drivers, trace runs, vehicle motor-hours and to make operative supervision. In introducing it, it was necessary to develop a new system approach to transport maintenance, the dispatcher workplace organization, to administratively assign responsibility for optimal system operation by dispatchers, drivers' liability for the correct performance of transportation tasks and integrity of the monitoring equipment , etc. The result was a decrease in length of runs from 23 % to 52 % (a distribution is due to heterogeneity of vehicle participation). The relative total annual savings on runs made was 53 474,67 km (it is calculated on 3 cars by a way of comparison of their run in 2011 and average run in previous years, since the 2007th). For the analysis of the received data and displaying the final effect, we collected the operational data of vehicles from 2007 for 2012. The studied vehicles are GAZ brand 3302 (see fig. 7). Although the volume of the work performed by vehicles from the period by the period expectedly varied, the data regarding the transported cargoes and numbers of the visited outlets however indicated moderately increased volume of the performed work.

Attempting to preserve the approximate number of visit of shops and the executed flights, there was a sharp reduction in run numbers together with a small increase in the tonnage of dispatched products. It should be noted that during the period vehicles transported confectionery, dough and croissants within of the same districts of Minsk, having almost identical structure of routes.

V. Conclusion

It is most important for manufacturing enterprise to develop and strengthen a freight delivery network direct influence on which renders the transport logistics. Introduction of system of support and transport control on routes increases productivity of transport, which increases competitiveness of the enterprise as a whole, while bringing notable reductions of financial expenses.

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