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INTELLIGENT OPTIMIZATION

TRUCK DRAYAGE DISPATCHING AND APPOINTMENT BOOKING

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Truck drayage operations are essential to link logistics nodes in the port and beyond. Truck drayage services mainly involve the short-distance transportation of cargo from/to facilities in the proximity of ports as well as inter-terminal transports [1]. Often, those transports are planned by a third-party drayage operator (e.g., an intermodal transport provider) and assigned to self-employed truck operators, referred to as truckers. In the Port of Hamburg, for example, about 90% of inter-terminal transports are handled by trucks and severely contribute to the road traffic volumes and situation at gates. Besides this, many ports increasingly suffer from peak transport demands due to the ever-increasing size of container vessels.

In recent decades, many international ports have introduced truck appointment systems (TAS) to alleviate the growing problems with respect to road and gate congestion, environmental impact, and reduced earnings for drayage drivers due to a loss of available working time. Some ports were successful, and others less so [2]. From the drayage operator perspective, the booking of appointments needs to be aligned with the planning of different tours in a way that booked time slots can be reached by the trucker. An intelligent and automated optimization of truck drayage operations can be the basis for a more efficient appointment booking and facilitates better utilization while coordinating available truckers based on real-time information and the use of mobile trucker apps.

In this article we present some insights and ideas from a current collaboration project between EUROGATE Intermodal (EGIM) and researchers of the University of Hamburg aiming at enhancing the dispatching system and related appointment bookings by introducing intelligent and automated decision support.

BUSINESS SCENARIO

Dispatchers of drayage operators act as brokers that need to assign and coordinate several transport orders among available truckers by considering many requirements and constraints, such as customer and cargo-related requirements, opening hours of facilities, qualifications of truckers, and the use of chassis. Moreover, the dispatcher may need to book appropriate appointments for specific time slots in order to guarantee the gate entry and low truck turn times at related port facilities. In addition, external factors, such as the expected traffic situation or truck turn times at port facilities, must be considered during the transport planning.

As a result of the above, dispatching becomes increasingly complex and time consuming when trying to ensure a high service quality, excellent customer experience, and fair conditions for truckers. While the current wave of digitalization already strengthens the

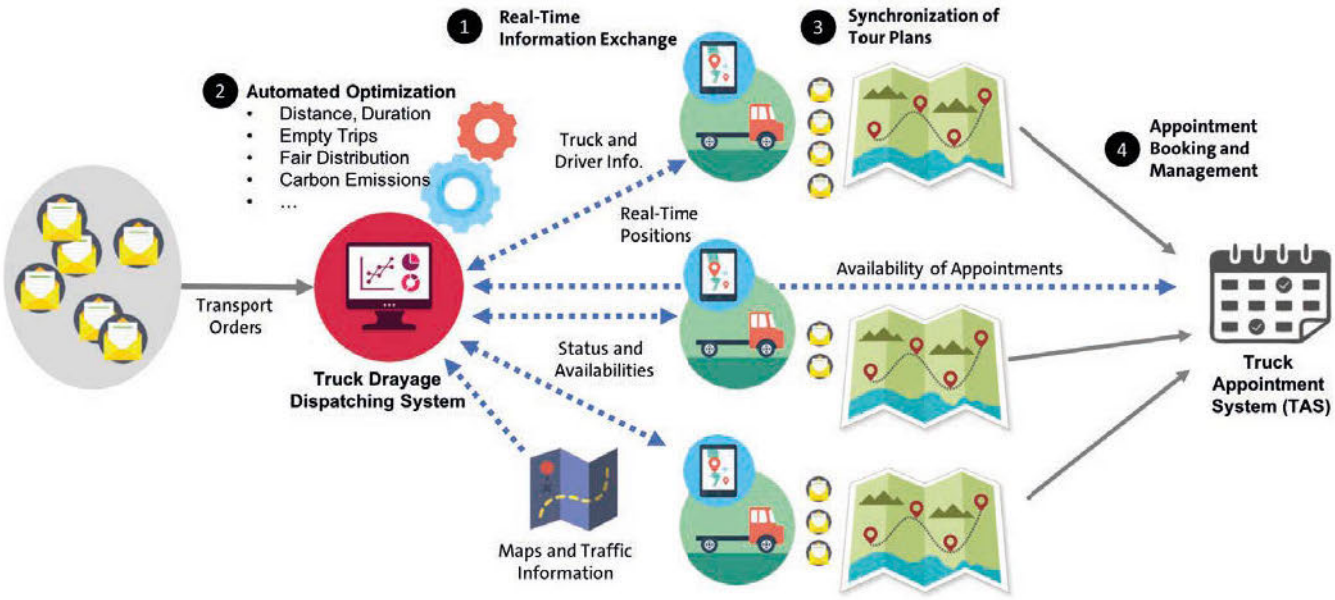

Figure 1: Automated truck drayage dispatching with appointment booking

communication and coordination with truckers, e.g., by introducing new mobile apps, the dispatching of transport orders to available truckers offers many potentials for optimization.

AUTOMATED DECISION SUPPORT

To better support the complex decision-making process of dispatchers and to avoid wasting valuable resources and time, an automated optimization of truck drayage operations is helpful. An efficient planning helps not only the drayage operator to save cost and time, but also allows truckers to better utilize their working time by benefiting from an improved routing and coordination of transport tasks. Based on scientific findings, we see that optimization can indeed lead to a win-win situation for both drayage and truckers. Besides the operational and economic impact, advanced decision support tools can consider and evaluate trade-offs between economic, environmental, and other key performance indicators, such as by using multi-objective optimization [3].

Against this background, we have designed an intelligent decision support system that supports dispatchers in assigning transport orders and appointments taking into account the current and future situation based on automated optimization, real-time information and predictions. Following the scheme presented in Figure 1, we explain the four core aspects in the following.

1. REAL-TIME INFORMATION EXCHANGE

A precondition for intelligent decision support is a high level of visibility and integration. Given the new possibilities of digitalization, real-time information that is vital for dispatching can be obtained from mobile apps and external systems. The latter includes not only traffic information systems, but also port and facility-related information systems that could be integrated. In the first instance, we consider current and predicted travel times and real-time traffic data from an external maps service as well as the percental availabilities of appointments at different times during the day. Using a trucker app further provides real-time information on the status and availability of truckers as well as additional truck and driver-related information. Obviously, the integration with other systems, such as transport booking systems, or, more generally, port community systems (PCS), is essential to facilitate smooth information flows.

2. AUTOMATED OPTIMIZATION

With all the necessary information at hand, automated optimization uses different computer-aided optimization methods to find the best possible solution among millions of possible combinations with respect to the assignment and sequence of transport orders among a number of available truckers. How the best possible solution is defined depends upon the preferences of the decision maker (i.e., the dispatcher) in terms of different objectives. This can include not only the minimization of transport distances, durations, and empty trips, but also a fair distribution of tours among truckers and the reduction of carbon emissions. A solution is only feasible if it satisfies all constraints and requirements. For each truck, the assigned orders must be sequenced in a way that matches the due dates, time slots at pick-up and delivery locations. Besides, other restrictions need to be fulfilled; for instance, the transport orders might consist of hazardous goods, for which truck drivers need a special permission.

Taking into account all these restrictions of multiple transport orders and available real-time information, very complex combinatorial problems need to be solved. To solve such combinatorial problems efficiently in terms of computational time and solution quality, advanced metaheuristics can be applied to search for the best possible solution by applying different problem-specific strategies (i.e., heuristics) iteratively. These heuristics are used to change a constructed solution, e.g., by modifying the sequence of transport orders, over and over again to achieve better results in terms of the objectives. This process involves, for instance, moves or swaps of orders among different trucks or in the sequence of a single truck. In contrast to manual planning, we can use computational power to generate and evaluate millions of possible solutions in this way.

The results of our computational experiments indicate that automated optimization can lead to improvements of all considered objectives compared to manual planning. In our case, the automated planning not only allows to significantly reduce transport distances and empty trips, but further allows a better utilization of available truck capacities so that, even on days with peak demands, more transport orders can be handled per day. Besides, it ensures a better distribution of orders among truckers so that the solution leads to a win-win situation for the drayage operator and truckers.

Another important aspect is the response to changes and disruptions during operations. Because of congestions, accidents or other disturbances the actual situation may differ from the target and the transport orders and appointments must be rescheduled. New transport orders may need to be integrated into an existing plan as well. Certain appointment slots for individual facilities might not be available anymore so that pick-ups and deliveries need to be postponed to a later slot. By using automated optimization, existing plans can be adjusted and optimized within seconds to cope with the new situation.

3. SYNCHRONIZATION OF TOUR PLANS

The best solution found by the automated optimization procedure comprises of all tour plans for the considered truckers. Based on this result, the dispatcher can inform the truckers about their next transport orders. During operations, the trucker can report progress and receive the next transport orders shortly before finishing the current move. This provides the flexibility to make adjustments to the overall plan (e.g., new transport orders and disruptions) without truckers noticing it. The tour plan furthermore defines the exact route based on real-time traffic information and needs to be followed by the trucker to fully benefit from the intelligent optimization.

4. APPOINTMENT BOOKING AND MANAGEMENT

Given the tour plans for all truckers, defining the sequence of transports and schedule of pick-ups and deliveries at the involved facilities, the dispatcher is able to book appointments hours or even days in advance by using a TAS. Once the appointments are booked, the drayage operator needs to make sure that the reserved slots are used by the truckers in order to avoid penalties. As a consequence, the dispatcher must react in case truckers are likely to miss one or multiple appointments. In this case, the booked slot could be beneficial for another trucker or, if not, need to be cancelled early enough. Here, the goal is to make best use of reserved slots. Obviously, the booking of the appointments can be automated based on the schedules of the automated dispatching. With respect to the management and utilization of reserved slots over time, making sure the best use of already booked slots implies an integration with the automated dispatching of transport orders. This means that the reassignment and rescheduling of transport orders consider already booked slots and slots still available in the TAS. Thereby, it is possible to adjust tour plans in a way that valuable time slots can still be used while others are cancelled and rebooked.

CONCLUSION

Digitalization leads to new opportunities for port operations. The combination of modern technologies and methods for advanced analytics is the basis for intelligent decision support and automated optimization. In this article, we provide insights and ideas from a current project introducing automated optimization for truck drayage dispatching and appointment booking using advanced technologies, predictive analytics, and optimization methods. The success of the project reflects the huge potentials for improving port operations by taking the next step towards automation and digitalization.

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ABOUT THE ORGANIZATION

EUROGATE Intermodal (EGIM) with headquarters in Hamburg (Germany) offers customised intermodal container transport by road and rail. We are a founding member of the boxXpress.de train service, a system of container block trains that provides daily shuttle services from the seaports of Bremerhaven and Hamburg to eight inland terminals in southern Germany. Our link between the economic regions of Hungary and the German seaports is also an important part of EUROGATE Intermodal. Germany's only deep-water port in Wilhelmshaven has also been integrated into this network.

The Institute of Information Systems of the University of Hamburg (Germany) specializes in interdisciplinary research for supporting decision-making within various application areas. A strong research focus is on quantitative methods, data science, and cloud computing for supporting the planning and management in port logistics. Numerous publications in highly-ranked journals emphasize the quality of the institute's research. Several projects in the port industry have been successfully carried out in recent years. Prof. Dr. Stefan Voß is the director of the institute.

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