AN EFFICIENT FLEET MANAGEMENT OF A RAILWAY FREIGHT OPERATOR IN IS ÚDIV SUPPORTED BY AN OPTIMIZED MATHEMATICAL MODEL

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A freight wagon is one of the most significant enterprise resources of a railway undertaking (RU) or an operator in the setting of a highly competitive transport market. Therefore as a primary concern any operator aims for an efficient fleet management, which is a necessary condition of the positive financial results of the enterprise. This paper emphasizes the importance of an effective information tool for managing the wagon fleet, based on the precise transport orders, wagon positions, and a network-wide coverage. Then it introduces IS ÚDIV as an example of a successful implementation of this tool within the environment of ČD Cargo with positive effects for its productivity. At the same time, it underlines the significance of a fundamental technological process reengineering in the field of the dispatching control, which is a necessary prerequisite of the successful implementation.

Key words: railway freight transport, fleet management, mathematical optimization methods, information systems, operational technologies, cost savings

1 Introduction

The railway transport in Czech Republic – and in many other EU countries as well - undergoes an extensive and complex transformation, whose aim is to eliminate the high dependency on the government budgets, enhancing the flexibility and efficiency of the management, and above all higher liberalization of the railway transport market and its opening to various other subjects (carriers or rail operators).

As a sustainable surface transport, the railway transport now re-gains its former position on the transport market. The key “buzzwords” – and at the same time the key challenges – are competitiveness, open access for the railway operators, and interoperability. The basic conditions for undertaking in the railway industry have been set by the European Directive 91/440 adopted by the Council of Ministers in 1991, then by Directive 95/18/EC (licensing of railway undertakings in EU) and Directive 95/19/EC (allocation of railway infrastructure capacity, later replaced by Directive 2001/14).

After joining the European Union, the freight transport entered the unified transport market which involves a strong **competitive environment**. The competition manifests not only among different transport industries, but also within the railway transport itself – and it notices a boom of new operators, which are more flexible than the dominating national carriers. Each operator or Railway Undertaking (RU) has to seek its market position to survive.

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2 Wagon as a Vital Resource

The most important "production resources" of any railway undertaking (freight operator) are the wagons, engines, and personnel, which are assigned to every train in operation. Obviously, they bring the largest share of costs of the railway operator. Of course they mean also the largest share of revenues, which can be brought only by loaded wagons and trains.

The overall technology of organizing, planning, and executing the freight transport is much more complex, and should be therefore covered by a separate contribution. Here we just name the most general technological processes involved and point their relationships.

As detailed in Section 3.1, the business processes of a railway undertaking can be divided into three levels, which are consequently covered by various specialized information systems. Narrowing the view only to the railway freight wagons, we can see them as follows:

1. **Strategic management –** general, long-term decisions; in the area of wagons it involves purchasing and maintenance of the wagon fleet, including the financial and overall business strategy.
2. **Tactical management –** planning train transport and wagon movement, or in the area of SWL (Single Wagon Loads) creating the marshalling and routing plans.
3. **Operation management –** involves the real operation in the field, i.e. monitoring the traffic, and resolving the exceptional events (in close cooperation with the IM).

For the real railway operation, the last of the mentioned process levels is the most important one. It can be further divided into sub-processes as deciding upon wagon assignment, loading the wagon, collecting by a feeder train, sorting in a marshalling yard, then long-distance haulage, another target re-sorting, and delivery and unloading. The wagon circulation is then completed by repositioning the wagon into the place of the next loading.

Each of these technological sub-processes comprises a complex problem of its own. IS ÚDIV, described by this contribution, makes a cut-through solution, which helps planning and monitoring the wagon movements in every single moment of the transport.

Figure 1: Technology of the railway freight transport: a local feeder train

3 IS ÚDIV as a Comprehensive IT Solution

Of course these processes cannot be supported by traditional “PPP” technologies anymore (Phone, Pencil, Paper); modern railway undertakings rely on information technology. The presented system, IS ÚDIV, is not any sole, all-purpose system; it is actually part of a much larger “puzzle”, which comprises a **comprehensive solution of the information systems of a freight carrier** (railway undertaking).

3.1 A Part of the Whole

This “kit” of the basic building blocks implements various components of planning and managing the railway freight transport in the environment of an open domestic and European competition. This solution allows for the Electronic Data Interchange (EDI) with other systems including the foreign ones, and respects the Technical Specification for Interoperability relating to the Telematic Applications for Freight subsystem (TSI TAF) of the trans-European conventional rail system and other legislation and standards.

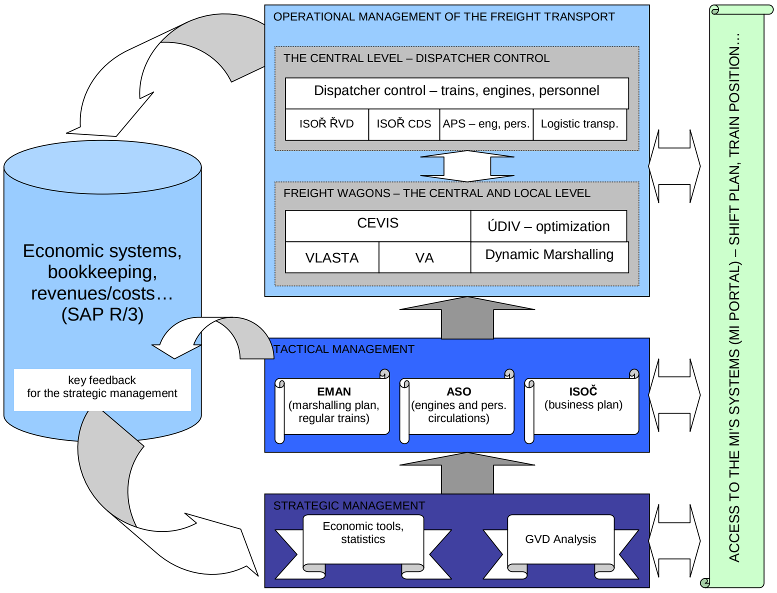

Figure 2: The solution architecture of IS for a freight carrier

The comprehensive information system of a railway freight carrier, built upon a digital data base, has to cover both internal functionalities (i.e. the functionalities for the internal use of the carrier) and external functionalities (i.e. above all the functionalities for communicating with the IM). As in any other enterprise, the operation of the organization of the railway freight carrier has to cover three basic levels of decision and management (as briefly stated in Sect. 2):

- **Strategic management** – general, long-term decisions on the highest, conceptual level with the most significant impacts for the organization as a whole. At the freight railway carrier they involve the strategies of purchasing and maintenance of the vehicles (both engines and wagons), financing, and the overall business strategy of the operation on the transport market.
- **Tactical management** – from both the organizational point of view and the time scale, it is the middle level. It implements the decisions made on the strategic level; at the freight railway carrier it involves planning the train transport and creating the basic plan and shift plan, procuring the capacity from the IM.
- **Operation management** – the lowest level of management, in the railway transport it is further divided into time and spatial levels. At the freight railway carrier it involves the operation management of the hauling vehicles, wagons, and personnel, or resolving the exceptional events (in close cooperation with the IM).

3.2 Technological Model

IS ÚDIV fulfils the roles of a Central Wagon Dispatcher, i.e. planning, monitoring, and adjusting the movement of both loaded and empty wagons. The system allows entering the transport orders according to the customers' requests, and at the same time, from other information systems it retrieves the real-time data on the wagon movement and status of the wagons and/or consignments. In preset time intervals the system makes an optimized batch calculation of the automatic balance to cover the Demands by the Supply of the available empty wagons. The operator can adjust the calculated results by hand, or he can make an individual manual assignment to a particular request. All the technological roles and modules of IS ÚDIV are denoted in Figure 3.

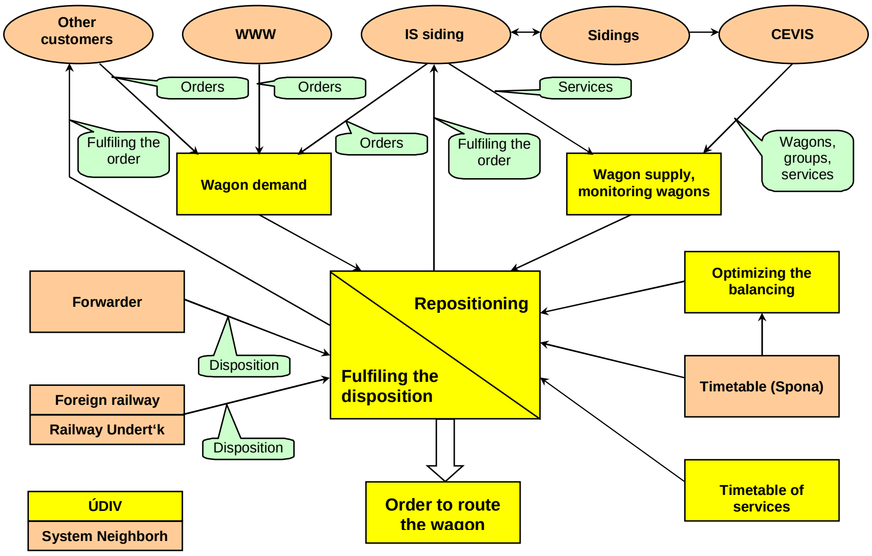

Figure 3: ÚDIV – the technology architecture

3.3 System Neighbourhood

As suggested in the figures above, the system relies on a heavy data exchange with other IS of the freight carrier (Cargo):

- Central Cargo Bookkeeping (CNP),
- Central Wagon Information System (CEVIS),
- Central Consignment Database (CDZ)
- Freight Wagon File (KNV),
- Basic Reference Tables

To facilitate the automatic balancing, the module SPONA (Connection in the Freight Transport) is used. ÚDIV system interacts also with the customers (sending a notification on cancellation, rejecting or suspended covering an order). The solution also includes direct data exchange with the customer's IS. The system facilitates managing the wagon fleet owned by the freight carrier.

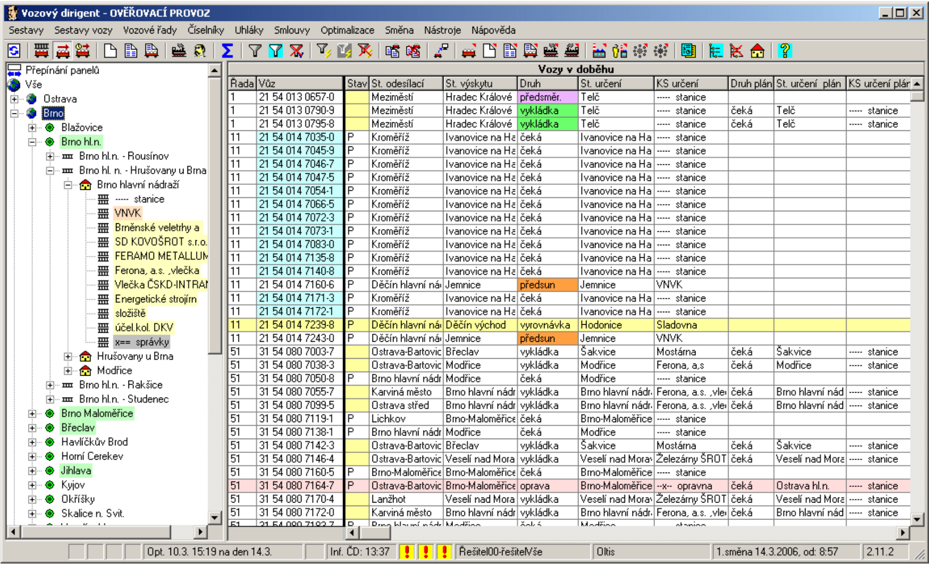

Figure 4: ÚDIV – the basic navigator (wagon sheet)

3.4 Optimized Wagon Repositioning

One of the most sophisticated modules of IS ÚDIV is the wagon repositioning, based on a mathematical optimizing method with internal heuristics. Namely, as mentioned in the Section 2, the revenues can be brought only by loaded wagons and trains: any empty wagon movement lacks revenues and brings therefore a net loss to the operator. Such non-productive costs should be then cut as much as possibly; and obviously, the optimal, the most cost-effective solution can be hardly achieved by manual assignment, by however experienced human dispatcher.

IS ÚDIV implements three optimizing methods:

- Index heuristic method
- Frequency heuristic method
- Modified distribution method (MODI)

Every calculation is based on the input data given by the calling application in the upper level, i.e. by the dispatcher's Navigator. The optimizing module works with wagons as abstract entities, not with particular wagon numbers. It collects all the data on wagon supplies (excess) and demands (deficiency); it counts with the mileage between both stations or both points, and with the evaluated price of the connection.

Together the input data of the optimizing module include:

- Railway transport network – basic data
- Marshalling system and connections (SPONA) in the freight transport – important to derive a "realistic" (practically achievable) assignment
- Price matrix – complete with the mileage, time factor, and costs of wagon re-sorting
- Other static parameters
- Dynamic parameters – wagon supply and demand

The best results are achieved only when the wagon assignment is calculated in one large batch, and when the optimized solution is not "corrected" by a manual intervention.

4 ČD Cargo: A Successful Implementation

In the environment of the Czech national freight railway undertaking ČD Cargo, IS ÚDIV has been implemented during years 2004-2005 as a joint project of ČD-Telematika a.s. and OLTIS Group a.s. Now it facilitates the dispatching control of all the freight wagons, excluding only some special types, and gives the dispatchers detailed overview of the loading processes, down to the level of the loading points, as sidings and station tracks.

4.1 Business Process Reengineering: Together with IT

Hand in hand with the implementation of the described IS ÚDIV, the business process reengineering was necessary: the brand new information system and the optimized solution could not support the old-fashioned technology anymore.

Figure 5: ÚDIV: the central dispatchers' workplace

The **fleet management** has therefore undergone a fundamental change: instead of six regional workplaces, all the agenda is nowadays operated from one central workplace in Česká Třebová. To dispatch routinely all the 25 000 freight wagons of ČD Cargo, only 6 operators (dispatchers) are employed instead of almost three dozens. Also the undesirable "wagon contention" among the individual regional dispatchers has been completely eliminated, as the wagons are managed in the network scope.

4.2 Benefits Achieved

The new information system together with the business process reengineering have brought many significant benefits. The cumbersome "PPP" technologies with manual "data" entry into paper sheets have been eliminated, the error rate has been lowered substantially, and the phone communication overhead has been reduced.

However the most important benefit is the **significant improvement of the fleet management**. The instant supervision of the wagon movement, together with the mathematic optimization of the empty runs, directly results in higher efficiency of the technological processes, and lowering the costs of wagon fleet. In some special areas, the wagon circulation has been reduced by unprecedented 13%; more conservative (and more realistic) estimates range between 3-5%, which means anyway several million EUR per year.

This way, huge reserves are released in the area of the fleet management: they could be reflected either in selling inutile assets (wagons) and saving costs for wagon purchases and maintenance, or on the contrary, in active utilization of the spare vehicles, i.e. lending wagons, or gaining new transports, which both lead to boosting the revenues of the railway undertaking. Anyway, the particular measures should be actively decided and implemented by the railway undertaking itself.

5 Conclusion

As stated in the introduction, a freight wagon is one of the vital resources of any railway undertaking. Therefore an efficient fleet management is needed to cut costs and boost revenues of the RU. The contribution suggests IS ÚDIV as a successful IT solution of this problem, together with the necessary business process reengineering, as implemented by Czech national freight operator ČD Cargo. The presented solution leads obviously to more transparent and more efficient processes, better fleet management, and consequently to releasing the reserves and saving costs of the railway undertaking, which is a necessary condition to survive on the highly competent railway market, especially in the present times of the global economic crisis. The RU should assume an active role in implementing the changes.

Reference literature

1. The official web pages of OLTIS Group a.s., http://www.oltis.cz/index.m?lang=EN
2. Internal documents of OLTIS Group a.s.