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RESTRUCTURING DRIVER PLANNING AT THE LEADING LONG-DISTANCE TOC IN POLAND

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Summary: This paper looks at the ongoing implementation of a new model of driver planning at the leading long-distance TOC in Poland. The main focus is the duty and monthly schedules efficiency. It contributes to the design of train crew planning structures at the strategic level.

Key terms: driver planning, rail operations, train crew optimization

1. INTRODUCTION

In recent years the leading long-distance Polish Train Operating Company (TOC) has experienced significant demand growth thanks to improvements in rolling stock, changes to the timetable structure and much more customer focus. Massive increase in rail operational work has been only partially compensated by an increase in the number of employees. Therefore, the company has actively started looking into ways of reducing inefficiencies in inter alia train crew planning to mitigate the operational pressure. A decision faced by the TOC herein is to determine how to improve the efficiency of rail operations planning, in particular, in the case of drivers, which is a highly unionized and privileged group, such that it is also socially acceptable from the drivers’ perspective.

2. BACKGROUND

Division of the monopolist, the national railway company PKP (Polish State Railways) in the beginning of the 21st century has resulted in the creation of a number of rail enterprises. Most of them inherited a lot of debt, old rolling stock, obsolete, inefficient organizational structures and very complex planning rules, some of which are still difficult to change nowadays because of the high level of unionisation. Times from the foundation of the before mentioned long distance TOC in 2001 until 2010 were very difficult because of the need to rise the challenge of fierce competition from the private transport modes as well as low cost
carriers and cheap bus operators while going through heavy restructuring of the company. The rail infrastructure was also heavily modernised and upgraded mainly thanks to the EU funds, which temporarily - for the time of the upgrade, resulted in extension of journey times on many routes making the rail even more unattractive. From 2010 onwards, however, the TOC has slowly started to experience growth and the effects of heavy restructuring have become noticeable - increase in the number of customers thanks to the introduction of the new rolling stock, more customer care and better (from the passenger perspective) timetable to mention a few causes [19]. Interestingly, one of the areas that has remained almost untouched through all these years was the planning of rail operations. In the UK, train crews account for about 20-25% of the total operating cost [13]. Crew-related costs constitute more than one third of general expenditure of the Turkish State Railways, while Dutch Railways report a share of more than 30% of their total operational expenses due to wages in both 2011 and 2012. Association of American Railroads has reported 21.3% of the total operational expenses to be spent on wages, which was ranked second after fuel [20]. In our case study, wages account for about 25% of expenses (there are c. 8,000 employees, of which traincrew account for c. 45% and the drivers themselves for c. 20%). This area has a great potential to reduce costs and contribute to strengthening the competitive position of the railway in the Polish long-distance transport market.

3. LITERATURE REVIEW

The literature on rail operations planning is rich in theoretical papers that are using a lot of sophisticated mathematics to model the rail operations planning (the models in most cases are based on very unrealistic and over-simplified assumptions which limit their practical application) and books describing the process in the ‘how to plan’ approach, however, there is very little written on the organisational structure of the planning process and how this can be improved to foster efficiency. Let us start with an analysis of other transport modes, namely the airline industry, which is much more flexible and liberalised than railways in many cases.

In the airline industry crew scheduling and rostering have received much attention. Many authors [see e.g. 1, 2, 6, 11, 12, 15, 21] studied airline crew scheduling and rostering. Margerison, McCann & Davies [14] tried to outline the key features of the aircrew team management based on the consultation with Australian Airlines. Their focus was more on designing workshops for the employees that would enable them to learn practical skills that should convert into more effective performance.

Much of the research in the field focuses on set partitioning or formulating mathematical models to solve the above described problems. Until recently, train crew scheduling and rostering have received less attention. Some authors who work in this area are Caprara et al. [3, 4, 5], Ernst [7, 8], Fores [9] and Morgado [16, 17]. Ernst, Jiang et al. [7] proposed an integer programming solution to train crew rostering for a freight train system. Their main objective was to minimise the overall roster cost accrued from using the available crew, while providing the requisite number of crew for each train trip in the schedule given the complex work rules and industrial regulations. What they stressed, and what is also very
important for the topic of this paper, is that produced rosters must also satisfy quality standards for all drivers by attempting to satisfy their personal preferences. In their paper, the authors presented some optimisation formulations and possible approaches, supplemented with some computational results.

Suyabatmaz & Sahin [20] studied a tactical railway crew capacity planning problem with the aim to determine the minimum required crew size in a region while both feasibility and connectivity of schedules are maintained. They proposed a path-based formulation in the form of set-covering problem with a column-and-row generation algorithm. The authors proved with a computational study that arc-based formulation is a viable approach to illustrate the effect of schedule connectivity on train crew capacity decision. Another paper, in which the authors try to mathematically capture the problem of train crew planning, is entitled ‘Scheduling Train Crews: a case study for the Dutch Railways’ by Freling, Lentink and Odijk [10]. Their proposition was the heuristic branch-and-price algorithm, then applied to a real life scenario provided by the Dutch Railways.

An interesting Doctoral Thesis ‘Train planning in a fragmented railway – a British perspective’ was written by Watson [22] who explored various elements of train planning – but again similarly to other authors – he focused on optimisation and paid little attention to organisational elements influencing train crew planning. Kwan [13] presented case studies of successful train crew scheduling optimisation e.g. Virgin West Coast and Southern Railway, both from the UK. As he writes in his paper ‘Crew scheduling, one of the last stages of operation planning before services go live, is mission critical to the train operating companies, which would feel the pain of manual scheduling’.

Under this backdrop of motivation to optimize, train companies are under immense pressure to automate train crew scheduling. It is one of the last stages of resource planning after timetable planning and rolling stock scheduling. As it cannot start until the preceding processes have been completed and the timetables and rolling stock schedules have been frozen, planners are usually pressurized by very tight deadlines for the production of crew schedules before the operation goes live. Automation would speed up schedule production freeing up valuable time for the planners to think strategically and to explore a fuller range of what-ifs [13].

The identified research gap applies to the organisational structure of the train crew, in our case study – drivers, planning process and looking at the problem from the institutional economics point of view. One can argue it is not a purely scientific problem because it stems from the business need and there is little science in how a particular railway company designs its process, however, research can help answer key questions e.g. if the planning structure should be more centralised or decentralised, or what the subordination in case of planners should be. Science should generate value and help business grow, especially in the very pragmatic disciplines such as transport.

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1 The author included organisational aspects, however, not from the day-to-day TOC’s business reality but rather from the national versus privatised railway perspective. He concluded with a list of lessons learnt for other to be privatised railway companies how to better prepare the vulnerable planning area so that it is more efficient and more stable throughout the privatisation process.
4. METHODOLOGY

The methodology of this research was based on a structure presented in a figure below. The idea for this research, as mentioned earlier, comes from business. The analysed operator is not the only one that is facing problems with efficient traincrew planning (the problem is particularly challenging in the light of active looking for ways to increase the competitive position of the railway to increase the rail share in the transportation market). Once the problem was identified, an extensive literature review was carried out in order to check what science tells about efficient planning of railway resources. Having conducted the desk-based research, the company managers were approached for permission to analyse the financial (aspects such as demand for resources, absences, overtime, percentage of expenses, regional differentiation etc.) and planning data (efficiency of duty building, rostering, number and types of errors in the monthly plans of the employees, efficiency of the plans, transparency of the process, fair allocation of better paid duties etc.). Due to confidentiality issues, these cannot be published in this paper. The data analyses were supplemented with site visits (observation how the planning activity is actually carried out in a decentralised form) and the semi-structured interviews with the key managers. The extensive analyses were followed by the mapping of the process „as is” and designing the „to be” structure with elaboration of internal experts in rail operations planning and the conclusions and tips from the source literature and the research process as described above. The last element was the comparison to other rail operators to validate the results.

![Fig. 1. Overview of the research methodology](image)

Source: own elaboration.
5. DRIVER PLANNING STRUCTURE - „AS IS”

5.1. OVERVIEW

The driver planning process can be split into two sub-processes: up to the preparation of the duty list and verification if the available driver resources will be sufficient to provide the services based on a given timetable version, and after that before the service actually goes live. Similar structure applies to many other TOCs in the country and elsewhere. Firstly, based on the schedule and the available resources at each depot, depot managers manually divide work to be covered between themselves. The outcome is the initial list of train parts allocated to each driver depot, which is then also manually verified by the depot managers collectively at the ‘planning conference’. Having divided the trains, the managers start to manually build duties. They have to obey both the Labour Law and the complex internal planning rules. The product of that is the Excel spreadsheet with a list of duties, their elements and validity days for each depot. However, since errors and inefficient allocation of some train parts are frequent, managers exchange some train parts between themselves during that stage, which enables to prepare the finalised version of duties and the statistic of the demand for resources.

Fig. 2. Driver planning process I - „as is”
Source: own elaboration.

Once the list is ready, the planner at each depot manually inputs them into the planning software, they add absences, holiday request etc. as well as the planned actual execution of
the preceding monthly plan. Absences and duties containing elements other than driving such as training, simulator etc. are inputted based on the paper work of the monthly ‘Wish list’ book and the holiday and training plans. The planner manually builds the monthly plan for each employee such that the total number of unassigned duties is minimised given the planning constraints. This stage is supported by the planning software, which does check the rules but neither supports the planner to make the right decision nor optimises the solution. Moreover, it does not check the inputted duties against the timetable. When the new month starts, dispatchers become responsible for the actual execution of the plan to provide smooth everyday operation. Since unassigned duties need to be covered and the dispatcher needs to find substitution when e.g. the employee calls in sick, changes to the plan are imminent. After each duty the driver brings manually filled in working cards that show the actual duty structure. The content of these cards is then checked and inputted into a separate software by hand, which generates the correct duty element codes. Based on that the payroll as well as the clearing with the traction power provider is conducted. Duty element codes also enable correct accounting of train costs that are used to settle the subsidy with the Ministry for Infrastructure and Construction. The data on train mileage etc. is sent to the statistical center.

Fig. 3. Driver planning process II - „as is”
Source: own elaboration.

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2 Monthly plans for the following month must be handed out to employees at least 5 working days before the beginning of the month, which means that their preparation involves some projections of the actual execution of the current plan – since there are some planning rules, which do not allow to plan work for more than 2 Sundays in a row irrespective if the work is allocated to two consecutive months or only one etc.
5.2. PROCESS REENGINEERING – JUSTIFICATION

Thorough analysis of the process has led to identification of the need to reengineer the whole process since at almost every step both errors and inefficiencies occur, which have a strong impact on financial performance of the company\(^3\). During the interviews with the managers the process itself has been often named as ‘non-transparent’, ‘unmanageable’ and ‘uncontrollable’. A list of issues at each planning stage can be found in Table 1. In addition to the above there is a very imbalanced workload for the planners in the driver planning area and the salary is not linked to the amount of work to be done (see Figure 3 for details). This causes additional pressure and high employee turnover.

Fig. 4. Driver planner work load versus the TOC average at each driver depot

Source: own elaboration.

\(^3\) The company conducted a series of tests and analyses but the Board did not agree to reveal the results to the public.
Tab. 1

<table>
<thead>
<tr>
<th>Planning stage</th>
<th>Identified problems (main)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Timetable development (pre-driver planning)</td>
<td>a) Timetable created in a way it is impossible to cover train parts without passenger trips (e.g. taxis) or making it difficult to change trains resulting in a lot of inefficient duties</td>
</tr>
<tr>
<td>2 Vehicle workings (pre-driver planning)</td>
<td>a) Vehicle diagrams not optimised making the demand for drivers unnecessarily high b) Local shunting activities not included in the vehicle diagrams</td>
</tr>
<tr>
<td>3 Initial allocation of train parts</td>
<td>a) Manual allocation based on train graphs – frequent errors requiring swaps and multiple rebuilding of duty lists</td>
</tr>
<tr>
<td>4 Duty building</td>
<td>a) Manual building resulting in errors b) Sometimes train parts are covered more than once (errors) – no check other than manual screening available</td>
</tr>
<tr>
<td>5 Input of holidays, planned absences,</td>
<td>a) Errors in transferring paper „wish list” into the software</td>
</tr>
<tr>
<td>6 Rostering</td>
<td>a) Complexity of the task; time-consuming; errors occur b) Rosters need to be handed out to 7 days before the beginning of the month but should refer to the actual execution of plan for the ongoing month – difficult to implement c) Distribution of rosters – time consuming (paper handed out to employee, who needs to appear in person to confirm by signature he received it)</td>
</tr>
<tr>
<td>7 Dispatch</td>
<td>a) Difficulties in finding a suitable candidate to take over unscheduled duties</td>
</tr>
<tr>
<td>8 Verification</td>
<td>a) Manual input of the whole content of the working cards filled in by employees on duty into a very obsolete software – errors b) Current software does not verify</td>
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</table>

6. DRIVER PLANNING STRUCTURE - „TO BE”

The managerial literature is rich in analyses of the advantages and disadvantages of centralised and decentralised organisational structures. The empirical data revealed that in the case of driver planning there is a strong need for a ‘body’ that will manage the process from the beginning to the end, otherwise the transparency is limited and the process is uncontrollable. It is not only the need to establish a new team, further referred to as CPU – Central Planning Unit but to reengineer the process. The inclusion of automation in the form of integrated IT planning solutions can help reduce cost and save time to plan the work. CPU and centralised database could in addition reduce the discrepancies in the planner workload. Figures 5 and 6 present a proposed design of the „to be” process.

As one of the last stages of research the managers were presented a new structure with a proposed response to each of the problems. The managers described the new structure as ‘more transparent’, ‘more manageable’ and with a higher potential to improve efficiency and hence reduce cost. Some managers also noticed that the new solution will bring benefit not only to the employer but also the employees because the plans will be more ‘fair’ and ‘efficient’.
Fig. 5. Driver planning process I - „to be”  
Source: own elaboration.

Figure 6. Driver planning process II - „to be”  
Source: own elaboration.
7. RESULTS

7.1. MAIN FINDINGS

In case of timetable development, the use of an integrated planning software through the CPU specialists will significantly reduce the time required to validate if all train parts will be covered and will provide improvements to the draft timetable. Observe that with a decentralised structure it was impossible because first the train parts had to be manually assigned to individual depots and then the planners had to (also manually) build duties, and based on that, calculate the demand. The same applies to vehicle diagramming, which in the new structure will take less time and resource, and the shunting duties can be included in the diagrams. The CPU using the IT tool can make sure that all train parts are covered and the use of optimisation techniques can help deliver initial results quickly. Constraints on the number of duties to be assigned to each depot can automatically solve the problem of too much or too little work. Employees through an employee portal or a dedicated app can make holiday and other requests that are immediately visible in the software without the need to transfer it from the manual ‘wish list’. The CPU can also impose central limits based on the demand for driver at specific peak periods. Central database and automatic rostering can contribute to more even workload distribution – a planner from a given depot or CPU can prepare rosters not only for the drivers from his home depot but also for other locations. In theory, further centralisation could limit the number of planners as some of the planning activities could be handled directly by the CPU. Instead of handing out roster printouts, these can be sent to tablets or other mobile devices in real time. The same applies to the working cards, which can be filled in on tablets and sent directly to the verifiers. Filters on qualifications, duties, other requirements can help dispatchers carry out their responsibilities.

The new more centralised structure can improve the efficiency, increase transparency and make the whole process more manageable. The implementation of an integrated software with a central database can support the experts and limit the number of errors. Moreover, the use of optimisers can quickly deliver initial solutions, which enable testing the ‘what if’ scenarios and help develop the timetable, define the long term hiring strategy or provide cost estimates and more precise control of costs.

7.2. LIMITATIONS

Main limitations of the research are as follows:

- The research was based on only one company (single case study) – other companies face similar issues and the case study was chosen as a representative example, however, there are always some peculiarities and company specificity that may skew the results; therefore, the study should be conducted also in other enterprises to validate results and conclusions;
- The was only one country analysed, which might be very specific and limit the general application of conclusions to other regions;
It has proved difficult to find a scientific ‘one size fits all’ solution and the implications of this research should be always carefully analysed in relation to the specific example, in which they are to be implemented;

Most of the data cannot be revealed to the public because of the business confidentiality issues.

7.3. POLICY IMPLICATIONS

It is worth mentioning that other large train operators in Poland have a very similar structure to the one described in this paper, which results in similar inefficiency issues. The analysis revealed that only newly established, small TOCs have a more centralised planning structure, which contributes to a more evenly spread work across the planning division. Transport policy makers, in particular in Poland, should consider creating guidelines with best practices in the planning area and help the operators establish structures and implement solutions that will foster efficiency and hence improve the railway competitive position.

8. CONCLUSIONS

Rail operators have been experiencing significant demand growth in recent years thanks to improvements in rolling stock, changes to the schedule structure and much more customer focus, a good example of which is the main long-distance Polish TOC analysed in this paper. The above mentioned factors resulted in a massive increase in rail operational work which has been only partially compensated by an increase in the number of employees. Therefore, the operators has actively started looking into ways of reducing inefficiencies in train crew planning to mitigate the operational pressure.

This study analysed the advantages and disadvantages of the existing, decentralized driver planning structure, it proposed an alternative with much more centralization and introduction of optimization techniques both at the duty and the roster planning level. The structural change was supported by an implementation of the new planning and dispatching software. It is revealed that implementation of the suggested solution has led to increased efficiency of duties and monthly schedules for employees, improved transparency of the train crew planning process and brought forward cost reductions.

The project of driver planning structure optimization at the main Polish long-distance train operator has started in October 2015 and finished in January 2017. Some aggregated numerical data were presented in this paper to support the argument thanks to the permission obtained from the TOC. The study contributes to the design of the train crew planning structures, in particular for drivers, in the long run.
Bibliography


**RESZTUKTURYZACJA PLANOWANIA PRACY DRUŻYN TRAKCYJNYCH U WIODĄCEGO PRZEWOŹNIKA DALEKOBIĘŻNEGO W POLSCE**

**Streszczenie:** Praca opiera się na analizie propozycji wdrożenia nowego modelu planowania pracy drużyn trakcyjnych na przykładzie dalekobieżnego przewoźnika kolejowego w Polsce. Przedstawione rozwiązanie koncentruje się na poprawie efektywności i transparentności planowania. Artykuł stanowi istotny wkład dla projektowania i restrukturyzacji struktur planistycznych na poziomie strategicznym zarządzania przedsiębiorstwami kolejowymi.

**Słowa kluczowe:** planowanie pracy maszynisty, przewoźnik kolejowy, optymalizacja pracy drużyny trakcyjnej