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28
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  By Murat Tarakci
- Business groups in emerging markets: the Chilean experience
  By Francisco Urzúa Infante
- Exemplifying how to bridge theory and practice
  Rebecca Morris on the career of Leo Kroon
- Disruption management in passenger railway networks
  By Joris Camiel Wagenaar

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Disruption management in passenger railway networks

By ***Joris Camiel Wagenaar***

The drive to encourage people to take the greener option of public transport means that rail networks are under increasing pressure to guarantee quality of service. What the frustrated passenger waiting for a delayed train does not realise is the myriad of potential hitches that can occur and the domino effect on an entire network. More than ever, a computerised system is required to assist rail operators in anticipating problems and managing the unforeseen, in the interests of all.

Delays will always represent the biggest headache for rail passengers and network managers alike. By opting and paying for train transport, the general public has a legitimate expectation of a certain level of service in order to get from A to B. Similarly, network operators need to do their utmost to get passengers from A to B with the minimum inconvenience in order to maintain customer satisfaction. This is a highly complex set-up that requires a quick response to dense traffic flow, rolling stock maintenance and the knock-on effect of any problems on timetabling.

However, the current reality is that many railway operators are rescheduling manually, managing problems over a short space of time that only serves to postpone technical hitches for the coming minutes. As a result, the displayed timetables are no longer tenable over a sustained period. An overall solution is needed rather than dealing with (or alternatively delaying in only the short term) the various disruptions that may occur.

Planning for problems

The issue faced by railway operators does not reside in the nature of the problems as much as in finding the right solutions. It is fully expected that rolling stock will require regular maintenance, which involves a certain proportion of trains being out of service for a particular amount of time. Repairs to damaged or faulty rolling stock simply adds to the workload.

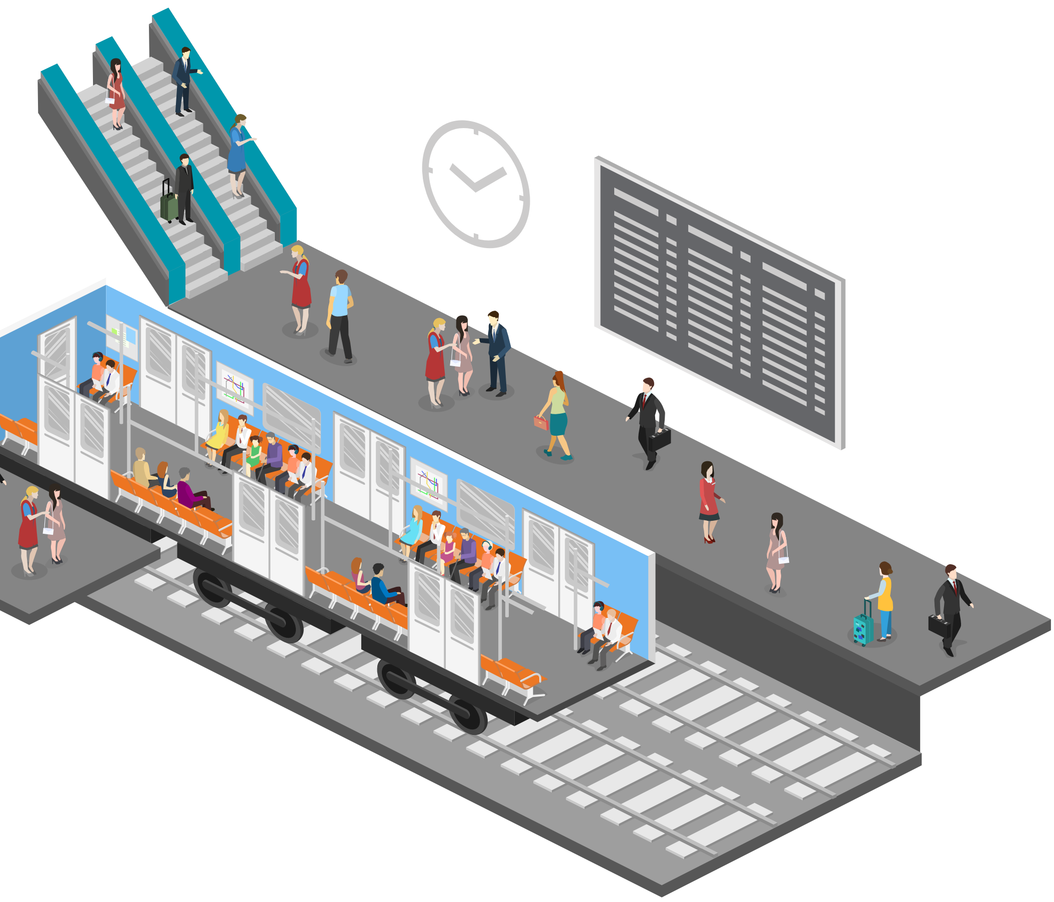
Even when the correct amount of rolling stock per station has been correctly identified, there is also the logistical issue of shifting trains from one place to another to ensure that there is not a surplus at one point and a shortage at another. In addition, rolling stock comes in all shapes and sizes, from self-propelled to locomotive-driven, single or double deck, and coupled or uncoupled. Crucial to anticipating and, ideally, avoiding problems is to have the appropriate contingency plan in place.

Until now, research into rescheduling and the actual real-time practice of railway disruption management has tended to approach this conundrum in a three-step manner. In the event of disruptions a new timetable is firstly developed, after which the rolling stock circulation is adjusted, and then crew rescheduling is applied.

In other words, each piece in the puzzle is dealt with individually, meaning that the quality of resource scheduling is by no means guaranteed due to the possibility of a domino effect if ever one of the pieces is not maintained. In an ideal scenario, a computerised system based on the application of algorithms is required to ensure a more efficient and effective management of disruptions, whereby all three steps are tackled collectively.

Current theory extended

A recent theoretical study into the matter based upon the Netherlands and



Danish railway networks offers hope that a collective approach can be applied. This study extends theoretical models for disruption management in passenger railways to include important practical details such as scheduled maintenance appointments for rolling stock, the phenomenon of "deadheading" (the movement of passenger-less stock from one point to another), and a more realistic management of passenger flow and demand.

The Dutch context is especially useful and applicable since the introduction in 2012 of a smart card system, making it considerably easier for rail operators to chart passenger flow and therefore the times of day where the strain on the network is potentially at its greatest.

Regarding the issue of including scheduled maintenance appointments while rescheduling, the study examines three different models. The first involves adding a rolling stock type for every unit requiring repairs. The second implies scheduling a shadow account specifically for the rolling stock requiring maintenance. The third requires the application of specific tasks to each train unit. The empirical tests applied showed the second and third option to be the most effective for rescheduling.

The next step in the study is focused upon the reality of deadheading trips and gauging passenger flow, including in the event of disruptions. In the latter case, it is important to track passenger behaviour when disruptions occur and the most effective way in which to combat such problems. It is incredibly dif-

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Disruption management in passenger railway networks *(continued)*

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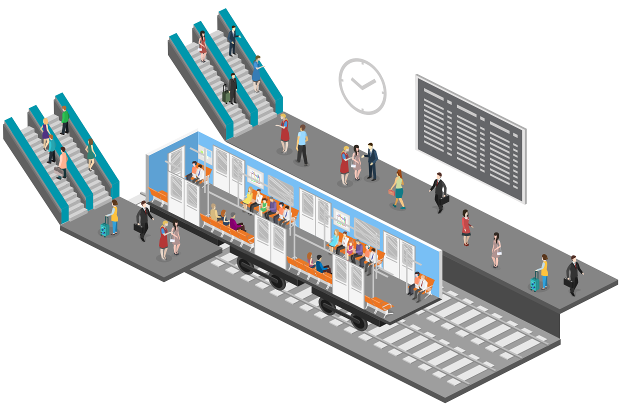
ficult to anticipate boarding strategies but what the study succeeds in doing is to establish appointing larger trains to the stations hit by a disruption just after the disruption is over. This ensures maximum seat availability for the passengers waiting a long time.

Just as importantly, effective deadheading trips are proven to be crucial to guaranteeing the appropriate amount of rolling stock at each point within a rail network. Deadheading trips also implies train storage, and so the study in question also explores the issue of shunting. Matching train units to arriving and departing train services at a station, as well as assigning the selected matching to a specific depot track, is of fundamental importance to deadheading and the entire network management operation.



Making things tick

Whilst the algorithm-based study does not yet offer up the ideal solution for railway disruption management, it nevertheless offers a very persuasive case for a collective approach of including important practical aspects, such as the scheduled maintenance appointments, deadheading trips, and passenger demand quandary in the theoretical approaches for rescheduling. This creates far more realistic conditions for feasible disruption management of all operations, applicable to real-life instances. The models developed can support dispatchers either for the disruption management process as a whole, for the rolling stock rescheduling problem, or for the train unit shunting problem.

As a consequence, using these models in practice will reduce the time it takes before the new resource schedules are operational and communicated to all people involved. This results in less inconvenience for the passengers and less time stress for the railway operators – in short, the ultimate win-win situation for users and managers of the system.

The debate does not end here. Such an approach needs to be integrated into existing systems present at railway operators. In addition, timetables should be feasible both on a microscopic and on a macroscopic level. Otherwise the resulting timetable cannot be used in practice. Therefore, either an integrated model or an iterative framework should be developed for creating a completely feasible timetable. Further, more important practical aspects must be found and included in the theoretical models.

Finally, further exploration is required of the typical duration of the various kinds of disruption that can occur. This kind of historical data is available to network operators, so a lack of information is by no means a problem in this case. One thing is certain, though. As the greener option of public transportation is quite rightly promoted and adopted, the challenge for network operators remains a stiff one. ■

This article draws its inspiration from the PhD thesis *Practice Oriented Algorithmic Disruption Management in Passenger Railways*, written by Joris Camiel Wagenaar. It may be freely downloaded at WEB http://repub.eur.nl/pub/93177

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