

## Train Scheduling and Rescheduling In Pakistan

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### Abstract

This paper provides an overview of Pakistan Railways scheduling and rescheduling. First of all, Pakistan Railways is introduced with its brief history and importance in this country. Assets of this network with passengers and freight using this are given. Current hope less situation is leading to privatization of this system as well as promoting short distance traveler to use road and Government efforts to retain is also presented. Train scheduling in Pakistan is being done manually, based on manual time distance graph preparation and resolution of conflicts based on manager's experience and ability. In Real-time management of this traffic Lahore head office is connected with six control stations in the Pakistan, decision for resolution of any disturbance is coordinated among them. It is recommended that computer aided tools must be developed for this system to help traffic managers and it is needed to invest on the segments to increase their speed limits which might attract passengers to use this mode of transportation with high priority.

**Keywords :** *Train scheduling, Manual train scheduling, Pakistan railways*

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### 1. Introduction

The Islamic Republic of Pakistan is a large country (land area of 796,000 km<sup>2</sup>) located north-east of the Arabian Sea and extending towards the Himalayas on the border of China. Pakistan has four provinces (Punjab, Sindh, Baluchistan, and North-West Frontier Province), two territories (Islamabad Capital Territory and Federally Administrated Tribal Area), and the Pakistan parts of Kashmir. The distance between Islamabad (the capital of Pakistan) and Karachi (the provincial capital of Sindh having two important international ports) is about 1,200 km in a straight line. The transport system in Pakistan plays an important role in unification of these regions in terms of political and economic activities.

An important mode of transportation in Pakistan is Pakistan railways. The first railway of Pakistan, between Karachi City and Kotri, was opened in 1861. At the time of independence, most of the existing network had been constructed.

#### 1.1 Assets of pakistan railways

Pakistan Railways had a total of 11,755.00 track-kilome-

ters (including double line track, yards and sidings) at the end of 2011. This consisted of 11,343.00 kilometers of broad-gauge and 412.00 kilometers of meter-gauge. On 30th June, 2011, Pakistan Railways had 12 steam locomotives, 500 Diesel Electric locomotives and 16 Electric locomotives on entire system (Pakistan Railways, Year book, 2010-2011).

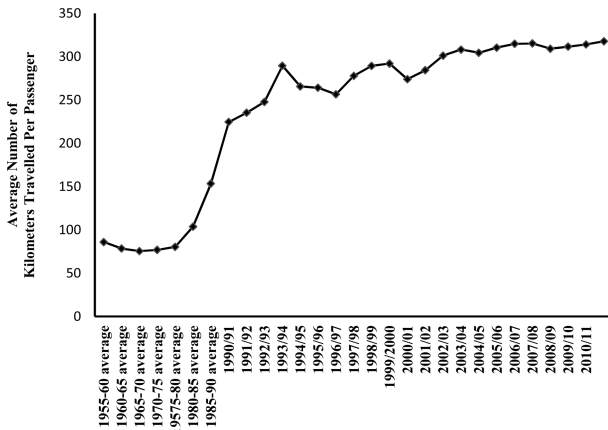
In Pakistan, the railway network was heavily used with heterogeneous train traffic. A large scale movement of goods and peoples takes place daily by this mode. During 2010-2011, 64,903 thousand passengers and 2,616,157 freight tones were carried by Pakistan Railways. Out of 64,903,467 passengers carried during 2010-2011; 39,891 (0.06%) travelled in Air-conditioned sleeper, 219,477 (0.34%) in Air-conditioned sitter, 33,011 (0.05%) in First class sleeper, 834,517 (1.28%) in Air-conditioned (Standard) class, 48,539,997 (74.8%) in Economy class 14,803,282 (22.8%) in the Second Class and 433,292 (0.67%) in Air- Conditioned Business Class (Pakistan Railways, Year book, 2010-2011).

#### 1.2 Current situation of pakistan railways

Despite of its moderate size, bankruptcy and poor management lead it to cancel as many as 115 passenger trains. Due to shortage of fuel and locomotives it was decided to stop freight as well (The Nation, September 29, 2011).

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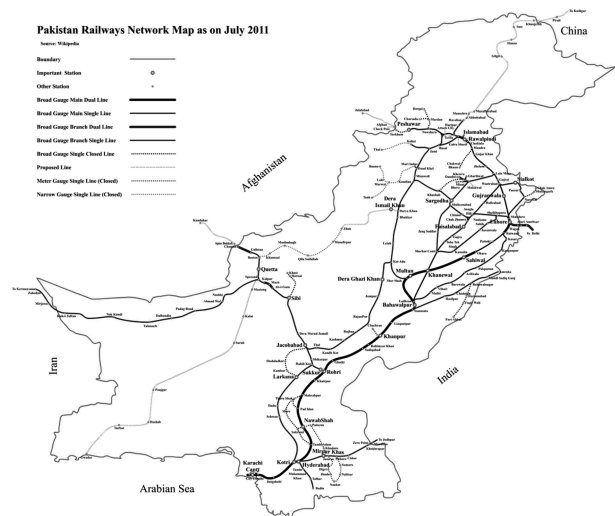
**Fig. 1** Distance travelled per passenger vs. years  
[Data Source Pakistan Railways, Year book (2010-2011)]

Railway employees are protesting against Pakistan Railways for failure to upgrade engines as well as to pay their salaries on time (Dawn, October 18, 20 and August 04, 2011). Keeping the existing hopeless state of the railways in view, a train “Business Express” which is a joint venture of Pakistan Railway and a private company, the first non-stop train between Karachi and Lahore, started operations from February 3, 2012, reached Karachi Cantt station 15 minute beyond schedule. More 5 trains would be run in collaboration with private sector. People said the ticket of this train was beyond their approach as it was fixed at Rs 5000 and the poor class of society even could not think of traveling by this train (The Express Tribune, January 7, 2012). Due to the Pakistan Railways’ collapse, nobody will be affected other than the lower middle class, as the affluent can easily avail themselves of PIA flights and Daewoo buses as their normal means of transportation. Fig. 1, indicates that short distance travel has shifted from railway to road transport, and the role of railway is specialized in middle/long distance travel. In current years, the degree of change tends to be slow.

Planning Commission took initiative to ask the World Bank to formulate the strategy to revitalize the organization (Dawn, October 13, 2011). On the advice of President Zardari the government has recently provided Rs1 billion funds to the Pakistan Railways for the salary of staff. In a recent meeting in the presidency the president advised the government to arrange a loan of Rs 6 billion for locomotive repairs and purchase of new locomotives (Dawn, October 23, 2011).

## 2. Pakistan Railways Schedule

Time tables are prepared in the operating branch of the



**Fig. 2** Pakistan Railways Network

Headquarter office and revises twice a year i.e. from the 15<sup>th</sup> of April and 15<sup>th</sup> of October. In conjunction with these time tables following publications are issued:

### 1) For the Public

- Time and Fare table: Besides the passenger train timings, it contains a variety of general information relating to passengers, luggage, and parcel office.
- Sheet timetables in English and Urdu are issued for exhibition at stations.

### 2) For the Staff

- A certain number of staff copies of the time table and fare table.
- Divisional working time tables for each division separately; these include timings for goods train also.
- Special time tables for troop trains which include both fast and slow timings.

## 2.1 Types of trains and network

The Pakistan Railways network is comprised of 7,791 route-kilometers; 7,346 km of broad gauge and 445 km of meter gauge. There are 625 stations in the network, 1,043 km of double-track sections (in total) and 285 km of electrified sections (Pakistan Transport Plan Study in the Islamic Republic of Pakistan, 2006 and Pakistan Railways, Year book, 2010-2011). Fig. 2 shows the extent of Pakistan Railways network.

Table 1 shows the summary of trains using Pakistan Railways network. Some important points for identification of type of train by their numbering are as follows:

- Even number shows downward/outbound movement from Peshawar to Karachi.
- Odd numbers shows upward/Inbound movement i.e.,

**Table 1** Summary of Trains Traversing Pakistan Railways Network (Rizvi, H., I., 2010)

S. No	Service	No. of Trains
1	Mail and Express	26
2	Intercity	39
3	Passenger	33
4	Mixed	24
5	International	3
6	Metre Gauge (Passenger)	3
7	Karachi Shuttles	3
8	Cargo	2
	Total	132

from Karachi to Peshawar.

- Mail and Express trains are named as 1Up/2Dn to 51Up/52Dn with total 26 trains.
- Intercity are named as 101Up/102Dn to 171Up/172Dn with total 39 trains.
- Passenger trains are named as 201Up/202Dn to 267Up/268Dn with total 33 trains.
- Mixed trains are named as 301Up/302Dn to 355Up/356Dn with total 24 trains.
- International trains are named as 401Up/402Dn to 405Up/406Dn with total 3 trains (International trip consist of Lahore to Amritsar, Quetta to Zahidan and Karachi to Mirpur Khas Zero Point).
- Two Metre Gauge trains M-G-1Up/M-G-2Dn (Mirpur Khas to Nawab shah), M-G-3 (Mirpur Khas -Pithoro-Mirpur Khas).
- To travel within Karachi except Sunday and gazette holidays three trains KM-1Up/MK-2Dn (Karachi city to Malir cant), KM-3Up/MK-4Dn (Karachi city to Malir cant) and KL-1Up/LK-2Dn (Karachi city to Landhi).
- Two cargo trains 501Up/502Dn (Karachi to Lahore) and 503Up/504Dn (Karachi to Faisalabad).

## 2.2 Design parameters of pakistan railways schedule

### *Running times and margins*

Running times based on speed restrictions on different segments is calculated with speed varying from 25 KMPH to 120 KMPH. Time compensation for loss in temporary engineering restriction is also estimated (Rizvi, H., I., 2010).

In this calculation fraction of a minute is rounded to nearest whole minute i.e., 29 seconds and below as well as 30 seconds and more are taken as one minute.

### *Acceleration and deceleration times*

Accelerations and decelerations used in the calculations of minimum running time are as follows:

- In case of stopping trains running at the speed of 75 KMPH and below, one minute for accelerations and decelerations is added.
- In case of speed of 80 KMPH 2 minute for accelerations and 1 minute for decelerations is added.
- In case of speed of 95 KMPH 3 minute for accelerations and 2 minute for decelerations is added.
- In case of speed of 105 KMPH 4 minute for accelerations and 2 minute for decelerations is added.

### *Buffer times*

In calculation of minimum running times for each track segments 5% slack time is used for double track and 10% slack time for single track.

### *Speed limits*

Different segments have different speed limits based on conditions of that segment. Engineering speed restrictions for each track segments are provided in Pakistan Railways Time Table for passengers trains (Staff Copy) (Rizvi, H., I., 2010).

## 3. Real-time Operations Practices of Pakistan Railways

During operations it is essential that every staff member to make efforts to run trains to scheduled timings. In event of a train running late, the cooperation of all staff makes it necessary to minimize delays and to make up time. Shunting of late mail and passenger trains are avoided as far as possible. However, saloons occupied by High Government officials and other coaching vehicles, where specially ordered, are attached or detached. The station Master of an engine changing station keep in close touch with the Loco Foreman when a mail, passenger, mixed or through goods train is running late. This enables the Loco Foreman to postpone calling the engine crew duty and also enable him to delay the lighting of an engine.

On controlled sections controller keeps junctions and other important stations informed of the late running of trains. On non controlled sections, Divisional Superintendent nominates certain stations to inform junctions on their divisions regularly of the time a mail or a passenger train passes their stations.

Subject to any special instructions issued from time to time in reference to particular trains, the detention allowed for connection between main line trains is half an hour. A main line train may be detained to connect with a branch line provided the delay caused by such connection will not make the main line train more than 15 minutes late. A

branch line train will wait one hour for a connecting main line or other branch line train, unless otherwise ordered by the Divisional Superintendent. Station Masters of junction stations may, under special circumstances, when the delay would not be considerable and when the time so lost can probably be made up on the onward journey, detain connecting trains longer than the limits laid down. These exceptions are left to the discretion of Station Masters, but should only be allowed when it is known that there are through reserved carriages to be transferred from the train running late, and a misconnection would entail very long delays and inconvenience to through booked passenger at the junction in question and possibly at junction beyond. Each such detention and reason for the same must be reported in daily station report for the information of the Divisional Superintendent concerned. In the above two cases no time can be allowed for passengers to take refreshments.

### 3.1 Crossing of trains

Crossings of trains subject to special instructions which divisional Superintendent may issue from time to time, crossings should be arranged so that trains likely to suffer the least detentions are detained.

The general principles to be observed are as follows, but it must distinctly understood that nothing in these instructions modifies the safety precautions laid down in General and Subsidiary Rules for the crossing of trains:-

- A train near the end of its run should not normally be detained in preference to a train which has a longer run before it, as the latter train is more likely to make up time and reach its destination punctually than the former.
- As a general rule, a train running to time should not be detained more than 30 minutes to affect a crossing.
- A train running late due to a defective engine or any other cause, which is likely to continue to operate against it and prevent it from making up time, should generally give way to a train running under some favorable conditions.
- Mail or fast passenger trains may be detained to cross mixed, special or slow troop trains running in the opposite direction as follows:-
  - If running to time up to a maximum of 10 minutes.
  - If running over 10 minutes late not to be detained.
- Mail and fast passenger trains should not ordinarily be detained for goods trains. Discretion must, however, be used in this matter, since small detentions to mail and passenger trains may frequently obviate heavy detentions to goods trains. In such circumstances and where mail or passenger trains are running to time, and

have plenty of time to make up the delay before arrival at an important station or junction, goods trains should be allowed to proceed. Mails and passenger trains should not be detained for more than 10 minutes.

- Mixed, slow troop and special trains for the public, if running to time, must not be detained more than 10 minutes for a goods train. They must not be detained at all if running more than 10 minutes late unless they can conveniently make up time to run.
- Ballast and material trains not running to a time table must give way to all trains.

### 3.2 Precedence of trains

Unless special orders to the contrary are issued by the Divisional Superintendent or by those acting on his behalf, the following general order of precedence must be observed:-

1. Accident relief trains proceeding to the site of accident.
2. Special trains for the President of Pakistan and head of foreign countries.
3. Mail and express trains and important Railcars.
4. Troops trains.
5. Passenger and mixed trains.
6. Ballast trains.
7. Parcel Express trains anchoring specials.
8. Express through goods and Material trains.
9. Accident relief trains returning from the site of accident.
10. Van goods and shunting trains.

### 3.3 Dispatching

Railway traffic management system in Pakistan is based on manual time-distance graphs preparation by traffic managers/dispatcher and removal of conflicts in control room. Fig. 3, shows basic dispatching system, used by



**Fig. 3** A Dispatcher Working at the Traffic Control Center in Pakistan

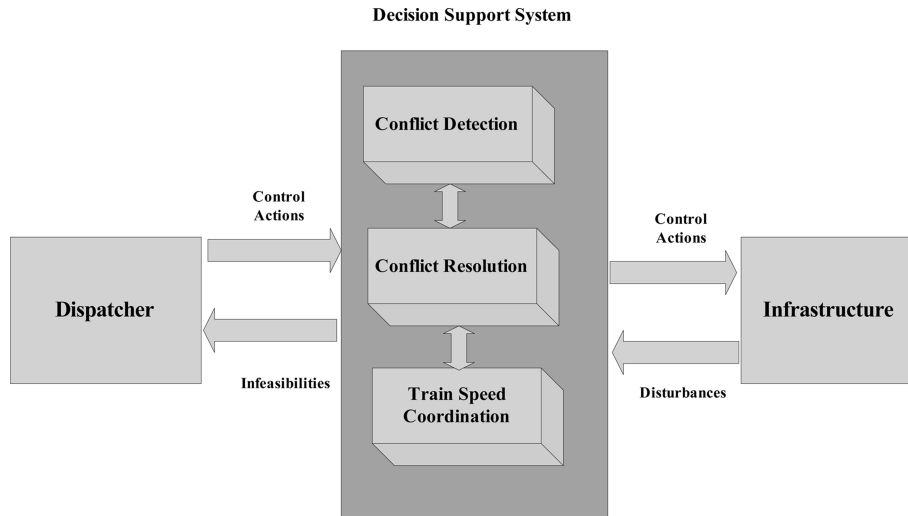


Fig. 4 Components of Train Dispatching Support System

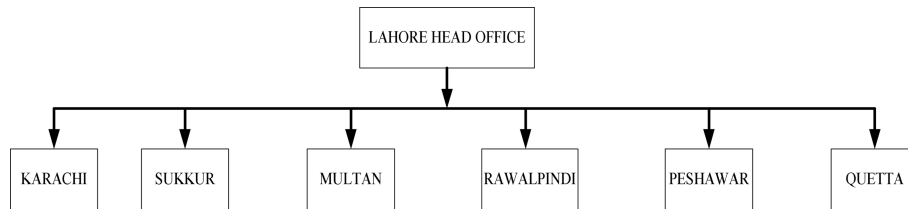


Fig. 5 Railway Control Stations for Real Time Traffic Management

traffic controllers in Pakistan.

This system without decision support aiding tools bounds the traffic managers/dispatchers to determine the instantly locally favorable actions by applying if-else conditions. Usually, traffic managers/dispatchers prefer to slightly change the original timetable based on their experience and knowledge instead of extensive rescheduling.

**3.4 Control stations and coordination**

Only decision support the dispatchers have is a manually prepared time distance graph of currently running trains and the corresponding train numbers and a panoramic route layout on the wall of the traffic control center, eventually printed or oral information on perturbed trains from neighboring control areas. Coordinator has to supervise the train movements on whole network scale by estimating the impacts of delayed trains and blocked tracks in regional dispatching areas. Traffic controller has to take decisions about train’s preferences, rerouting and holding after taking into consideration all factors e.g. headway times, estimated delays, severity of present and future conflicts etc. Traffic controllers evaluate mentally about pro’s and con’s of different control activities available within short time and costs and benefits of their interventions are

unknown. They can’t watch over the propagating delays in larger interconnected networks in case of large perturbations creating multiple consecutive delays and even in these cases it is difficult for them to recognize precisely the impacts of different dispatching strategies on the performance of network.

A general plan of a real-time train dispatching supporting system is presented in Fig. 3. Shoji and Igarashi (1997), Kawakami (1997), Konig and Schnieder (2001), Luthi et al. (2007) and Montigel et al. (2007) and D’Ariano (2008) describe same architecture. Network level coordination for each dispatching measure is necessary to practically implement this system.

To control rail traffic over a complex network control section is composed of so many regional control centers. Pakistan railway network is subdivided in one main center in Lahore, six regional centers (Karachi, Sukkur, Multan, Rawalpindi, Peshawar and Quetta). Regional traffic controllers have a centralized complex control system in which local interlocking is controlled by dispatchers and movement of trains controlled by signal indication.

At least one dispatcher is working in each dispatching area of a traffic control center, which after appropriate intervals of time gets information about the status of net-

work to which he is connected. Dispatcher after analyzing data search whether there is potential for occurrence of conflicts and if he finds some conflicts he resolve it according to his knowledge and experience.

#### 4. Conclusions and Recommendations

Train scheduling in Pakistan is being done manually, which is time consuming and based on thumb rules. It is required to model train scheduling and rescheduling operations using these parameters of Pakistan Railways, to develop tools based on latest computer based techniques to be applied here and find profit in the form of time savings and improved schedules. Some of track segments has speed restrictions as low as 25 KMPH which elaborates the necessity of planning to invest on these segments which might improve train running times over those segments and result in attraction of passengers and freight to this mode of traveling.

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