IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Optimization In Railway Transportation For An Arrangement

In Multi-Platform Stations.

AUTHOR: JOSHI DUNGDUNG
DR.SHYAMA PRASAD MUKHERJEE UNIVERSITY
RANCHI JHARKHAND

GUIDED BY : Dr.ANITA KUMARI
ASSOCIATE PROFESSOR AT DR.SHYAMA PRASAD MUKHERJEE UNIVERSITY
RANCHI JHARKHAND

Abstract

In railway transport all trains operate according to pre-established timetable of trains. But also there are some worst punctuality performance. In this paper related mathematical model and methods from operational research, are applied to enhance railway service. An integer programming model is taken in consideration to solve the problems. Delays affect the performance of railway transportation and quality of service provided to passengers and terms related to cost and benefits. The proposed method is applied in case studies of some running trains on Indian railway tracks between multi platform stations. Some improvement are suggested to obtain better results and to make railways more attractive to travellers by giving quality services with minimum cost and punctuality. An arrangement of trains on a multi platform stations is formulated to support the effective and efficient running of railways on tracks.

Introduction

Railway transportation is one of the most dependable modes of transport in India. Indian railways has the fourth largest rail networks in the world. Indian railways has a multi-gauge, multi-traction system covering 67,368 KM of route length. Railways runs about 13,300 passenger trains and 9200 freight trains daily, covering around 7,200 stations. Trains are fast and least affected by weather problems. It has fixed routes and scheduled. Studies in this field can help to make railway transport more efficient and sustainable. It can help railways to provide a number of good services with reducing cost to the customer. To improve the quality of railway transportation it is necessary to build optimal train schedules. In most countries like India, government is paying large subsidies for railways. In previous year Indians railways had poor performance. The main cause of poor performance is due to lack of coordination between trains and station arrangement. There is lack of ensuring timely arrival and departure of trains from stations. This should be one of the most important parameters of the quality of services being provided to the passengers.

CAG selected 15 stations in 10 zonal railways falling on the routes with heavy passenger traffic for audit. It analysed one month data to study how scheduling and infrastructure leads to detention of trains at adjoining stations in routes and on platforms. It was found that only 100 platform out of 164 have the capacity to handle trains with 24 or more coaches. The committee on Restructuring Railways had noted that with high levels of capacity utilisation, and the introduction of new trains, trains tend to slow down.

Solving of railway transport circulation by mathematical methods is a necessary step to it optimization. Generally the optimization aims at minimizing the cost and maintaining the time table also the process of getting delayed trains back to schedule is called delay recovery.

The objective is to create a master plan for stations with heavy passenger traffic to identify constraints of station line capacity and devise measures to be taken to address these constraints on priority. Main focus of this paper is to improve railway services and minimize cost of operation without any change in infrastructure.

So our aim is to design a mathematical model for optimisation of railway transportation with consideration of the constraints of trains characteristics, track gradients, curves, loops and speed time.

Literature Review

For delay determination , the importance of punctuality is discussed in [15]. The aim of this paper is to provide a critical literature review on delay in railway transport.

The survey work has been done on this paper.Survey includes train related time tabling, train departure, train arrival, route problem track allocation from s strategic, tactics and operational level [17].

For high speed railway network [7] it gives a brief plan to provide a better service. This is a multi objective optimization model based on train scheduling.

The author in [2] studies about the importance of regularity, which is represented by passenger train time tables, this is based on optimization of railway vehicle circulation in passenger train transport system.

An advanced traffic management system[TMS] [13] is proposed in this paper. This gives a management in traffic fluency in large railway network with block signalling system. It definitely reduces the delays in train system.

This paper [9] is also a study on blocking problem and train scheduling design problem which includes train origin destination and route. In a train network system solving blocking problem for better service quality in train transportation system.

In a single track line a work has been done to provide optimal speed profile to reduce delays and save energy consumption but the methods used in [1] is a multi track optimization method a study on a time space network representation technique was used to represent car moves on possible sign of car-to-block and block-to-train assignment on a general merchandise rail service network has been done.

In each major US railway ships million of cars over its network so a study to identify the classification plan for all shipments at all Yards has done [8]. hence the main purpose is to minimize the total shipment cost in railway network.

A bi-level programming model for the multi classification yard location[MCYL] problem is proposed [11] in which a simulated annealing [SA] algorithm is then applied to solve the MCYL problem of a large scale railway networks.

The author describes the starting point as a format structure for service intention thus the augmented periodic time table problem is solved [10].

Also models based on time tabling are classified by time horizon and infrastructures constraints [5].

Two heuristic approaches has been done [4] to solve the [RAS] problems based on a MILP formulation and to get results and to compare to other approaches to the [RAS] problem.

An investigation for a broad range of algorithmic problem in both freight and passenger railway transportation problem is given [3].

Mathematical Model Formulation

The approach of this mathematical model is to provide an arrangement for trains in certain multi platform stations and to recover from their delay timing if there is any or to maintain their schedule if there is no delay timing travel informations regarding their running time stopping time etc are from their last stoppage in multi platform station and their current stoppage in multi platform stations. Now according to these data we set some general notification first for formulation then we defines parameter and variables. After that we define objective functions and different constraints for the model.

Subscript and Superscript

S - Scheduled Time L - Latest Time s - Stopping Time r - Running Time t - Total Time Duration c - Current Multi-platform Station l_a - Last Multi-Platform Station
a - Arrival Time d - Departure Time

Parameters and Variables

P_{1i} - Running priority (i.e. Priority variable for Running time)

P_{2i} - Sopping priority (i.e. Priority variable for Stopping time)

U_{1i} - Delay Deviation of Running Time

U_{2i} - Delay Deviation of Stopping Time U_{3i} - Delay Deviation of Total Time λ_{1i} - Expected Running Time λ_{2i} - Expected Stopping Time

$(S_{ac})_i$ - Scheduled Arrival At Current Station

$(S_{ala})_i$ - Scheduled Arrival at Last Station

$(S_{dla})_i$ - Scheduled Departure at Last Station

Objective Function

The objective function of this problem is to find the priority value for different constraints to minimize delay time of a train. All the delay times are positive deviations. Thus the multi objective functions modelled by using the goal programming method.

$$minZ_i = (priority_1)_i(U_{1i}) + (priority_2)_i(U_{2i}) \quad (1)$$

In equation (1) the first term form right side is the priority value with weight of running time deviation and second term form right side is the priority value with weight of stopping time deviation.

Constraints

For the model we take different constraints related to a trains during its travelling. We consider the train running and stopping constraints with total time duration constraints.

Equation(1) is the running time priority constraints in which expected time of running with some underachievement in scheduled time is equated with scheduled running time between two multi platform stations. that is,

$$\lambda 1i + U1i = (Sac)i - (Sdla)i \quad (2)$$

Equation (2) is the stopping time priority constraints in which the expected time of stopping with underachievement in scheduled stopping time is equate with the scheduled stopping time on last multi platform station. that is,

$$\lambda 2i + U2i = (Sdla)i - (Sala)i \quad (3)$$

Equation (3) is the total time priority in which the expected number of total time duration of a train with underachievement is equate with the scheduled total time of a train from arrival at last multi platform station to the arrival at current multi platform station.

$$\lambda 1i + \lambda 2i + U3i = (Sac)i - (Sala)i \quad (4)$$

$$\lambda 1i, \lambda 2i, U1i, U2i, U3i \geq 0$$

Solving

After formulation of different constraints with multi objective functions we are applying the simplex method to solve goal programming problem in the modified form.

Here we write the pre-emptive priority goals that is P_1, P_2 in order.

There is no profit maximization or cost minimization in the objective functions. Here we minimize the unattained need portion of the goal as much as possible by minimizing the derivative variable ($\lambda_{1i}, \lambda_{2i}$) through the use of certain pre-emptive priority factor and different weights attached with the deviation in the objective function. During solving by simplex method for the test of optimality we compute the value of Z_j and ($C_j - Z_j$) values separately for each of the different goals P_1, P_2. It is because the different goals are measured in the different units.

Now after solving there can be cases like;

Case:1

$$priority_1 = 0 \; priority_2 = 0$$

this shows that there is no priority with weight attached. So there is no delay in time.

Case:2

$$priority_1 > 0 \; priority_2 = 0$$

then this implies that there is some delay or priority with weight attached, which is greater than zero in running time.

Case:3

$$priority_1 = 0 \; priority_2 > 0$$

then this implies that there is some delay or priority with weight attached,which is greater than zero in stopping time.

Case:4

$priority_1 > 0$ $priority_2 > 0$ then this implies that there are some delay or priority with weight attached, which are greater than zero in both running and stopping time.

Arrangement

Now on the basis of these priorities achieved, we assign the platform numbers to the certain train. We fix the first platform [platform no.-1] of the current station for the train that have no delays in both running and stopping time.

The second platform [platform no.-2] of the current station to assign the train that have the running priority with some weight attached.

Next the third platform [platform no.-3] of the current station to assign the train that have the stopping priority with some weight attached.

The fourth platform [platform no.-4] of the current station to assign the train that have the both priority with some weight attached.

In this way of arrangement we can reduce the complexity in the multi platform station, so that there will be no cases to put the trains in loops and to recover from there delay timing.

Results

The result present in this paper is according to possible real problem scenarios on track during train travelling .

The two time table of trains between two multi platform stations[station A and station B] is given below by table 1 and table 2

STATION A

Train no.	Arrival	Departure	Stop Time
07007	10:45	11:00	15 min
03287	11:10	11:20	10 min
05592	13:05	13:10	05 min
18616	21:25	21:40	15 min
18109	15:20	15:35	15 min

table-1

STATION B

Train no.	Arrival	Departure	Stop Time
07007	12:10	12:13	3 min
03287	12:33	12:35	2 min
05592	14:18	14:20	2 min
18616	23:05	23:25	20 min
18109	16:55	17:30	35 min

table-1

The mathematical model formulation has been done based on our proposed work as follows; For train 1:

$$minZ1 = P11U11 + P21U21$$

such that constraints;

$\lambda 11 + U11 = (Sac)1 - (Sdla)1$ $\lambda 21 + U21 = (Sdla)1 - (Sala)1$ $\lambda 11 + \lambda 21 + U31 = (Sac)1 - (Sala)1$ $\lambda 11, \lambda 21, U11, U21, U31 \geq 0$

From table 1 and table 2 we have;

$$(Sac)1 - (Sdla)1 = 70$$

$$(Sdla)1 - (Sala)1 = 15$$

$$(Sac)1 - (Sala)1 = 80$$

After solving by simplex method in modified form we get;

$$(priority_1)_1 = 0$$
$$(priority_2)_1 = 5$$

This shows that there is priority with weight value =5, thus this train 1 is delay in stopping time. Hence we assign this train 1 in the platform no.3 in the current station.

For train 2:

$$minZ2 = P12U12 + P22U22$$

such that constraints;

$\lambda 12 + U12 = (Sac)2 - (Sdla)2$ $\lambda 22 + U22 = (Sdla)2 - (Sala)2$ $\lambda 12 + \lambda 22 + U32 = (Sac)2 - (Sala)2$ $\lambda 12, \lambda 22, U12, U22, U32 \geq 0$

From table 1 and table 2 we have;

$$(Sac)2 - (Sdla)2 = 45$$

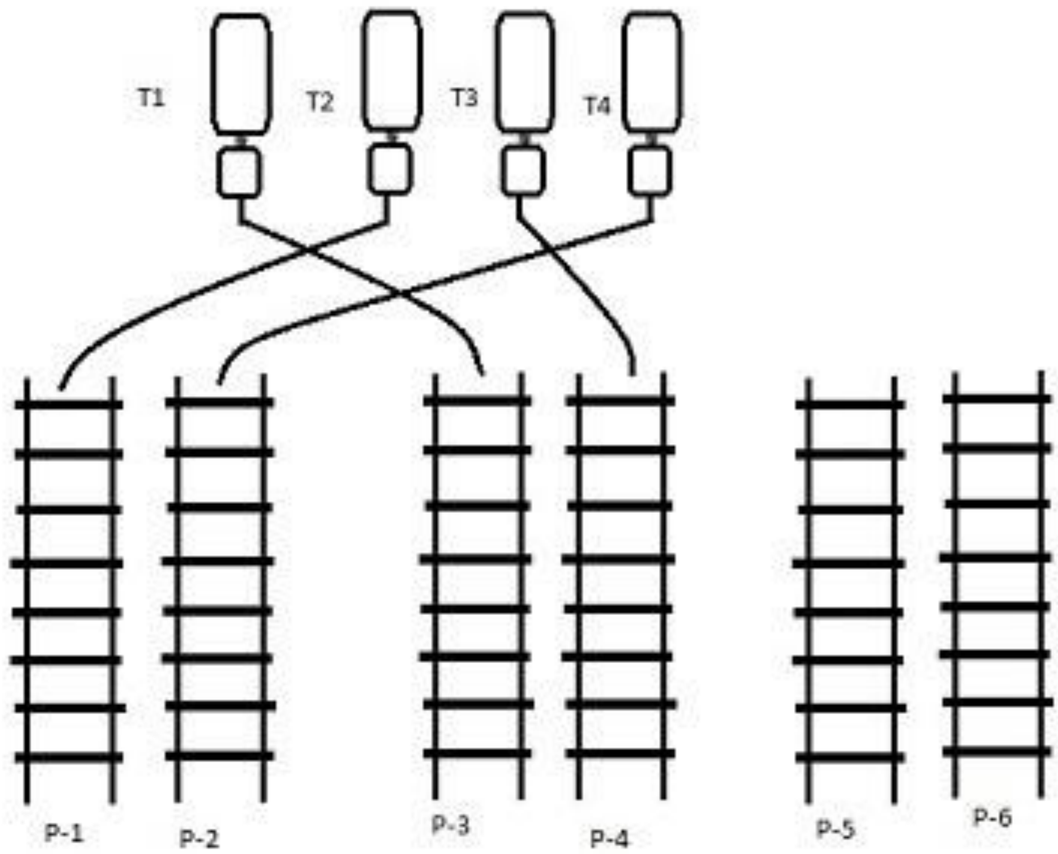
$$(Sdla)2 - (Sala)2 = 10$$

$$(Sac)2 - (Sala)2 = 55$$

After solving by simplex method in modified form we get;

$$(priority_1)_2 = 0$$
$$(priority_2)_2 = 0$$

This shows that there is no priority with weight value, therefore there is no delay for train 2. Hence we assign this train 2 in the platform no-1 in the current station. And for the same arrangement with other trains.



In this way we are getting an arrangement as shown in above diagram which is helpful in maintain their scheduled time table on tracks and also to reduce delay timing.

Conclusion

Railways play a major role in transportation people mostly prefer travelling by railways and goods can easily carried via trains. Railway transportation has fixed route and scheduled. Its services are more certain uniform and regular compared to other modes of transport. Now it has evolved into a modern, complex sophisticated system used both in urban and cross-country networks over long distances.

In perspective of Indian railways there is large increase in passengers as well as number of trains in comparison to available tracks in stations. So there are many uncertainties and complexities arises in railway transportation and hence the need of studies in this field is required.

In this paper the proposed work of an arrangement in multi platform station is given to make a significant difference in case of management and delay timing. Also to maintain the routine bases work on tracks and stations without any disturbance.

References

[1] Multi -train trajectory optimization for energy efficiency and delay recovery on single -track railway lines;Pengling Wang a, Rob M.P.Goverde 2017.

[2] Optimization of railway vehicles circulation in passenger transport Martin Vojteka Kendraa,Stoilovab University of Zilina, Faculty of Operation and Economics Transport Communications, Department, University of Zilina May 2019.

[3] Optimization of Railway Operations, Algorithms, Complexity, and Models Holger-Frederik Robert Flier,Dipl.Wirt Inf. (University of Cologne)born November 11,1979, citizen of Grevenbroich, Germany.

[4] Boccia Boccia ,M.Mannino, C; Vasilyev,N. The Dispatching Problem on, Multitrack Territories: Heuristic Approaches Based on Mixed Integer Linear Programming. Networks 2013,62,315–326.

[5] Harrod,S.S.A tutorial on fundamental model structures for railway, timetable optimization. Surv.Oper.Res. Manag. Sci. 2012, 17, 85–96.

[6] J. F. Cordeau, P. Toth, and D. Vigo, "A survey of optimization models for train routing and scheduling", Transportation Science, vol. 32, no. 4, pp. 380–404, 1998.

[7] Y. Sun, C. Cao, and C. Wu, "Multi-objective optimization of train routing problem combined with train scheduling on a high-speed railroad network", Transportation Research Part C:Emerging Technologies, vol. 44, no. 2014, pp. 1–20, 2014.

[8] R. K. Ahuja, K. C. Jha, and J. Liu, "Solving real-life railroad blocking problems" , Interfaces, vol. 37, no. 5, pp. 404–419, 2007.

[9] K. C. Jha, R. K. Ahuja, and G. Sahin, "New approaches for solving the block-to-train assignment problem" , Networks,vol. 51, no. 1, pp. 48–62, 2008.

[10] O. K. Kwona, C. D. Martlandb, and J. M. Sussmanb, "Routing and scheduling temporal and heterogeneous freight car traffic on rail networks," Transportation Research Part E: Logistics and Transportation Review, vol. 34, no. 2, pp. 101–115, 1998.

[11] B. Lin, S. Liu, R. Lin et al., "De location-allocation model for multiclassification-yard location problem," Transportation Research Part E: Logistics and Transportation Review, vol. 2019, no. 122, pp. 283–308, 2019.

[12] Caimi, G. , Fuchsberger, M. , Laumanns, M. , Schu¨pbach, K. , 2011. A multi-level framework for generating train schedules in highly utilised networks. Public Transport 3 (1), 3–24.

[13] Mazzarello, M. , Ottaviani, E. , 2007. A traffic management system for real-time traffic optimisation in railways. Transp. Res. Part B 41 (2), 246–274.

[14] Palu´ch, S,. Majer, T., 2017. Kastor – A vehicle and crew scheduling system for regular bus passenger transport, Transport Probblems: An International Scientific Journal, Vol.: 12, Issue: 1, Pages: 103-110.

[15] Grechi, D.; Maggi, E. The importance of punctuality in rail transport investigation on the delay determinants.Eur. Transp. Trasp. Eur. 2018, 70, 1–23.

[16] Makovsek, D.; Benezech, V.; Perkins, S. Efficiency in Railway Operations and Infrastructure Management;Discussion Paper No. 2015-12; OECD, International Transport Forum: Leipzig, Germany, 2015.

[17] Cordeau, J.-F.; Toth, P.; Vigo, D. A survey of optimization models for train routing and scheduling. Transp. Sci.1998, 32, 380–404.

[18] Lusby, R.M.; Larsenz, J.; Ehrgott, M.; Ryan, D. Railway track allocation: Models and methods. OR Spectr.2010, 33, 843–883.

[19] Nirmala, G.; Ramprasad, D. A Genetic Algorithm based railway scheduling model. Int. J. Sci. Res. 2014,3, 11–14.

[20] Reddy, S.S.; Prasada Reddy, G.S.; Hemanth, P.V.; Chatterjee, P. Train Time Scheduling using Genetic Algorithm. Int. J. Civ. Eng. Technol. 2017, 8, 410–413.

[21] Union International des Chemins de fer (UIC). Timetable Recovery Margins to Guarantee Timekeeping—Recovery Margins, 4th ed.; UIC CODE 451-1 OR; UIC: Paris, France, 2000.

[22] Boccia, M.; Mannino, C.; Vasilyev, N. The Dispatching Problem on Multitrack Territories: Heuristic Approaches Based on Mixed Integer Linear Programming. Networks 2013, 62, 315–326.