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Predicting the operational efficiency of Sinhagad express

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Abstract:
Present business trends push transport system and hence the assosiated companies to improve the efficiency of their entreprenureial activities, which has to be closely related to cost reduction, increased revenue, and a good reliability. There are three classic management levels for rail planning, viz. strategic, tactical and operational. Many transport compaines achieve some mathematical algorithams mostly from Operation Research, thus improving the operational efficiency of railway transport by finding the optimal solution of specific problems. The performance of railway operations highly depend upon the quality of timetable. Mumbai-Pune being one of the densed railway networks, it is challenging to obtain stable robust conflict-free timetable with available infrastructure. The paper is focused on calculating the operation efficiency of Mumbai-Pune intercity Sinhagad express using advanced statistic tools, also further predicition of times(delay) in minutes using Beta Regression. The paper represents performance based calculation of railways efficiency from the past data.
Keywords: Operational efficiency, statistic tools, railway.

Introduction:

The Indian nationwide rail network is the fourth longest in the world, after USA, China and Russia, and is owned and operated by state owned Indian Railways and includes an operating route length of more than 65,000 km. It is the lifeline for nation providing transportation over the length and breadth of the country.

For measuring the performance of railways some of the known and popular performance indicators are:

Journey time efficiency: The time scheduled between any origin and destination including running times, dwell times and transfer times.

Timetable feasibility: the ability of all trains to adhere to their scheduled train paths. A timetable is feasible if (i) the individal processes are realizable within their scheduled process times, and (ii) the scheduled train paths are conflict free, i.e. all trains can proceed undisturbed by other traffics.

Timetable stability : the ability of the timetable to absorb initial and primary delays so that the delayed trains return to their scheduled train paths without reschedulling.

Measuring, calculating and interpreting the operational efficiency of railways is always a researchable topic.

The operational efficiency of railways can thus be considered as an important research topic.

Literature Review:

Indian railways has a complex nature of rail operations. This will always hold a fascination. They are spread over 18 divisions with a total track length of 121,407 kilometres. There are combination of activities that are executed in a timely order to ensure that the objectives are met. Rail operations involve two types of resources, viz. static resources (steady) and dynamic resoures (moving). (Indian Rail Info)

Static resources are those which belong to the rail infrastructure, viz. tracks, signals, lines, buildings, platforms, catenary, sidings, bridges, switches, interchanges and junctions. The standing capacity of the Indian railways is defined by these resources. These components of the rail infrastructure can further be classified by their layouts and technical schemes. Layouts and technical resources of these static resources individually play a vital role in determining the efficiency of rail operations. Dynamic resources consists a list of all moving assets. Few to be stated as passengers and freight wagons, locomotives (electric and diesel), whole train sets, machines for rail maintenance. Also the staff involved, plans, schedules, commercial departments, administration and likewise are also considered as dynamic resources. Dynamic resources are play an important role in the working and smooth flow of rail operations. Thus, the rail efficiency without the optimum use of dynamic resources would be very less. (Marinov M., Sahin I., Ricci S., Vasic G.)

Railway efficiency is one of the most interesting, researched, challenging work for railway managers. Throughout the world recent studies done by researchers indicate that a railway efficiency is different in different regions of Europe. Comparing these efficiencies with the non-European railway systems, the analysis from the research papers provides further evidence that significant efficiency gap exists. Indeed, some countries with their strained

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government have managed to achieve a high level of efficiency while others, for a varied reasons, can be classified a s relatively less efficient. (Beck A., Bente H., Schilling M.)

Operations research is a vivid field where one can use various advanced analogies in optimizing cost of transportation, travelling time, profits, etc. Operations research is used in railways to find optimum time required to reach a train from source to destination. These times include the average train speed with the networking media into consideration. Also, some passage time is included and thus, the arrival and departure of any train at particular platform is calculated. Computing is done through soft wares. (Kumar R.)

The performance and effectiveness of rail network operations very much depend upon the quality of railway timetable. In particular, for a dense rail networking location like India, it can be challenging to obtain a stable robust, conflict-free and energy efficient timetable with acceptable infrastructure availability, and short journey times. Goverde and Hansen have proposed an integrated timetable construction and evaluation, with the aim to incorporate all timetable performance indicators in the timetable design process and thus achieve the highest timetabling level. They have zoomed in and out at different levels to optimize the various performance indicators. They proposed an integrated timetable design process at three levels:

A microscopic level based on accurate running time and blocking time calculations using train dynamics, infrastructure characteristics, and signaling logic. This level is required for evaluating feasibility, infrastructure occupation, and stability.

A macroscopic level based on an aggregated network structure of main timetable nodes only. This level is required for optimizing and evaluating journey time efficiency and robustness over large-scale networks.

A mesoscopic level for fine-tuning the train trajectories on corridors between the main nodes. This level is required for optimizing energy-efficiency and robustness on corridors between the main nodes. (Goverde R., Besinovic N., Binder A., Cacchiani V., Quaglietta E., Roberti R., Toth P.)

These considerations taking in view, we took a timetable where the rail network would work under highest exactness. Even after these vast calculations, including every pinch of the data, the circumstances comes where most of the times the trains are not as per the schedule they should run on. That’s where the efficiency of rail networks comes into picture. (Beck A., Bente H., Schilling M.)

Efficiency in simple words is the result obtained versus the expected results. Nevertheless, efficiency is a broad term which may have multiple definitions, according to the situation. In railway sector, one can focus on efficiency from the varied views. It can be potential efficiency, reliability efficiency, energy efficiency, etc. For us, operational efficiency is an important factor, which drives customer satisfaction. Thus the operational efficiency of railways can be stated as the ratio of actual time of arrival to the expected time of arrival. Efficiency as a whole would give us the percentage change of the express with the original time line.

Mathematically,

Efficiency = (the actual time of arrival)/(the expected time of arrival)×100 %

Research Methodology:

Research Objective

To calculate and hence predict the operational efficiency of Sinhagad express.

Research Design

The present study is exploratory in nature. The study includes 30 days of the schedule from Pune to Mumbai and have taken late timings in the stations coming in between the two cities.

Means, standard deviations, correlations were calculated for all the late times of all the stations coming in between Pune and Mumbai. Regression analysis was applied to know the effect of max(late time) and late time at Mumbai.

Data Analysis :

Station	Pune	Shivajinagar	Khadki	Pimpri	Chinchwad	Lonavala	Khandala	Karjat	Kalyan	Dadar	Mumbai
Average Delay	0.37	1.77	3.77	4.63	7.12	10.25	12.73	17.40	13.90	8.53	11.33
Standard Deviation	1.798	2.565	3.676	4.513	5.064	6.195	7.641	9.420	7.463	6.727	7.696
Covariance			7.112	15.01	20.459	28.821	38.817	61.2	43.23	32.15	46.789

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Correlation			0.75	0.91	0.89	0.919	0.820	0.84	0.61	0.64	0.90

Regression analysis was done by taking the maximum late time at any in between station as independent variable and the late time at Mumbai as dependent variable. The results are:

Regression Statistics	
Multiple R	0.349331
R Square	0.122032
Adjusted R Square	0.090676
Standard Error	7.463857
Observations	30

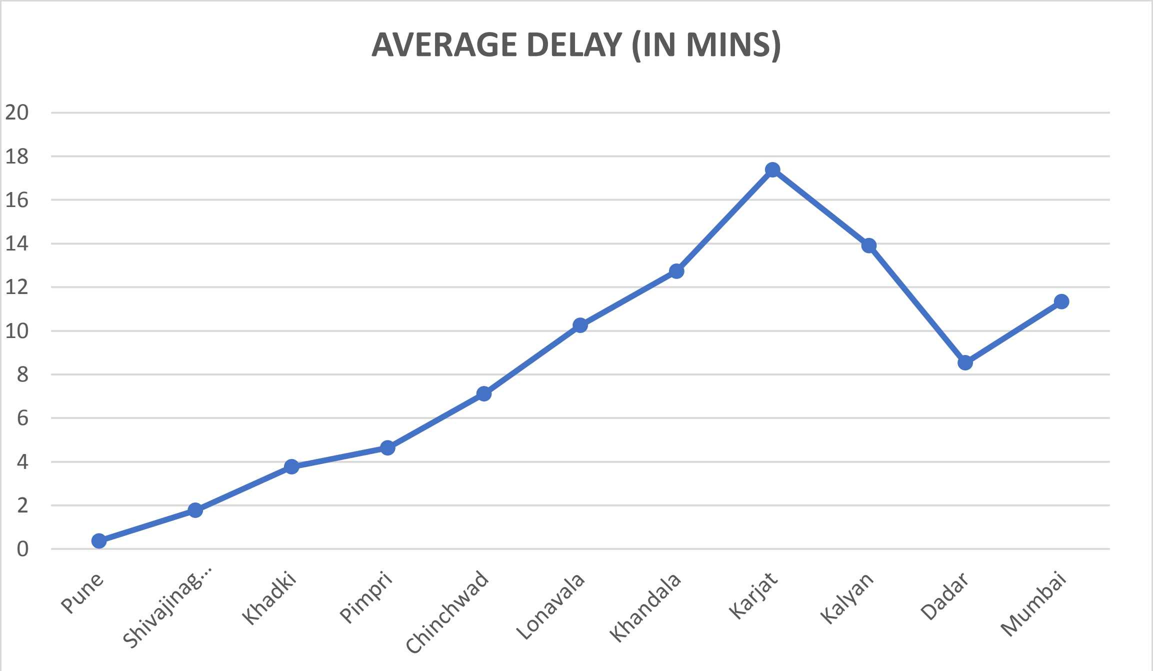
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	216.8102	216.8102	3.89182403	0.058469005
Residual	28	1559.856	55.70916		
Total	29	1776.667			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	5.178127	3.404685	1.520883	0.13950293	-1.796054606	12.15231
X Variable 1	0.324243	0.164359	1.972771	0.058469	-0.012431539	0.660917

The results indicate that the train reaching late at Mumbai is not effected by being late at any one of the station in between.

Findings and Interpretations:



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The operational efficiency of Sinhagad express is given from the graph. From the graph plotted above, the average delay and beta value can be drawn. The average delay is for the past 30 days observation starting from 30th January. From this graph of beta, the approximate delay can be predicted. It states the times by which the next station will be delayed. For instance, train is 10 mins late at Karjat and beta factor for Kalyan is 0.488, thus the train will approximately be delayed by 4.88 mins.

Conclusions and Recommendations:

Mathematical approaches are very suitable for optimization of all problems that are connected to railway transport operations. The study here gives the operational efficiency which is found to be low as the average delay is more than 8 minutes. Also, there is a need for upgradation of timetable, as the beta value is never 1 (1 indicates train running on time). The data can be read and thus can be concluded that only 19% of the timetable is followed. The reliability factor can be increased by strategic planning with the consideration of infrastructural and weather conditions.

The delay trend is studied, and hence the average delay graph is drawn, thus the study can be used in revising the timetable and hence working on factors such as journey time efficiency, timetable feasibility and timetable stability. The integrated timetable construction can be done, thus evaluating into one consistent framework. The performance indicators should be taken into account during the timetable construction by which the resulting timetable computed together with all performance indicators would give satisfied and optimized timetable.

Bibliography

Arne , B., Heiner , B., & Martin, S. (2013). Railway efficiency - An overview and a look at opportunities for improvement. International Transport Forum, 4-6.

Asmild, M., Holvad, T., Hougaard, J. L., & Kronborg, D. (2009). Railway reforms : Do they influence operational efficiency ? United Kingdom, France, Denmark, Denmark: Springer Science + Business Media.

Goverde, R. M., Besinovic, N., Binder, A., Cacchiani, V., Quaglietta, E., Roberti, R., & Toth, P. (2016). A three level framework for performance based railway time tabling. Netherland, Germany, Italy, Denmark: Elsevier.

Indian Rail Info. (n.d.). Retrieved from Indian Rail Info: https://indiarailinfo.com/train/-train-sinhagad-express-11010/1575/76/12282

Indian Railways. (n.d.). Retrieved from Indian Railways: http://www.indianrail.gov.in/enquiry/SCHEDULE/TrainSchedule.html?locale=en

Kagra, H., & Ekram, S. (2012). Train operations, on Mumbai suburban (Central Railway network) through pervasive computing method. Maharashtra, India: International journal of neural networks.

Kumar, R. (2014). Applying operations research to railway operations. Vadodara, India: National academy of Indian railways.

Marinov, M., Sahin, I., Ricci, S., & Vasic, G. (2012). Railway operations, time tabling and control. UK, Turkey, Italy: Elsevier.

Shaikh, P. S., Patil, A. N., & Thombare, R. B. (2013). Brain Computer Interfacing. International Journal of Scientific and Research Publications.

Sharma, S., & Kumar, A. (2014). A comparative study of Indian railways and worlwide railway network. Hyderabad, India: International Journal of Mechanical engineering and Robotics research.

Vojtek, M., Kendra, M., Zitricky, V., & Siroky, J. (2019). Mathematical approach for improving the efficiency of railway transport. DE GRUYTER.