PASSENGER FLOW IN RAILWAY TRANSPORTATION: LITERATURE SURVEY

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Railway transportation is common, preferable and cheapest mode of transport across world. Suburban or metro train plays major role in public transport system in almost all metro cities worldwide. Sustainable passenger railway system can be means of checking the growth of the automobile in cities.

Railways are growing in by increasing their capacity. But passenger demand prevails over supply capacity. Outburst of passenger in and around railway station premises is common phenomenon especially during peak hours. Railways are keen in improving the comfort, safety and security of passengers using rail transports.

This paper is aimed to map available literature on passenger flow in railway transportation.

Keyword: *Passenger, Passenger flow, Railway, Transportation*

Introduction:

Passenger trains plays important role in public transportation across world. Normally passenger trains are means of intercity and intra-city travel. Operations of passenger trains are conducted with multiplicity of vehicles, operating speeds, and service frequency. Intercity passenger train operations are characterized by higher speeds, longer routes, and lower frequency whereas intra-city passenger train operations are characterized by lower speeds, shorter routes, and higher frequency.

International Union of Railways (UIC-Union Internationale des Chemins de fer) is an international rail transport industry body which works to promote rail transport at world level and meet the challenges of mobility and sustainable development. UIC has 194 members across world.

Passenger railway usage is normally measured in passenger-kilometers. Passenger-kilometers is the number passengers multiplied by the average distance of their journeys in kilometers. Table

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1 shows top 10 countries by passenger-kilometers of rail transport per year and Table 2 shows top 10 countries by passengers carried in rail transport per year.

Rank	Country	Billion Passenger-Kilometers
1	China	1,196
2	India	1,147
3	Japan	260
4	Russia	120.4
5	France	83.2
6	Germany	79.3
7	United Kingdom	64.4
8	Ukraine	37.1
9	Italy	40.4
10	Spain	25.9

Table 1: Top 10 countries by passenger-kilometers of rail transport per year (Data year for Russia is 2014 and for all other countries is 2015) (Assessed on 24 Feb 2017)

Rank	Country	Million Passengers
1	Japan	9,090
2	India	8,224
3	Germany	2,007
4	United Kingdom	1,717
5	China	1,544
6	France	1,123
7	Russia	1,020
8	Italy	622
9	Spain	571
10	Switzerland	488

Table 2: Top 10 countries by passengers carried in rail transport per year (Data year is 2015 for all countries) (Assessed on 24 Feb 2017)

Research Method:

We have assessed research papers from google scholar, researchgate and scopus data with the combination of keywords such as railway transportation and passenger flow. Some papers could be assessed as full length papers as available online.

Passenger Flow Study:

Trains have become one of the most viable alternatives, especially for daily commuting. Researchers across world have studied passenger flow in railway transportation arena mainly for passenger flow perdition, volume prediction, forecasting, dwell time calculation, alighting/boarding pattern, waiting line pattern, route choice behavior, timetabling, train movement, station design, platform design, etc. Most of the researchers have used real-time observation, videotaping, sensors, ticket-data's for passenger flow studies.

Some of the literatures are mentioned as follows:

Si, B. et al., (2016) conducted case study comparing a multi-class transit assignment model with its single class counterpart for estimating the passenger flows of the Beijing subway network taking into account the variation in users' route choice behaviors. The proposed model is

motivated by the fact that transit users of different socioeconomic characteristics have different preferences in terms of route choices.

Wang, L. et al.,(2015) emphasized on joint passenger control methods during the occurrence of large passenger flows with help of an integer programming model based on the analysis of passenger delay and the processes by which passengers alight and board. Xu, X,et al., (2014) presented three practical operational strategies, i.e., increasing train frequency, improving train capacity and applying express trains, which may help dispatchers to relieve the traffic pressure in a subway system.

Wei and Wang. (2014) focuses on the method for effective calculation of the month index and week index on the basis of time series clustering. It proposes an algorithm for calculating the seasonal index which is impacted by both months and weeks. The seasonal index is used for predicting the railway passenger flow.

Jiang and Jia (2014) paper takes Beijing urban rail transit network as an example to simulate the process of emergency passenger flow guidance.The emergency passenger flow guidance system was adopted, which can realize the effective guide of passenger flow under the emergency.

Hibino, N et al., (2010) developed passenger flow in railway station analysis system, which is one of the sub-systems of the simulation system for analysis of train delay. During rush hours, the boarding and alighting processes are not smooth because of crowded in the train. Therefore, the train stopping time becomes longer which affects following trains speeds owing to the departure delay of the forward train.

Li S. et al.,(2013) has done prediction of the future passenger flow of a railway station, which can provide an important reference for decision-making on scales of building a station and the management after the completion of the construction.

Jin J. et al., (2013) predicted the section passenger flow for the real-time data of the section passenger flow which can't be acquired in the process of urban rail transit operation, which brings some difficulties to the passenger monitoring and controlling using BP neural network with MATLAB.

Tang Q., Shen L., Tang X. (2013) studied characteristics of large passenger flow. Hongyan L., et al., (2013) researched on the change of passenger flow through analyzing the data recorded every 15 minutes at Zhaojiabang road station on the rail transit line 9 in the rush hours.

Zhang D., et al., (2012) analyzed and modeled metro passengers' modal choice when they have to take a vertical shift where escalators and stairways are available at the same time. Data is collected via photography based RP surveys in four typical stations of Shanghai Metro.

Zhou F., Xu R.-H. (2012) worked on the path chosen by passengers between the origin station and the destination station. Huang Y and Pan H. (2011) studied short-term prediction of railway passenger flow using Radial Basis Function (RBF) neural network.

Nakanura,K et al., (2005) developed a unique system to analyses passenger flow on the busy concourse in railway stations in Tokyo by using networked laser scanner sensors to extract data such as passenger trajectories, velocity, density and the collision avoidance among passengers.

Sugiyama Y., et al., (2010) obtained passenger flow information in real time in railway traffic operations. They attemped forecasting of the number of gate passages according to the time of day using past data from automatic ticket-checking gates, and the number of passages by each origin station was estimated using the number of gate passages.

CONCLUSION:

In this paper an attempt has been made to review the literature on passenger flow studies in railway transportation. Most of the papers were available for complete review. Some papers could not be assessed due to restrictions on use. However, we have considered an abstract of such papers as a source. There is further scope to extend this research in detail with detailed review of more research papers.

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