Survey of Passenger Ridership in Mumbai Suburban Railway.

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Abstract: Mumbai is a dense metropolitan city. The thing which keeps Mumbai going is the people which are aided by the local transport. Of all the local transport available, The Local Trains are the lifeline. But this lifeline has been plagued by a lot of problems one of which is overcrowding. Overcrowding can be attributed to poor infrastructure, urgency to reach destinations, wastage of train resources, etc. This leads to a lot of physical and mental stress among the people using the facility. This in turn leads to increased risks of cardiovascular diseases, less time with family, etc. So, a survey was conducted by us to get an idea about the passenger usage statistics. Survey of different aspects is vital to the railway company as a whole as it provides the basic input for the planning and control of all functional areas including railway transport operations planning, marketing and finance. Demand levels and the timing of their appearance (on a day, week, month or seasonal basis) greatly affect capacity levels, financial needs and general structure of the business. Survey employs actual data and then various forecasting methods can be used to make accurate estimates of future demands. This may help in using the existing facilities better and even help while planning for the future expansion**.**

IndexTerms - Survey, Overcrowding, Railway, Mumbai, Crush Load.

I. INTRODUCTION

Mumbai is the financial capital of India, the country having a tremendous increase in the GDP in recent years. The availability of port led to development of lot of industries which created job opportunities and people started to migrate to Mumbai to fulfil their dreams and earn a living. This trend has continued over the years, saturating the city. Most of these people live in the suburbs and require daily transport to travel to their offices. To cater services to these many people the authorities have implemented many schemes and projects. The Local Train services, BEST bus services, the Metro Rail Services & the Jetty Services on the Western Seashore have been trying to keep this city running day and night. Apart from these, there are many other means of transport such as the Private Cab Services, auto rickshaws, etc. which can be used to travel. The local train services being the cheapest and spanning throughout the city, is used by a majority of the population of Mumbai. The Railway Infrastructure has not increased in proportion to the number of commuters using it leading to overcrowding. Overcrowding leads to uneasy travel, mental and physical stress, accidents among others. With a view to reduce overcrowding and subsequently its effects, we undertook a Survey of the commuters using the Western Line of the Mumbai Local Railways which can be used for reducing the travelling time and stress developed during the tedious travel which will have a domino effect on the productivity and financial conditions of the employee as well as the corporations.

II. NEED FOR STUDY

2.1 Background

Due to its nearness of coast and presence of ports, Mumbai always attracted many people due to the commercial benefits. This trend started during the World War and still continued today. This led to increase of businesses Mumbai is the financial capital of India and the suburban railways its lifeline. If the railways are slowed down or stopped, it will have big impact on the economy of a country and indirectly affect the people. Mumbai's population has always increased and continue to do so at an unprecedented rate, making it one of the most densely populated cities of the world. Let's look at Mumbai's population growth:

- 1971: 59,70,575
- 2001: 1,63,68,084 (Greater Mumbai, incl. Thane)
- 2011: 1,83,94,912 (Greater Mumbai, incl. Thane)
- 2018: 2,25,00,000 estimated (Greater Mumbai, incl. Thane)

Mumbai, the brightest city of the nation, is run by 7.5 million daily commuters who mostly live in suburbs. They live in suburbs not by choice, but because only the wealthy can afford to live in Mumbai. These lower middle-class commuters have adjusted their lives around the local train schedule. If trains don't operate, their life is disrupted. If fairs increase, their finances are disrupted. They don't mind getting 'squeezed' in crowded trains in return of inexpensive and predictable work commute. On one hand the central government does not provide enough funds to meet the growing need and modernization of the system, and on the other hand commuters don't want fare hikes. This is the reason why we continue to commute in overcrowded trains!

2.2 Current Scenario

One of the main sources of this problem are the users. Some of them adopt different means- such as travelling in opposite direction from their destination towards a terminal station and take advantage of the train being emptied at that terminal to get seats to sit and to make their travel easier. This in turn causes difficulty to people originally travelling that route. To overcome this

problem and to make train travel easier, safer and stress free, we will be conducting a research and on the basis of the data obtained, provide a better scheduling of trains.

About 2.64 billion people commute daily through the suburban railways in Mumbai. Considering just the Mumbai Western Suburban Railway, approximately 7.5 million people use it daily. And with the current construction work in progress for the Mumbai Metro works on the Western Express Highway and other important roads and its effects on traffic flows, the load or the number of people using the Western Suburban Railway of Mumbai just keeps on increasing day by day. [1]

To give an about the stress the Mumbai Western Suburban Railways is under, here are some numbers:
Approx. commuters using the Western Line of Mumbai Suburban Railways- 21,42,000/day (peak hours between 7:00 to 11:30 in the morning and 4:00 to 8:30 in the evening)
No. of services during that period- 287
Therefore,
No of commuters per train- 7463
Capacity of 12 coach train- 3504 (1168 seated, 2336 standing)
This means that Mumbai Western Suburban Railway carries more than 2 times or double the capacity it is designed to. This leads to overcrowding and subsequent health effects and also accidents and deaths. This data is achieved from a survey by Mumbai Rail Vikas Corporation in 2011-2012. Since then the population has increased significantly and there is a need for current data for design of infrastructure facilities for future. [2]

III. LITERATURE REVIEW

3.1 Mumbai Suburban Rail Passenger Surveys & Analysis – by Wilbur Smith Associates (2012):

This was the study on Mumbai Suburban Railway network with the key objective to assess present travel patterns of the suburban railway commuters & their preferences. It has surveyed 13 stations each from WR & CR and 11 stations from harbour line with total sample size of 25,000 commuters.
The major objectives of their study were:
• To assess the present travel pattern of suburban rail passengers.
• To estimate existing peak hour and peak directional flow of passengers.
• To assess the crowd level in suburban trains at entry / exit points, stations and foot over bridges (FOB's).
• To suggest measures to reduce congestion on FOBs.
• To know the level of commuter's satisfaction on various aspects of the system
The research findings were: -
• The Daily Ridership Growth Rate (CAGR) was 1.55% for the western railways
• The maximum peak hour passenger load was observed at the stations: Churchgate, Mumbai central, Dadar, Bandra, Andheri, Borivali.
• The crowded FOB was observed at the stations: Dadar, Bandra, Andheri, Borivali, Bhayandar, Nalasopara, and Virar.
Though it is the most recent study for overall Mumbai Suburban Railway network, there are several limitations with respect to the findings.
• Methodology or basis for selection of stations & sampling at each station is not disclosed.
• Purpose of trip as well as Levels of Satisfaction/ Dissatisfaction may differ widely for each of the parameters (such as seating pattern, comfort riding, etc) during peak / off-peak period which has not been captured
• The survey results do not show the commuter travel pattern based on1st or general class for each of the income category. [2]

3.2 Rail Demand Forecasting Estimation, Final Report, Final Draft (November, 2016):

In the above report, we got to understand the basic objective of various questions to be asked during a survey whether online or offline. In this report, the questions were divided into two major classes:
1) Socio economic characteristics.
2) Network effects.
3) Time effects.

The socio-economic characteristics are further classified:
- Age
- Overall income of family
- Availability of car
- Occupational status
- Economic status of traveler
- Working sector of the traveler

The network effects are further classified:
- Change in the average rail generalized journey time over years
- Change in the yield per flow over years [3]

3.3 Railway Demand Forecasting by Miloš Milenković of Zaragoza Logistic Centre, Spain & University of Belgrade, Serbia and NebojšaBojović of University of Belgrade, Serbia (January, 2017)

This paper mentions the importance of crowd forecasting for various future calculations for the further development, expansion of infrastructure, necessary steps for crowd management, making policies for future land use, pricing programmes of diff activities & expansion of transportation supply of high-speed railways, etc

It further bifurcates our knowledge into how many diff ways forecasting can be done effectively. There are two types of forecasting: -

1) Qualitative analysis
2) Quantitative analysis

Qualitative analysis is further subdivided into 5 categories:

- Market surveys
- Historical analogy
- Delphi method
- Personal insight
- Panel consensus

Quantitative analysis is further subdivided into 2 categories:

- Time series method
- Casual method

Fuzzy models and state space models are also some of the other types.

Qualitative forecasting techniques are often subjective in nature and require judgment on the part of experts. These techniques are often used in situations where there is little or no historical data.

Quantitative methods for forecasting the future railway demand are used in case a company has records of past sales and knows the factors that affect them.

Railway passenger demand can be classified into two categories:

1. Passenger demand
   - Intercity demand
   - Commuting demand
2. Freight Demand

3.4 Modeling Train & Passenger Capacity - A Study by Douglas Economics (2012):

In 2012, Douglas Economics, a Transport Economic Firm took the challenge for modeling train And station demand and capacity of the Sydney CBD. The problem of modeling train schedule to provide comfortable service to passengers was the goal. But the ever-increasing population and unpredictable nature of humans, it became difficult for them. By the study of different recent rail networks, they found out that current dwell times of train in the peak hours increased due to the alight rate being increased. Also, the spatial distribution of the passengers on the platform as well as in the train was considered. To analyze the data obtained, they used two software's namely- Opentrack or Railsys (Train simulation modeling) and Legion or Sim-Walk (Multi stations pedestrian simulation). This two software's working individually provided excellent analysis but using them simultaneously proved to be tedious and tiresome as data from one software needed to be entered into the other one manually and it proved to be a huge task for a large and big project such as the Sydney CBD. Finally, they had to settle for manual entering of data into one of the Software from another and hence it didn't work out. No example of a linked train and station simulation model could be found on the scale required to model Sydney CBD. However, the continued rapid pace of development in simulation modeling suggests that such applications will become available in the near future. Before embarking on developing an integrated simulation of train and station performance for Sydney CBD, the adequacy of the patronage forecasts, representation of rolling stock and stations and the algorithms underlying passenger behavior and train/station operation should be assessed in terms of their likely predictive accuracy. [5]

IV. BACKGROUND

To get a background about the current scenario of the Western Railways, we visited the Divisional Railway Manager's (DRM) office on 15th September, 2018. On reaching there, we visited the TMS room (Train Management System) which is also known as the 'Brain of the Railways', where we got the facts and figures about the western railways. According to the data received, the Western Railways runs **1355** local train services everyday with the help of 89 rakes between Churchgate and Virar along with **120** outstation trains. Out of those 89 rakes, **84** are 12 car rakes, **4** are 15 car rakes &**1** is A.C. local. The Western Railways is divided into two main stretches - Churchgate to Andheri & Andheri to Virar. These two stretches are controlled by two officers respectively who work on 6 hr shifts each. Each and every train passing through this network is monitored & controlled by them. They ensure the smooth and timely running of the trains without any accidents. During the peak hrs, i.e**. 8:00 -11:30** in the morning and **5:30-8:30** in the evening, the western railway runs a train every **3 min** which is normally **5 min** during the non-peak hrs. To get a sense of the people commuting daily, it can be said that it is almost equal to the population of **New Zealand.**

The average speed of the train is **80 kmph, while** the permissible is **105 kmph**. The waiting time of a train at a station is **30 sec** accept for Dadar station which is 45 sec. To run the Railways efficiently, maintenance works are carried out during the early morning hours every day along with Mega Blocks on Sunday. These data are transferred from the tracks to the TMS via a network of **Optical Fiber Cables** and with the help of **GPS**. Also, the timetable is prepared manually due to lack of required data and lack of IT personnel and department. This causes a lot of mental stress to the people working services which may somehow reduce 5-10 percent crowding.

V. DATA ANALYSIS

In order to conduct an Origin and Destination Studies and also to collect data about the number of commuters using the Western Line, Google Forms are created and circulated by us. The following questions along with the reasons are asked:

Name:

This question is just to get the authencity of the person filling the form.

Age:

An age criterion is an important factor as it affects the way people are impacted by overcrowding. The 50-60 age group people may get affected more because of their age as well as the below 18 group because of the lack of experience of travelling in such overcrowded trains. Also, since this data is not only for the current year it will help in forecasting the future population to properly design and develop the infrastructure facilities like platforms, bridges, train capacity, etc.

Gender:

This question is asked to get an estimate of number of women, men and transgender people using the services of local train and by comparing it with the previous data available one can determine if the female population or the male population has increased more and also calculate their percentage increase so as to decide the number of coaches required for individual gender. Since in the current coach distribution, the division between male and female compartments is not equal, it will us determine if the distribution system needs to change.

Occupation:

This question will help us to get an estimate of the bifurcation of the type of people using the railway and see if they can afford to travel by some other mode of transport. For example, the self-employed people or the business owners are more likely to afford to use roadways as compared to students or workers and employees. This will also give an idea about the need for a different strategy such as if more students are travelling, the colleges can be asked to start their own transport services such as busses to reduce the load on the railways and also an estimate of the future population using the Mumbai Western Suburban Railways and use the information obtained to properly design the rail services and use the taxpayer's money in a more efficient method.

Frequency of travel:

There are 3 different options available for this question and they are -

1. Daily
2. Weekly
3. Monthly

These options help us to know if a person who gives his views on travelling using the Mumbai Western Suburban Railways is a regular traveller or a once a blue moon traveller. From getting this information, we can determine how much percent of the total commuters using the suburban railway services are rare travellers and if possible, can determine times, dates, months on which a majority of such population travels and can have different plans and strategies for those specific dates, months or times. It will also tell if extra services are needed for a particular date of month or specific group of months (such as exam months where students avoid using personal vehicles to avoid getting into situations which will hamper their preparations, time, confidence, etc. Such a situation for an example can be mechanical failure of the vehicle, etc.).

Boarding Station:

For implementation of any transport system, it is required to know if it is really needed to be executed. To find out about its need an OD Study, i.e. Original and Destination Study is done. As the name suggests, it finds out about the origin or start of journey and its finish or destination. This survey is carried out for months and the sample space is taken as large as possible so as to get an accurate number of people using the route. This is then compared with the original or currently available system and the final decision is taken whether to implement the new system or not. To get an idea about which station or place has more demand or commuters, so that more services can be started from that particular station itself or can be passed through them, the question where a person boards the train while going to one's office or college, etc. is asked. The options given are of all the 29 stations currently present between Churchgate and Virar for Mumbai Western Suburban Railways.

Time of Boarding (while going to office/college/school/workplace):

This is one of the most important questions in this survey. As we know that this survey is for Railways planning and development and it is being done in one of the most densely populated metropolitan cities in the world, i.e. Mumbai, and as anywhere else in the world, the offices start in the morning and end by evening, it is imperative to know the nearly accurate timings of commuters boarding a train at a particular station. This information gives a nearly accurate number of people using the railways at which exact hours and gives us the peak hour distribution. This information with or without the Boarding Station question, gives an idea about the number of train services that is going to be needed during a particular time of a day and if required standby services can be arranged in case of emergencies or different strategies to reduce the load for a particular hour can be thought of with proper data available. We have provided a manually answer option so we can get as accurate an answer as we can get.

Destination Station:

As already discussed about Original and Destination studies, it is important to know the destination of a journey to get an idea about the importance or necessity of a particular place. While travelling along a particular route, several points or places will come but some of them will be more popular among the travellers and hence more thought can be given about such places and accordingly the facilities and routes can be designed. In our survey and project, this question gives us information on number of people boarding a train at a particular station while coming back home and only in rare cases it happens that a person gets off on one station while going to his workplace or educational institutions and boards the train at some other station while coming back to his home. This

helps in identifying checkpoints or stations where more services are required so as to provide smooth and comfortable journey to the commuters. Again, the options available for this question are all the 29 stations available between Churchgate and Virar for Mumbai Western Suburban Railways.

Do you carry any luggage? If yes, what type?

A particular compartment of local train is designed for a fix number of users. But it is not in the case of Mumbai. A train with capacity of 1500 accommodates around 4000 during peak hours. We think this number can be increased. But carrying luggage plays a major role in the process. If we determine the approximate number of people carrying baggage's, etc, then satisfactory accommodations can be made to overcome that problem for the people who will be standing with their luggage.

Do you think overcrowding in train leads to spread of any diseases?

Although we know the answer of this question, it may seem not reasonable to ask this question in the form. As people are very stand and sit very close to each other due to lack of space, there are high chances of spreading of contagious diseases such as cold, cough, conjunctivitis and other deadly outbreaks such as Ebola, etc. This gives an idea about the health and hygiene of the people which is mostly neglected.

Will you start using metro services once it has been constructed & ready for usage?

As we are seeing these days, Mumbai is upgrading its services by adding metro services. Many people have a thought that this may change the current condition of Mumbai local train services. This question is mainly to get the count of people who may actually shift from local trains to metro services. Now, the problem here will be high ticket pricing which may have a huge effect on the employees and low-grade workers. But we also have many business officials and owners who use local train services just to save travel time. Might be these people switch to metro

Would you like to suggest any measures for reducing overcrowding in railways?

Being an engineer & also a commuter of local train, I understand the problems faced by the commuters while travelling. But here it is an open platform where anyone can suggest any measures. Also, the best solution can be provided by people who use a particular service as they face the problem on regular basis and it is a human tendency to keep thinking about a solution to the problem they face. Hence this question may help us to get innovative solutions.

VI. RESULTS

- About 87% of total passenger travelling in western local train are students and employee at the age group between 19 to 30 years.
- 65.6% accounted for students and 27.9% accounted for employees.
- Passengers commuting daily were 66.2%, while those who were travelling weekly and monthly were 12.9% and 20.9% respectively.
- 2nd class commuters were 69.7%, whereas only 29.4% were 1st class commuters.
- People commuting from Dadar had a total of 14.7%, while at Andheri and Borivali were 10.3% and 9.1% respectively.
- The peak hours were observed between 7:00am to 10:00am and 5:00pm to 9:30pm.
- In order to travel comfortably and occupy seats for longer distance about 47.9% people said they take a return journey i.e. Malad/Kandivali to Borivali then to Churchgate.
- Almost 77.4% commuters carry backpacks and 17.6% carry handbags while travelling, which occupied around 25% space of the compartment.
- A total of 91.2% people believe overcrowding may lead to spread of various disease.

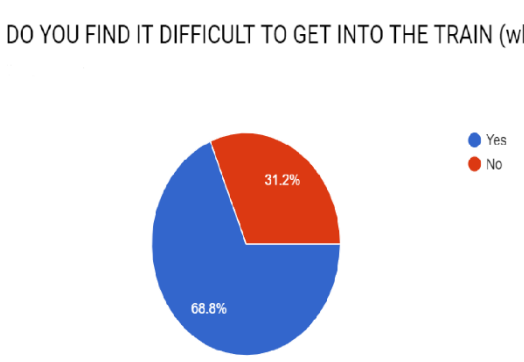

FIGURE 1

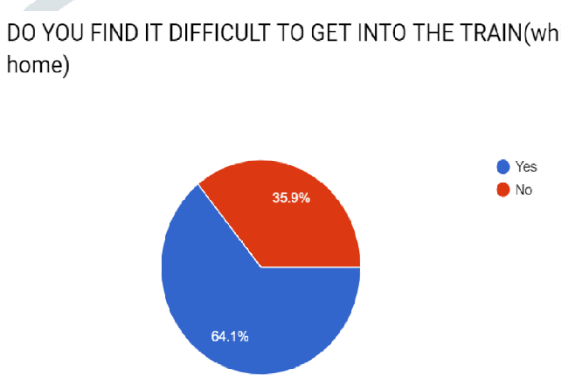

FIGURE 2

VII. ACKNOWLEDGMENT

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