

Efficient Train Management System - An AI Approach

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Abstract: *The main mode of commuting in Mumbai is local train system. Around 8 million passengers travel daily by local trains. These trains are heavily crowded and create chaos with even a slight change in schedule. The number of trains running daily is so high that it's difficult to accommodate more trains in the schedule and retain their performance. At the same time, the overcrowding issue needs to be resolved by improving performance and efficiency of the trains. Artificial Intelligence is growing rapidly and can be applied in many areas to make the existing system intelligent and better. This paper gives an overview of how Artificial Intelligence can be used to improve efficiency of the system by providing a dynamic timetable to make trains less crowded. This can be done through analysis of Historical Data to identify reasons for issues such as delay in trains, overcrowding, etc. On the basis of this analysis, a model for efficient train allocation and time table management is proposed. Furthermore, the viability and application of the model is also proposed in this paper.*

Keywords: Artificial Intelligence, Local Trains, Mumbai, Optimization, Delay, Overcrowding

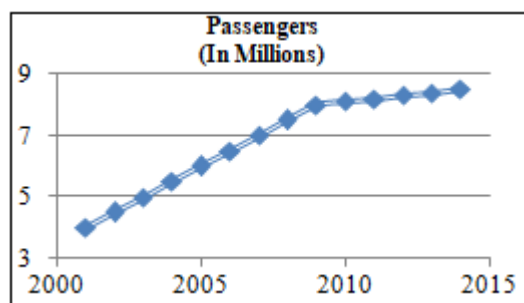
1. Introduction

Mumbai Suburban Railway, the oldest railway network in Asia, started its operations in 1853. Popularly known as "Locals" in Mumbai, Local Trains are the primary and most significant means of transportation in Mumbai. The majority population of Mumbai relies on this railway network for commuting. [1]

According to a survey conducted by Mumbai Rail Vikas Corporation (MRVC), 8 million people travel by Local Trains every day. For this survey, the count of people was taken during morning and evening peak hours. (i.e., from 8 am-11.30 am and 5 pm-8.30 pm). [2]

The following table depicts the number of people travelling by the Local Trains on the Western and Central railways:

	No. of daily services	No. of daily customers
Western Railways (WR)	1,306	37 lakh
Central Railways (CR)	1,710	43 lakh



The above graph shows increase in the local train passengers over the last 15 years.

The frequency of these trains is so high, that there is a train every 3 to 4 minutes. Because of this, even if a single train gets late, all others trains are also affected. [4]

The reasons why trains get late can be classified into two categories: manual errors and others, e.g., machine failure, track issues, signal failure, etc.

This paper aims to improve the efficiency of the Local Train system by eliminating / reducing the manual errors through usage of Artificial Intelligence.

What is Artificial Intelligence?

Using Artificial Intelligence, machines can also start thinking like humans. It means they will have their own brain and intelligence (though artificial!!), and will take their own decisions. Artificial Intelligence work is carried out by self-learning computers. So after they complete enough learning through data analysis and encountering the errors, over time, they become capable of eliminating most of the manual errors.

The areas of using Artificial Intelligence are expanding very fast. Today it has its presence in almost all industries in all areas, viz., manufacturing, medical, banks, homes and many more.

Basically, Artificial Intelligence is a way of making a computer, a computer-controlled robot, or a software think intelligently, in the similar manner the intelligent humans think.

Artificial intelligence is the intelligence exhibited by machines or software. It is the subfield of computer science. Artificial Intelligence is becoming a popular field in computer science as it has enhanced the human life in many areas. Artificial intelligence in the last two decades has greatly improved performance of the manufacturing and service systems. [5]

Artificial Intelligence is accomplished by studying how human brain thinks and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems.

Artificial Intelligence aims at creating an expert system which exhibits intelligent behaviour, learning and decision making capabilities. [3]

2. Literature Review

Increasing the number of trains or the number of coaches in the train may not be a viable solution for this problem, as it may lead to increase in traffic and further delayed trains. So a better solution is to optimize the timings and working of the trains. To arrive at a good solution for optimizing the train operations, systems of similar train operators in the other parts of the world were studied.

Japan Railway

Rail Transport in Japan is the most widely used transport system. It provides high speed travel between cities and commuter transport in metropolitan areas. Japan's railways carried 7.289 billion passengers (260 billion passenger-kilometres) in the year 2013-14. Because of the massive use of its railway system, Japan is home to 46 of the world's 50 busiest stations. Japan Railway is also privatized by 6 groups. This makes management easier as the load is divided into 6 different parts of the entire Railway System. Privatization also allows the use of advanced and expensive technologies. This is the main reason behind the efficiency of the Japan Railway.

The hardware capabilities of rail systems in other countries with similar population deal with this problem without having to use AI. Since a hardware upgrade of such a scale is infeasible and costly, introducing Artificial Intelligence systems becomes a cheaper solution giving more or less similar results.

3. Existing System Architecture

The three lines of this railway network are the Western Line, the Central Main Line and the Harbour Line. Mumbai locals have recorded around 8 million commuters each day, and the route network is spread over 464 km. These trains are divided into two classes- first and second. Travelling in second class during rush hours can be a hassle to your journey. So, tourists generally prefer travelling in first class. Although the ticket fares are six to seven times more for first class compared to that of second class, still it does not facilitate the travellers with comfortable journey. There are special coaches for women in both the classes. [1]

In spite of so many trains and so many coaches, many people travel dangerously standing on the footboards risking their lives. In peak hours, the number of people alighting and on boarding is very high.

To add to that, the train stops at every station for about 90 seconds to 120 seconds. So people usually try to get-down from or get-in in moving trains which causes accidents.

In spite of all this, there is also no guarantee of the train being on time.

4. Proposed System Architecture

This paper proposes to augment the current manual system of signalling and driving by an automated system. This automated system will be based on Artificial Intelligence

that will work on the collected data. This system will consist of two components:

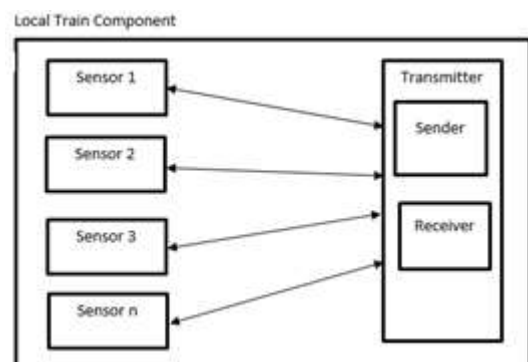
- The Local Train Component, installed on each train
- The Server Component, installed on the central control room of local trains.

The Local Train Component

The local train component will have two parts – 1. The Sensor and 2. The Transmitter.

The Sensor will be installed at the door of each coach of the local train. Function of the Sensor will be to collect passenger load data and send it to the Transmitter.

The Transmitter will be installed in the Motorman cabin. Function of the Transmitter will be to transmit data to-and-fro between the Sensor and the Control Room Component.

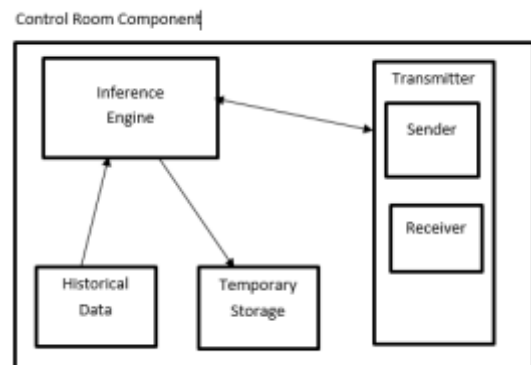


The Control Room Component

The control room component will have a transmitter which will receive data from the Local Train Transmitter.

Also, there will be an inference engine which will be responsible to analyse this data and make decisions based on it.

The transmitter will send these decisions to the local train component.



As the load in coach increases beyond the capacity, there will be a buzzer which will start buzzing and the doors will shut automatically. The system will also have the capability to monitor the life of doors. So it will send signals to repair or replace the doors two weeks (or any specified time) before the door may go un-operational. And it will communicate with the control room component.

Overall Process Flow

The sensor of the Local train component will gather the passenger load data and send it to the transmitter who will further send it to the Control room component.

The control room transmitter will receive this passenger load data and send it to the inference engine that will then make decisions in real time. These decisions will include the following:

- Whether to halt at a particular station
- How much time the train will halt at each station
- The schedule / timeframe
- Estimated load

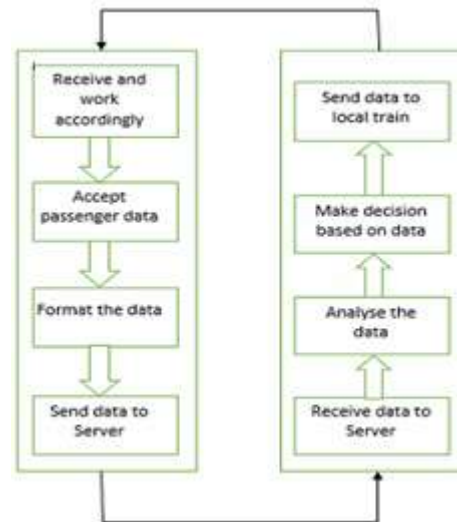
These decisions will not be based only on the collected data but also on the historical data stored in the Central Database.

The Local Train Component will be notified about these decisions and will perform operations accordingly.

In case of any delays, the Control Room Component will be notified. The Control Room Component will hence calculate and send the updated information to those Local Train Components who will be affected by these changes. Those Local Train Components will change their schedule to adapt to the situation.

For example, let's consider the route from Borivali to Churchgate. In an ideal situation, the train is supposed to cover the distance in 45 minutes. So, the Local Train Component will create a schedule which fits the timeframe. According to this schedule, the train will start at its scheduled time and halt at each station based on historical data and current passenger data.

Suppose the train breaks down at Andheri, the Control room component will be notified at what point the breakdown has occurred. The controller will make an announcement to the passengers that the train can't go further and they would be accommodated in the upcoming trains. The controller will know about the trains which are going to be affected by this breakdown. So the controller will now recalculate the schedule for the trains affected by this breakdown. The affected trains will undergo a change of schedule. For example, the affected trains may get delayed by a few minutes or they might have to re-route or might have to take extra passenger load.



However, the Control Room Component will give the most optimized solution in order to minimize the impact of the breakdown.

Since the system will learn on its own, based on the data collected, it will require some amount of time for the learning process. In this time, only the sensors will be implemented and data will be collected by the system. After enough data has been collected, the system will make its own schedule for the trains which will be tested and verified by the experts and once it is verified, the system will be ready for implementation.

5. Challenges

Although the proposed system may be solving quite a few problems of the current system, the implementation of the proposed system has a few challenges which need to be addressed.

Since it is a centralized system, there is a single point of failure. Communication might be a problem as strong network connectivity will be needed. In case of breakdown, the train will no longer be able to communicate with the controller and it will depend on the manual intervention. Even though the system will be automatic, it will still require a human expert (motorman) to supervise the working of the train.

6. Conclusion

Since the system will be continuously learning, as the time passes by, more and more data will be gathered and based on the learning the system will get more intelligent and efficient. It will improve the train scheduling and load balancing.

7. Future Enhancements

Since the proposed system is centralized, the train components will not be completely independent. So in the rare case of the Controller component completely breaking down, the whole system will become ineffective; hence the motorman will have to take charge. So in future, each local

train component can be upgraded to have the capability of the controller component also.

The changes to the schedule can be broadcasted so the commuters will be able to get real time updates.

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