Modelling the impact of Weather Conditions on Passenger Mobility

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Abstract

Transport system and passenger mobility is the backbone of any country's economic growth. With increase in the rate of urbanization, the management of transport infrastructure and demand has also become crucial in India. The extreme weather conditions, GHG emissions, adaption and mitigation issues have become a challenge for the betterment of urban transport mobility and passenger behavior toward the choice of travel mode. Further, the frequency of extreme weather conditions has increased owing to global climate change (IPCC, 2014). Transport disruption due to meteorological conditions such as congestion, delayed trips or cancelled necessary travel for work and services is also responsible for economic losses. The study aims to analyse the effect of weather condition on public transport which is in line with the United Nations' Sustainable Development Goals 9 and 11 which focuses on sustainable transport. United Nations Sustainable Development Goals (SDGs) which is adopted by all member nations to deal with socio, economic and environmental issues by 2030. These issues and transport disruption are also related SDGs industry, innovation and infrastructure (SDG 9), sustainable cities and communities (SDG 11) and climate action (SDG 13). Therefore, there is a need for policy makers to adopt a multi- dimensional policy approach to provide sustainable transport. The meteorological conditions have been affecting passenger mobility across the globe. Bad weather may reduce and divert the demand for public transport to other modes.

The objective of the study is to analyze the role of weather conditions on passenger mobility in case of Mumbai Suburban Railways. Three major weather conditions - temperature, humidity and wind speed, have been taken into consideration whereas passenger mobility is measured in the number of tickets sold through the major ticket booking systems. The study analyses the daily data related to the number of passengers travelled and meteorological conditions. The fundamental research question is "How weather conditions affect the total passenger mobility of Mumbai suburb railways?"

Wavelet Coherence and Quantile-on-Quantile Regression approaches have been used to check the association among them for the daily data from 2012 to 2017. The result of the first method of Wavelet Coherence portrays the negative association of aggregate passenger movement with temperature and humidity in the short to medium term, but mixed results are found in the long run. In the case of a passenger-wind association, the results are mixed, and the co-movement is found to be both negative and positive in the short to medium term, whereas in the long run, the

relationship is periodic. All the three variables, i.e., temperature, humidity, and wind, are found to be the leading indicators, which act as predictors for passenger movement in aggregate mobility analysis. The analysis has also been done for different ticketing services because the availability of tickets may affect passenger mobility during inclement meteorological conditions. In the case of three booking systems, both mixed and differential results are found, which shows that ticket services may have a different role. For example, people with monthly pass are more likely to travel irrespective of the meteorological conditions, whereas people who buy a daily ticket either from booking office or e-ticket, the decision of travelling by train may get changed. For a more comprehensive analysis, the study also used the QQR approach. The results of QQR show that the rise in temperature leads to decrease in the total number of passengers travelled. However, the differential results at different quantile show that at the peak of temperature, people try to avail the services that reflect travellers' adaptability to the continues increase in the temperature. Humidity has a positive relationship with passenger movement in all the quantiles. Nevertheless, the rise in passenger movement due to humidity is declining, which shows that initially, humidity may not have a powerful effect on passengers' movement but if humidity prevails for a longer time, people feel tired and dehydrated, thus reducing the increase in passengers' movement. The Passenger-wind relationship shows a periodic fluctuation in the impact. The QQR results are more segregated and vary across the three booking systems. Overall, the results show that the selected weather variables are serially correlated with passenger mobility. The results show that the impacts of extreme weather conditions tend to converge for aggregate passengers, whereas the impacts largely differ based on various ticket booking systems.

Results have important implications for transport planner to design the infrastructure and improve operational efficiency during the extreme weather conditions in coastal cities like Mumbai. Such transport system would not only to increase passenger mobility but also the experience and safety of the passengers.

Moreover, one size fits all approach can not apply especially in case of Mumbai suburban railway given the need, demography, and geographical conditions of the city. Weather disrupts the regular traffic, which may pile up to huge losses and safety issues, as it has reported that high temperature, wind speed and humidity leads to more accidents (Stern and Zehavi, 1990). The study will act as an essential signal for transport planner that how traffic volume is affected by maximum temperature, wind speed, and humidity. The adaptation to different practices for dealing with adverse climate may be helpful in passengers' movement or traffic shift during unpleasant windy, warm and humid atmosphere. It is essential to manage potential amenities and improve operational efficiencies such as more AC coaches, seating facility in the shelter, shedding, shutter services, elevator and consumer-friendly other additional services. The suburban rail has prominent importance compare to any other mode in the city; therefore, tackling weather conditions are not only crucial for mobility but also for the safety of the passenger. The finding may have implications for other public transport and suburban transport system in other cities with homogeneous climate and geographical conditions. The results may b ehelpful in addressing the disruptions of the timely reaction of the passengers' travel demand because of the adverse meteorological conditions. It may help in exploring the ways to improve the services and sustainability during weather fluctuations.