Model for Crowd Distribution in Public Transport Buses

Ved Prakash Mishra, Amna Rafi Chaudhry, Kajal Shah Surname

***Abstract*—Public Transport plays the major role in growth as well as to make the pollution free environment for any city. In this manuscript, the result of a survey from a public transport is analyzed in regard to the public convenience. After analyzing the problem as well as past research in this area, a new model is being proposed which may help to the commuters for not picking the crowded buses and how can they reach to their destination easily without any difficulty.**

***Keywords*—bus crowding, display system, trackers, road display system, peak hours, car sharing**

I. INTRODUCTION

A well-planned transportation system has a great impact on the quality of life of people and the environment. Quality of life greatly depends on the kind of environment we live in, and a weak public transport could encourage people to use their individual car and thus could leave an impact on the environment by increasing carbon footprint. Ideas which reduce the use of individual usage of cars is encouraged worldwide. Urban level initiatives such as the idea of car sharing has been uplifted by high population metropolitan cities of the world [1] e.g. dedicated car pool lanes in California reduce the traffic congestion during office hours [2].

Since public bus services are used globally they provide an opportunity for economical and user friendly transport but from a user perspective there might be difficulties in smooth navigation and travelling. This can be attributed to the numerous bus routes and waiting time involved. For example London alone has 700 different routes for buses whereas Madrid has around 400 routes for buses and 4,500 bus stops.

Also some cities have bus routes which change with timing for example night routes are different from day routes, some routes are faster yet other are slow. These routes also have to be coordinated with respect to the timing of subways, trams and other means of transport. All these reasons can reduce the efficiency of bus systems and especially for elderly, disabled people and tourists who are not familiar with the city layout and bus routes. These passengers are cumulatively known as *disadvantaged passengers.*

A recent change which has shown improvement in working of bus routes is the use of mobile apps and systems. These online tool help passengers find the convenient of fastest route. Answers to questions such as is there a need to take bus C or which route will be the shorter is provided through these apps. Also questions such as when the next bus leaves are answered.Disadvantaged bus users usually have a greater requirement for information which is more fine grained to 'micro-navigate'. [3]

In this regard crowding of a bus plays a major role in decision making whether a bus route should be taken or not. Since urban activities keep changing in different parts of the city an efficient bus route with less crowding drastically enhances user comfort. The following graphic is a representation of the general perception of crowding in a public transport vehicle and at which point necessary steps need to be taken to reduce crowding. [4]

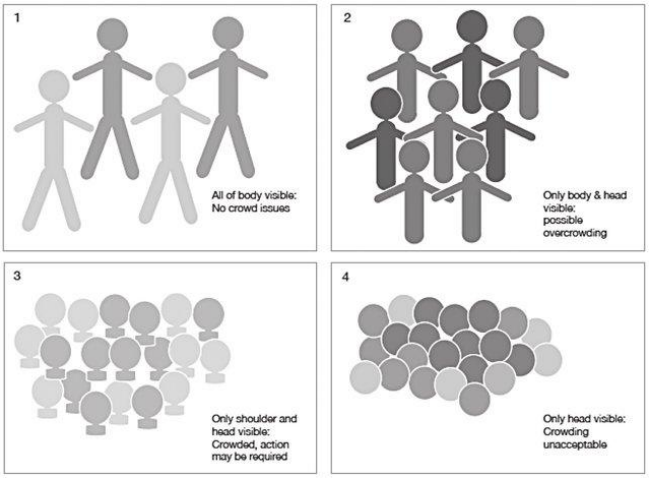

Figure 1. Graphic representations of public transport crowding [4]

Quantification of crowding in a bus by passenger perception is not typically incorporated in public transport modelling. Public transport crowding usually affects only the nominal travelling duration unless there is denied boarding.

Recent apps are taking into consideration real-time public input on how crowded was the bus they rode. Although this perception might vary from user to user but it provides partial accuracy to the decision of the next bus user.

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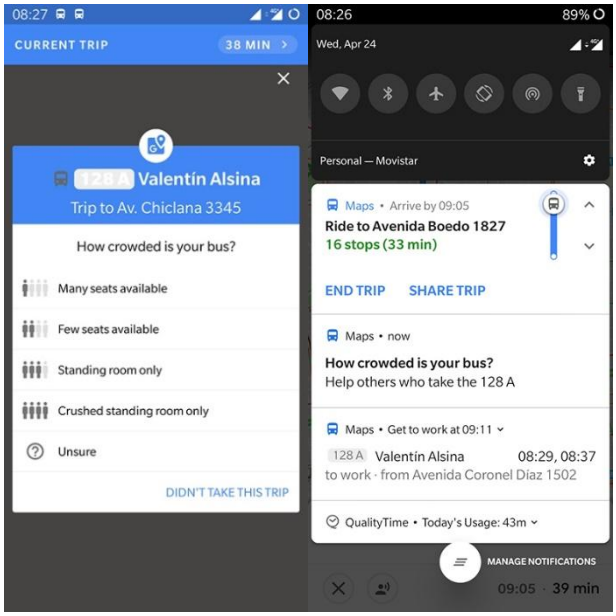

Figure 3. Mobile app collecting data of bus crowding [5]

II. RESEARCH SIGNIFICANCE

A. Efficient Usage of Public Transport

Efficient organization of public transport is very important as it can reduce a lot of environment and traffic related problems. The intensity of use of personal cars on the roads, leads to a lot of traffic congestion and pollution in many cities [6]. Dubai is one such example, the roads and transport authority started in 2005 and since then has sever a large number of population. The number of passengers using bus escalated from 107,850,049 in 2012 to 167,929,519 in 2018, which explains why public transport is such a vital factor for growth of any city [7][8].

B. Revenue Utilization

Public transportation is a key factor for growth of any city. These days majority of the economical and organizational activities are started in the area which are close to a public transport system. Due to this urbanization, population growth and economic development are exposed to mobility problem. Thus public transport is a vital part of different category of user, be it working class, students or tourist [9].

As cities become bigger public transport becomes an even more pressing issue. In smaller towns people who cannot afford a car mostly use public transport [10]. As cities grow citizens having financial possibilities for buying a car rather prefer to use public transport in order to reduce traffic problems and support more efficient land use patterns. There are many factors which can affect public transport demand such as demographics, quality of facilities, price of alternatives and land use patterns.

Also at an urban level the different zones of the city should be planned keeping in mind the public transport [12].

C. Reduction in Stress Level

When people are encouraged to use more public transport, not only the environment has a positive impact but also the social life is changed as they would meet different people on the way which would lead to a healthy day to day human interactions.

A passenger feels increased dissatisfaction due to diminished privacy and increased stress when he is travelling in crowded public transport. Similarly for the service provider crowding signifies service level of any public transport [4]. The following graphic explains how perceived crowding effects the health, stress and overall perception while using public transport

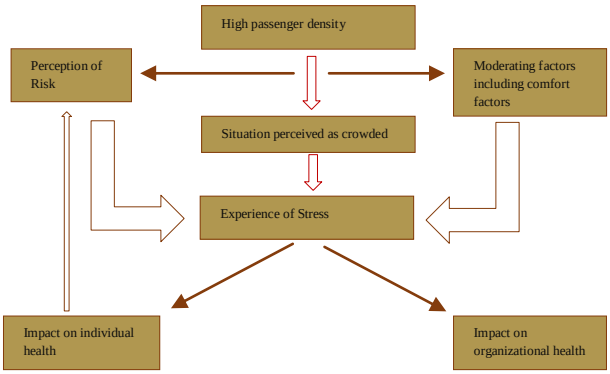

Figure 2. Graphic model of perceived crowding, health and stress of humans using public transport. [4]

III. RELATED WORK FOR CROWD DISTRIBUTION IN PUBLIC TRANSPORT

D. Mukundan et al. have worked on crowd conscious internet of things enabled smart bus navigation system. They have devised a model which provides real time information of the bus which is arriving at the stop. Each bus is fitted with IR sensors which count the number of passengers entering the bus. The first IR calculates the in count and the second IR calculates the out count. This information is collected by an IOT modem.

The bus information is stored in a cloud which is displayed on the LCD Display Boards located at bus stops. If the density in the arriving bus is too much an alternate bus option is shown thus helping passengers to make a decision to take the next bus. In this way users are able to make decisions promptly by real time monitoring of crowd density, time of arrival and information regarding traffic is processed and displayed on a board near the bus stop [13].

Menno Yap et al. in their study for Crowding valuation in transport systems based on smart card data emphasize on how crowding can affect user choice of selecting different routes. The results show that according to preference experiments there can be a tendency to overestimatecrowding values. Further studies are suggested for calculating distribution of passengers in the vehicle [14].

Zheng Li et al. in their study regarding objective and subjective measures of crowding propose a number of methods to deal with crowding. A common one is to increase frequency of vehicles or capacity of transport systems. Another suggestion is to improve the tolerance of traveler through improved design and overall services. This can be done by providing proximate seating instead three seats in a row. Perceived crowding can also be reduced by improving air quality, air circulation and pleasant sound systems [15].

Stefan Foell et al. have researches on how to use public transport experience through use of IoT. The proposal consists of an Urban Bus Navigator which is a reality based urban navigation system which recognizes and tracks actual bus networks for bus passengers. In this the navigator re plans according to the movement of passenger and bus. It also provides personalized information aiding users to decide if they should take the next bus, whether they are on the correct bus and how long will be the remaining bus trip. The system comprises of Semantic Bus Ride Detection and Dynamic Trip Tracking system [16].

Andréde Palma et al. in their research on the economics of crowding in rail transit study the decision of rail transit users who make choices of traveling early of late based on cost of ticket and how crowded is the public transport. As expected trains which have no fares or same fares for all timings are more crowded at peak hours. This can be controlled by having time dependent fares [17].

Xiao-lei MA et al. in their research on transit smart card data mining for extraction of information of origin of passenger developed a decision tree algorithm which extracts data of passenger using GPS data loggers. This was required since in Beijing there was no system for extracting data when a passenger boards a bus. This information is of use for route optimization and transit system planning [18].

An upcoming addition to google maps shows if the bus has available seats and how crowded is a train or bus but this system is not directly linked to the card linked to the server of the public transport system. This is based only on user feedback. The survey includes questions such as how many seats are available, if there is standing room only, if people are crushed or cramped [19].

IV. A SURVEY ON USER EXPERIENCE OF BUS CROWDEDNESS

Objective of Study

Major growing cities have an ever-changing map with new projects and sprawled developments happening in an everyday, but with this everchanging map it's also important to understand the quality and the quantity of the public transport system. Along with the development it is crucial to provide enough reduced crowding in public transport systems.

This survey tries to understand the ease of accessibility, cost and passenger satisfaction and review the public transport network. This survey also studies the facility planned for the easy working for the public transport and how strong the transport routes are to make sure different areas are well connected with respect to the human traffic flow and the function of the area.

Methodology

This survey was conducted on a sample size of 33 bus users, based on random sampling for a bus route of forty minutes. The total number of seats are 40 with maximum bus capacity for 68. The residents are mostly students, working professionals or a few retired citizens. The survey questions are based on how convenients it is to find a seat, user satisfaction of travel and time taken to travel shown in table 1.

TABLE 1: SURVEY CONDUCTED ON USER EXPERIENCE OF BUS ROUTES ASD CROWDEDNESS

SURVEY ON USER EXPERIENCE OF BUS CROWDEDNESS		
Questions	**Responses**	
How often do you travel by Public Transport Buses?	Almost everyday	69.70%
	Few days a month	15.15%
	Few days in 2 months	15.15%
What timedo you travel by Public Transport Buses?	7:30 -8:00	23%
	9:00-11:00	32%
	4:00-6:00	45%
Do you get a place to sit ?	Yes	45.45%
	No	54.55%
How crowded is the bus during your hours of travel (percieved number)?	78	
How many hours do you spend in the bus going and coming?	1-2 hours	65%
	2-3 hours	35%
Is the bus stop available near your place?	Yes	90%
	No	10%
On a scale of 1-100 how satisfied are you with the journey ?	55	

As the survey shows that most of the users find the bus crowded during office hours and do not find a seat. The results of the survey would be used to propose an algorithm which reduces the issue of peak hour crowding.

V. PROPOSED ALOGRITHM FOR CROWD DISTRIBUTION IN PUBLIC TRANSPORT BUSES

A new model is proposed which is being implemeted to develop a mobile app through which commuters can get live infrmation about the different routes and crowd status in each bus. This app will provide an alternate option where combination of more than one buses could be used. Commuters arriving from different source stations yet planning to reach the same destination can chose to shift to another bus coming from a different source stations yet ultimately reaching the same destination. This change in route will primarily be done to take up the option of a lesser crowded bus. The destination and fare will remain the same. Figure 1.1 is showing the proposed model.

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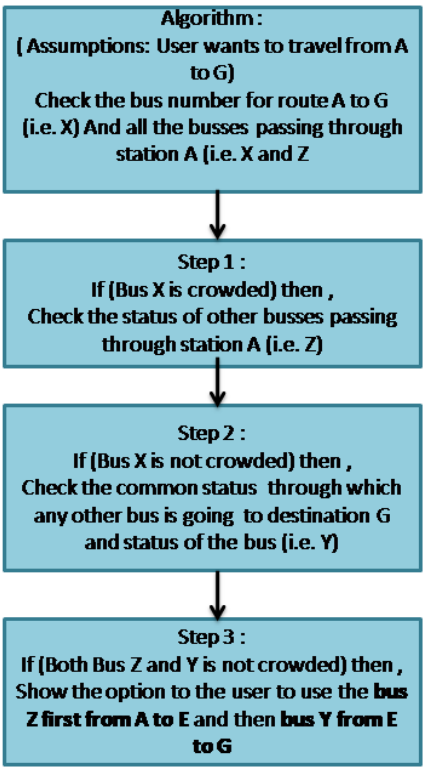

Fig 1.1 Proposed Algorithm

Figure 1.2 depicts the example of the proposed algorithm where three buses with different routes have been considered i.e. X, Y and Z.

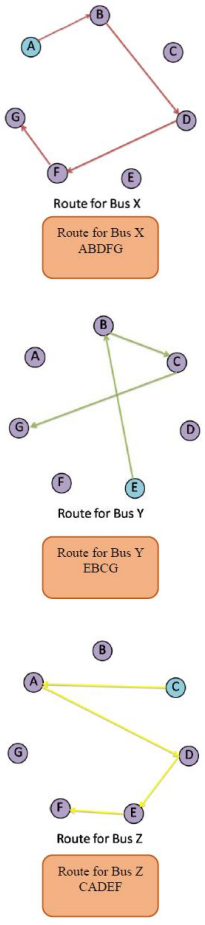

Fig 1.2 Routes of the different buses with halting stations

Suppose a commuter initially plans to take bus X passing but it is overcrowded. Through the app he will be provided the option of checking the common station through which any other bus such as Z and Y is going i.e. E, as shown in Fig 1.2. Now from source station A, commuter will leave the crowded bus X and will take the bus Z from station A to station E. From station E he will take bus Y for the final destination point G.

CONCLUSION

In this manuscript is analysis is done on the survey from the daily commuters by public transport i.e. bus and it was found that commuters have faced the problem due to the crowd on prime time. Review of past research is also done and on the basis of that a model is proposed through which this issue could be resolved in efficient manner.

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