A Survey to Justify the Need for Carpooling

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Abstract*— In India people mostly prefer road transportation to move around places. The increasing number of vehicle on road lead to several issues as congestion, environmental degradation and energy problems. Research and development have been progressively done in this field to reduce the environmental degradation and for the better utilization of fossil fuels. Different approaches and techniques to solve these issues emerged which address fields of emission reduction, increase efficiency of vehicle, energy alternative, decrease the road density with care of safety and comfort, etc. In this paper survey on these emerging drifts and elaborate on one of the ways to reduce the vehicular density and emission, we have identified carpooling as one such solution to provide user, flexibility in time, enjoyable, efficient and safe ride.

***Index Terms*— Drivers, Efficiency, GHG emission, HOV [high occupancy vehicle], Passenger, Road density, Safety.**

I. INTRODUCTION

India is the second largest road network in the world. It has a road network of over 4,689,842 kilometers (2,914,133 mi) in 2013. For every square kilometer of land there is 0.66 kilometer of road. Thus the rapid increase in transportation makes it difficult to provide basic infrastructure for vehicular population.

The increasing need for mobility has brought about significant changes in transportation infrastructure. Inefficiencies cause enormous losses of time, effect on environment due to increase in pollution, degradation of quality of life, and nonrenewable fossil energy depletion. The scope of this paper is to introduce need of a mobile based solution to this problem which jointly manages the traffic problems and the safety.

Carpooling is when two or more people sharing their car journey together from different households in order to save money and to protect the environment by burning less Gasoline and enjoy each other's company together. From the computational point of view carpooling services uses a web page as interface between different people, who becomes a board and manage their displacements together.

Carpooling is seen as a more environmentally friendly and sustainable way to travel as sharing journeys reduces carbon emissions, on the road traffic congestions, and the parking spaces desires makes authorities often encourage carpooling, especially during high pollution periods and high fuel prices. Also by having more people using one vehicle, carpooling reduces each person travel cost such as fuel cost, tolls, and the stress of driving. This paper describes the issues related to the traffic infrastructure in section 2, in section 3 we discuss the existing research and development, in section 4 proposed solutions. Finally in section 5 we conclude the paper.

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II. TRAFFIC INFRASTRUCTURE

Energy security and global climate change present particularly tough challenges for transportation, much less progress has been made on reducing overall oil consumption and GHG emissions from transportation. Annual highway fuel consumption, almost all from petroleum-based fuels, increased 59% between 1973 and 2007, from 110.5 to 176 billion gallons (Davis et al., 2009, Table 2.11). U.S. crude oil and petroleum product imports have increased from 6 million barrels per day in 1981 to 12.9 million barrels per day in 2008.

In [1] Tiwari, shows that in India only urban population is 285 million and 100 million rural, this data is sufficient to indicate the travelling patterns and needs. Although 20-65 % of total passengers prefer bus, who skeleton service provided by municipality in most of cites is not well-intentioned to carry the load. 2006 onwards city and central governments both have paid attention in road infrastructure development to solve transportation crisis. In Delhi, the total funds allocated for the transport sector in 2002–2003 have doubled in 2006–2007. However, 80 per cent of the funds have been allocated for road-widening schemes benefiting primarily the car and motorcycle users.

In [2] shows the statics of Delhi, the total number of vehicle in delhi in 2009-10 it was 6.4 million, in 2010-11 its 6.9 million, in 2011-12 it was 7.4 million and in 2012 -13 it has become 7.7 million and this rate is increasing rapidly and shows the demand of proper transportation planning and development.

However in [3] Jonathan Norman1 et al, indicates three major elements of urban development transportation is one of them. The result indicates that the most targeted measures to reduce GHG (Greenhouse gas) emissions and reduce energy in an urban development context should be aimed at transportation emissions.

III. EXISTING RESEARCH AND DEVOLOPMENT

As we have discussed above, about the problem of increasing road density, the extensive emission of GHG and reduce energy, there are many research have been progressively done in these fields.

In [4] Hirschman et al, suggests a speed profile for all vehicles within the network using traffic flow simulator VISSIM and PHEM

(passenger-car and heavy duty Emission model) which calculates vehicles fuel consumption and emissions using speed trajectories as model input. However the overall model performance was evaluated by comparing the calculated and measured PHEM emission based on simulated speed profiles and the 'on-road' driving cycles.

In [5] Vivek Tyagi and Raghuram Krishnapuram , extracted spectral envelope features of the cumulative acoustic signals, and model their class-conditional based probability distributions, conditioned on one of the three broad traffic density states namely- Jammed(0-10KpH), Medium-Flow(10-40Kph) and Free- Flow(40Kph and above) traffic. Here, the proposed solution is based on data that been collected from different traffic zones, the accuracy of data provided may not be up to the mark, it may get distorted while transmission.

In [6] Dimitrakopoulos et al, introduces a novel functionality for providing knowledge to the vehicles, thus jointly managing traffic and safety. The proposed design to achieve the high functionality will compromise sensor network formed by the vehicles of certain vicinity that exchange traffic related information and cognitive management functionality in the overall transportation infrastructure. The goal of this paper is to issue directives to the driver and the overall transportation infrastructure valuable in context handling. Practically, providing an intelligent system and implementing on each and every existing vehicle is nearly impossible.

In [7] Heinz Jansen and Cecile, with the EUCRAS model policy options are simulated to reduce passenger transport emissions in Europe. Consumer surplus, congestion and tax revenues are the changes included in the EUCARS welfare analysis. Simulations also address consumer myopia, i.e., the underestimation of fuel costs by car buyers. To correct the assumed myopia the best policy mix is to reduce CO2 consisting of fuel taxes which are combined with differentiated purchased taxes. Over 25% of CO2 emissions can be reduced with the above combination without reducing contemporaneous well-being. Conventional emissions can be reduced by a equivalent best mix which includes an emissions-based kilometer tax combined with a purchase fee bate. Without any noticeable welfare reduction the above mixture allows a 60% reduction in toxic emissions. The overall superiority of these two mixes compared to alternative choice is higher when the evaluation includes a broad group of externalities, a premium and public funds and positive feedbacks across emissions categories. For an overall initial strategy the local traffic management measures are important zero-cost compliments.

In [8] Moshe Ben-Akiva and Andre de Palma, here develops a dynamic model of peak period traffic congestion that considers a limited number of bottlenecks. This model uses an elastic demand model to predict the temporal distribution of traffic volumes. Travelers can change to different mode or shift the trip forward or backward or divert to an alternative route in response to change traffic condition and to avoid a long delay. For a case study the author has taken a simple example of travelers jointly selecting the route and the departure time and two parallel routes. The routes and modes can be chosen based on traveling cost and traveling time. Departure time can be chosen based on tradeoff between scheduled delay (it's a difference between desire arrival time and actual arrival time) and travel time. The delays of the bottlenecks are modeled with a deterministic queuing model that determines waiting time as a function of the length of queue at the time of arrival at the bottleneck. The adjustment of day to day distribution of the traffic is derived from a dynamic Markovian model, this model performs simulation experiments. This simulation result demonstrates the response of it at the bottleneck to a change in system. This model is used to analyze the impacts of alternative pricing policies and preferential treatment of high occupancy vehicles.

In [9] Jason Hill et al explain that the Negative environmental consequences of fossil fuels and concerns about petroleum supplies have spurred the search for renewable transportation biofuels. Biofuel should provide a net energy gain, have environmental benefits, be economically competitive, and be producible in large quantities without reducing food supplies to be a viable alternative. Based on life-cycle different biofuels are compared, ethanol from corn grain and biodiesel from soybeans, result states that the biodiesel have advantage over ethanol because it has lower agricultural input and high feedstock to fuel. Biodiesel provides sufficient environmental advantages but with high production cost. Other alternatives to transportation biofuels such as synfuel hydrocarbons or cellulosic ethanol, if produced from low-input biomass grown on agriculturally marginal land or from waste biomass, could provide much greater supplies and environmental benefits than food-based biofuels.

In [10] Olof Johansson and Lee Schipper, focus on oil crisis that led studies on energy demands, and the oil import led to design energy prices in order to reduce its usage and concern towards environmental problems as emission of CO2. By estimating separately total vehicle stock, mean fuel intensity and mean annual driving distance, based on a new data set consisting of 12 OECD countries from 1973 to 1992 estimates a long run fuel demand. Price elasticity for a part of estimated long run fuel arises from changes in mean fuel intensity, while the long run income elasticity arises largely from changes in the number of cars. The effects of changed taxes on car ownership and use are significant, but smaller than the change in fuel tax.

IV. PROPOSED SOLUTION

In spite of the research and development that been carried out in different fields there are drawbacks and assumptions that are been made to arrive at solution. So we propose an alternative solution i.e carpooling. Research shows that there are reasons why carpooling will be a better choice.

A. Why carpooling

In [11] Sisinnio Concas, Philip L.Winters, proposes a hypothesis in an activity-based framework that says the carpooling imposes a constraint on the way individuals organize their

activities , with resulting impacts on traffic peak congestion and trip-chaining behavior. The hypothesis was tested by estimating the joint probability density functions (PDFs) of subsistence, maintenance, and discretionary trips made by carpool and single-occupancy vehicle (SOV) users. Results show that whereas SOV maintenance and discretionary activities are linked to subsistence trips in a joint undertaking, carpool activities suggest discontinuity in the formation of trip chains. A comparison of the joint probability density functions of subsistence and discretionary activities reveals that trips are conducted either before or after the commute schedule; this results in a temporal shift that reduces peak-period traffic congestion and emission pollution. Marked differences are found to exist between SOV and carpool trip-chaining behavior. Carpoolers are more likely to engage in a greater number of cold-start trip chains; this behavior uncovers a potential negative impact on emission pollution. These findings suggest that a comprehensive approach to the evaluation of carpool programs must take into account the benefits as well as any ensuing negative externalities

In [12] Moshie Ben-Akiva and Terry J. Atherton, tells about range of occupancy of private automobiles used for home and work locations. The range of private automobiles used for work trips is 1.2 to 1.4 persons per car and the average occupancy of car pools is about 2.5 persons per car. At most 13 percent of vehicle carries 2 or more persons and 28 percent of auto commuters are sharing rides. This figure shows the great deal of work trips, and then carried by public transports in most urban areas in US. The paper extends the reasons for carpooling: these include savings in travelling expenses, limited parking space, and poor transit service for individual who cannot drive. An attention has been paid on potentials of increasing carpooling for reducing fuel consumption and traffic congestion and improving air quality. This paper presents a methodology for short range transport which is based on the application of disaggregated travel demand models.

The authors [13][14] threw up some interesting fact about why carpooling. Without carpooling, the amount required for 968,316 kiloliter petrol for 1.3 mn cars is Rupees 4,213 crore per annum. By carpooling, this amount reduces to Rupees 2902 crore. Thus, revenue of Rupees 1310.98 crore can be saved by saving 301,307 kiloliter petrol by carpooling. This case study was applied on traffic of Delhi.

Considering the fact that the study was done way back in 2007, the numbers must have obviously spiraled up. So go on make a carpool to ride to work.

B. Technical Resolutions

Subsequently, several technical solution also provided to improve carpooling services.

In [15] Burmeister, B. et al, in this author uses a new approach called Agent-Oriented techniques which supports the whole software development process. All the phases in the software development process are treated with a single uniform concept, and the system modeled by a collection of agents which is called a multi agent system. And these Agent Oriented techniques can be used as advance in information technology can help to respond to the growing interest in traffic and transport more efficient, ecological, and resource saving. The Author gives a huge range of applications where multi agent system can create a great impact in this domain.

In [16] Lalos, P et al, Carpooling is the concept of people sharing a vehicle for a ride when their departure and destination locations are similar. Dynamic car pool is the dynamic coordination of ride offerings and ride requests based on the, in real time created, transportation and offering needs. Taxi pool is a mode of transport that falls between private transport and conventional bus transport. The routes are fixed or semi-fixed, but with the added convenience of stopping anywhere to pick or drop passengers and not having fixed time schedules. Positioning Systems are systems for finding the location of a mobile device using several different positioning technologies. This paper describes how Positioning Systems can be utilized in order to support a dynamic network of car and taxi pool services that will maximize the exploitation of empty seats traveling with tenable advantages.

In [17] Kavita Sheoran et al, suggest that increasing number of vehicle on road have caused several issues. And with the help of intelligent transportation system (ITS) it can be solved with ease. ITS can be applied with ride sharing which will provides dynamic booking, travel and on-board navigation system departure and facility that user could trace the location. There are different ITS techniques are mentioned as GPRS and Bluetooth, Vehicular Adhoc Network based system, RFID based system, etc. With help of statics and the case study in small region he shows that is can make a huge difference in traffic congestion, parking deficiency, and co2 emission situations.

In [18] Tejas Talele et al, introduce the problems related to traffic, and then brief of other similar project as carpooling.com, waze.com, etc and their limitations. And introduces an adhoc ridesharing which tackles the traffic issues and provide an additional in-built social media platform. With 800 million active users on facebook online social media can have an advantage. And explains that interaction for the ride sharing can be easy, use can invite any one for ridr sharing and view its profile and after the ride can give feedback so people can refer it before ride etc. The system implement without compromising user functionality and ease of use.

In [19] Swati.R et al, states the reasons of not proper participation is unavailability or portability. And suggest android mobile application as solution, which contains rating, comment on user and user information, and explains that through an android application can be more hande. Explain the architecture and the design of the system. Through an interactive graphical representation it shows its effect on congestion, cost reduction, fuel reduction, usability, etc.

C. Carpooling why not embraced reason

In spite of these comparison measures and technical improvements suggested carpooling is still not a widely adopted service.

In [20] Gonçalo Correia and José Manuel Viegas, Supports carpooling and gives two reasons for the limitation of its success: the psychological barriers associated with riding with strangers and poor schedule flexibility. They suggest a solution to group the riders for traditional groups based on a trust level for the compatible match and at the same time allowing searching for a ride in an alternative group when pool member has a trip schedule different from usual. On a web survey they found through a binary logit Discrete Choice Model calibration that saving money is still an important reason for participating in carpooling.

In [21] J. D. Hunt et al, performed an experiment to examine the various influences on the decision to carpool to work. 678 interviews were totally conducted, for each interview five successive pairs of automobile was presented to the each respondent and asked to indicate which alternative was preferred in each case. The respondents were forced to trade off among condition regarding specific attributes. Several socio economic characteristics of respondent and attributes of the respondent's actual trip to work were also recorded, and the contents of the hypothetical alternative presented were adjusted accordingly .To estimate the parameter value from the observation for different utility functions in logit models representing this choice of behavior. The results indicate that the extra time spent in the automobile serving other carpool participant is valid at the premium rate of about 4 dollar per hour more than the automobile ride time for the direct trip. The availability of the guaranteed ride to home has a value roughly equivalent to basic transit fare in Calgary. Each additional household member in the carpool adds for the benefit in a reasonable linear manner, but does not alter the effect of parking cost of the respondent.

As in the Article [22] presents the view of different commuters that why not carpool, and the main concern that most people have is safety.

Finally based on these studies we can conclude the parameters that are hindering adoption are safety, flexibility in availability time, trip-delay, and level of comfort.

V. CONCLUSION

We have made a survey on issues related to traffic, briefed upon on various research activities that have been carried out to overcome these problems, identified carpooling as one of the solution that can be adopted with ease. The various obstacles that are hindering the adoption of carpooling are discussed. In next paper we tend to propose a system that addresses these obstacles.

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