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Analyzing the Real Time Factors: Which Causing the Traffic Congestions and Proposing the Solution for Pakistani City

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Abstract

Vehicle ownerships integral part of modern life and traffic congestion an unavoidable inconvenience. The Western countries have a far better control on the pace of number of vehicles on a road matched with supporting infrastructure. In contrast, cash strapped underdeveloped countries have a poorly built and scarce number of main roads with problems compounded by soft car loans, leases and other discounts. As a result several developing countries have been inundated with peripheral complications such as pollution and congestion undermining their economy with enormous energy bills negatively impacting respective economy. Case in point is Pakistan, where depilating infrastructure or absence outright thereof and ever more number of vehicles on the road presents a unique and highly complicated problem. One can term traffic in Sub-Continent as controlled chaos and we plan to develop an organized solution from the chaos. This presents a unique challenge in traffic management. We have developed a smart phone application when the phone is placed in vehicles, provides data for the origin and destination routes. Taking 6 parameters, which we believe mostly impacts the destination arrival time for the driver in Pakistan we propose to develop a model supported by empirical data that will enable driver to select weather they are interested in economy of fuel or economy of time in reaching their destination. We propose to plot time it takes to reach destination versus the 6 factors that determines destination arrival time. The curve will be generated for each route and from the graph median time, standard deviation as well as confidence interval will be computed. Large data will be collected and statistical analysis will be performed to verify the integrity of the model.

Selection and Peer-review under responsibility of the Program Chairs.

Keywords: Traffic Management, Congestion Control, ICT

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1.0 Overview of Study Area

This research is related to traffic problems in Urban cities of Pakistan. Where certain hurdles slow down the traffic and commuters feel helpless and caught in situation, from where commuter stranded and pay the price in terms of cost and time. There will be six different hurdles/obstacles will be observed which are the main cause of the slow down the traffic. The city of Islamabad in Pakistan is selected for gathering data on 10-11 different routes which are directly related with any point of start and end for commuter run. The city of Islamabad is one of the planned city of Pakistan and established on grid style. The capital of Pakistan was shifted from Karachi to Islamabad in 1964 and small town was converted into Metropolitan city. The one of the reasons is that there is twin city Rawalpindi which is just few kilometres from Islamabad. These two cities are adjacent to each other and in recent time around 100,000 people commute on daily basis from Rawalpindi to Islamabad. In early 70s, there was one single road with two lanes linking between two cities. The movement of these 100k people every day to capital city created a lot of traffic issues and lack of public transport system added more difficulties for commuters. Due to the lack of public modes, like metro system, subways and public buses which are essential commodities for any metropolitan city and country, like Pakistan, still in developing stage, it could not afford to have these essential public needs. In addition to traffic conditions in Pakistan, this country is struggling against the energy crisis with 35% and 25% of the current deficit in peak and off-peak days, respectively. Moreover, the population in this city is reached up to 2 million from 100,000 since 1964.

2.0 Observed Hurdles

2.1 Behaviour of Commuter

The behaviour of commuter is serious issue in Pakistan. One of the reasons might be that people get driver's license without taking proper written and driving test. Licences are issued on personal contacts and in some cases people take classes from local driving schools, most of them are not authorized to run such facilities. Due to a lack of proper driving rules and regulations, people do not seem to well know about these. Therefore, behaviour is transferring from generation to generation and one see that behaviour in all ages. Commuters do not care about such rules and intend to reach to their destinations without following the traffic rules. This behaviour causes more delays and in turn, creates traffic congestions. Even, most people do not maintain the lanes and try to move their vehicles from one lane to other frequently.

As Pakistan has more small cars than any other part of the world, in reality it causes more congestion. Because most of the time, two small cars stay in one lane and they switch lanes right to left and left to right depending upon the space they find, and big vehicles drivers behind them get frustrated and cannot over take the small vehicles easily. Although on site traffic warden play their role and guide the commuters to maintain the lanes and sometime they achieve their goals, but when they are out of site same situation occurs again. This is serious issue, and traffic police is trying different methods to teach the commuters to follow the traffic laws and even install paging system on the crossing and traffic signals and continuously playing the rules, so may commuters listen while standing at traffic signals, and sometime walk to the vehicles and explain them what traffic rule they are not following and sometime distribute the brochures. This shows that how much traffic police is serious about giving knowledge to the commuters but real issue how many are taking this seriously and would like to learn the traffic rules. There are few private transport vehicles available for public on limited routes, which runs by local transporter and each transporter owns 5-10 commuter vans with capacity of 12-14 passengers. The drivers of these vehicles drives very dangerously and sometime even ignore the red light of a traffic signal to reach their destination and getting more passengers on the next bus stop. Similarly they stop where ever they find passenger standing other than designated Bus Stop and block the lane and creating congestions for whole traffic behind them, and in that situation the vehicles behind them change the lanes, and which create delays. It is obvious that those who obey the traffic laws they suffer more and reach to their destination much later as they expect, whereas pay the price in terms of cost and time by obeying the traffic laws.

2.2 Establishment of Schools

There are no restrictions from government authorities for private sector educator to establish school in residential areas or main boulevards, schools are established in any locality in multi-story house and crowding together 200-300 students from grade 1-12 and without playground or other essential features that are normally a standards for establishing the schools. These schools are even opened on residential lanes and there is either one lane or two lanes with total width of 30 feet including the shoulders. As mentioned earlier, since there is no public transport system in Islamabad such as buses, subways, etc., people drop their kids on their own vehicles and in most case the children drop off line extends to major roads.

Let's assume that if there are 300 kids in a school, at least 75-100 vehicles will drop them at one facility and these vehicles have to reach school within time span of 15 minutes and due that scenario whole road is blocked from both directions and adjoining major road. Vehicles are stuck and as mentioned earlier that behaviour of the commuters are abnormal as compared to West and every vehicle tries to leave kids in front of the school gate so they block the shoulders and even other houses entrance gates. Few snaps are provided the real scenario to understand the situation. The same arises during the close of the school session every day. So there are two peak times for this kind of hurdle, one which starts from 7:30 am – 8:30 am and second start from 12:30 pm to 2:30 pm. Very few schools have their own transport, and if they do have they only carry 15% - 20% of the students from total strength, and remaining comes on their own transport. The requirement of opening such kind of schools are due to two major apprehensions; one is government didn't increase the capacity of the existing public schools and secondly new government funded schools are not opened at regular interval, although two obvious reasons, the increase in population of the Pakistan with the rate of 2.8% yearly and migration of people from rural to urban area due to non-availability of the jobs and less development in rural areas and government more focuses on urban cities and Pakistani cities are expanding at exponential rate. From the meagre resources of which most of the development funds are utilized in urban areas with little impact for the purposes that they are intended. In reality the problems are worsening for the big cities albeit at slower pace but the capacity is reducing to accommodate the transports for new comers causing congestion on rapid scale.

Due to the fact that, these private schools opened in small houses are mushrooming, creating hurdles in traffic movement and congestion is worsening day by day and negatively impacting flow of traffic in peak hours.

2.3 Construction/Repair of the Roads/Pavements

This is another hurdle for smooth flow of traffic, it's a universal hurdle, but developed countries have implemented standards for the constructions of roads/pavements or repairing or filling the pit holes on regular basis. Such as detour, special hours like road work during the night time or not in peak hours and providing special routes or diverting the traffic to other routes to avoid congestions, minimum usage of heavy construction machinery to avoid the occupying the space. However, it is observed that in Pakistan, no such precautionary measures are taken during the road work and leave the situation in the hands of the commuters. Thus, they find their own ways and make decisions which way suits them best. Many accidents happened during the constructions work at the roads and usually when commuter see there is some pile of sand or constructions material on the road driver applies sudden breaks and vehicles behind him/her do not react as fast which causes many to hit each other, and this happens more likely during the peak hours when everyone wants to reach their destination on time and in minimum time. This is a routine matter on Pakistani roads to start construction work without intimating the commuters, which causes great hassle for road users.

2.4 Traffic Lights (Signals)

Traffic signal is universal technique to control traffic all over the world, many advance measures are taken to improve the working of the traffic signals, and sensor technology is used to improve the traffic flow, increasing comfort zone for commuters. In current scenario city like Islamabad is also equipped with traffic signals, but

reliability of the functioning of these signals are very low. The main reasons are no preventive maintenance, energy crisis, and faulty lights. When traffic signals are not working due to unscheduled power shut down then traffic signals are manage by traffic warden, if traffic warden is not available then traffic moves on its own. Unlike West where generally rules are that when traffic light stops working then commuters are aware to perceive this as a STOP sign where every commuter when they reach the intersection make the vehicle at complete stop, give others right of way and then proceed to cross the intersection. In Pakistan, you are on your own. It creates a chaos and traffic flow gets congested. The warden also create traffic congestions when handling traffic manually, they do not manage the traffic in terms of time, but move the traffic depending upon the number vehicles coming from one side and allow 2-3 minutes from one side and then other three sides gets jam packed, and one gets turn after 8-10 minutes, however when traffic lights are in process each side traffic move according to the timer pre-set for each side. This process releases more vehicles for the next crossing/traffic signal and major crossings get jammed, and usual time for commuter increase almost 4 times from actual. This practice becomes the usual activity during the electricity shut down and sometime traffic wardens deliberately turn off the traffic signals and handle the traffic manually. Every day traffic department try different options and various traffic lights are being non-functional as crossing are closed by putting barriers to close the traffic from two sides and commuters make U-turn.

2.5 Weather Conditions

This hurdle is universal, and obviously unavoidable in any circumstances. This creates serious issues for commuters in Pakistan and rate of accidents increases tremendously during rain or storms. Many areas do not have proper drainage system, and rain water started accumulating very fast and slows down the traffic especially for small size cars, and many vehicles get stuck and engines of vehicles stop working due to poor maintenance. There is average delay of each vehicle between 30-45 minutes during the rain period as compare to sunny days. They need proper training sessions, how to drive when there is rain and road are wet

Hence we can summarize traffic in Pakistan as follows;

i. The conventional technique as developed in the West will not work
ii. Pakistani traffic does not heed to traffic lights
iii. Pakistani traffic does not obey law
iv. Pakistani traffic specializes in cutting in front of other cars
v. Speed limit is not honoured by the public
vi. Pakistani drivers do not believe in stopping for pedestrians
vii. Number of cars has increased by perhaps 200% yet the roads has not widened and very little to no new roads have been built
viii. Pakistani traffic is a combination of traffic light and no traffic light “chaos” intersections
ix. Load shedding that interrupts traffic lights
x. Lack of smart traffic lighting system – do not differentiate between peak hours and normal hours creating frustration for the commuters in general and in some cases they break laws

If one facing all hurdles as mentioned above then travel time will increase and of course, cost will also rise accordingly. The study is conducted and gathered all information as mentioned above which creats huge congestions in traffic and increasing more problems for commuters.

3.0 Methodology

In light of the above mentioned unique hurdles specific to Subcontinent and adjoining countries, a unique situation arises which does not exist anywhere else in the World. Given advance solutions that exist in West cannot be

applied as is for various reasons, such as high cost, establishing public transport systems, rapid training of public in commuters best practices and instilling this behavioural practices in the commuter. This research will propose the solution from ground up starting from a very basic approach and progressively compare empirical data with the model developed, model will be tuned until there is a decent accurate predictive capability. The developed product will be used to guide the commuter to take the path which will help the commuter to reach the destination within specified time and with minimum cost.
The starting and destination points of the commuter will be predefined and routes option will be given to commuter. The routes details will be as follows:

- *Six predefined Routes (*R_x*)*
- *Each Route will be predefined Hurdle (*H_x*)*
- *Time (*T_x*) for each Route from Starting Point (*S_p*) to End Point (*E_p*)*
- *Distance (*D_x*) covered from Starting Point to End Point for each travel of the commuter*
- C_x *the total cost from Starting Point to End Point for each Route (*R_x*) and each hurdle will have its own cost in terms of burning of fuel and time consume at each hurdle.*

For simplicity we assume maximum of six hurdles that can be faced by commuter for any given route, and cost (due to fuel consumption) and distance will be calculated based on number of hurdles and distance travelled by commuter. The data will be calculated manually and with smart phone application, which will be verified randomly. The first basic scenario will be as follows*;*

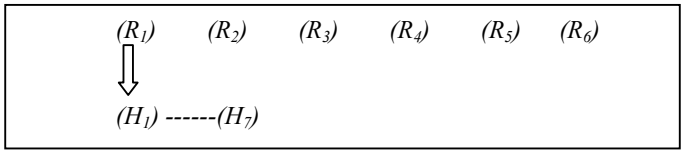

Figure 1

Figure 1. depicts that if commuter will select the R1 then commuter will face maximum of seven (H7) hurdles. Each route has various hurdles, so some have multiple hurdles and others have few hurdles. On the other side, distance increases which cause in increase of cost, however time reduces.

We will address the problem in stages. We will assume, initially, that same type of hurdles carry equal weight i.e. increase in time to reach destination is same for same type of hurdle encountered on any of the route. For example, if there is construction work on the road the delay in reaching destination will be assumed to be the same. If there is one construction on Route 1 the delay is set, for example, at 20 seconds than for ten constructions on Route 2 the related hurdles implies 200 seconds delay. Similarly, other hurdles will be assigned a number deduced from the data. Hence as a starting point bigger the number of hurdles, longer the time to arrive at destination. This assumption will be applied at initial stage of the studies and as we collect large volume of data, factor that contribute to delay in arriving at destinations will be determined.

4.0 Pre-requisites Tools

4.1 Data

Data will be collected from routes by having “test” vehicles operate through the respective routes. A smart phone will be provided, which will have log apps, and data will be collected from starting point and till the destination. Data will be log by predefined “legs” and will note the time spend on each hurdle (H), there will be multiples hurdle in one leg. Smart phone device will collect GPS coordinates with time stamp and plotted on “Google Maps”. It will be analyzed the actual speed of the vehicle with Speed limits imposed on each route, which varies from leg to leg.

4.2 Approach

Each hurdle characteristics will be analyzed such as how many lanes are available for schools, any drop and pick up lane or using the general lane, speed limit impose during the school hours, marking of the lanes, using standardize lane widths for each route, average traffic light in operation. Factors that contribute to deviation at higher level is empirically determined

Data will be collected from multiple paths by having “test” vehicles operated through the designated route. Each of these vehicles will have a mobile phone and data will be collected. Field assistant will collect GPS coordinates and any of the hurdles that are encountered during the run will be entered and time noted automatically. This data will be plotted on GOOGLE Maps. Numerous runs will be made over same set of conditions and later for different set of conditions at various time for a given route. The integrity of the data will be assured. The user will be given two choices from where they will select either

a) Minimum time to destination or
b) Economy in fuel to arrive at destination

To allow the driver to select, from one of the above two choices, we will offer maximum of 6 routes for specific “Travel” for the commuter. The type and number of hurdles for specific routes will determine the time and give commuter options in making a decision to take a particular route. The total time from Origin to Destination of the commuter depend upon the following "Hurdles" :-

1. *Speed limits vs actual vehicle speed analysed-[Commuter Behaviour]*
2. *Educational Institutions*
3. *Number of roads conjoining*
4. *Number of traffic lights*
5. *Weather condition for the particular day*
6. *Road Condition - construction, unpaved etc.*
7. *Number of lanes*

Based on our observation of Pakistan daily traffic we believe, these particular parameters plays a significant role in commuter determining from choices a) or b) above. To generate the relevant data we will carry-out following steps in our methodology*:*

Step 1: Identify point of origin A and destination B
Step 2: Identify number of routes from A to B
Step 3: Select maximum 6 routes that are most travelled by commuters
Step 4: In each of these routes identify any of the 7 "Hurdles" as described above that we have determined to effect the time in moving from origin to destination
Step 5: In each of the route identify number of times each of the or any of the 7 hurdles that will be encountered when taking the six routes
Step 6: Plot the graph
Step 7: Calculate the Average Time of Commute, Median, Standard Deviation.
Step 8: Compare data with actual time and improve algorithm (subject of follow-on work).

For the X-Axis:
Since we restrict ourselves to 6 routes for a given origin-destination so there will be corresponding columns. The x-axis is the time for the set of routes and in our case we have set it to six. Depending on the number of Hurdles and the type of Hurdles as defined from 1 through 7 above the time will be estimated to commute from origin to destination. In the initial part of our investigation, we have made an assumption that in an event there were no hurdles, the time that it takes to commute Route 1 through 6, is almost the same. This assumption will be tweaked once we have the empirical data from our future study. Route that is taken with only single obstacle results in shortest time of travel between origin to destination with minimum delay and may result in higher fuel consumption.

Note on Fuel Consumption:
Speed is one of the variables that is of concern to commuter. Our algorithm will include following assumptions in event the commuter main objective is to save on fuel. Saving fuel has the following variation:

i. *Slow speed – stop and go worst fuel economy*
ii. *Too fast worst fuel economy*
iii. *Moderate speed best fuel economy*
iv. *Speed is determined by the law*
v. *Must be entered in software*
vi. *Weather condition - slows speed by 20%*

For the Y-axis:
Obstructions along any of the Route is given along y-axis. The larger the number of Obstacles higher the column as shown in the Figure 2. Dead-end and no chance of reaching destination is not included here since the premises of this assumption stated above won't be valid for this particular. As illustrated above we propose to plot each of the path as a column in the graph.

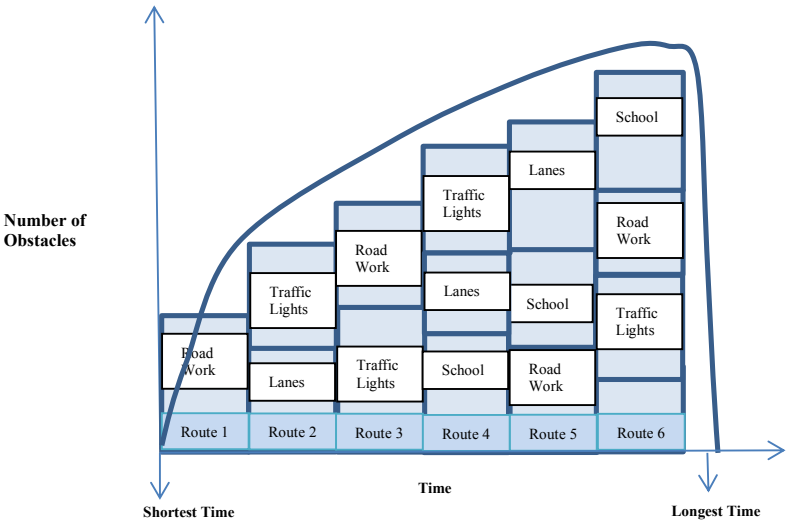

Figure 2

5.0 Illustration of the Methodology by an Example:

Let us consider the extremum of this approach. Route which has no obstacle and route which has a dead end. We do not consider the case of dead end and the Route that has no obstacles only the fuel consumption may be the consideration.
Based on the method describe above for other routes additional column will be plotted as illustrated in the graph. Including the number and types of obstacles in a column for a specific route we will plot a curve. For illustration purposes we assume that the plot appears to be a bell curve as shown in Figure 3. From this bell curve full wave half maximum, standard deviation, median, confidence interval can be calculated.

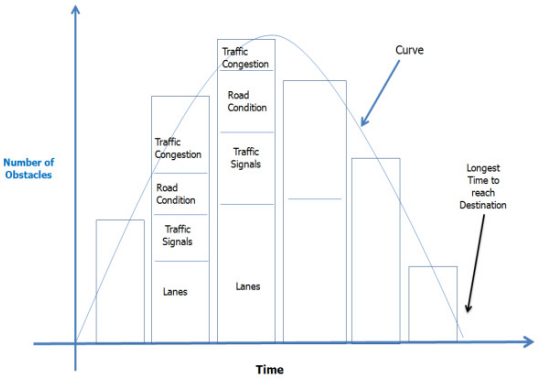

Figure 3

Correspondingly, from a shape of a curve such information can be calculated.

6.0 Conclusion and Future work

Pakistan's commuter erratic behaviour and lack of obeying road laws and other one of a kind factors offer us a unique problem where the standard methodology as used in the West cannot be directly applied. This offers an opportunity to devise new hypothesis and model it using mathematical techniques to address the problem. Here we have proposed to address the problem using first principal with minimum assumptions while heavily weighing in on field collected empirical data to formulate our opinion. The raw data will be collected in the first stage of this study. We will test our basic analysis with the hard data and ascertain which factors weigh heavier than others. For example, does school closing of a single lane over say 30 meters slows the traffic by the same factor then say a construction over the same distance that also closes a lane over the same distance? Or does a main road intersection or lane merge weighs the same or differently? Higher posted road speed for the same number of obstacles needs to be addressed clearly for different number of lanes or/and traffic congestion? Addressing these inter-related factors will be subject of our follow-on study and paper. We will formulate the algorithm based on empirical data and apply the method in other cities away from where the data was collected.

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