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An Overview of Kabul Traffic Congestion

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Abstract: ***Traffic congestion is a problem over the worldwide but it is very critical and harmful for the cities which the speed of development is very high such as Kabul. This paper intends to investigate the cause and impact of traffic congestion in Kabul city. This study indicate that there are variety of reasons that cause traffic congestion such as shortage of urban infrastructures, lack of proper traffic management, demographically issues, Rapid growth of private vehicles, traffic fining strategy, internal immigration, lack of parking, failure to implementation Master Plan, lack of data, security issues, budget etc. Moreover, this paper discussed about the effect and feasible solution of traffic congestion, the solution which proposed in this article in order to mitigate traffic congestion split into two branches, first brunch focuses on the existing situation of infrastructures which need to be revised and second brunch that focus on the new systems and technologies such as BRT, ITS (intelligence traffic system) etc.. According to this article Transportation problems are the generator of socio-economic problems such as undesirable consumption of fuel, entity of unfavorable traffic congestion, air pollution…etc. The focal point to this paper is on the government of Afghanistan and other organization which directly and indirectly are involved with traffic, transport and urban development and planning.***

I. INTRODUCTION

Concurrent with emerge of business and civilization in Kabul, Transportation had been issued. Transportation play a vital role in the business field. According to human's algorithm, the desirable condition for comfortable transport system is to transfer people and goods in the minimum possible time, suitable convenient travelling state, less fuel consumption, less contaminating air and safe. When the transportation's system does not support one of these factors, lack of desirable transport system occur thus the result will be the congestion which squanders the time, inappropriate convenient state of travelling, over fuel consumption, air pollution and lack of safety. Although the entity of all factors regarding to appropriate transport system thought to needs a huge amount of budget but by planning, managing and monitoring we can achieve to the standard transport system by notably reduced budget. Every city according to population, efficient area, geopolitical position and culture the planning of transportation system should be considered. Unfortunately in previous decades due to lack of transportation engineering knowledge, wars, internal immigrations and destruction of infrastructures caused which population aggregation occur in the area which possess security. Therefore, the population in secure areas crossed the saturation threshold so caused undesirable serviceability such as transport services, hygiene, water supplying, water management and municipality services.

A. Study Area

The research study's area located in the center of Afghanistan which has neighborhood with Wardak, Logar, Parwan, Kapisa, Laghman and Nangarhar. Six highways connects Kabul to adjacent provinces and other provinces. Two out of six highways connect Kabul to north provinces (Kabul-Bagram highway) and (Kabul-Charikar highway), two out of six highway connect Kabul to east provinces (Kabul-Jalal Abad highway) and (Kabul-Nangarhar highway), one out of six highway connects Kabul to south province (Kabul-Gardiz highway) and one connects Kabul to middle and western provinces (Kabul-Ghazni highway). The study area is capital of Afghanistan and a metropolitan city.

Figure 1: Location of Kabul (Google Map)

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II. PROBLEM INVESTIGATION

A. Lack of Planned System

According to relation between roads. In order to enter from express highway to collector roads it needs to cross arterial road or in order to enter from arterial roads to local roads it needs to cross collector roads. Therefore no vehicle can enter from local roads to arterial or express highway directly. Unfortunately this hierarchy didn't consider in most of areas. Hence, Kabul city suffer from this issue. Though this problem is not simple to solve but by planning, managing and engineering this issue can notably mitigate. For the sake of solving this problem cooperation between related organization such as municipality, ministry of transport, ministry of public work, ministry of urban development and land affairs is compulsory.

B. Budget

Transport related to public convenience. Therefore, projects which is related to public convenience need huge amounts of budgets for Afghanistan which development budget of road transport affair is $32,000,000. Hence, the budget only satisfy short term projects therefore it is difficult to cover all aspect of transportation issues simultaneously. Moreover that previously mentioned which cooperation between related organizations plays the vital role, international institutions also can play a pivotal role from the finance perspective. Therefore, interaction between planning proposals and attracting funders should consider as one of the most important tracks.

C. Security Checkpoints

There are a lots of security checkpoints in the Kabul city. The security checkpoints impact traffic flow and speed of running vehicles. Due to entity of security checkpoints the carriageways are being narrowed which cause interrupt traffic flow, even some particular roadways and street are being restricted upon traffic due to security concerns.

D. Movements of Authorities

One of the rare reason of traffic jam which only happen in Kabul city almost every day cause due to movements of VIP (very important persons) . An entire carriageway has been blocked while some authority or political leaders are moving on the roadways. It can be due to security concern. Although this issue generally related to security or politics but it has to undertake as a reason of traffic congestion or traffic jam which nowadays Kabul citizens are facing.

E. Rapid Growth of Private Vehicles

Excessive amounts of private vehicles are one of the main reasons of traffic congestion. Unfortunately the main concept of transport which imply that transferring commuters from origin to destination by fast possible speed, major safety and convenient services does not exist among people. Instead, people think according to the culture that it is wise and prestigious to travel by using private car. In other hand, lack of assessments in order to forbidden unregistered vehicle which imports from Pakistan's boarder cause excessive amounts of private vehicles. Some statistics calculation below shows the rapid growth rate of vehicles versus population growth rate.

Number of vehicles in 2005	341,047
Number of vehicles in 2010	1,224,000

According to the above table number of vehicles in 2010 increased by 72.1 % than 2005 which indicate a rapid growth in vehicles.

Population of Kabul in 2005	2,500,000
Population of Kabul in 2010	3,100,000

According to above statement population of Kabul city in 2010 increased by 19.3 % than 2005 which also indicate a rapid growth but not as much as vehicles growing. A comparative calculation between vehicles growing and population indicate that vehicles growth rate is 52.7 % more than folk's population.

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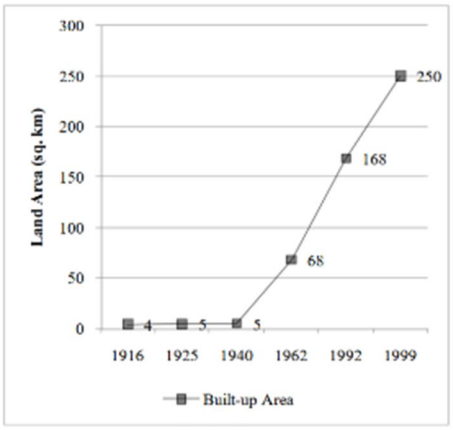
F. Rapid Growth rate of Population

From the demographic perspective Kabul is placed the fifth fastest growing city among all cities of the world. The population growth rate of Afghanistan was 2.36% in 2017. Around 5,000,000 people live in Kabul, which makes $980\ p/km2$ density. After 2001 that refugees return to Afghanistan and international relations of Afghanistan spread in one hand and in other hand investment and enterprises by government, international donors, NGOs' and institutions attracted people from all over the world into Afghanistan especially into Kabul city which caused not only population growth but also changed Kabul city to from a destroyed place to a city of high rise buildings. The below figure shows the built-up are with the respects of land and time.



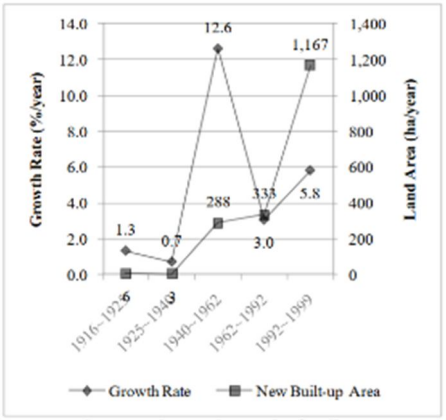


Figure 2: Figure 3: Growth of Built-up Area Figure 3: Figure 3: Growth Rate and Annual Growth of Built-Up Area

However, in order to supply urban services to all folks consideration of saturated population in necessary where the saturated population influence the serviceability in an urban, sub urban and even rural area. Therefore, according to topography and hydrography the saturated population could be calculated. By the way according to such criteria Kabul's master plan is created in 2013 which indicate that the Kabul city (particularly the urban area) is designed for maximum 3,500,000 citizens. However, that the previous master plans of Kabul city which designed in 1962, 1970 and 1978 has considered the population of 0.8 million, 1.4 million and 2 million respectively.

	Approved Year	Horizon Year	Planned Population (Million)	Covered Area (km^2)
First Master Plan	1962	1987	0.8	237.80
Second Master Plan	1970	1995	1.4	299.00
Third Master Plan	1978	2002	2.0	323.30

Table 1: Master Plan of Kabul According To Area and Citizens

G. Immigration

Internal immigration means that people immigrate from rural and sub urban locations to urban area. Internal immigration cause due to lack of job market, security issues, education and health care services. Despairing job's market, security, university and health care centers can notably diminish immigrations to urban places.

According to Mahatma Gandhi's economics' theory, the economic growth should be started from rural area. Thus, investors and government cooperatively provide its security, the result will be avoid of immigration. Because all the raw material which is the motive of almost all factories and industries produce from rural area such as raw materials of iron, bronze, cement, stone, glass …etc. it became economy to produce raw materials of factories by human resource of particular rural area than hiring people from other places and dispatch them to there. Moreover, immigration of rural people from their origin places cause air pollution. As people which is living in rural place work as farmers. Due to immigration of them, the lands which formerly were green beds change to desert area. Because agricultural soils are very loss and light by a seldom wind in said area the result will be a dust storm.

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H. Implementation of Master Plan

As traffic directly affected by roads and the existence and stat of road directly related to implementation of city's master plan. Therefore, failure to implementation of Kabul master plan caused traffic congestion. Designing and implementation of Kabul master plan is the hottest discussion nowadays. Hence, a deep look below is needed to understand the situation of Kabul master plan.

Unfortunately due to insufficient amounts of budget and geopolitics issues which directly affect implementation of master plan caused occurrence of traffic jam and traffic congestion.

According to the designed master plan and present situations of Kabul city. One observation indicate the lack of planning in Kabul which is caused due to various reasons. The reason behind not implementation of Kabul's master plan is related to lack of sufficient budget (as mentioned before), availability of corruption crisis, absence of cooperation between Afghanistan's organizations and international donors, availability of aggregated population which exceeded from saturated population.

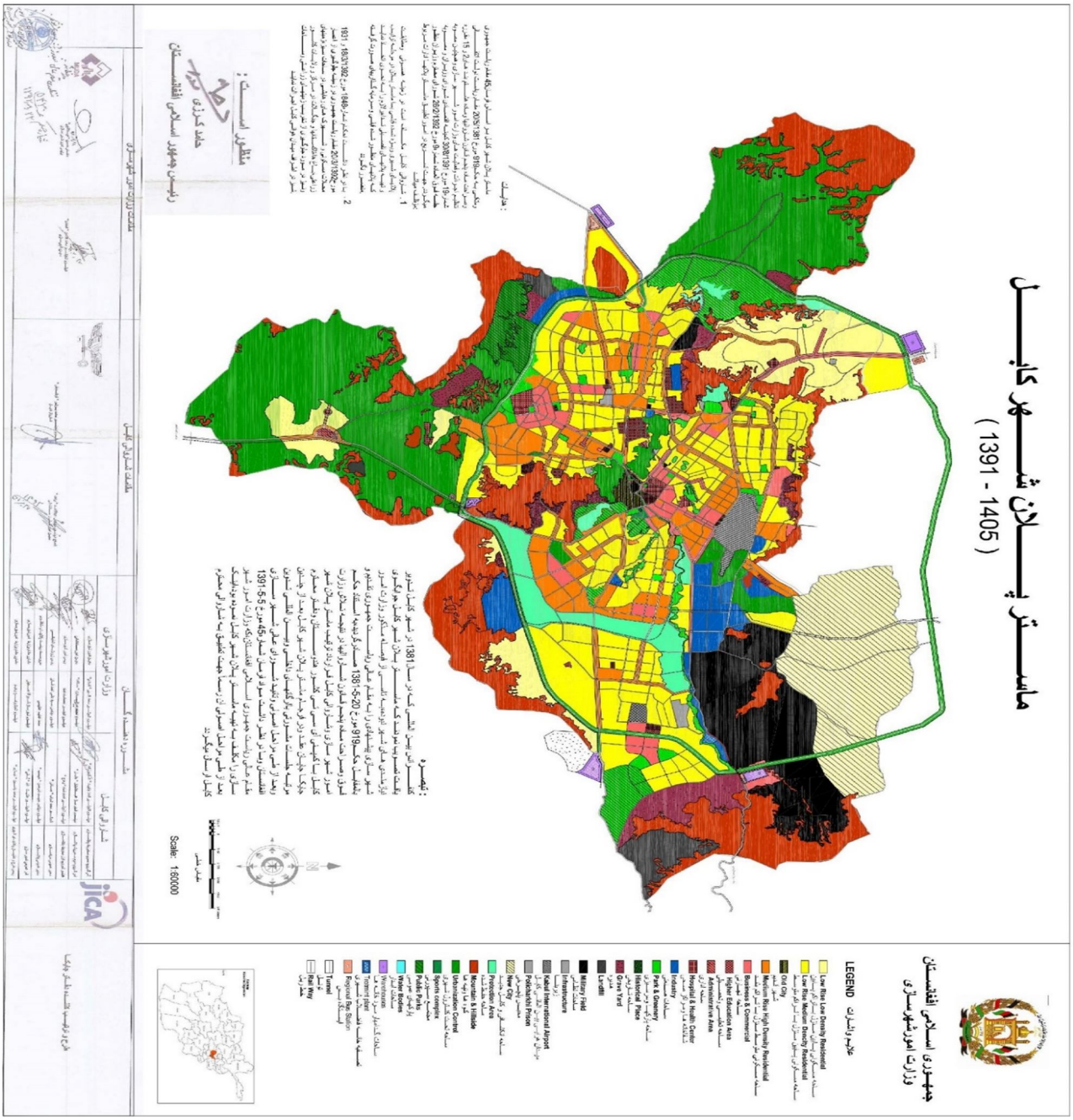


Figure 4: Present Master Plan of Kabul

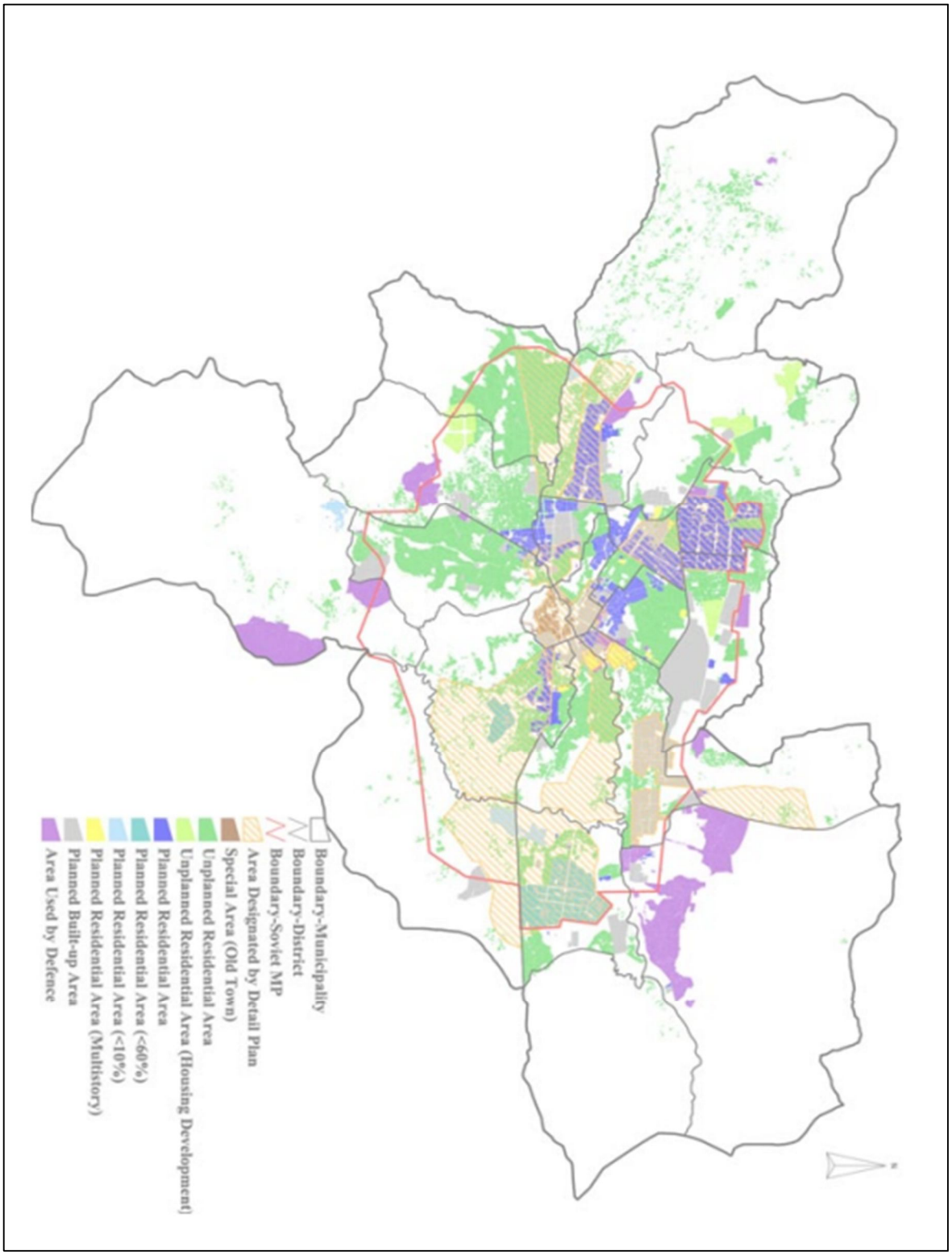


Figure 5: Present Situation of Kabul

As shown above around 75% to 80% of households are dwelling in unplanned area and the planned area which is shown in blue color is about less than 10%. However, that the detail plan of Kabul's districts is designed but unfortunately due to implementing issues such as land acquisition the inhabits still dwelling in unplanned area.

I. Excessive Security

Distinct from political issues the excessive security of Kabul city influence the transport sector. the problem of excessive security in roadway of Kabul include the security check point and prohibiting specific roadways in order to protect the important location from bomb blasting. The locations which is forbidden to movements of vehicles is mentioned below.

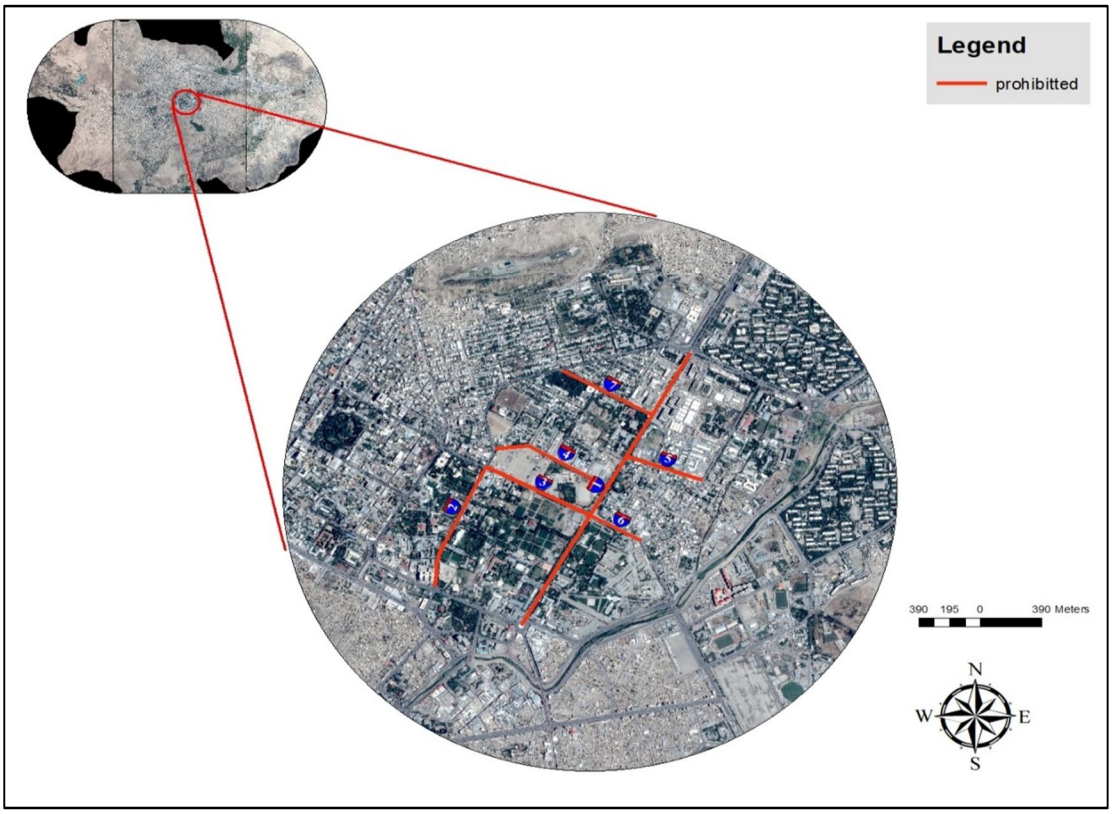


Figure 6: prohibited roadways in Kabul

Sahat e Ama Square To Pashtunstan Watt	2100 meter
Ministry Of Foreign Road To 11th Road Of Wazir Akbar Khan	646 meter
Ministry Of Foreign Road To Shash Darak	510 meter
Ministry Of Foreign Road To Embassy Of Germany	790 meter
Aryana Square To Anqara Roadway	740 meter
Anqara Roadway To Malik Asghar Square	912 meter
Aryana Square To Shash Dara Roadway	375 meter
Total	4073 meter

Table 2: Prohibited roadways in Kabul

J. Lack of Data

All research and comprehensive projects such as transport projects implement by entity of data. Unfortunately planners in Kabul city encounter to lack of data in such fields. Traffic congestion and other traffic issues such as traffic's fatal accidents contribute with data. Therefore, data provides base of each project and research.

K. Traffic Signalization

The conflict which occur during approach of vehicles to intersections can be managed by allocating times to each corridor. Although the traffic signalization is simple and cheap but unfortunately in Kabul city drivers encounter to absence of signals. Despite of the importance of traffic signals in Kabul city only one signal is available. Unfortunately, absence of traffic engineering knowledge in past decades caused inconsideration of traffic signals.

L. Intersection

Intersections are the connectors of routes. Therefore, design of intersection possess notable value. The clue which make engineers able to recognize improper state of an intersection is, to select a strip of road (between two intersections) whether congestion is only in intersections or not. If congestion occurred just in intersections it means which the problems came from improper design of intersections otherwise indicate that the corridor's capacity is lower than demand. In such case (improper design of intersections) by traffic count survey and collecting related data, the particular intersections simply can be designed.

Figure 7: Abdul Haq Roundabout

According to above satellite image of Abdul Haq roundabout the problem not only come from the inappropriate design of the roundabout but the existence of security checkpoints which exist in 20 meter away from the roundabout in order to check the vehicles that come from north west of Kabul such as Laghman province, Nangarhar province, Yaka Toot …etc. slow movement of vehicles cause that round about does not vacant as much as the roundabout reach to its desirable performance. Meantime, absence of exclusive carriageway for right turners in such roundabouts is another cause of traffic congestion in the roundabouts. Since, the entity of islands in intersections prevent the entry of vehicles into intersection. Consequently, the traffic volume alleviate within the intersection. Unfortunately, no one's of Kabul's intersections contain island.

M. Parking

Absence of parking in Kabul's markets is one major cause of congestion and traffic jams. Thus vehicles occupy a noticeable width of road which the result will be narrowing the roads, traffic congestion and jam. Although parking consideration avoid in poste modern planning (because parking facilities encourage people to drive their vehicles since it is ease to park vehicle in proper place but lack of parking encourage people to utilize public transport which does not require parking) but it is necessary to implement modern planning to receive to poste modern plans.

N. Improper Assembling Street Vendors

In urban areas street vendors assemble around markets and business centers. Therefore assembling street vendors occupy parking, pedestrians (walk-Sides) and narrow carriageways. The result will be traffic congestion and traffic jam.

Figure 8: Street Vendor is Caused Traffic Congestion

O. Traffic Fining Strategy

According to human's behaviors, people do not pay attention to rules and regulation until they force by authorities. Therefore, setting up fining regulation could be a forceful strategy in order to prohibit irregular actions. Observance of traffic regulations should be considered under an intelligent fining system. Under such circumstance no one can escape from fining due to irregular action relevant to traffic such as crossing traffic signals during red light period, accident, driving over speed limits, improper vehicle parking. Old traffic fining system work on the base of manual system, in such system traffic police has to present in particular place in order to note number plate of vehicles. Then by submitting fining paper the particular vehicle under limited period should pay penalty fee otherwise the vehicle driving license will not update after expiry. Modern fining system use camera in intersections and other critical spots for the sake of recoding movement and number plate of the vehicles which cause accident or irregular movements. Modern fining system is good for the sake of collecting evidences during the irregular actions but has the same process for collecting fine. In other words, after irregular action from a driver the camera record the number plate of the vehicle then traffic police wright a fine ticket and mail it to the driver home. The driver has to pay fine during determined date. Modern traffic fining system is accurate but it also take long time to force drivers to pay penalty fee.

Postmodern traffic fining system concern with intelligent detector, actuator, supersonic cameras and online server database. The advantage of postmodern system is that fining process does not take long time. When an irregular action occur, supersonic camera and number plate detectors detect number plate of particular vehicle then transfer data into database server, make report related to the foul then dispatch it for appraisal by police then system automatically send a message to the delinquent driver. He/she has to pay penalty fee within defined period. In such system online banking provide facility for fast paying fine.

III. FEASIBLE PROPOSED SOLUTION

A. BRT (Bus Rapid Transit)

Nowadays in all over rapid developing areas BRT (Bus Rapid Transit) known as a prevalent solution for traffic congestion for those cities or states which the development budget for transport is not as much as satisfy for metro purpose or other mass transit system.

1) *Redesigning Intersections:* In order to figure out that the issue regarding traffic congestion comes from inappropriate design of intersections, a strip of corridor between two intersections at least has to consider. If the roadway between intersections possess congestion the issue which led congestion comes from inadequate capacity of roadway. But if the congestion exist on intersections in spite of the roadway between intersections possess free flow. It indicates that the problem comes from inappropriate design of intersections.

According to above hypothesis in Kabul city here are five critical intersections which contain most traffic congestions that below are mentioned.

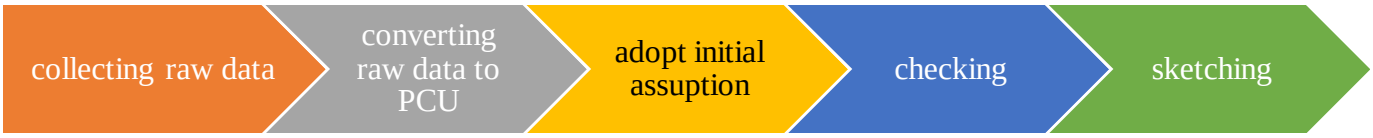
- Abdul Haq square
- Shaheed square
- Massoud square
- Kote Sangi intersection
- Dehmazang square

All above intersections which are mentioned above are congested due to inappropriate design of intersections. The problem which face intersection split into two parts.

- ➢ Those intersections which is built as roundabout (Rotary) need to recollect data regarding their new demands and redesign. In such case one roundabout in Kabul city is needed Abdul Haq square. Indeed some extra services such as island has to consider in Abdul Haq square. According to overall considerations the roundabout has been designed by using secondary data and algebraic calculations
- ➢ Those intersections which the existing feature is roundabout but it has to be substituted to signalized

a) Redesigning Abdul Haq roundabout

- Procedure



b) Current Situation: Abdul Haq square is located to the north of Kabul city where that that not only connect north districts of Kabul city to central districts but also connect east province of Afghanistan such as Laghman and Jalal Abad to other province. Therefore, it is not only a connector of Kabul's roadways but also a connector of Afghanistan provinces. The reason behind over traffic congestion of Abdul Haq roundabout is related to roundabout demand (improper design of roundabout), entity of security checkpoint at the roundabout and breaking traffic law.

c) *Raw Data:* The data is collected from Sunday 26/Dec/2017 to Tuesday 28/Jan/2017 between 7:00 o'clock and 10:00 o'clock in morning and 03:00 o'clock to 06:00 o'clock in evening in terms of (P) for private cars (B) for buses (T) for trucks. Then by using Microsoft Excel the data converted to PCU (passenger car unit).

d) Converting Data

The traffic flow in terms of PCU is converted as below.

Time	Leg	A-North-East App. (Kabul Jalal Abad Street)			B-South-West App. (To Pule Mahmood khan Street)			C-South-East Approach (Macroryan Street)			D-North-West Approach (To Masood Int. Street)				Total
	Movement	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	U-Turn	Through	Right	
	Class	P	P	P	P	P	P	P	P	P	P	P	P	P	
3:00 - 3:15 PM		151	227	105.2	111.6	260	7	126.6	288.8	148	93.8	4	260.2	57	1840.2
3:15 - 3:30 PM		177	266	29.8	123.6	287.2	2	111.4	255.8	149.2	87.6	14.8	412.8	52	1969.2
3:30 - 3:45 PM		88.4	130.8	192.4	169.8	401.2	3	100.4	236.2	238.8	125.4	31.6	353	62	2133
3:45 - 4:00 PM		179	263.8	88	137.6	323	2	72.6	166.2	197.6	85.6	76.4	348.2	66	2006
4:00 - 4:15 PM		216.8	327.6	33	138.6	325	4	77.2	183.8	195.4	127.4	154.2	289	94	2166
4:15 - 4:30 PM		169.6	258.2	79.8	144.8	336.6	3	88.2	212.6	176.4	111.6	92	315	77	2064.8
4:30 - 4:45 PM		186.6	280.8	51	138.6	324	6	92.6	214	198	155.6	123.8	270.2	53	2094.2
4:45 - 5:00 PM		176	263	78.8	150.6	353	0	54.6	132.6	227.6	65.6	183.6	451	49	2185.4
5:00 - 5:15 PM		153.4	230.6	63.2	126.6	300.8	9	80.2	183.4	190.8	49.8	102.4	383	57	1930.2
5:15 - 5:30 PM		146.8	222	73.8	138.6	326.8	7	59	131.2	173.6	119	179.2	263.6	41	1881.6
5:30 - 5:45 PM		136	203.6	83.8	129.4	298.8	5	89.4	205.8	147.6	111.8	45	274.8	98	1829
5:45 - 6:00 PM		177.4	265.6	51	119.8	282.4	6	96	223.6	184.8	142.6	83.8	340.8	67	2040.8
Total		5826.8			5502.4			5710			7101.2				24140.4
3:00-4:00 PM		595.4	887.6	415.4	542.6	1271.4	14	411	947	733.6	392.4	126.8	1374.2	237	7948.4
Total		1898.4			1828			2091.6			2130.4				
4:00-5:00 PM		**749**	**1129.6**	**242.6**	**572.6**	**1338.6**	**13**	**312.6**	**743**	**797.4**	**460.2**	**553.6**	**1325.2**	**273**	**8510.4**
Total		2121.2			1924.2			1853			2612				
5:00-6:00 PM		613.6	921.8	271.8	514.4	1208.8	27	324.6	744	696.8	423.2	410.4	1262.2	263	7681.6
Total		1807.2			1750.2			1765.4			2358.8				

Table 3: Traffic data according to PCU

According to the data the most congested period occur between 4:00 to 5:00 PM in Thursday. Therefore, calculation of roundabout capacity has to be done on the basis of 4:00 to 5:00 o'clock. As kept below.

The maximum two-way flow in the roundabout leg north east (Kabul Jalal Abad roadway) is 4715 PCUs per hour between 4:00 to 5:00 o'clock in Thursday and maximum in one direction is 2595 PCU per hour. According to IRC (Indian Road Congress) the calculation is depicted below.

e) Initial Assumption

Design speed: according to (IRC), current Indian practice is to design rotaries in rural and sub urban areas for a speed of 40 K.PH and those which exist in urban area to a speed of 30 K.P.H.

- Radius of entry to roundabout: the radius at entry is determined by the super elevation, design speed and coefficient of friction. A range of 20 to 35 is found to be suitable for rural and a range of 15 to 20 meter is suitable for urban design. However, that the roundabout is located to urban area the entrance radius is selected 20 meters initially.
- Radius of exit from roundabout: the exit radius should be higher than the radius of the rotary island so that it favors a higher speed by drivers. This will enable the rotary to be clear rapidly. The general practice is to keep the radius of exit curves $1^1/_2$ to 2 times the radius of the entry curves. Therefore, the exit radius is assumed 30 meters.
- Radius of the central island: a value of 1.33 times the radius of entry curves is probably adequate for initial assumption.
- The weaving length determines the ease which the traffic can merge and diverge. According to the Indian standards the weaving length is selected accordingly.

Design speed (K.P.H)	Minimum weaving length (m)
40	45
30	30

Table 4: Minimum Length of Weaving Section

However, that the intersection is located to urban area. Therefore, the weaving length has to be selected with the respect of design speed. So, the weaving length should not be less than 30 meters.

- *Width Of Carriageway At Entrance And Exist*

Carriageway width of approach road	Radius at entry (m)	Width of carriageway at entry and exit (m)
7 m (2 lanes)	25 to 35	6.5
10.5 m (3 lanes)	25 to 35	7
14 m (4 lanes)	25 to 35	8
21 m (6 lanes)	25 to 35	13
7 m (2 lanes)	15 to 25	7
10.5 m (3 lanes)	15 to 25	7.5
14 m (4 lanes)	15 to 25	10
21 m (6 lanes)	15 to 25	15

Table 5: width of carriageway at entrance and exit

Width of carriageways of Abdul Haq is 15 meter. Therefore, according to the table 4 width of entrance and exit carriageway has to be 10 meters.

- *Width Of Rotary Carriageway*

According to IRC (Indian Road Congress) width of non-weaving section has to be equal to the width of widest entry carriageway. Hence, width of non-weaving section equal to 10 meter. And the width of weaving section calculate from below equation.

$$w = \frac{e_1 + e_2}{2} + 3.5$$

Where

e_1 Width at entry

e_2 Non-weaving section

$$w = \frac{10 + 10}{2} + 3.5 = 13.5\,m$$

Now with the respect to the PCU (Passenger Car Unit), the vehicles has to be converted to PCU in order to compute capacity of roundabout. According to IRC (Indian Road Congress) the minimum length of weaving section has to be 30 meters as shown in table 3 and the ratio of weaving section's length over width of weaving section should be at least 4. Therefore, the length of weaving section is selected 55 meters in order to serve the requirements.

$$\frac{l}{w} = \frac{55}{13.5} = 4.07 > 4$$

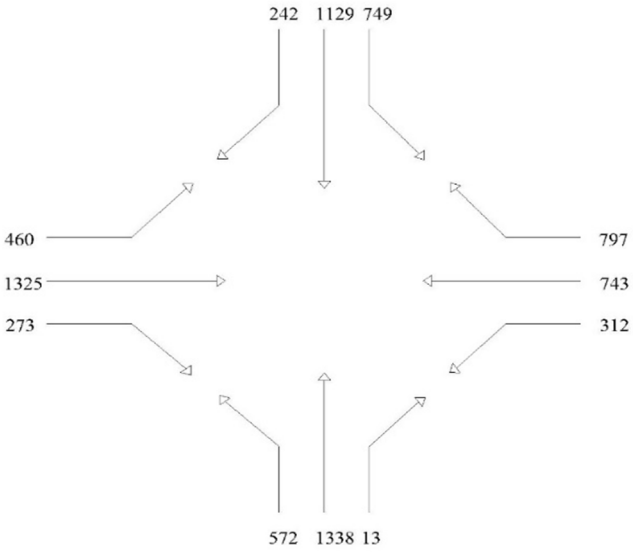


Figure 9: flow direction in terms of PCU

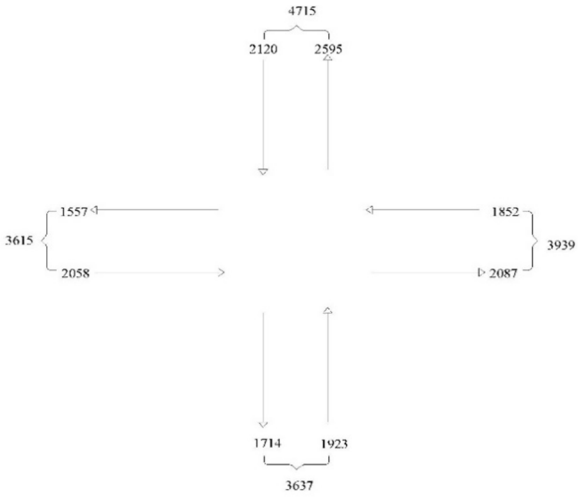


Figure 10: traffic flow through each leg

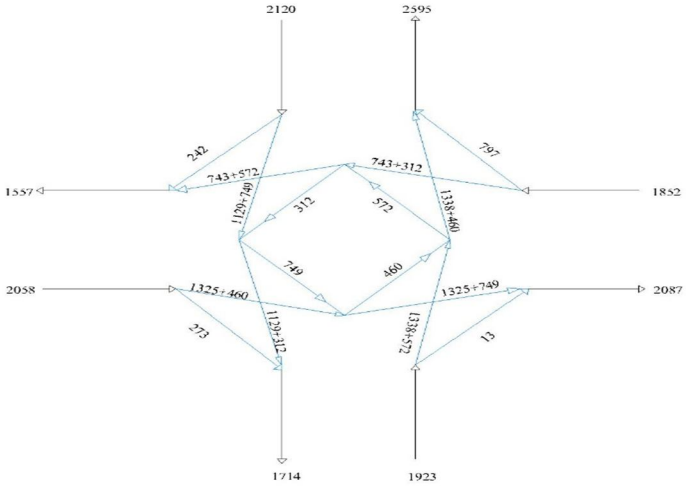


Figure 11: traffic network in terms of PCU

The most maximum weaving flow occur south east (Pol e Mahmud Khan Roadway) to east (1st Macrorrayan's roadway). Hence.

$$p = \frac{b + c}{a + b + c + d}$$

$$p = \frac{1325 + 749}{1325 + 749 + 13 + 460} = 0.81$$

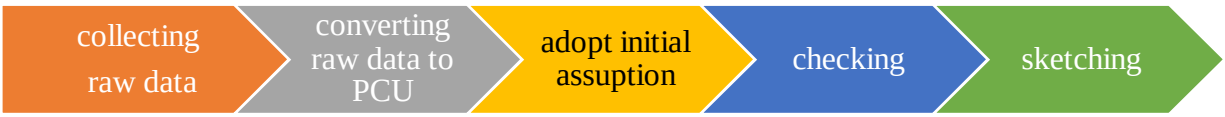
$$Q = \frac{280 \times w(1 + {}^{e}/_{w})(1 - {}^{p}/_{3})}{1 + w/e}$$

$$Q = \frac{280 \times 15.5(1 + {}^{10}/_{13.5})(1 - {}^{0.81}/_{3})}{1 + 0.23} = 4805\ PCU/hour$$

According to maximum flow from leg north east which is 4715 PCU/hour the practical capacity of the weaving section is slight higher. Therefore, according to the requirements of IRC (Indian Road Congress) the design is completed. Sketch of roundabout by using civil3D software is drawn below.

f) Redesigning Shaheed Roundabout:

- *Procedure*



- *Current Situation:* Shaheed Square is located between two highway which connect north of Kabul to south and west of Kabul. Therefore, it is an important and most populated square in Kabul. Shaheed Square is made as roundabout with three main Legs which has 80 meters width and one small leg with 6 meters width. Recently, the small leg is prohibited on movements of vehicles in order to prevent the traffic congestion.

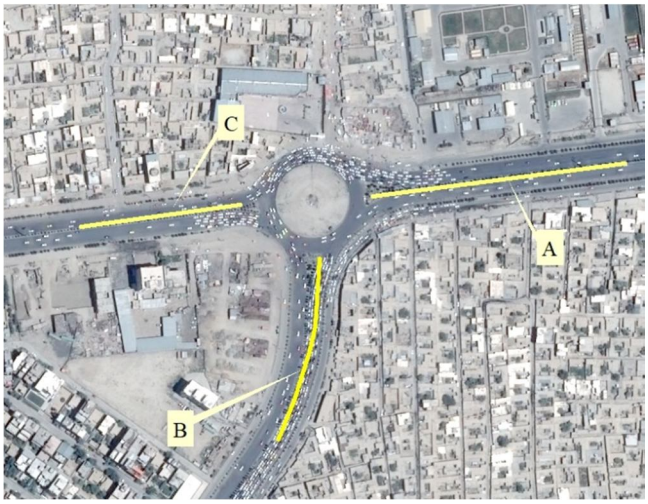


Figure 12: Current Situation of Shaheed Intersection

- *Raw Data:* The data is collected from Sunday 31/Dec/2017 to Tuesday 01/Jan/2017 between 7:00 o'clock and 10:00 o'clock in morning and 03:00 o'clock to 06:00 o'clock in evening in terms of (P) for private cars (B) for buses (T) for trucks. Then by using Microsoft Excel the data converted to PCU (passenger car unit). According to traffic flow data the most congested traffic flow in terms of PCU (Passenger Car Unit) occur between 03:00 PM to 04:00 PM in Sunday. Therefore, the said period has to be considered as the critical period and the intersection should be designed on the basis of that. The brief traffic flow data is shown in table 6 below.

Time of the Day	Leg	A-North- East Approach (To Maidan)			B-South-West Approach (To Khair ul bashar Masjid)			C-South Approach (To Saleem Karvan INT)			D-North (Circulating)									Total
	Movement	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left			Through			Right			
	Class	P	P	P	P	P	P	P	P	P	P	B	T	P	B	T	P	B	T	
3:00 - 3:15 PM		308.8	460.4	0	324.6	0	171.6	207.2	0	383.6	Only Circulating Vehicles									1856.2
3:15 - 3:30 PM		292.4	441	0	292.8	0	165.8	186	0	395.2										1773.2
3:30 - 3:45 PM		293.8	445.4	0	294.2	0	156.4	156	0	375.8										1721.6
3:45 - 4:00 PM		295.2	437.2	0	218.8	0	137.8	225.2	0	356										1670.2
4:00 - 4:15 PM		299.4	451	0	224.6	0	134	147.8	0	482										1738.8
4:15 - 4:30 PM		296.4	446	0	316.2	0	112.8	58.4	0	458.8										1688.6
4:30 - 4:45 PM		287.2	432.2	0	391.6	0	103	70.4	0	468										1752.4
4:45 - 5:00 PM		313.6	467.6	0	309.2	0	128.6	190.4	0	354.8										1764.2
5:00 - 5:15 PM		273.8	409.8	0	296	0	97.6	194.4	0	284.8										1556.4
5:15 - 5:30 PM		265.2	396.4	0	232.4	0	122.8	135.6	0	404.8										1557.2
5:30 - 5:45 PM		256	383	0	327.2	0	133.6	122.8	0	409.2										1631.8
5:45 - 6:00 PM		226.8	341.6	0	269.6	0	129.2	239.4	0	399.6										1606.2
Total		8520.2			5090.4			6706.2			0									20316.8
3:00-4:00 PM		1190.2	1784	0	1130.4	0	631.6	774.4	0	1510.6	0	0	0	0	0	0	0	0	0	7021.2
Total		2974.2			1762			2285			0									
4:00-5:00 PM		1196.6	1796.8	0	1241.6	0	478.4	467	0	1763.6	0	0	0	0	0	0	0	0	0	6944
Total		2993.4			1720			2230.6			0									
5:00-6:00 PM		1021.8	1530.8	0	1125.2	0	483.2	692.2	0	1498.4	0	0	0	0	0	0	0	0	0	6351.6
Total		2552.6			1608.4			2190.6			0									

Table 6: traffic data according to PCU

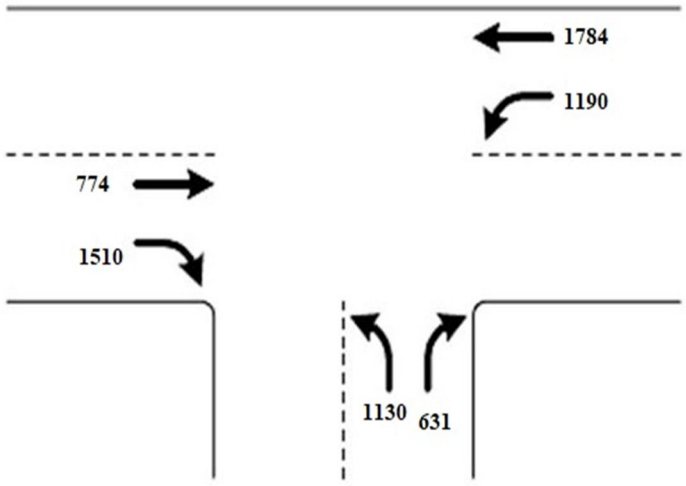


Figure 13

- Adopting decision: However the current feature of Shaheed intersection is roundabout. But, IRC (Indian Road Congress) prefer that those intersections which contain three legs is better to be consider signalized intersections. Therefore, in this research Shaheed roundabout substituted with signalized intersection with priority for right turners.
- *Initial assumption*
  - One stage for each approach (3).
  - Every stage 30 second green time.
  - One signal group for each approach lane (5).
  - Inter-stage time 5 second.
  - Cycle time 105 second.
  - 2 pocket lane for south and west approaches.
- *Simulation:* The intersection with given data has been analyzed by PTV VISSIM software in order to figure out vehicles delay, emission of carbon di oxide and fuel consumption.
- *Results:* As shown in figures 26, 27 and 28 below. Whenever, the time pass the delay, emission of carbon di oxide and fuel consumption respectively increasing.

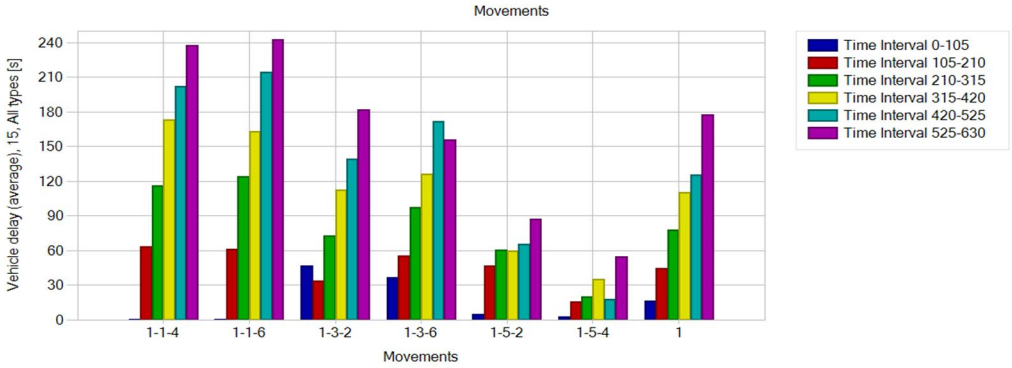


Figure 14: vehicle delay during rush hour

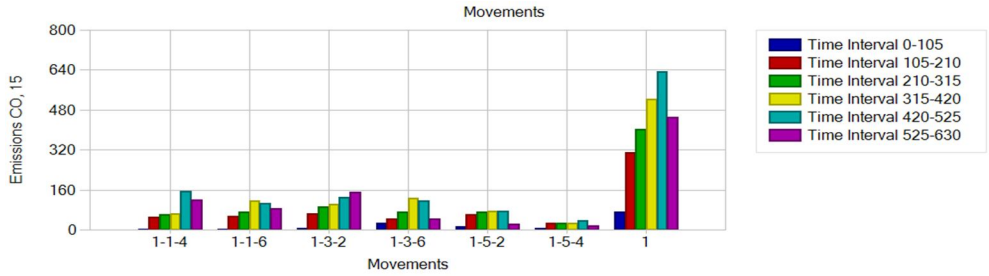


Figure 15: CO2 mission during rush hour

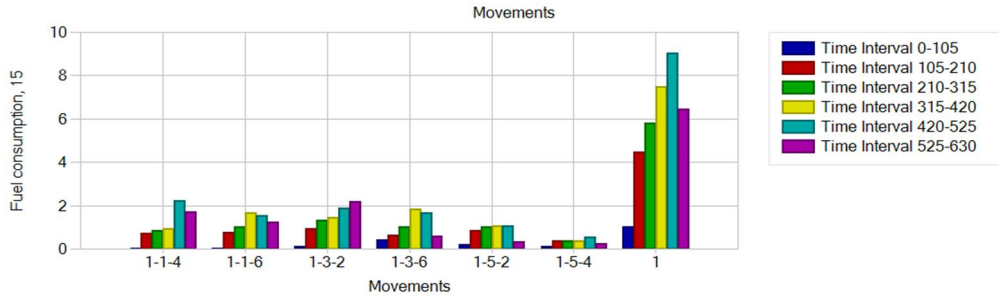


Figure 16: fuel consumption during rush hour

As shown in figures 26, 27 and 28 the delay, carbon di oxide emission and fuel consumption respectively is high. Therefore, the first assumption is not desirables in order to solve traffic congestion and other aspects. Hence, as the most traffic flows come from west and east. Thus, the green period of traffic signals should be increase. As the designing of traffic signals is a trial and error process the final trial numbers is shown in figure 30.

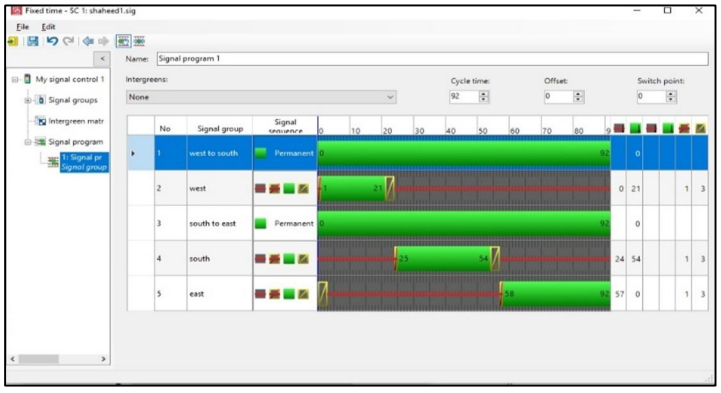


Figure 17

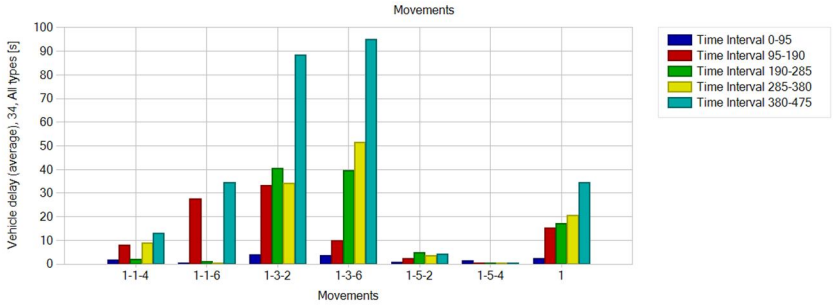


Figure 18: delay during rush hour

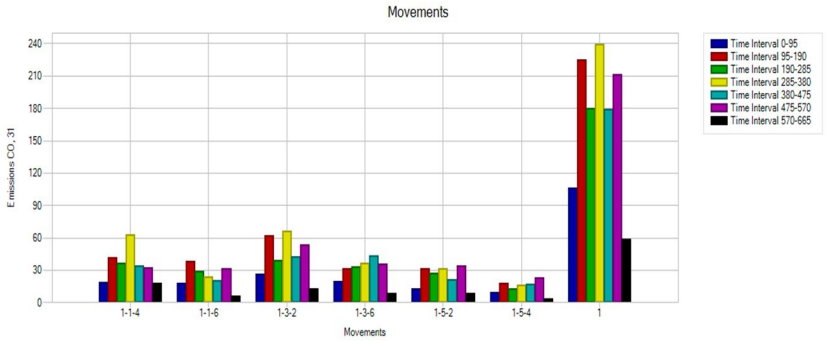


Figure 19: CO2 emission during rush period

2) *Parking Facility:* On street parking is the most attractive parking for drivers. However, the entity of such parking convenience may effects the capacity of roadways and be a contributory cause of roadway congestion and accident. Although, the studies shown that the design of on-street parking often influence roadway capacity if parking locations are not selected in a precise method, now suppose if on-street parking does not consider in a roadway or the vehicles demand induces to utilize on-street parking as carriageway, the result may be a disaster of traffic congestion. Consequently, the reduction in carriageway width to accommodate for roadside parking (on-street parking) reduces the roadway capacity.

According to existing state in Kabul city most of capacity of roadways occupy with illegal roadside parking. Below all roadways which contain congestion due to illegal parking are mentioned.

a) Shahr e Naw
b) Pol e Mahmud Khan
c) Ibne Sina
d) Deh Afghanan
e) Sevom e Aqrab (Kote Sangi)
f) Pol e Surkh
g) Char Qala e Chahar Dehi

The aim for these locations traffic congestion is to accommodate garage parking instead of on-street parking. Due to Lack of rehabilitation and keeping strategy in order to control and distribute population growth caused the vehicles demand arise and capacity of roadways diminish. Therefore, those roadways which contain legal on-street parking, the on-street parking could be utilize as carriageway and in order to provide parking for vehicles, A particular adjacent lands of roadways could be utilize as garage parking. The advantages of garage parking are that the garage parking occupy less area than on-street parking (roadside parking). Garage parking such as tower parking or spiral parking has more safety against car accident than roadside parking because garage parking has just one access for entry and one access for exit which preventing excessive vehicle collisions but in on-street parking each segment of parking is an access to the roadway. Meantime, from the enthusiastic perspective garage parking such as Spiral parking or tower parking portrait nice looks for urban area. In order to implement such solution the government role is pivotal. Some roles which government has to conduct in order to make ease the implementation of proposed solutions are below.

3) *Encourage The Investors By Government:* As the transportation and traffic congestion projects are count public projects. Therefore, it need a lots of cooperation between variety organizations. Almost it is impossible for the situation of Afghanistan according to its financial state to handle such projects only by the Afghanistan government. Meantime, a cooperation between citizens of Afghanistan (particularly Kabul citizens in this research) with the government, some NGOs' and institutions provide more ease and sustainability in order to implement, maintenance and assessment such public projects. In other words, public projects need public cooperation. Hereby, government encouraging investors and provide facilities could make a cooperation between governmental and non-governmental individuals that helps the government from the financial perspective. Encouraging investors to invest in making garage parking in the locations which possess excessive traffic congestion. Ratifying strict regulations: in order to prevent irregular actions relevant to parking, irregular movement of vehicles and irregular placing of street vendors the government has to ratify strict rules and regulations. Thereby, ratifying a strict regulation against illegal traffic actions and a conducting operation precisely function before the traffic congestion which come from irregular issues. The legislation could be operated by executive affairs (traffic POLICE). Forbidden unregistered vehicles: nowadays in all over Afghanistan including Kabul unregistered vehicles which come from Pakistan's boarder are cruising to Kabul city. According to their low costs, income of folks and lack of assessment. People's stimuli encourages them to purchase unregister vehicle. Although, unregistered vehicles are existed as much as registered vehicles are but the wise action is to forbidden unregistered vehicles. Unregistered vehicles not only occupy a notable amount of roadway which caused traffic congestion but also increase crimes in Kabul and other metropolitan such as Herat, Mazar e Sharif …etc. absence of number plate in unregistered vehicles provide problem for POLIC to recognize the owner of vehicles in order to execution. Conclusion: however the population growth directly affect the economic growth but if urban planning such as transport facilities does not consider properly it may bring negative consequences such as public health problems which come from vehicles emissions, psychological issues which come from traffic congestion or traffic jam and transport casualties which come from vehicles accidents. All the feasible solutions which proposed above directly affect to transport and traffic mitigation. May some solutions such as consideration of public transport right of way category A (Metro transit) be a good idea but according to Kabul situation such as budget issues, the proposed solutions which is mentioned above be feasible.

IV. RESULTS

According to Kabul traffic, road, infrastructure and cultural situation the problems which discovered are mentioned as in table 7.

Rapid growth of private vehicles	Traffic fining strategy
Rapid growth rate of population	Improper assembling street vendors
Immigration	Parking
Implementation of Master Plan	VIP Movements
Excessive security	Security Checkpoints
Lack of data	Budget
Traffic signalization Intersection	Lack of Planned System

Table 7

According to Kabul traffic, road and infrastructure situation the solution which propose in order to relief the traffic congestions are as below.

1) Redesigning the Intersections the intersection in Kabul split into two parts, one those which are square roundabouts which need to redesign their components and one are those which need to substitute with signalized intersections.
2) Consideration of BRT Right of way Category B in order to transfer a huge mass of commuter in shortest possible time from one place to other place.
3) Consideration of bicycle infrastructure in order to encourage people to utilize bicycle in short travels, it also help the environment.
4) Consideration of parking at those places which people park their vehicles at road sides because it cause traffic congestion due to narrowing the roads.
5) Encouraging people to use public transport in order to minimize amounts of vehicles in roads and decrees vehicles emissions such as carbon di oxide etc.
6) Revising the existing Bus System.

However, Afghanistan from budget aspect is not affordable but relieving transportation in Afghanistan could be done according to the proper planning and optimized budget. I.e. according to the Kabul's area, population and despairing of people's destinations is proper for public transport right of way category a (metro) in order to transfer commuters in minimum amounts of possible time.
As an overview the problem of Kabul urban transportation problem is related to lack of transport planning and transport knowledge because the most of the problems can be solved by very less amount of budget such as traffic signalization, redesigning of intersections, adopting strict law against traffic offenders, substituting classic traffic system with electronic systems in order to be precise and quick against traffic offenders, encouraging people by using television, radio, mosque, schools etc. to use bicycle for short distances, revising existing public transport system (Mili Bus) and beside revising public transport system the government can increase price of gas (Petrol and diesel) in order to force people to replace their private vehicles with the public transport vehicles. Hence, the above solutions which is written doesn't need any huge amounts of budget in order to mitigate Kabul traffic congestion.

The government of Afghanistan has to adopt three types of plan as mentioned below:

a) Short-term plan
b) mid-term plan
c) Long-term plan

In short term planning the government of Afghanistan has to implement the strict traffic law in order to fine those of bricks the traffic law as discussed in chapter 3 and revising existing bus system.
In mid-term planning the government has to implement redesigning the intersections, encouraging people to use bicycle by using media advertising, schools, mosque…etc. and constructing parking at those places which recently are congested due to road side parking of private vehicles.
In long-term planning the government of Afghanistan has to implement public transport right of way category B (BRT) Bus Rapid Transit. Beside this the government has to always study and survey the current and upcoming transport situations.
In order to understand the demands of transport from different folks group, this study extract the relation between choosing dwelling land and transportation choice. Most of Kabul's urban citizens are replaced from the other Cities of Afghanistan and they are now live in low-price areas. This research asks to mention why Kabul's dwellers decided to choose Kabul city as the current location for living. The questionnaire distributed to 105 several profession and groups commuters. The result indicates that about 90% male and 60% female selected the job facilities as the main reason for choosing Kabul city as dwelling land; they believe that Kabul has a lots of job opportunities Table 7. Amrollah, 26 years-old a worker mentioned that: "I am from Takhar city, in Takhar there is no opportunity for job. Hence, I have brought my family to Kabul city in order to find a job and to support my family". The Table 7 indicates that more than 70% of male and female have chosen Kabul city to utilize living convenience; Shamsi, 27 years old , a school teacher states: "of course, Life in Kabul is has very convenience than other provinces; all living facilities such as education for children, developed hospitals and living convenience are provided for us".

Major characteristic	Variable categories	Number		Percentage	
		male	female	male	female
	Work Facilities	59	21	90.77	60
	Educational facilities	46	31	70.77	88.57
The reason for the living in current location of Kabul	Educational facilities	46	31	70.77	88.57
	Permanent living	19	25	29.23	71.43
	House low price	37	15	56.92	42.86
	Medical facilities	21	15	32.31	42.86
	Medical facilities	21	15	32.31	42.86
	Security stability	28	25	43.08	71.43

Table 7: The reason for living in the city by various salary groups.

V. CONCLUSION

Nowadays, traffic congestion contribute to plenty of issues such air pollution, travel delay, psychological impacts…etc. according to the world bank report, Kabul city has the 5th rank of most rapid growth city among all cities in the world. Therefore, managing such cities from traffic and transportation perspective play vital role in order to provide convenient. According to current situation of Afghanistan from economic, politics and cultural perspectives the problems investigated and solutions accordingly proposed in order to solve traffic congestion of Kabul city. However, may a variety solution can also contribute to relief traffic congestion such right of way category A (metro) but from economic aspect it may not be feasible. Today the global warming and climate change is the world number one challenges which caused due to excessive emission of CO_2 that a notable amount of CO_2 is producing by vehicles engines and this amounts of CO_2 intensify where the vehicles settle in expose of traffic congestion. Therefore, relieving traffic congestion not only prevent economic, air pollution health and convenience impact but also contribute to prevent global warming and climate change.

VI. FUTURE SCOPE

As the population is growing day by day specially in the country such as Afghanistan the infrastructures has to develop and progress beside population. In order to satisfy the needs of a society the organizations which is involved to the infrastructures development such as municipalities, institution, and universities has to continue the carrier of founders. Therefore, those who involve in the future to infrastructures development and researching in the field of Kabul's urban transportation issues has to collect data as listed below:

A. Traffic Count Survey
B. Traffic Speed Survey
a) Spot Mean Speed
b) Space Mean Speed
C. Trip Generation
a) origin – destination
b) trip attraction
D. Turning movement counts
E. Queue length survey
F. Journey time survey
G. Roundabout survey
H. Study of parking
I. Study of illegal movements

As the data forms the base of researches and the researches form the projects. Therefore, the data collection play the vital role in the researching and project implementation. I as a researcher strictly encourage future scholars to work and study in the fields which is mentioned above. However, in Afghanistan traffic data is not available but the traffic and transportation projects are implementing. Therefore, why the traffic and transportation projects are failing or reactive.

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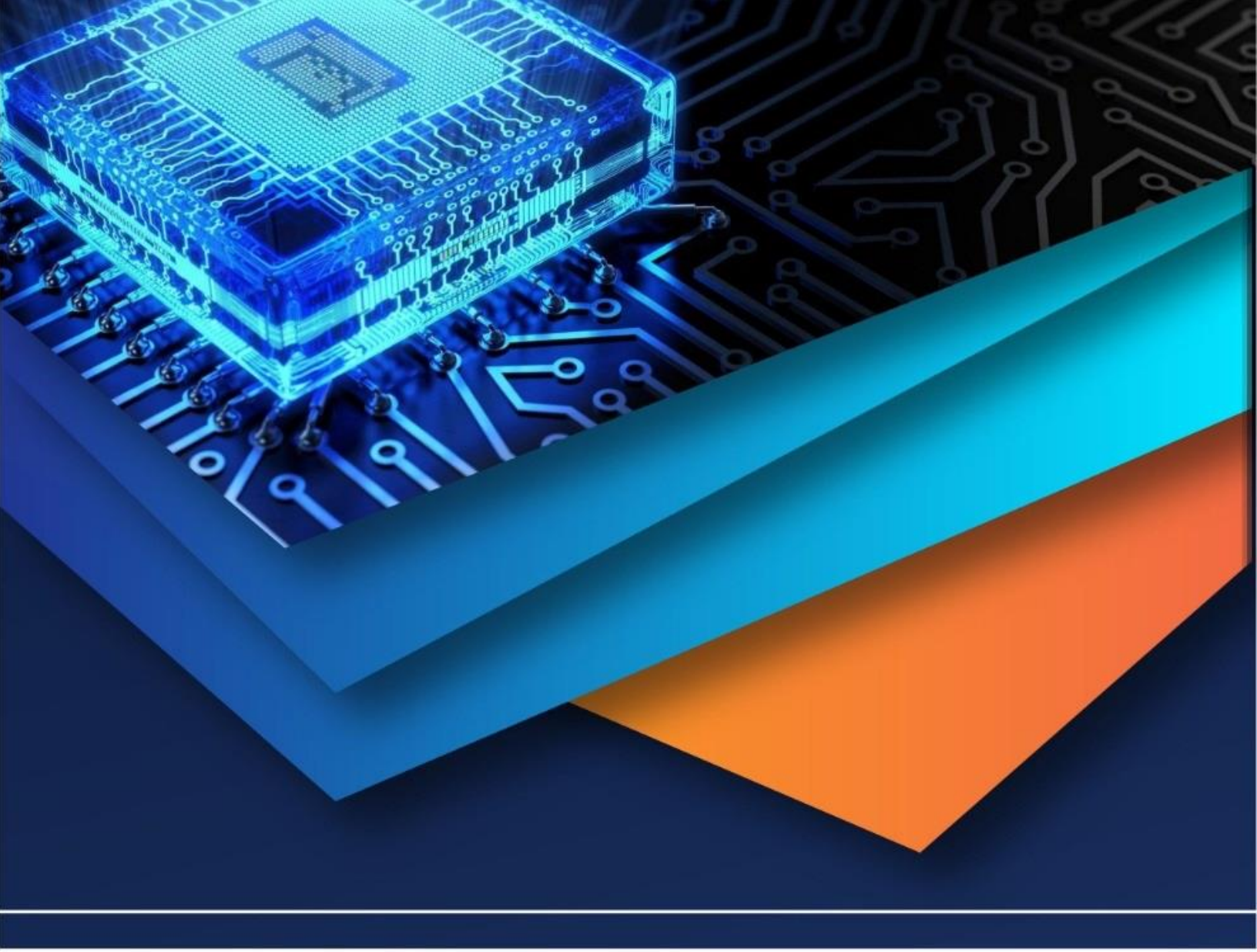

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