CHAPTER TWO

LITERATURE REVIEW

2.1 Traffic Congestion

Traffic congestion is a condition on transport networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. When traffic demand is great enough that the interaction between vehicles slows the speed of the traffic stream, this results in some congestion. While congestion is a possibility for any mode of transportation, this article will focus on automobile congestion on public roads.

As demand approaches the capacity of a road (or of the intersections along the road), extreme traffic congestion sets in. When vehicles are fully stopped for periods of time, this is colloquially known as a traffic jam or traffic snarl-up. Traffic congestion can lead to drivers becoming frustrated and engaging in road rage.

Congestion is defined as traffic flowing at speeds less than 45 miles per hour. Many factors can affect congestion levels such as the local economy, population growth, fuel prices, transit ridership and vehicle miles traveled. Mathematically, congestion is usually looked at as the number of vehicles that pass through a point in a window of time, or a flow.

2.1.1 Causes of Traffic Congestion:

Traffic congestion occurs when a volume of traffic or model split generates demand for space greater than the available street capacity; this point is commonly termed saturation. There are a number of specific circumstances which cause or aggravate congestion; most of them reduce the capacity of a road at a given point or over a certain length, or increase the number of vehicles required for a given volume of people or goods. About half of U.S. traffic congestion is recurring, and is attributed to sheer weight of traffic; most of the rest is attributed to traffic incidents, road work and weather events.

Traffic research still cannot fully predict under which conditions a "traffic jam" may suddenly occur. It has been found that individual incidents (such as accidents) may cause a big effects (a cascading failure) which then spread out and create a sustained traffic jam when, otherwise, normal flow might have continued for some time longer.

- **Separation of work and residential areas**

People often work and live in different parts of the city. Places of work are often located away from housing areas, resulting in the need for people to commute to work. Millions peoples in the country commute between their work and residential areas daily.

- **Movement from one part of the city to another to obtain or provide goods and services**

People may need to move about within the city to obtain goods and services, for instance to purchase goods or attend classes in a different part of the city. Brussels, a city with a strong service economy, has one of the worst traffic congestion in the world, wasting 74 hours in traffic in 2014.

2.1.2 Effects of traffic Congestion

- Wasting time of motorists and passengers ("opportunity cost"). As a non-productive activity for most people, congestion reduces regional economic health.
- Delays, which may result in late arrival for employment, meetings, and education, resulting in lost business, disciplinary action or other personal losses.
- Inability to forecast travel time accurately, leading to drivers allocating more time to travel "just in case", and less time on productive activities.
- Wasted fuel increasing air pollution and carbon dioxide emissions owing to increased idling, acceleration and braking.
- Wear and tear on vehicles as a result of idling in traffic and frequent acceleration and braking, leading to more frequent repairs and replacements.
- Stressed and frustrated motorists, encouraging road rage and reduced health of motorists

- Emergencies: blocked traffic may interfere with the passage of emergency vehicles traveling to their destinations where they are urgently needed.
- Spillover effect from congested main arteries to secondary roads and side streets as alternative routes are attempted ('rat running'), which may affect neighborhood amenity and real estate prices.
- Higher chance of collisions due to tight spacing and constant stopping-and-going.
- Road angry is aggressive (angry behavior by a driver of vehicle). Such behavior might include rude gestures, verbal insults, deliberately driving in an unsafe or threatening manner, or making threats. Road angry can lead to fighting, assaults, and collisions which result in injuries and even deaths. It can be thought of as an extreme case of aggressive driving.

2.2 Urban planning and design

City planning and urban design practices can have a huge impact on levels of future traffic congestion, though they are of limited effects for short-term change.

2.2.1 Short-term

I. Grid plans including fused grid road network geometry, rather than tree-like network topology which branches into closed roads (which reduce local traffic, but increase total distances driven and discourage walking by reducing connectivity). This avoids concentration of traffic on a small number of branch roads and allows more trips to be made without a car.

II. Zoning laws that encourage mixed-use development, which reduces distances between residential, commercial, retail, and recreational destinations (and encourage cycling and walking)

III. Carfree cities, car-light cities, and eco-cities designed to eliminate the need to travel by car for most inhabitants.

IV. Transit-oriented development are residential and commercial areas designed to maximize access to public transport by providing a transit station or stop (train station, metro station, tram stop, or bus stop).

2.2.2 Road capacity (supply)

Congestion can be reduced by either increasing road capacity (supply), or by reducing traffic (demand). Capacity can be increased in a number of ways, but needs to take account of latent demand otherwise it may be used more strongly than anticipated. Critics of the approach of adding capacity have compared it to "fighting obesity by letting out your belt" (inducing demand that did not exist before). For example, when new lanes are created, households with a second car that used to be parked most of the time may begin to use this second car for commuting. Reducing road capacity has in turn been attacked as removing free choice as well as increasing travel costs and times, placing an especially high burden on the low income residents who must commute to work.

Increased supply can include:

- Adding more capacity at bottlenecks (such as by adding more lanes at the expense of hard shoulders or safety zones, or by removing local obstacles like bridge supports and widening tunnels)
- Adding more capacity over the whole of a route (generally by adding more lanes)
- Creating new routes
- Traffic management improvements (see separate section below)

Reduction of demand can include:

- Parking restrictions, making motor vehicle use less attractive by increasing the monetary and non-monetary costs of parking, introducing greater competition for limited city or road space. Most transport planning experts agree that free parking distorts the market in favour of car travel, exacerbating congestion.

- Park and ride facilities allowing parking at a distance and allowing continuation by public transport or ride sharing. Park-and-ride car parks are commonly found at metro stations, freeway entrances in suburban areas, and at the edge of smaller cities.
- Reduction of road capacity to force traffic onto other travel modes. Methods include traffic calming and the shared space concept.
- Road pricing, charging money for access onto a road/specific area at certain times, congestion levels or for certain road users.

2.3 Traffic Engineering

Traffic engineering is that phase of engineering that deals with the planning, geometric design and traffic operations of roads, streets and highways and their networks, terminals, abutting lands and relationships with other modes of transportation for the achievement of safe, efficient and convenient movement of people and goods.

Traffic engineering applies engineering principles that help solve transportation problems by considering the psychology and habits of the transportation system users.

Many people still wonder why a traffic problem is so difficult that an engineer should be called upon for a solution. Why not just install a traffic signal, or raise/lower the speed limit, or erect more signs?

One of the greatest obstacles a professional traffic engineer faces in applying sound principles of traffic engineering is competing theories from vocal non-traffic engineers who lack expertise. The unfortunate result is the creation of traffic hazards when false theories are put into effect. Whenever unnecessary or excessive traffic controls are installed, hazardous traffic conditions usually result.

1- Handling traffic using traffic engineering.

The role of traffic engineers may be compared to that of the medical profession in protecting the public. As trained professionals, traffic engineers look at the symptoms of general traffic conditions, and to make a competent diagnosis, they take traffic counts,

analyze accident statistics, study speed data, examine roadway conditions, conduct research and study what other professionals are doing and the results they have achieved.

Just as the doctors' decisions are accepted in matters regarding health, even though the medicine may be bitter or the needle painful, so should the decisions of professional traffic engineers be given the prime consideration.

2- Traffic engineers make traffic conditions safer

Traffic engineers promote safer traffic conditions by providing roadway conditions that contribute to smooth and efficient traffic flow.

Experience has shown that safety goes hand in hand with smooth traffic operation. Disrupting the smooth flow of traffic increases the probability of accidents.

Erratic traffic operation may be caused by vehicles stopping or slowing in the roadway, passing and weaving maneuvers, or other surprise elements. For example, unwarranted traffic signals, unreasonably low speed limits and too many signs may cause driver confusion and indecision.

Slower speed does not necessarily mean safer traffic operation. The chances of a drivers becoming involved in an accident are lowest when they are traveling at the average speed of traffic.

3- Traffic control devices.

Traffic control devices are all signs, signals, markings and devices placed on, or adjacent to, a street or highway by a public body having authority to regulate, warn or guide traffic.

4 - Uniformity of traffic control devices

"Uniformity" means treating similar situations in the same way. Applied to traffic engineering, uniformity simplifies the drivers' tasks because it aids in instant recognition and understanding. Uniformity aids police, courts and road users by giving everyone the same interpretation. It aids public-highway officials through economy in manufacturing, installing, maintaining and administering the roads.

The Manual on Uniform Traffic Control Devices is the publication that sets forth the basic principles that govern the design and usage of traffic control devices. The manual was prepared by a national committee that included state, county and municipal representation. The standards in this manual, with certain exceptions, apply to all streets and highways regardless of the government agency having jurisdiction.

5 - Determination of speed limits.

Legal speed limits are established by law (in Arizona) and may be changed only when justified on the basis of an engineering study.

A widely accepted principle is to set speed limits as near as practicable to the speed below which 85 percent of the vehicles are traveling on the highway. Experience has shown that approximately 85 percent of motorists drive at a speed that is reasonable and prudent. Established speed limits therefore encourage voluntary compliance because they appear reasonable to the public. Those 15 percent of drivers who will not comply with reasonable speed limits are the drivers who are subject to enforcement action.

6 - Effect of posted speed limits.

Posted speed limits have very little effect on actual traffic speeds. There is a common belief that the posting of speed limit signs will cause drivers to react accordingly. This is not true and is why posted speed limits must be realistic to achieve compliance.

Unrealistically low speed limits invite violation even by responsible drivers. Enforcement of unreasonably low limits sets up the so-called "speed trap," which results in poor public relations. The posting of proper speed limits has the beneficial effects of smoothing traffic flow and aiding effective law enforcement.

7 - Traffic signal lights.

Traffic signals should be installed when they will alleviate more problems than they will create. This determination must be based on an engineering study.A warranted traffic signal that is properly located and operated may provide for more orderly movement of traffic and may reduce the occurrence of certain types of accidents. On the other hand, an unwarranted traffic signal can result in increased delay, congestion and accidents.

Many people seem to believe that traffic signals are the answer to all traffic problems at intersections. If this were true, no traffic engineer would deny a request for a signal. However, a traffic signal only functions by stopping traffic, and any time a motor vehicle is stopped in the road, there is the potential for an accident. It does not matter whether the stop is caused by a flat tire, a left turn into a driveway, or a traffic signal; the possibility exists that a following motorist will not notice the stopped vehicle until it is too late.

What traveler has not experienced a traffic signal suddenly turning amber a few hundred feet away? Who has not experienced waiting in a long line of cars for a traffic signal to change, moving ahead a few feet, and then having the signal turn red again? To avoid these kinds of inconveniences and the increased potential for accidents, the need for traffic signals should be based on competent engineering study.

8 - Primary purpose of guide signs.

The principal purpose of guide signs is to direct travelers to their destinations by the best route. However, it is not feasible to install signs listing all the possible destinations that may be reached from the highway. Drivers must make reasonable preparation for locating their destinations and have information that is readily available on road maps or GPS systems.

10 - Determining of guide sign messages.

Guide signs require simplicity and clarity because drivers of moving vehicles are unable to read lengthy or complicated messages on signs. For this reason, sign messages should not exceed three lines.

On freeways, high traffic speeds demand that the number of signs be limited to those absolutely essential for the guidance of the motorist. Freeway exits are identified by the exit number, the route number or the name of the intersecting road. Certain additional messages may be provided where justified.

In rural areas signs may be installed to direct travelers to services such as roadside rests, gas, food and lodging.

11- Traffic Signals

Traffic signals are electrically operated traffic control devices that alternately direct traffic to stop and to proceed. This page answers questions about what factors enter into traffic engineers' decisions to install traffic signals. Because there is a common belief that signals are the answer to all traffic problems at intersections, this page is offered in the interest of developing broader public understanding about what signals will do and don't do.

12 - Advantages of traffic signals.

Signals offer the maximum degree of control at intersections. They relay messages of both what to do and what not to do. The primary function of any traffic signal is to assign right of way to conflicting movements of traffic at an intersection, and it does this by permitting conflicting streams of traffic to share the same intersection by means of time separation.

By alternately assigning right of way to various traffic movements, signals provide for the orderly movement of conflicting flows. They may interrupt extremely heavy flows to permit the crossing of minor movements that could not otherwise move safely through the intersection.

When properly timed, traffic signals increase the traffic handling capacity of an intersection, and when installed under conditions that justify its use, it is a valuable device for improving the safety and efficiency of both pedestrian and vehicular traffic. In particular, signals may reduce certain types of accidents, most notably the angle (broadside) collision.

13 - Disadvantages of traffic signals.

While many people realize that traffic signals can reduce the number of angle collisions at an intersection, few realize that signals can also cause an increase in other types of accidents. For example, it has been well documented that other types of accidents, notably rear-end collisions, usually increase when a signal is installed.

Normally, traffic engineers are willing to trade off an increase in rear-end collisions for a decrease in the more severe angle accidents; however, when there is no angle accident problem at an intersection, there is nothing to trade off, and the installation of traffic signals can actually cause a deterioration in the overall safety at the intersection. Traffic signals should not be considered a "cure-all" for traffic congestion, and the primary goal of all traffic engineers is to attain the safest and most efficient traffic flow feasible.

In addition to an increase in accident frequency, unjustified traffic signals can also cause excessive delays, disobedience of signals and diversion of traffic to inadequate alternate routes.

Traffic signals are much more costly than is commonly realized, even though they represent a sound public investment when justified. A modern signal can cost taxpayers between $80,000 and $100,000 to install, depending on the complexity of the intersection and the characteristics of the traffic using it. On top of this, there is the perpetual cost of the electrical power consumed in operating a signalized intersection 24 hours a day. This cost now averages about $1,400 per year.

14 - Effects of an unjustified traffic signal.

Because of the widespread belief that traffic signals offer the solution to all intersection traffic-control and accident problems, a number of signals have been installed nationwide where no legitimate operational warrant exists. Traffic records clearly show that the attitudes and misunderstandings that sometimes lead to unjustified installations should be resisted. It is important that the selection and use of this traffic control device be preceded by a thorough study of traffic and roadway conditions and that the determination of the type of control and method of operation be based on the study data.

Traffic signals should be used only where lesser forms of control have proven ineffective because signals almost always create more "overall intersection delay." In fact, minor movements may experience excessive delay, particularly if the signal is improperly timed. As a result, many drivers switch to less desirable alternate routes or to residential streets to avoid the added delay.

2. 4 Tram and metro systems

- **The Tram System** is one of the urban transport systems that run on railways in specific tracks with a tram driver. It is designed to operate within residential and commercial areas with high density and relatively short distances. This system is characterized by the simplicity and ability to connect passengers to areas close to their work sites Or their homes. The trams are usually on the ground level and intersect with roads in the areas where they pass. The trams generally do not require the use of other means of transportation to reach the desired location. The capacity of tram systems is generally 3000 to 9000 passengers per hour in one direction and the length of the tram between 30 to 60 meters.
- **The Metro System** is one of the urban transport systems that run on iron bars in specific routes with driver or without driver, designed to work within residential and commercial areas with high density and longer distances from the tram. This sometimes requires the metro to use other means of transportation to help get to the desired location (taxi, bus or tram). The metro route is usually completely separate from the road network through a tunnel below ground level, ground level, or over-ground bridges. The total capacity of metro systems is between 9,000-30000 passengers per hour in one direction and the length of the metro is between 45 to 100 meters.

2.5 Geographical Information System (GIS)

A geographic information system (GIS) is a computer-based tool for mapping and analyzing spatial data. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies. GIS is considered to be one of the most important new technologies, with the potential to revolutionize many aspects of society through increased ability to make decisions and solve problems

2.5.1 Geographical Information System applications.

Mapping locations: GIS can be used to map locations. GIS allows the creation of maps through automated mapping, data capture, and surveying analysis tools.

Mapping quantities: People map quantities, like where the most and least are, to find places that meet their criteria and take action, or to see the relationships between places. This gives an additional level of information beyond simply mapping the locations of features.

Mapping densities: While you can see concentrations by simply mapping the locations of features, in areas with many features it may be difficult to see which areas have a higher concentration than others. A density map lets you measure the number of features using a uniform areal unit, such as acres or square miles, so you can clearly see the distribution.

Finding distances: GIS can be used to find out what's occurring within a set distance of a feature.

Mapping and monitoring change: GIS can be used to map the change in an area to anticipate future conditions, decide on a course of action, or to evaluate the results of an action or policy.

2.5.2 Spatial analysis

Spatial analysis or spatial statistics includes any of the formal techniques which study entities using their topological, geometric, or geographic properties. Spatial analysis includes a variety of techniques, many still in their early development, using different analytic approaches and applied in fields as diverse as astronomy, with its studies of the placement of galaxies in the cosmos, to chip fabrication engineering, with its use of "place and route" algorithms to build complex wiring structures. In a more restricted sense, spatial analysis is the technique applied to structures at the human scale, most notably in the analysis of geographic data.

Complex issues arise in spatial analysis, many of which are neither clearly defined nor completely resolved, but form the basis for current research. The most fundamental of these is the problem of defining the spatial location of the entities being studied.

Classification of the techniques of spatial analysis is difficult because of the large number of different fields of research involved, the different fundamental approaches which can be chosen, and the many forms the data can take.

2.6 Map References and Projections

In Geographical Information System maps coordinate system must be define using map references and projections.

2.6.1 World Geodetic system WGS 84: Is a standard for use in cartography . geodcsy and satellite navigation including GPS. It comprises as standard coordinate system for the earth.

2.6.2 The Universal Transverse Mercator (UTM). Is a system of coordinates that describes position on map most maps uses UTM coordinate system .