

DEVELOPMENT OF A FREEWAY INCIDENT RATING
SYSTEM

by

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Presented to the Faculty of the Graduate School of
The University of Texas at Arlington in Partial Fulfillment
of the Requirements
for the Degree of

MASTER OF SCIENCE IN CIVIL ENGINEERING

THE UNIVERSITY OF TEXAS AT ARLINGTON

August 2008

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ACKNOWLEDGEMENTS

This thesis could not have been written without the assistance of Dr. Siamak Ardekani, who encouraged and challenged me throughout the analysis and thesis completion process. He never accepted less than my best efforts.

I would like to acknowledge and extend my gratitude to Dr. Stephen Mattingly, whose support and guidance were instrumental in the successful completion of this thesis.

Special gratitude to Dr. James Williams, for his great efforts explaining traffic engineering and operations concepts used in the completion of this study.

I would like to appreciate Mr. Joe Hunt with the Texas Department of Transportation Dallas District for providing and helping me to understand the incident data base.

To my family, friends, and fellow transportation engineering students for have provided a stimulating environment of unconditional support.

Special thanks to Mr. Koorosh Olyai and Mr. Mahesh Kuimil, Project Managers at Dallas Area Rapid Transit (DART) for their financial support while conducting this study.

July 9, 2008

ABSTRACT

DEVELOPMENT OF A FREEWAY INCIDENT RATING SYSTEM

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A freeway incident rating system is proposed to classify incidents in terms of their disruptive potential to cause delays, fuel wastage, secondary accidents, and other adverse operational impacts. A two-dimensional rating scale is used which classifies incidents in terms of their severity and the number of agencies required to respond and clear incidents. Variables used in characterizing the severity include number of vehicles involved, number of lanes and shoulders blocked, time of incident occurrence, duration of incident until full clearance, and weather conditions at the time of the incident.

The objective behind the development of such a rating system is two-fold. First, it provides a systematic and standard way of organizing the information about the number of incidents of various severity occurring in a freeway network over a time period. This would be particularly helpful in analyzing incident data to identify temporal and spatial trends in a freeway network and to monitor and quantify the efficacy of incident prevention and response efforts. A second objective, once some experience has been gained in rating incidents, is to allow traffic management centers to rate incidents at their onsets in terms of their potential severity.

Communicating those ratings using a commonly understood terminology to all responding agencies could then result in a more coordinated response to the incident, thus accelerating return to normalcy and minimizing adverse impacts such as user delays and secondary accidents.

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CHAPTER 1
INTRODUCTION

1.1 General

Traffic congestion occurs when traffic demand approach the capacity of the road (1). In the last decades, the United States has experienced a skyrocketing increase in highway demand. Construction of new highway capacity has not kept pace with increases in population and car use, causing dramatic congestion and delay. The Texas Transportation Institute estimated that in 2000 the 75 largest U.S. metropolitan areas experienced 3.6 billion vehicle-hours of delay, resulting in 5.7 billion gallons in wasted fuel and \$67.5 billion in lost productivity, or about 0.7% of the nation's GDP. It also estimates that the annual cost of congestion for each driver is approximately \$1,000 in large cities and \$200 in small cities (1).

In 2005, the three areas in the United States with the highest level of congestion were Los Angeles, New York City and Chicago. The congestion cost for Los Angeles alone was estimated at \$9.3 billion (1).

There are a number of specific circumstances which cause or aggravate congestion; one study conducted stated that the main root causes of congestion are: bottlenecks, traffic incidents, work zones, poor signal timing, and special events. The 2002 Urban Mobility Study attributed 52% to 58% of the total delay experienced by motorists to crashes and breakdowns (incidents) (2).

A traffic incident is any non-recurring event that impedes or negatively affects the flow of traffic. This can be anything from a serious injury crash blocking all lanes to a relatively minor property damage crash on the shoulder. It can be a stalled vehicle on or adjacent to the travel way or a person changing a tire on the right shoulder. It can be debris spilled in the lane or even a loose animal on the road.

Incidents critically limit the operational efficiency of the transportation network and put all its users at risk. An appropriate traffic incident management system is necessary for efficient clearance of incidents and congestion relief. Incident management is defined as the systematic, planned and coordinated use of human, institutional, mechanical, and technical resources to reduce the duration and impact of incidents, and improve the safety of motorists, crash victims, and incident responders. A rapid incident response will reduce traveler delay, secondary crashes, danger posed to response personnel, lost time and productivity, fuel consumption, emissions, etc.

To assist traffic management centers in a quick and rapid response, a severity rating system would be useful. Enabling operators at traffic management centers to rate incidents at their onsets in terms of their potential severity and communicating those ratings using a commonly understood methodology to all responding agencies could result in a more coordinated response to the incident. This has the potential to reduce the incident response and clearance time, thus accelerating return to normalcy and minimizing adverse impacts such as user delays, wasted fuel, emissions, and secondary accidents. At the same time, severity rating records could generate data reporting that will aid in analyzing trends and alternatives for improvements. The severity rating will be based on the impact of the incident to freeway operations and on the number of service entities responding to the incident scene.

1.2 Objectives and Goals

The objective of this study is the classification of incidents in terms of their severity, response and clearance time.

The intention of this study is to develop a severity rating system for freeway incidents, which considers different variables that are directly related to the severity of the incident such as number of vehicles involved, travel lanes or non-travel lanes blocked, time of day, weather conditions, incident duration and number of service entities responding. The first goal of this

study is to accelerate incident response and clearance time. Once some experience has been gained in rating incidents, traffic management centers could rate incidents in their onsets in terms of their potential severity. Communicating those ratings using a commonly understood terminology to all responding agencies could then result in a more coordinated response to incidents and further mitigation of adverse impacts of incidents. The second goal is to have an organized way of collecting and reporting incident data. A systematic and standard way of collecting and reporting incident data would help in data analysis to identify temporal and spatial incident trends in a freeway network over a time period. This would allow for better monitoring and quantifying of efficacy of incident prevention and response efforts. Up to this date, there is no type of such comprehensive incident report mechanism.

The incident rating system can be very beneficial to traffic management centers to determine the event impact and to keep a database of incidents within their jurisdiction.

1.3 Organization of Thesis

This thesis is organized in five sections or chapters. Each chapter covers specific information regarding the rating system development process as follows:

- Chapter I gives an introduction to the current congestion status in the United States, its negative economic and environmental effects, and the importance of an effective incident management program, which should include an appropriate incident severity rating system. Also, this chapter contains the goal of this study.
- Chapter II includes background information about current traffic incident management strategies and techniques in the United States.
- Chapter III reviews other severity systems available as well as literature that serves as a base for the development of this incident rating system. It also covers the impact of incidents and lists the parameters used for the proposed system.
- Chapter IV describes the methodology to obtain an appropriate incident rating scale.

- Chapter V covers the conclusions from the study, and limitations of this model in current traffic management practice.

CHAPTER 2
BACKGROUND STUDY

2.1 Incident Effects

A traffic incident represents an unplanned event creating a temporary reduction in roadway capacity that in turn, impedes the normal flow of traffic. Examples of incidents include vehicle disablements, crashes, cargo spills and roadway debris. Incidents vary widely in severity (3). They could be a single vehicle stranded on the roadway shoulder with an overheated engine or flat tire to a multi-vehicular crash or overturned truck blocking the entire highway.

The following are the main problems and secondary effects associated with highway incidents:

- Traveler delay,
- The serious risk of secondary crashes,
- Danger posed to rescue and response personnel,
- Reduction in productivity,
- Increased fuel consumption,
- Reduction in air quality,
- Reduction in quality of life.

When the magnitude of these problems is severe, they critically limit the operational capacity of the freeway and put all drivers at risk. An efficient incident management program can help mitigate many of these problems and expedite return of the freeway capacity to a normal level.

Safety Implications of Incidents

A study conducted in Minnesota found that 13% of all peak-hour crashes were the result of a previous incident (4). A study by the Washington State Department of Transportation further emphasizes this point. This study found that 3,165 shoulder collisions occurred on interstate, limited access or other state highways during a period of seven years. The injury rates for shoulder collisions were much higher than the rates for all other accident categories (5).

The severity of secondary crashes is greater than that of the original incident. This is the reason why it is very important to respond and clear incidents as soon as possible, since the longer the incident is in place, the greater exposure to secondary crashes. A 1995 analysis of collision statistics in California showed that secondary crashes represent an increase in collision risk of over 600% (6).

Congestion Caused By Incidents

Incident related delay accounts for between 50 and 60 percent of total congestion delay. In smaller urban areas, it can account for an even larger proportion, according to studies conducted by the American Trucking Association and Cambridge Systematics, Inc (7). In the ten most congested urban areas in 1998, the amount of incident-related congestion delay ranged from 218,000 to 1,295,000 person-hours (8).

As a consequence, millions of gallons of fuel are wasted by incident delay. The wasted fuel in the ten most congested urban areas ranges from 56 to 383 million gallons per year (8).

The impact of incidents on freeway capacity is alarming. Incidents reduce capacity by an amount greater than the physical reduction in roadway space caused by the event. Table 2.1 from the 1996 Traffic Control Systems Handbook illustrates this issue.

Table 2.1 Fraction of freeway capacity available under incident conditions (13)

Number of Freeway Lanes in Each Direction	Shoulder Disablement	Shoulder Accident	Lanes Blocked		
			ONE	TWO	THREE
2	0.95	0.81	0.35	0.00	N/A
3	0.99	0.83	0.49	0.17	0.00
4	0.99	0.85	0.58	0.25	0.13
5	0.99	0.87	0.65	0.40	0.20
6	0.99	0.89	0.71	0.50	0.25
7	0.99	0.91	0.75	0.57	0.36
8	0.99	0.93	0.78	0.63	0.41

2.2 Incident Types

Mitigation of freeway incidents is critical to improve drivers' and rescue responders' safety, highway efficiency, and in general, the nation's economic competitiveness. In an effort to understand how to minimize incident impacts, I need to understand its types and general characteristics.

Cambridge Systematics combined results of previous research efforts to develop a classification of incidents (7). Figure 2.1 illustrates the type, common location as well as duration and delay caused by freeway incidents.

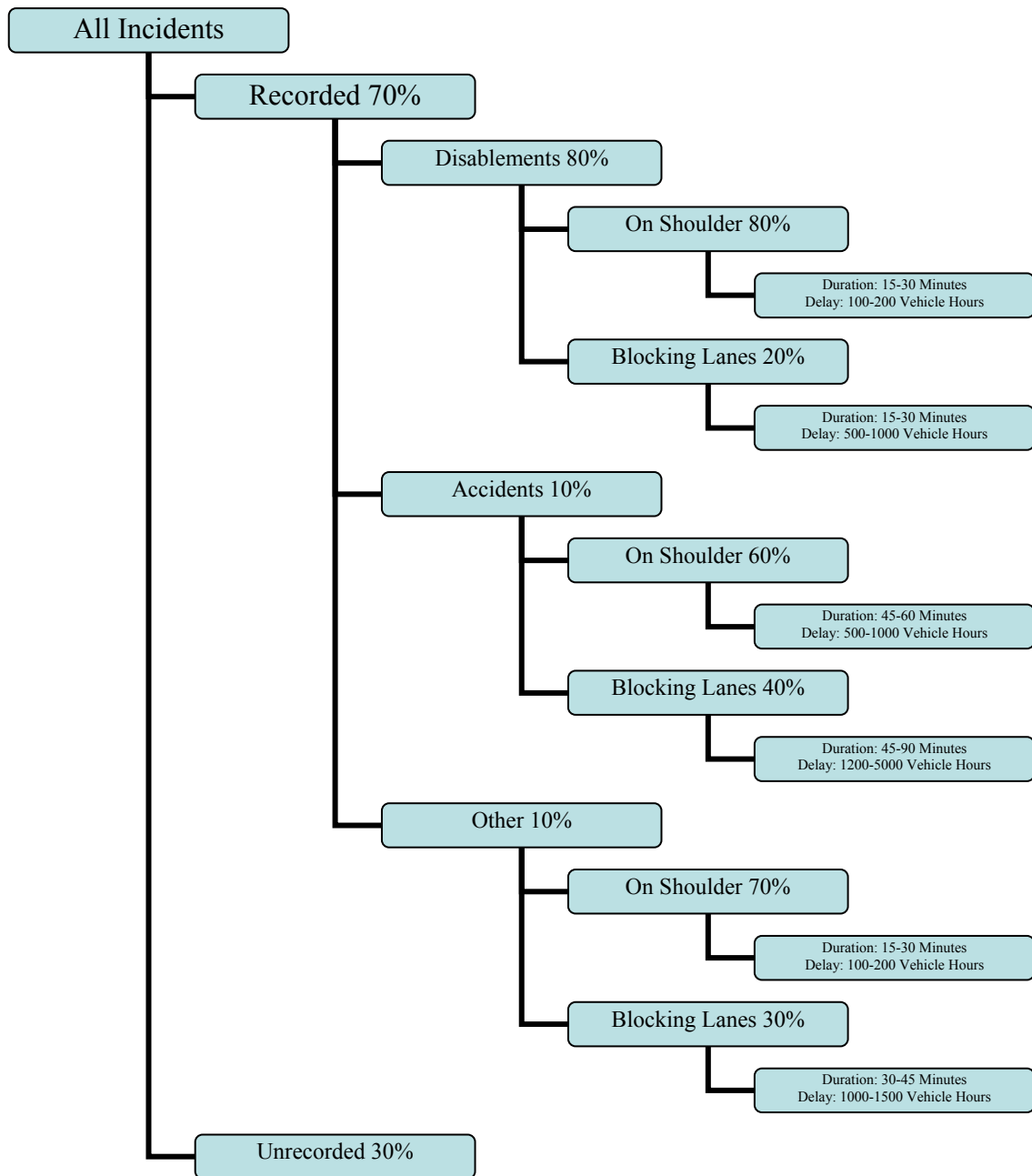


Figure 2.1 Profile of reported freeway incidents by type (13)

Figure 2.1 shows that the majority of the incidents consist of disabled vehicles on the freeway shoulder, which also cause the least amount of delay to users. However, when the system

experiences crashes blocking lanes its capacity is reduced dramatically and delay is extremely high.

2.3 Incident Management Activities (13)

It is very helpful to discuss the functions that comprise the incident management process. Incident management entails different types of activities by personnel of different response agencies. A close coordination between these agencies is required in order to clear the event as soon as possible and bring the freeway to normal operating conditions. There are several activities that characterize the incident management process, including: detection, verification, motorist information, response, site management, traffic management and clearance.

Detection

Detection is the first step of the incident management process. This is the action by which an incident is brought to the attention of the agencies responsible for safe operations on the freeway. The most common methods of detection include:

- Mobile telephone calls from facility users,
- Closed circuit television systems along the freeway,
- Detection software,
- Electronic measurement devices and sensors that detect abnormalities on the vehicle flow patterns,
- Police patrols,
- Courtesy patrols.

Verification

Verification is the action that confirms that an incident has occurred, determining its location and obtaining as much information as possible. Once all available information is gathered the initial response is dispatched. Some of the most common verification methods include:

- Closed circuit television cameras on the freeway,
- Dispatch of field units to the incident scene (courtesy patrol, police, etc.),
- Combining information from multiple users' phone calls.

Motorist Information

Once the incident has been verified, it is extremely important to alert motorists approaching the incident location and all potential facility users. This is an effort to reduce the possibilities of secondary crashes that usually result in higher risk of injury or death to approaching motorist generating more congestion than the original incident, and to advise motorists to take alternate routes and avoid a more critical congestion condition. The methods used to inform freeway users of the incident are:

- Commercial radio broadcast,
- Highway advisory radio (HAR),
- Dynamic Message Signs (DMS),
- Telephone information systems,
- Public television traffic reports,
- Internet services.

The incident information needs to be disseminated as quickly as possible and until the highway reaches its normal flow conditions.

Response

Traffic incident response includes the deployment of the required agencies and equipment and the activation of the appropriate communication links and motorist information media as soon as the incident is verified. The appropriate response is fostered by appropriate training and planning as individual agencies and collectively with other response agencies.

Site management

Site management is the process of effectively coordinating and managing on-scene resources. The main objective of incident site management is ensuring the safety of response personnel, incident victims and all other motorists. Site management encompasses the following activities:

- Assessing incidents,
- Establishing priorities,
- Coordination with the appropriate agencies and organizations,
- Using effective liaisons with other responders,
- Maintaining clear communications.

Traffic management

Traffic management involves the application of traffic control devices in the areas affected by the incident. The traffic measures in an incident location include:

- Establishing point traffic control on-scene,
- Managing the roadway space. This means to open and close lanes, blocking only the portion of the freeway that is strictly necessary for safety,
- Deployment of the appropriate entities to assist in traffic management, such as state police, local police or courtesy patrol,

- Management of traffic control devices including traffic signals, ramp meters and lane control signs in affected areas,
- Designating, developing and operating alternate diversion routes.

Clearance

Clearance is the process of removing wreckage, debris, or any other element that disrupts the flow of traffic or force lane closures. This clearance will restore the roadway capacity to its normal condition.

2.4 Agencies and Responsibilities (13)

It is very important to understand the roles and responsibilities that all agencies play in an effective incident management program. These responsibilities are not necessarily the same in all regions of the country, but this section describes how each agency is typically involved in incident management.

Law Enforcement

The typical roles and responsibilities assumed by law enforcement include:

- Assist in incident detection,
- Secure the incident scene,
- Assist disabled motorists,
- Provide emergency medical aid until help arrives,
- Direct traffic,
- Conduct accident investigations,
- Serve as incident commander,
- Safeguard personal property,
- Supervise scene clearance.

Fire and Rescue

This service is provided by the local fire department. Incident roles and responsibilities offered by the fire department are:

- Protect the incident scene,
- Provide traffic control until police or DOT arrival,
- Provide emergency medical care,
- Provide initial HAZMAT response and containment,
- Fire suppression,
- Crash victim rescue from wrecked vehicles,
- Rescue crash victims from contaminated environments,
- Arrange transportation for the injured,
- Serve as incident commander,
- Assist in incident clearance.

At the same time, the fire department is the primary emergency response agency for hazardous material spills. They operate under a highly organized team structure with the close supervision of a commanding officer.

Emergency Medical Services (EMS)

The primary responsibilities of the emergency medical service (EMS) are the triage, treatment and transport of crash victims. In many areas, private companies provide this service to the local jurisdictions. The roles and responsibilities of EMS are:

- Provide advanced emergency medical care,
- Determine destination and transportation requirements for the injured,
- Coordinate evacuation with fire, police and ambulance or airlift,
- Serve as incident commander for medical emergencies,

- Determine approximate cause of injuries for the trauma center,
- Remove medical waste from incident scene.

EMS has evolved as primary caregivers to individuals needing medical care in emergencies. They focus on providing patient care, crash victim rescue and ensuring the safety of their personnel.

Transportation Agencies and Municipalities

The Department of Transportation and Municipalities are typically responsible for planning and implementing incident management programs. These agencies are also directly responsible for traffic operation centers. Their responsibilities include:

- Incident detection,
- Incident verification,
- Traffic management strategies,
- Protect incident scene,
- Initiate medical assistance until help arrives,
- Provide traffic control,
- Assist motorist with disabled vehicles,
- Provide motorist information,
- Determine incident clearance and roadway repair needs,
- Establish and operate alternate routes,
- Repair transportation infrastructure.

Towing and Recovery Service

Towing and recovery service providers are responsible for the safe and efficient removal of wrecked or disabled vehicles and debris from an incident scene. Their typical duties include:

- Remove vehicles from incident scene,

- Protect victims' property and vehicles,
- Remove all debris from the freeway,
- Provide transportation for uninjured vehicle occupants,
- Serve as incident commander for recovery operations.

They are indispensable components of all incident management programs.

Media

The media's roles related to incident management are:

- Report traffic incidents,
- Broadcast information on delays,
- Provide alternate route information,
- Update incident status frequently,
- Provide video or photographic service of the incident and traffic back up.

Coroners and Medical Examiners

Coroners and medical examiners are responsible for investigating deaths that result from anything other than natural causes. As such, they play an important role in investigating fatal crashes that occur on roadways.

Hazardous Materials Teams

Hazardous material responders are hired by emergency or transportation authorities to clean up and dispose of toxic or hazardous materials on the road as a consequence of an incident.

2.5 Opportunities for Improvement

Up to this day, there is no comprehensive severity rating method considering the variables proposed in this study. This severity rating system could aid as a measure of performance from

one study period to another, or from one region to another. At the same time, trends could be analyzed and even funds for equipment and personnel could be requested as a result of a severity rating analysis.

A severity rating system could also increase incident response efficiency, reduce incident clearance time and congestion delay, and prevent secondary crashes by alerting approach motorist of the incident severity rate.

Current available documentation shows a basic procedure for incident severity classification. This documentation includes the Manual on Uniform Traffic Control Devices (MUTCD) (9) and the Manual on Classification of Motor Vehicle Traffic Accidents (17).

The MUTCD ranks incident severity in order to assign the proper traffic control. This classification is based on general variables including injuries or fatalities, lanes blocked and incident duration.

On the other hand, the Manual on Classification of Motor Vehicle Traffic Accidents rates incident severity according to its duration, vehicles involved and on service entities needed.

Both cases use general incident characteristics to assign severity. The advantage of the proposed methodology is that it includes more parameters such as number of vehicles involved, lanes blocked, duration of the incident, weather conditions, time of day and service entities responding as will be explained in Chapter IV.

CHAPTER 3

LITERATURE REVIEW

This chapter covers some literature where incident severity classification is used. Three different sources of incident severity classification are presented. One is based on the Manual on Uniform Traffic Control Devices (MUTCD), a second method is extracted from the Manual on Classification of Motor Vehicle Traffic Accidents and a third classification is utilized by the Rhode Island Department of Transportation. Then, three methods for classification of hurricanes, earthquakes and fires are discussed as a starting point for the methodology used on this study for incident classification. A discussion regarding the impacts of incidents is also covered. In the final section of the chapter, the parameters used in the incident severity rating are listed.

3.1 Manual on Uniform Traffic Control Devices-2003 Edition (9)

The Manual on Uniform Traffic Control Devices covers some basic incident classifications. The MUTCD defines a traffic incident as follows: “A traffic incident is an emergency road user occurrence, a natural disaster, or other unplanned event that affects or impedes the normal flow of traffic” (9). The MUTCD’s Chapter 6I titled “Control of traffic through traffic incident management areas,” has divided incidents into three general classes of duration, each of which has unique traffic control characteristics. The classes are as follows:

- Major,
- Intermediate,
- Minor.

Major Incident

A major incident is an event that takes more than 2 hours to clear. It usually involves hazardous materials, fatal traffic crashes of multiple vehicles or other disasters, which are natural or man made. Full or partial closure of travel and non-travel lanes is required for the entire clearance duration. Proper temporary traffic control measures should be implemented for smooth and safe flow of approaching traffic.

Intermediate Incident

The MUTCD defines an intermediate traffic incident as follows: "Intermediate traffic incidents typically affect travel lanes for a time period of 30 minutes to 2 hours, and usually require traffic control on the scene to divert road users past the blockage. Full roadway closures might be needed for short periods during traffic incident clearance to allow traffic incident responders to accomplish their tasks."

Minor Incident

Minor traffic incidents are typically disabled vehicles and minor crashes that result in lane closures of less than 30 minutes. In this type of incident, on-scene responders are typically courtesy patrol or towing services to move vehicles away from the incident site, and occasionally highway agency service patrol vehicles. Diversion of traffic into other lanes is often not needed or is needed only briefly.

3.2 Manual On Classification of Motor Vehicle Traffic Accidents (17)

The manual on classification of motor vehicle traffic accidents classifies accidents into four different categories (17). Accident severity is ranked based on the accident characteristics. Each category and its characteristics are discussed herein.

Severity 1

- Single or multiple car incident involving mechanical difficulties or slight vehicle damage,
- Last no longer than five to ten minutes,
- Vehicle remains operational or can be pushed to the nearest exit without endangering life and property of those involved,
- Very little debris, if any, is present,
- No freeway towing response necessary to move vehicles,
- Law enforcement involvement may or may not be necessary,
- Agency involvement beyond law enforcement may not be necessary,
- No injuries reported.

Severity 2

- Assistance is necessary in the form of towing and law enforcement,
- Typically last from fifteen to forty minutes,
- Vehicles typically can not move from freeway to the nearest off ramp or crash investigation site under their own power,
- Debris or fluid is seen,
- No reported injuries.

Severity 3

- Assistance is necessary in the form of towing, law enforcement, fire, and EMS,
- Typically lasts from twenty minutes to 1 hour or more,
- Vehicles typically can not move from freeway without mechanical assistance,
- Debris or fluid is seen with potential fire hazard,
- Possible injuries or fatalities.

Severity 4

- Incident lasts longer than an hour and may involve multiple disable vehicles,
- Possible need for EMS and Fire Department,
- Possible need for towing,
- Debris may require special clean up or none at all,
- Represents incidents that last longer than a type 2 or 3.

3.3 Rhode Island Department of Transportation (18)

The Rhode Island DOT uses a simple classification system (18). It is based on the incident characteristics and the number of travel or non-travel lanes closed, injuries or fatalities, and whether or not the Fire Department or Hazardous Material team is responding to the scene.

Severity 0

- No injuries and no travel lanes blocked.

Severity 1

- More than 1/4 of the travel lanes are blocked with no injuries, or Median/shoulder closed with injuries.

Severity 2

- 1/3 or 2/4 or more travel lanes blocked, or Fire with no lanes closed, or Haz Mat response team with no lanes closed.

Severity 3

- 1/2 or 2/3 or 3/4 or more lanes blocked, or Fire with 1/3 or 2/4 lanes closed.

Severity 4

- All travel lanes blocked, or Fatality, or Haz-Mat response team with clean up, or Fire with 1/2, 2/3, 3/4 lanes closed, or Structural damage with 1/3, 2/3 or more lanes closed.

Note: For travel lanes blocked terminology, “1/4” indicates 1 out of 4 lanes blocked.

3.4 Scales for Natural Disasters Classification

Natural disasters such as earthquakes, hurricanes and fires each have a severity classification associated with them. This classification is based on the event’s strength and destructive power. This is the same concept used behind my analysis of incident rating, where traffic incidents are classified based on its severity magnitude and disruptive potential. The following is a brief summary of how the classification ratings for each of the above mentioned disasters were obtained.

Richter Magnitude Earthquake Scale (10)

Earthquake classification is based on the Richter magnitude scale. This scale, developed by Charles Richter, assigns a single number to quantify the amount of seismic energy released by an earthquake. It is a base-10 logarithmic scale obtained by calculating the logarithm of the combined horizontal amplitude of the largest displacement from zero on a Wood-Anderson torsion seismometer output.

Richter’s motivation for creating the local magnitude scale was to separate the large number of smaller earthquakes from the few larger earthquakes observed in California at that time.

Table 3.1 describes the typical effects of earthquakes of various magnitudes near the epicenter. This table should be taken with caution since intensity and ground effects depend not only on the magnitude but also on the distance from the epicenter, the depth of the earthquakes focus beneath the epicenter and geological conditions.

Table 3.1 Earthquake effects by Richter magnitude (10)

Richter Magnitude	Description	Earthquake Effects
Less than 2.0	Micro	Micro earthquakes. Not felt.
2.0 – 2.9	Minor	Generally not felt, but recorded.
3.0 – 3.9	Minor	Often felt, but rarely causes damage.
4.0 – 4.9	Light	Noticeable shaking of indoor items, rattling noises.
5.0 – 5.9	Moderate	Can cause major damage to poorly constructed buildings.
6.0 – 6.9	Strong	Can be destructive in areas up to about 100 miles in populated areas.
7.0 – 7.9	Major	Can cause serious damage over larger areas.
8.0 – 8.9	Great	Can cause serious damage in areas several hundred miles across.
9.0 – 9.9	Great	Devastating in areas several thousand miles across.
10.0 or Greater	Epic	Never recorded.

Events with magnitudes of about 4.6 or greater are strong enough to be recorded by any of the seismographs in the world, given that the seismograph's sensors are not located in an earthquake's shadow.

Saffir-Simpson Hurricane Scale (11)

The scale was developed in 1971 by civil engineer Herbert Saffir and meteorologist Bob Simpson. This system was first introduced to the general public in 1973. The initial scale was developed by Saffir, who in 1969 studied low-cost housing in hurricane-prone areas for the United Nations. The rate mirrors the Richter scale in describing earthquakes, consisting of a 1-5 scale based on wind speed that showed expected damage to structures. Later, Simpson added the effects of storm surge and flooding.

The Saffir-Simpson Hurricane Scale is a classification used for most Western Hemisphere tropical cyclones that exceed the intensities of tropical depressions and tropical storms and thereby become hurricanes. The scale separates hurricanes into five different categories distinguished by the intensities of their sustained winds. Table 3.2 illustrates these categories:

Table 3.2 Hurricane categories (11)

Saffir-Simpson Hurricane Scale		
Category	Wind Speed (mph)	Storm Surge (ft)
5	≥ 156	>18.0
4	131 - 155	13.0 - 18.0
3	111 - 130	9.0 - 12.0
2	96 - 110	6.0 – 8.0
1	74 - 95	4.0 – 5.0
Additional Classifications		
Category	Wind Speed (mph)	Storm Surge (ft)
Tropical Storm	39-73	0-3.0
Tropical Depression	0-38	0

In order to be classified as a hurricane, a tropical cyclone must have maximum sustained winds exceeding 73 mph. The highest classification of the scale is Category 5, and is reserved for storms with winds greater than 155 mph. These classifications are intended primarily for use in measuring the potential damage and flooding a hurricane could cause upon landfall, although they have been criticized as being too simple. Officially, the Saffir-Simpson Hurricane scale is used only to describe hurricanes forming in the Atlantic Ocean and northern Pacific Ocean east of the International Date Line. Other areas use different classification scales to label these storms, which are called cyclones or typhoons.

Rating Scale For Fire Danger (12)

The National Fire Danger Rating System (NFDRS) is a set of computer programs and algorithms that allow land management agencies to estimate fire danger for a given rating area. NFDRS characterizes fire danger by evaluating the approximate upper limit of fire behavior in a fire rating area during a 24-hour period. Calculations of fire behavior are based on fuels, topography and weather, or what is commonly called the fire triangle. NFDRS output gives relative ratings of the potential growth and behavior of any wildfire. Fire danger ratings are

guides for initiating presuppression activities and selecting the appropriate level of initial response to a reported wildfire in lieu of detailed, site and time specific information. It links an organization's readiness level to the fire problems of the day.

Table 3.3 summarizes the rating scale used to classify wildfires danger.

Table 3.3 Classification and rates of wildfire danger (12)

National Fire Danger Rating System	
Classification	Rate
Low	Green
Moderate	Blue
High	Yellow
Very High	Orange
Extreme	Red

The characteristics of each rating are as follows (12):

- GREEN – Fuels do not ignite readily from small firebrands, although a more intense heat source may start fires in duff or punky wood. Fires in open cured grassland may burn freely a few hours after rain, but wood fires spread slowly by creeping or smoldering. There is little danger of spotting.
- BLUE – Fires can start from most accidental causes, but with the exception of lightening fires in some areas, the number of starts is generally low. Fires in open-cured grassland will burn briskly and spread rapidly on windy days. Woods fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may not burn. Short distance spotting may occur, but is not persistent. Fires are not likely to become serious, and control is relatively easy.
- YELLOW – All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short distance spotting is common. High intensity burning may develop on slopes in

concentrations of fine fuel. Fires may become serious and their control difficult, unless they are hit hard and fast while small.

- ORANGE – Fires start easily from all causes and immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high intensity characteristics such as long distance spotting and fire whirlwinds, when they burn into heavier fuels. Direct attack at the head of such fires is rarely possible after they have been burning more than a few minutes.
- RED – Fires under extreme conditions start quickly, spread furiously and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the orange rate. Direct attack is rarely possible and may be dangerous, except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme building condition lasts. Under these conditions, the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

All these concepts for natural disaster classification based on strength and destructive power have served as a reference for this incident rating study. This study presents an incident rating method based on its unique characteristics like number of vehicles involved, number of lanes blocked, weather conditions, time of day the incident happened, duration and number of service entities responding to the incident.

3.5 Impacts of Incidents

The primary considerations related to incidents include vehicle delay and the safety of motorists and emergency response crews. The vast majority of incidents are vehicle disablements and minor accidents. During off-peak periods when traffic volumes are low, these incidents have little or no impact on freeway traffic. But, when traffic volumes are high, their cumulative effect is substantial. Police and tow trucks can clear these incidents rapidly and efficiently if all agencies give this work high priority. Incident congestion can be reduced considerably by assigning a high priority to the detection and clearance of minor incidents.

Traffic Congestion And Delay (8)

Although urban freeways make up less than 2.4% of the total urban highway mileage, they carry about 20% of the nation's traffic. Congestion on this roadway system can occur under recurring conditions (for instance, due to capacity or operational problems such as bottlenecks) or can be caused by crashes or breakdowns known as non-recurring congestion. By some estimates, as much as 60% of all freeway congestion is considered non-recurring. A key strategy for reducing congestion in major urban areas is to handle accidents and incidents as quickly as possible to keep traffic flowing. Limiting the impact of non-recurring events such as crashes, traffic stops, fire or disabled vehicles through effective incident management should be the top priority of the incident management program.

It is estimated that the annual delay due to congestion is more than 2 billion hours at a cost exceeding \$16 billion per year. The Federal Highway Administration has estimated that almost 60% of this delay is due to crashes. Using the incident management handbook (13) is an essential factor to reduce the effects that traffic incidents have on road capacity and travel conditions.

3.6 Parameters Used for Incident Severity Rating

My first approach for the development of the incident rating system was to obtain incident information for the Dallas area. An incident database was obtained through the Texas Department of Transportation Dallas District. This database contained 2006 and 2007 incident information along US75 in the City of Dallas. After analyzing the information contained in the database, key information was extracted for the development of the rating system.

The parameters extracted and used for our study are as follows:

- Number of vehicles involved,
- Lanes and/or shoulders affected,
- Time of the incident,
- Duration of the incident,
- Service entities responding.

In an effort to obtain additional information that could influence the number of incidents, web research was done to obtain weather information for the period of time the incident database covered. A more detailed explanation of each of these variables is covered in the next chapter.

CHAPTER 4
METHODOLOGY

This section discusses the necessity and benefits of an incident severity classification model and the methodology used in this study. At the same time, the variables used for the severity classification are listed and support information is provided for the assumptions considered when assigning index values to each variable. Finally, the incident severity classification is presented with some study cases.

4.1 Incident Severity Classification

Incident severity classification is an important factor for prediction, inference and decision making based on the impact that a freeway incident has on traffic operations. The intention of the incident rating is to identify and comprehend the nature and degree of traffic disruption caused by an incident on the freeway system. The methodology used for such classification generates a two dimensional scale that relates incident severity and the number of service entities responding. Table 4.1 shows this two dimensional scale.

Table 4.1 Incident rating based on a two dimensional scale

		Service Entities Responding				
		1	2	3	4	5
S e v e r i t y	A					
	B			X		
	C					
	D					
	E					

As is shown, an A1 rating represents the least critical incident case whereas E5 is the most critical of all cases.

The benefits of implementing a classification rating are:

- Assist in rapid deployment of required agencies and equipment,
- Reduce incident duration and user delays by communicating incident rating to all responding agencies for a more coordinated response,
- Prevent secondary crashes by alerting approach motorist about the incident severity rating,
- Improve incident data reporting and analysis,
- Improve quality of traveler information service to motorists,
- Gain experience and learn from previous incidents of the same severity,
- Compare the actions taken for similar rate of incidents,
- Useful for proactive decision making and response for a specific incident rate,
- Estimate delay that would be caused to the network after analyze the relation between each severity rate and delay.

4.2 Methodology

The main goals of this study are to develop a systematic way of recording and communicating incident data, and to increase incident response efficiency. This method can be very useful for traffic management center personnel to quickly assess the incident rating based on the incidents' characteristics. The logic behind using this method is that the severity rating depends not only on one factor, but on multiple factors representing the duration and resources needed to clear incidents and the disruptive potential of incidents. The output of this method is a rating which serves as an indicator of the criticality of the event as well as a measure of the impact on the freeway system operations.

The procedure for the incident rating is as follows:

- 1) Identify the incident variables and characteristics,
- 2) Assign index values to each variable based on its specific characteristics,
- 3) Calculate a severity index as an average of each variable index value (SI),
- 4) Assign severity according to the severity index,
- 5) Identify the number of service entities responding,
- 6) Assign service entities responding index (I_a),
- 7) Combine severity and service entities responding index to obtain the incident severity rate.

Each of these steps is described in more detail in the following section.

4.3 Incident Parameters and Index Values

In order to know exactly which variables were available for the development of this rating system, an incident database was provided by the TxDOT Dallas District. The incident database contained 5011 incident records along an approximate 30-mile section of US75 (North Central Expressway) in Dallas from Interstate Highway 30 on the South to State Highway 121 on the North. The data was collected from January 2006 to October 2007. The variables contained in the database were:

- Record number,
- Incident key number,
- Road and cross street where incident happened,
- Detected time,
- Cleared time,
- Incident duration,
- Status of incident,
- Features affected (number of blocked lanes or shoulders),
- Type of incident,

- Vehicles involved,
- Agencies responding.

After reviewing the incident database, the parameters selected for the rating system are:

- 1) Vehicles involved,
- 2) Features affected,
- 3) Time of day,
- 4) Incident duration,
- 5) Service entities responding.

At the same time, weather conditions for the analysis period are considered since they have a high influence on incident severity. In the United States each year, approximately 7,000 highway deaths and 800,000 injuries are associated with about 1.2 million weather related accidents (20). The estimated annual economic cost from weather related crashes (deaths, injuries, and property) amounts to nearly \$42 billion dollars (20). The impacts of adverse weather on the highway system are huge. Road weather data are used by emergency managers responsible for responding to incidents such as crashes, disabled vehicles and other potentially life threatening situations. These weather conditions are obtained from the National Weather Service website (21).

Different bins are created within each variable. The bins assign an ordinal index value to each variable, where the higher the value, the higher the impact on freeway operations. A description of each variable is presented herein.

Vehicles Involved

The number of vehicles involved indicates the severity of the event. In general, the number of vehicles involved is correlated to the severity of the incident (14). An incident may involve a

single stalled vehicle on the shoulder of the road; in this case, the severity of such an incident is very low. On the other hand, it is possible to have a multiple vehicle accident having a very high impact on freeway operations.

In 1997, Cambridge Systematics completed a report (13) where they found that the majority of freeway incidents involve disabled vehicles on the shoulder and other incidents that have little impact on freeway capacity, as shown in Figure 4.1. It also found that 30% of incidents are not recorded and that 7% are classified as other.

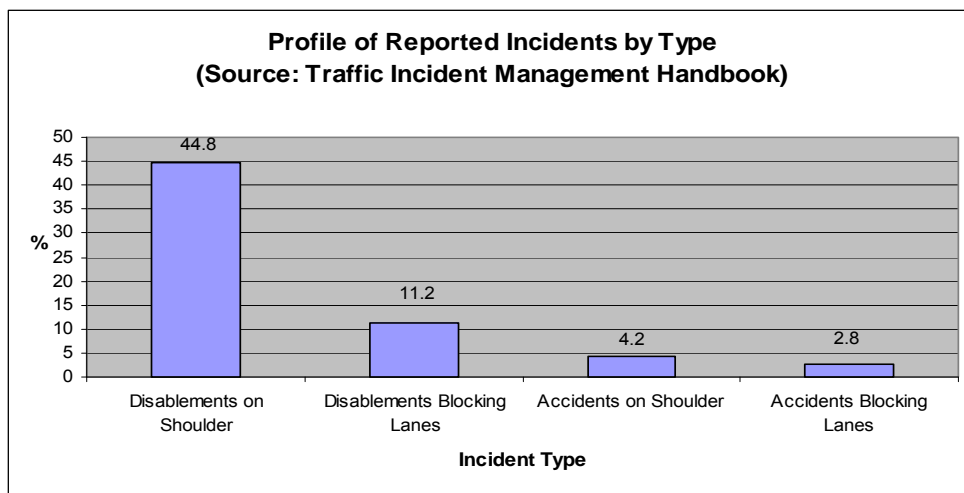


Figure 4.1 Profile of reported freeway incidents by type (13)

Weights for the index values were assigned from 1 to 5. An index of 1 represents an incident with low impact on freeway operations while an index of 5 represents a very critical operational disruption. Please note that values for this index were selected arbitrarily since no study relating number of vehicles with severity is available.

Different ranges for each index value are assigned considering the fact that incidents involving a single vehicle are much more frequent than multi-vehicle incidents. The final ranges are selected when their frequency distribution (using the database provided by TxDOT Dallas

District) was similar to the distribution presented by Cambridge Systematics. The selected ranges for the vehicles involved index I_v are shown in Table 4.2. The frequency distribution obtained from the database provided, is generated using these ranges and shown in Figure 4.2.

Table 4.2 Vehicles involved index (I_v)

Vehicles Involved	
Description	I_v
No Vehicles	1
1 Vehicle	2
2 Vehicles	3
3 Vehicles	4
4+ Vehicles	5

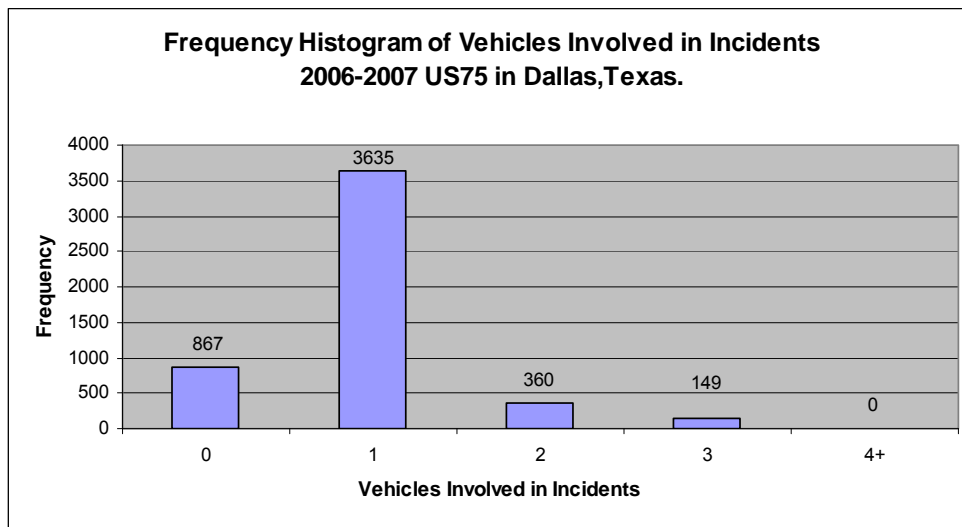


Figure 4.2 Frequency histogram of vehicles involved per incident

Note that incidents involving a low number of vehicles are more frequent than multi-vehicle incidents. In the frequency histogram, no vehicles involved means that debris on the road was causing the operational disruption.

Features Affected

The number of travel and non-travel lanes affected is a good indicator of the incident severity. It is possible that all lanes of the freeway must be shut down to keep traffic away from the incident scene and provide safety for rescue personnel and injured motorists. In some minimal incidents, such as a vehicle with a flat tire, only the shoulder may be affected. Table 2.1 shows the effect of blocked lanes or shoulders on freeway capacity (13). The available capacity is related to the total number of lanes per direction of the road.

Table 2.1 illustrates that an incident reduces freeway capacity by an amount far greater than the physical reduction in roadway space caused by the incident. For example, an incident blocking one lane (having one or more lanes blocked assumes that the shoulder is blocked too) of a three lane freeway reduces capacity by 51%, although only a third of the lanes are blocked.

Table 2.1 does not include the available capacity for cases when the freeway has more than four lanes and more than 4 lanes blocked. In order to get a complete understanding of the available capacity for those cases, extrapolation is used to calculate the missing data. The extrapolation results are presented in the next tables and figures.

For a five lane freeway:

Table 4.4 Lanes blocked and fraction of capacity available for a 5-lane freeway

5 Lanes	
<i><u>Lanes Blocked</u></i>	<i><u>Available Capacity</u></i>
1	0.65
2	0.40
3	0.20
4	0.06
5	0

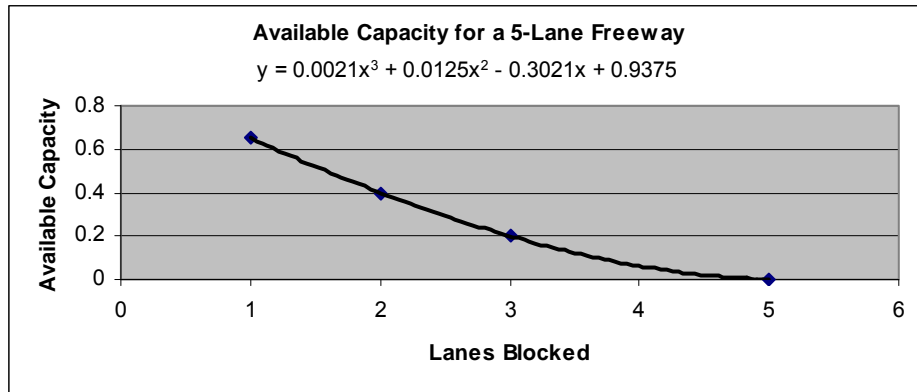


Figure 4.3 Lanes blocked vs available capacity for a 5-lane freeway

For a six lane freeway:

Table 4.5 Lanes blocked and fraction of capacity available for a 6-lane freeway

6 Lanes	
<i>Lanes Blocked</i>	<i>Available Capacity</i>
1	0.71
2	0.50
3	0.25
4	0.13
5	0.03
6	0

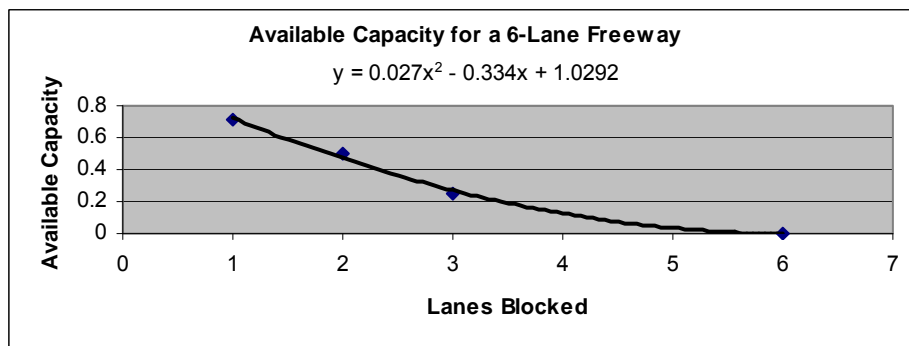


Figure 4.4 Lanes blocked vs available capacity for a 6-lane freeway

For a seven lane freeway:

Table 4.6 Lanes blocked and fraction of capacity available for a 7-lane freeway

7 Lanes	
<u>Lanes Blocked</u>	<u>Available Capacity</u>
1	0.71
2	0.50
3	0.25
4	0.20
5	0.11
6	0.04
7	0

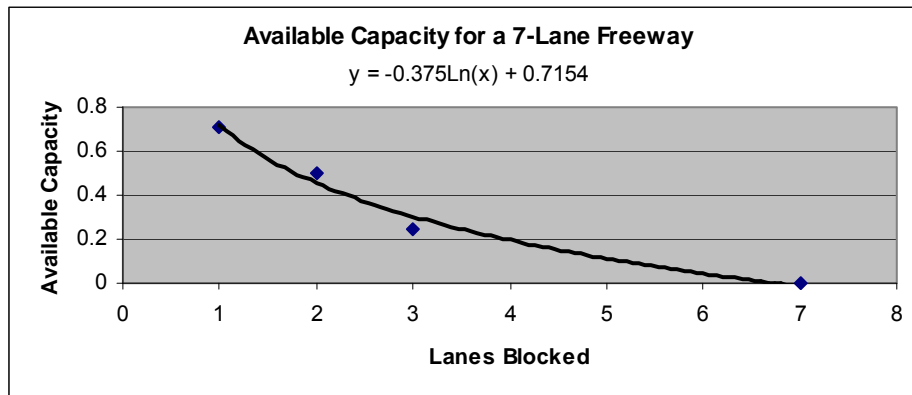


Figure 4.5 Lanes blocked vs available capacity for a 7-lane freeway

For an eight lane freeway:

Table 4.7 Lanes blocked and fraction of capacity available for an 8-lane freeway

8 Lanes	
<u>Lanes Blocked</u>	<u>Available Capacity</u>
1	0.78
2	0.63
3	0.41
4	0.29
5	0.17
6	0.09
7	0.03
8	0

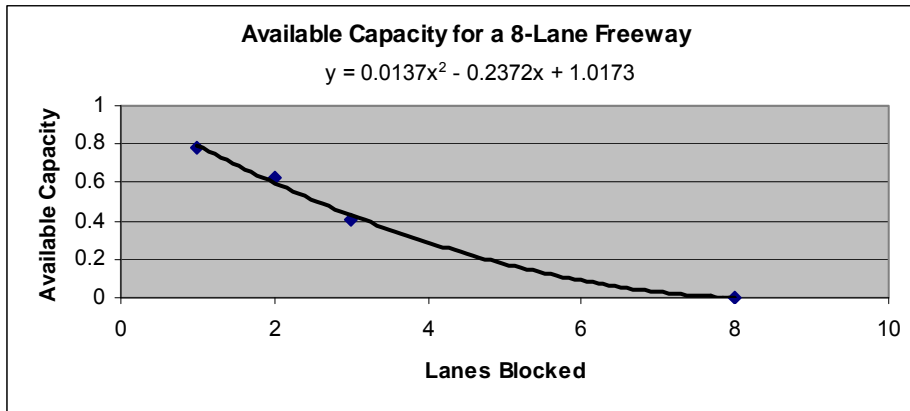


Figure 4.6 Lanes blocked vs available capacity for an 8-lane freeway

The final available capacity per direction results as follows:

Table 4.8 Final fraction of freeway capacity available

Lanes (per Direction)	LANES BLOCKED								Shoulder Disablement	Shoulder Accident
	1	2	3	4	5	6	7	8		
2	0.35	0	-	-	-	-	-	-	0.95	0.81
3	0.49	0.17	0	-	-	-	-	-	0.99	0.83
4	0.58	0.25	0.13	0	-	-	-	-	0.99	0.85
5	0.65	0.4	0.2	0.06	0	-	-	-	0.99	0.87
6	0.71	0.5	0.25	0.13	0.03	0	-	-	0.99	0.89
7	0.75	0.57	0.36	0.2	0.11	0.04	0	-	0.99	0.91
8	0.78	0.63	0.41	0.29	0.17	0.09	0.03	0	0.99	0.93

An index I_f for the total number of features affected is assigned according to total capacity available depending on the total number of freeway lanes per direction and on the number of features blocked. The features affected index I_f is assigned as follows:

Table 4.9 Features affected index (I_f)

Features Affected	
Description	I_f
$0.80 < \text{Capacity} \leq 1.00$	1
$0.60 < \text{Capacity} \leq 0.80$	2
$0.40 < \text{Capacity} \leq 0.60$	3
$0.20 < \text{Capacity} \leq 0.40$	4
$0.00 < \text{Capacity} \leq 0.20$	5

The weights assigned to each bin of I_f were arbitrarily selected since there is no available literature about the relation of the available freeway capacity and severity of incidents. These weights consider a rating of 1 as the less critical and 5 as the most critical for freeway operations.

Time Of Day

An incident impact depends to a large extent on the time of day it occurs. If the incident takes place during the off peak hours, it will not have the same impact on the freeway operation as if it had occurred during either the morning or afternoon rush hours.

Based on the typical hourly traffic variations for urban streets (16), weights are set for the time of day index I_t based on five different categories according to the variability in traffic flow throughout the day. It is very important to mention that these weights were proposed arbitrarily since there is no documentation available relating time of day and severity of incidents. The five proposed categories were extracted from the Highway Capacity Manual Exhibit 8-7 (Figure 4.7 in this thesis).

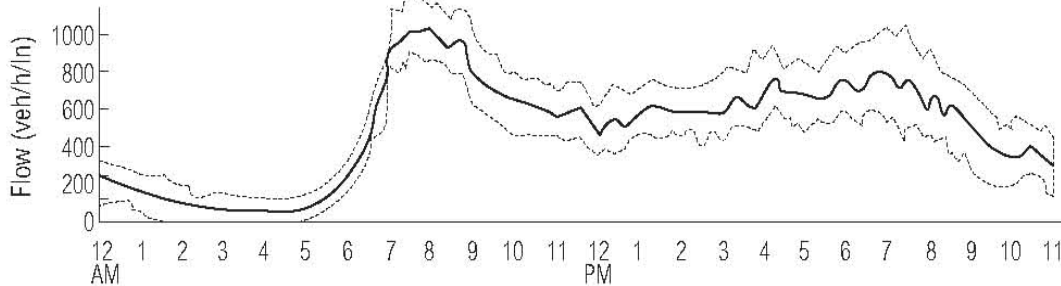


Figure 4.7 Traffic variations for urban streets

This figure represents the typical traffic flow variations in urban areas. The dotted lines indicate the range within which one can expect 95 % of the observations to fall. This pattern could of course be adjusted accordingly to locally obtained data.

On the proposed categories, an I_t of 1 is assigned to incidents occurring between 12 am and 6 am (when traffic flow is low) having little effect on highway operations whereas an I_t of 5 is assigned if incidents occur during the morning peak hour between 6 am and 9 am, which may affect traffic flow dramatically.

The proposed index values for the time of day are shown in Table 4.10:

Table 4.10 Time of day index (I_t)

Time of Day	
Description	I_t
Night (12am \leq TIME < 6am)	1
PM Off Peak (6pm \leq TIME < 12am)	2
AM Off Peak (9am \leq TIME < 4pm)	3
PM Peak (4pm \leq TIME < 6pm)	4
AM Peak (6am \leq TIME < 9am)	5

I recommend considering the volume-capacity ratio variations during the day for the facility in study to assign the time of day index I_t . Unfortunately, this information was not available when I conducted this study.

Duration of Incident

The duration of the incident is an important variable for determining the severity or impact of the incident. Incident duration depends on the type of incident that has occurred. For a severe incident involving multiple vehicles, its duration may take between three hours to one day. A major motor vehicle crash involving fire and motorist injury might take around half to one hour to clear. At the same time, minor incidents like a stalled vehicle on the shoulder may not take more than half an hour to be removed.

In the study “Dynamic Traffic Assignment Applications for Incident Management” (15), a model was executed to simulate the impact of incident duration on incident delay. This study appears to have been under the assumption of a non-steady demand, which increases with time. The study used durations that ranged from fifteen minutes to two hours. The results obtained from the model are summarized in Table 4.11:

Table 4.11 Incident duration related to incident delay

Incident Duration (min)	Incident Delay (veh-hr)
15	601
30	2,241
45	5,583
60	15,120
120	77,902

Since the maximum incident duration covered by this study is two hours, these data points were used to extrapolate for four and eight hours. The resulting graph of the current model is shown in Figure 4.8:

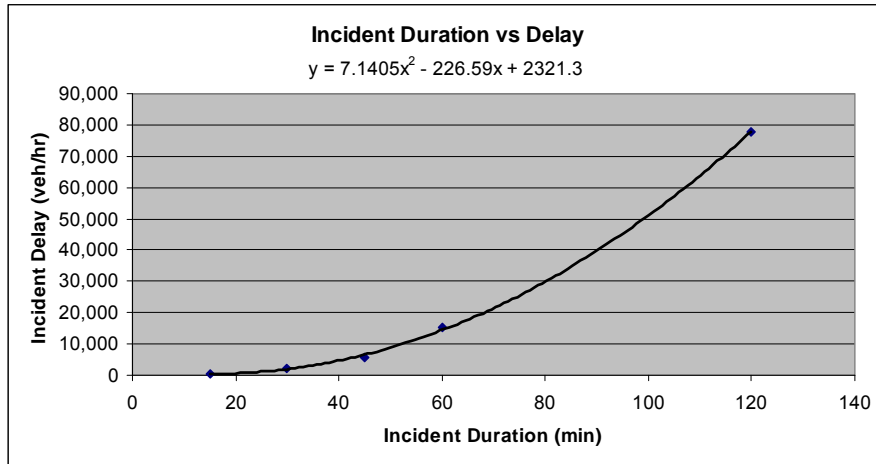


Figure 4.8 Incident duration vs incident delay

The extrapolation for four and eight hours is listed in Table 4.12:

Table 4.12 Extrapolation results for incident duration related to incident delay

Incident Duration (min)	Incident Delay (veh-hr)
15	601
30	2,241
45	5,583
60	15,120
120	77,902
240	359,233
480	1,538,729

As can be seen from Figure 4.8, when the incident duration is greater than two-hours, delay grows exponentially. For this study a steady demand condition is considered to assign the duration index I_d . The values are as follows:

Table 4.13 Incident duration index (I_d)

Duration	
Description	I_d
DURATION \leq 60 min	1
60 min < DURATION \leq 80 min	2
80 min < DURATION \leq 100 min	3
100 min < DURATION \leq 120 min	4
DURATION > 120 min	5

The I_d values were assigned from 1 to 5 depending on the delay caused by the incident. An index of 1 represents a very low delay and an index of 5 represents the most severe delay case. When an incident is detected the duration is unknown. In such a case, an estimated duration can be used based on past experience and adjusted later for data recording purposes.

Weather Conditions (20)

Weather conditions at the time of an incident have a considerable impact on freeway operations and incident response. Adverse weather, including rain, snow, sleet, fog, etc., can quickly reduce roadway capacity and compromise both efficiency and safety. At the same time, adverse climate conditions hamper rescue and other incident response efforts, increasing clearance time of the incident. A ranking of a variety of weather conditions from dry weather to natural disasters is provided. This rank ranges from 1 to 5 according to the impact the weather could have on driver safety and traffic capacity at the time of an incident. Unfortunately, there is no literature relating weather conditions and severity of incidents that could support these proposed index values. The weather index I_w that represents the influence of the meteorological conditions on incident severity was defined as follows:

Table 4.14 Weather conditions index (I_w)

Weather Conditions	
Description	I_w
Dry (Sunny or Cloudy)	1
Wet or Fog	2
Light Snow	3
Heavy Snow and Ice	4
Natural Disaster (Hurricane, Tornado)	5

Weather conditions for the analysis period were obtained from the national weather service website (21).

4.4 Severity Index

The indices assigned for each incident parameter must be averaged to obtain a single severity index (SI). The main idea for averaging the indices is that, if incident data is not available for a particular variable, the index for that parameter can be omitted. Once we have all available parameters, the severity index is calculated with the following equation.

$$SI = \frac{\sum \text{Indices}}{n}$$

Where:

SI = Severity Index

$\sum \text{Indices}$ = Summation of indices ($I_v + I_f + I_t + I_d + I_w$)

n = Number of indices

4.5 Assign Severity

I now proceed to obtain the severity of the incident or event. Freeway incidents will be classified into five different proposed categories based on their severity index (SI).

Severity A incidents will have a very low severity and impact on freeway operations whereas Severity E incidents will have the maximum severity and very high impact on the freeway network.

Several ranges of severity indices were analyzed using the database provided by TXDOT. The typical incident distribution for urban freeways is to have a very high number of small or low impact incidents and a low number of high impact incidents affecting operations on the network. The main idea was to find the best ranges that could simulate the typical frequency distribution of freeway incidents in urban areas, with a very high number of low impact events decreasing gradually to a very small number of high impact incidents.

Based on the typical incident distribution of incidents in urban freeways the severity index ranges selected are:

Table 4.15 Severity based on severity index

Severity	
Description	Severity
Low ($SI \leq 1.5$)	A
Moderate ($1.5 < SI \leq 2.0$)	B
High ($2.0 < SI \leq 2.5$)	C
Severe ($2.5 < SI \leq 3.0$)	D
Critical ($SI > 3.0$)	E

The analysis of the data using the final severity index ranges reflects a frequency histogram as shown in Figure 4.9.

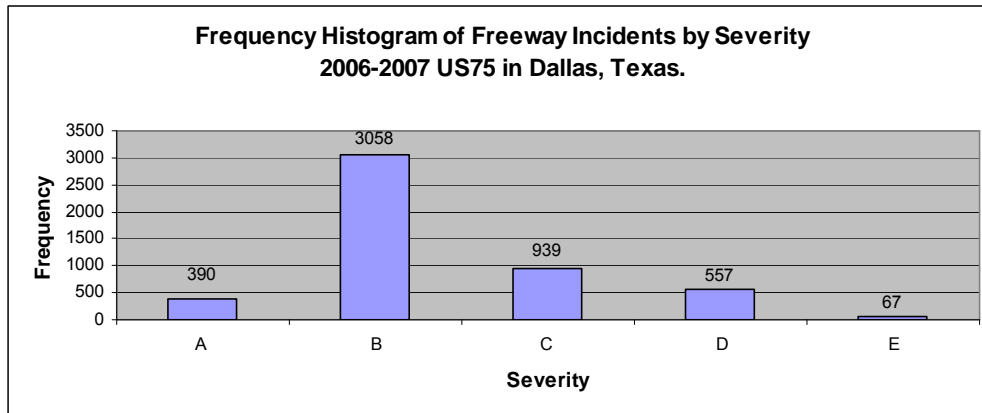


Figure 4.9 Freeway incidents histogram by severity

The histogram shows a low severity A frequency relative to severity B incidents. However, as discussed in the first sections, the total number of incidents recorded represents just 70% of the total incidents along this highway section. Non-recorded incidents representing 30% of the total are very minimal events that do not affect operations. My database contains 5011 records (representing 70% of the total), so the non-recorded incidents count for 2150. If I add this number to the total 1189 recorded severity A incidents, I have a total of 3336. I would then have a gradually decreasing histogram that simulates the typical urban incident frequency.

Once I have assigned severity, the next step to complete the rating process is to determine the number of service entities responding.

4.6 Service Entities Responding

The last step for incident rating is to obtain the service entities responding index I_a for the incident. This index is based on the emergency entities responding to the incident scene.

Service entities responding to the event include:

- Courtesy Patrol/Tow Service,
- Police,
- Ambulance or Medical Services,

- Fire Department/Rescue,
- Hazardous Material Response Team (Haz-Mat),
- Coroner/Medical Examiner.

It is important to keep in mind that the vast majority of highway incidents are relatively minor and require a few if any service entities responding. Figure 4.10 shows the fact that the incident size and complexity is reflected by the number of responders (19).

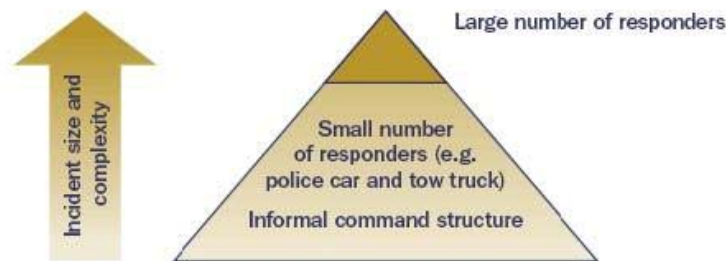


Figure 4.10 Incident size and complexity based on number of responders

Even though the figure indicates that the number of responders is related to the incident severity, there is no literature available that could show a more specific and exact relation. However, in case the freeway needs to be shut down due to an incident, there is a high probability that the service entities responding index I_a is 5. The same is expected when the Haz-Mat team or the Medical Examiner respond to the incident scene. The bins for the service entities responding index I_a were selected considering the fact that low severity incidents happen more frequent than high severity incidents.

The service entities responding index I_a is assigned as follows:

Table 4.16 Service entities responding index (I_a)

Service Entities Responding	
Description	I_a
0 – 1 Agency	1
2 Agencies	2
3 Agencies	3
4 Agencies	4
5+ Agencies	5

Applying this index criterion to the incident database provided by TXDOT, resulted in the frequency distribution shown in Figure 4.11. Note that this Figure does not include non reported incidents.

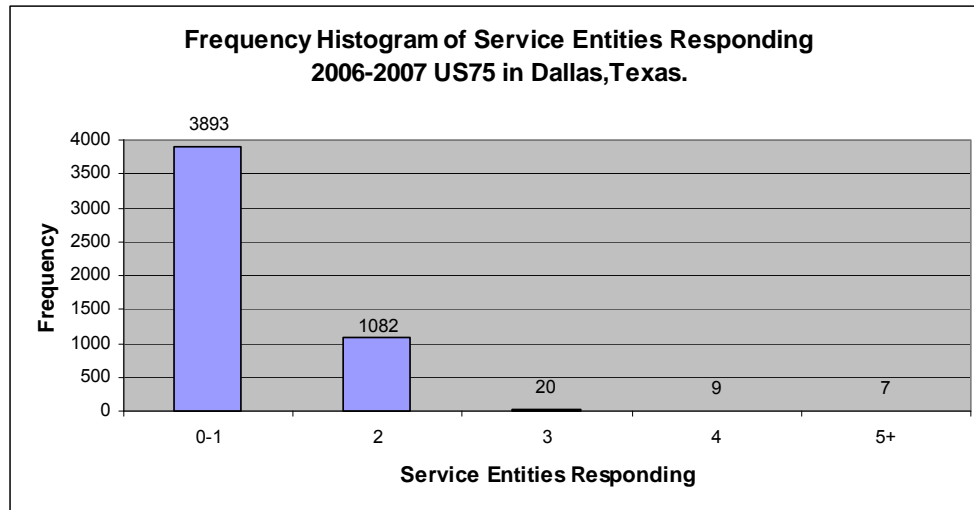


Figure 4.11 Service entities responding histogram

As expected, the distribution shows a high frequency of few incident responders (low severity incidents) decreasing as the number of responding entities increase (high severity incidents).

4.7 Final Incident Rating

The final incident rating system includes the combination of severity and the service entities responding index I_a . For instance, if for a particular event we obtain a severity C, and there are 3 service agencies responding with an index $I_a = 3$, the final rate for the event is C3. The full incident rating system will be illustrated in the next section.

4.8 Examples of Incident Rating Classification

The following examples illustrated in Tables 4.17 and 4.18 show the application of the incident rating system method. The incident parameters are provided and the rating is calculated for each event.

Table 4.17 Example of incident rating

Incident Description:		Accident	
Location:		Dallas, TX	
Freeway Lanes (Direction of Incident):		4	
Vehicles Involved:	2	$I_v =$	3
Features Affected:	2	$I_f =$	4
Time of day:	1:45 PM	$I_t =$	3
Duration of Incident:	30 minutes	$I_d =$	1
Weather Conditions:	Dry	$I_w =$	1
		Severity Index (SI)=	
		Severity =	2.4 C
Service Entities Responding:	1	$I_a =$	1
		RATING (Severity + I_a) =	
		C1	

A second example, involving a stalled vehicle on the shoulder of the road, is shown in Table 4.18.

Table 4.18 Example of incident rating

Incident Description:	Stalled Vehicle		
Location:	Dallas North Toll Way		
Freeway Lanes (Direction of Incident):	3		
Vehicles Involved:	1	$I_v =$	2
Features Affected:	1(Shoulder)	$I_f =$	1
Time of day:	11:15 AM	$I_t =$	3
Duration of Incident:	1:00 hour	$I_d =$	1
Weather Conditions:	Dry	$I_w =$	1
		Severity Index (SI)=	1.6
		Severity =	B
Service Entities Responding:	1	$I_a =$	1
		RATING (Severity + I_a) =	B1

4.9 Application of the Freeway Incident Rating System

Once the incident rating system has been developed, the methodology illustrated in the previous examples is used to rate the severity of each event contained in the incident database provided by TXDOT. The final distribution of severity ratings are shown in Figure 4.12.

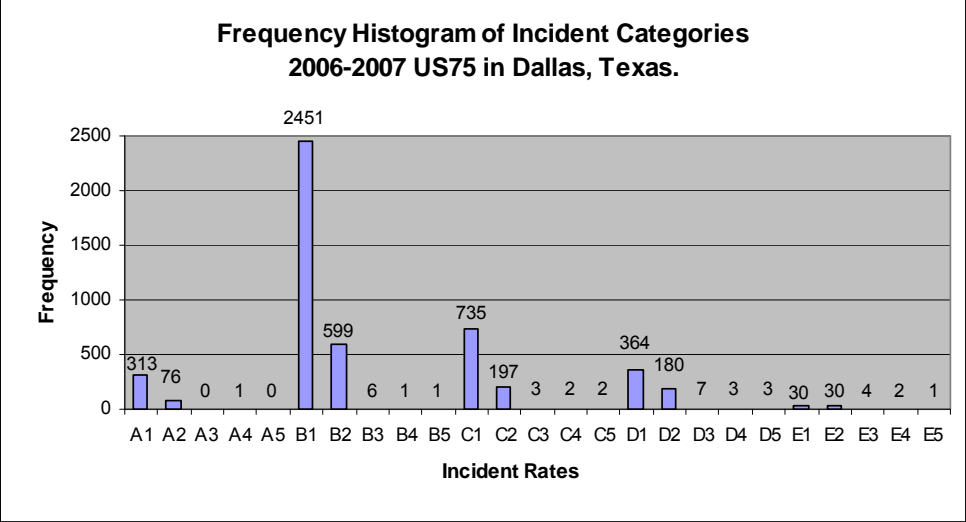


Figure 4.12 Incident frequency histogram

This histogram illustrates the typical incident distributions for an urban freeway and does not include non-reported incidents. This typical distribution shows a large number of low severity incidents, and a small number of high severity events. Also, note how the frequency decreases as the service entities responding increases, confirming the fact that incident frequency decreases as incident severity increases.

CHAPTER 5

CONCLUSIONS AND LIMITATIONS

Incidents are non-recurring events which result in a reduction in roadway capacity. Common types of incidents include:

- Stalled vehicles on shoulder,
- Stalled vehicles blocking one lane of the roadway,
- Abandoned vehicles,
- Minor accidents,
- Motor vehicle crashes,
- Motor vehicles on fire,
- Major truck accidents,
- Accidents with hazardous materials,
- Accidents with a load of cargo spilled,
- Overturned cars or trucks,
- Roadside stalled or disabled vehicles.

5.1 Conclusions

The proposed freeway incident rating system can aid traffic control centers and transportation departments in analyzing and studying incident trends and measuring the progress of efforts in incident prevention. Besides, it is a great tool for presenting incident information in a simplistic format anyone can understand. In addition, it can contribute to reduction of congestion in major urban areas by using the severity rating analysis results to adopt proper mitigation techniques. In summary, the main benefits of using such an incident rating system include:

- Improving incident data reporting and analysis,
- Uniformity in incident reporting,
- Assisting in rapid deployment or required service entities responding to the incident,
- Reducing incident duration and user delays by adopting the required mitigation measures after an incident severity analysis,
- Preventing secondary crashes,
- Reducing fuel waste due to traffic congestion,
- Improving quality of traveler information services to motorists.

5.2 Limitations of the Proposed Method

The methodology proposed for an Incident Rating System was based on the information provided by TXDOT Dallas District. Parameters such as vehicles involved, travel or non-travel lanes affected, time of day, duration of incident and service entities responding are included in the incident information gathered by the Traffic Management Center (TMC) in Dallas, TX. In addition to these parameters, it is recommended that the TMC records weather information at the time of the traffic incident since it is an important variable required for the rating system. Implementation of the Incident Rating System could be done through a pilot program, where improvements could be measured and compared with statistics prior to a final implementation.

Detailed studies about the relation or interaction of each of the parameters with incident severity are recommended. Once concluded, these statistical results can be useful to calibrate each variable index depending on the region-specific traffic characteristics and driver behavior. It is also recommended to conduct studies and incorporate the interaction of capacity available at the time of the incident in relation with the actual demand, for example, if the traffic flow is very low and 1 lane of the freeway is blocked, the impact will not be as critical as if having high vehicular flow. Another limitation of the method is the fact of considering gradually lane clearance of incidents, when we could have a certain rating for a particular event, but since

freeway lanes are clear gradually as conditions allow, the severity rate will decrease gradually as well. Duration of the incident is unknown when it occurs, but a critical input for rating, so I suggest estimate duration and adjust later for an accurate severity rating.

At the same time, additional variables or parameters can be included according to the influence they could have on the incident severity. Potential variables could include characteristics of vehicles involved, since the impact on operations will be different if a passenger car is involved as if a heavy duty truck is involved. Other potential variable could be the type of service entities responding, as it will not have the same severity rating if a light tow truck is responding to the incident scene as if a heavy duty crane is needed for towing and recovery services, even both will have an index I_a of 1.

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BIOGRAPHICAL INFORMATION

Jose Javier Lopez earned his Bachelor of Science degree in Civil Engineering at the Instituto Tecnológico y De Estudios Superiores De Monterrey (ITESM) in Monterrey, Mexico. He worked for a couple of years in Mexico before moving to Texas and where he worked in the hydraulics and transportation fields. During this time he passed the Fundamentals of Engineering test and obtained the Engineer-In-Training Certification by the Texas Board of Professional Engineers.

This current study is part of the requirements to obtain the Masters of Science degree in Civil Engineering, in the area of Transportation Engineering at the University of Texas at Arlington. Mr. Lopez is looking forward moving to the Houston area and working in the Traffic Engineering field. His short term goal is to take the Professional Engineer examination of the Texas Board of Professional Engineers and get licensed.

Mr. Lopez will be considering returning to school at some point in the future to pursue a Doctoral degree.