Emergency Incident Management, Benefits and Operational Issues

-- Performance and Benefits Evaluation of CHART

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Abstract *- The need to implement an effective Incident Management Systems (IMS) has received increasing attention by general public, media and policy makers, that in turn has required transportation agencies to perform a rigorous evaluation over any implemented plan. Since 1996, the Maryland State Highway Administration (MSHA) has conducted a comprehensive evaluation of its incident response and management program, named CHART. The evaluation study consisted of two phases. Whereas the focus of Phase 1 was on the reliable assess of system performance including incident detection, response, clearance and duration, the core of Phase 2 was to develop the methodology and to estimate resulting system benefits from data available in the CHART incident operations record.*

Keywords: Incident, CHART, system performance, benefit, evaluation

1 Introduction

CHART (Coordinated Highways Action Response Team) is the highway incident management program of the Maryland State Highway Administration (MSHA). Initiated in the mid 80' as "Reach the Beach", it has been extended to a statewide program headquartered in Hanover, Maryland where the Statewide Operations Center (SOC) is located. The SOC is also supported by three satellite traffic operations centers (TOC), where TOC-3 is based in Washington D.C. region, TOC-4 in Baltimore, MD, and TOC-5 being seasonal. The current network as shown in Figure 1 covered by CHART consists of both statewide freeways and major arterials with a total length of about 450 miles (~700 km).

As most delays experienced by highway drivers are due to incidents, the focus of the evaluation is to assess the effectiveness and efficiency of the CHART program, especially with respect to its ability to detect, response and manage non-recurrent congestion on the principal highway network. The entire evaluation report includes two parts: analysis of operational efficiency and benefits to the users as well as the entire environment.

Figure 1. Area road network covered by CHART

2 Available data

All evaluation work in this study is based on the CHART incident reports for Year 2002, which contains a total of 32814 records. A summary of a total available data in Year 2002 and Year 2001 is shown in Table 1. Note that during Year 2001, CHART program has completely migrated to CHART II database from traditional paper forms.

Table 1. Data collected for analysis in 2002 and 2001

Available Records		Year 2002		Year 2001	
		Records	Total (%)	Records	Total (%)
CHART II Database	Disabled Veh	13,752	41.9	16,236	58.6
	Incident	19,062	58.1	8,743	33.6
Paper Form (Both Type)		N/A	N/A	2029	7.8
Total		32,814	100	26,008	100

3 System performance evaluation

The evaluation of CHART system performance consists of the following four parts: incident detection, response, clearance and incident duration.

3.1 Incident detection

All CHART operation centers were able to take full advantage of various available sources for identifying incidents. The distribution of incidents detected by all sources is shown in Figure 2. It is notable that, despite the lack of automated incident detection systems, MSHA/ CHART patrols itself has detected about 54.1 percent of incidents while maintained an effective coordination with all other state and municipal agencies responsible.

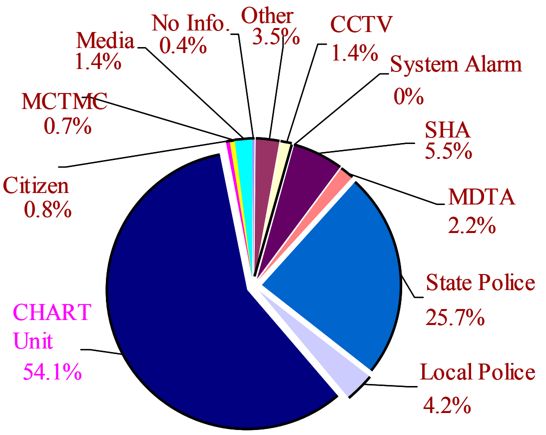

Figure 2. Distribution by detection source

3.2 Incident response

Due to the lack of a sufficiently comprehensive real-time surveillance system, the time on incident occurrence is not yet available under the current CHART operations. The closest parameter related to incident detection is the response time from detection to the arrival of response vehicles. The average response time was founded to be 12.85; 13.65; 13.51 and 13.10 minutes for TOC-3, TOC-4, SOC, and the average of CHART as shown in Figure 3.

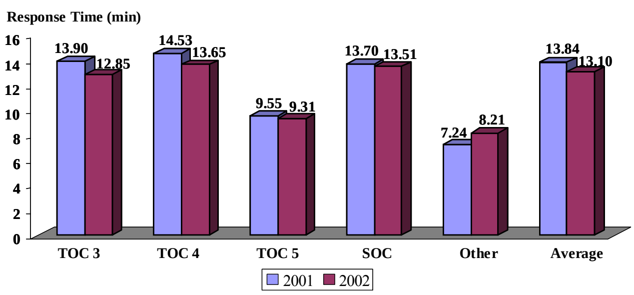

Figure 3. Incident response time in Year 2002 and 2001

3.3 Incident clearance

Here clearance time is defined as the difference between the time response team arriving at the incident site and the complete recovery of traffic. This performance indicator will be highly related to the severity of incident and on-site operation efficiency of response team. We show the comparison of clearance time with and without CHART units involved in Table 2. An apparent reduction for incident is clearly indicated in both cases (12.9:26.2, 15.7:28.2, unit: min), while only slightly reduction is shown for cases involved of disabled vehicles (6.4:7.3, 7.2:8.5, unit: min).

Table 2. Comparison of clearance time

3.4 Incident duration

As one of the major performance indicators, incident duration is the time from incident detection to its completely recovery. Similar to the analysis of incident response, we first show the average incident duration for different operation centers in Figure 4, which is 14.06; 15.83; 42.98 and 16.48 minutes for TOC-3, TOC-4, SOC, and the average.

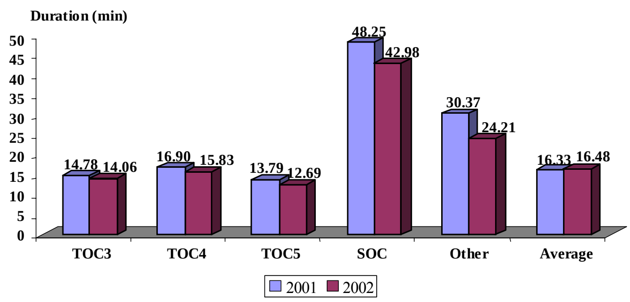

Figure 4. Incident duration in Year 2002 and 2001

To assess the contribution of CHART operations in terms of reduction in incident duration, this study has computed the average incident duration with and without the response of CHART units. As shown in Table 3, the average duration to clear an incident with and without the assistance of CHART was about 27.7 minutes versus 38.8 minutes. Note that since the CHART incident management team responded to most incidents in Year 2002, the data associated with incidents not responded by CHART, for performance comparison, are quite limited.

Table 3. Comparison of incident duration

Blockage	With SHA Patrol	Without SHA Patrol
	Duration (min)	Duration (min)
1 lane	18.5 (17.0)	21.1 (23.9)
2 lanes	37.6 (32.2)	36.9 (69.3)
3 lanes	44.1 (51.7)	47.3 (74.1)
>=4 lanes	79.7 (79.7)	38.5 (56.4)
Weighted Average	**27.7 (28.8)**	**38.8 (50.7)**

Note: The numbers in parentheses show the data in Year 2001.

4 System benefits evaluation

Because of the concern for ensuring the quality of analysis under the data limitations as well as resource constraints, the benefit assessment of CHART is focused only on those either directly measurable or quantifiable from the incident reports. Such direct benefits, both to roadway users and to the entire community, are classified as follows: reduction in driver delay time, reduction in fuel consumption, reduction in emissions reduction in secondary incidents, and assistance to drivers.

Some other indirect impacts, such as improving the air quality, vitalizing the local economy, and increasing network mobility, are not included in this study.

4.1 Reduction in delay and fuel consumption

To approximate the reduction in delay due to efficient incident response operations, the following procedure is implemented.

1. Analyze the distribution of incidents on different segments of major freeways covered by CHART; Analyze the distribution of incidents by number of lanes blocked on major freeways covered by CHART;

2. Design sampling scheme and select sample incidents from each category

3. For each sample incident, simulate the entire highway segment to obtain the total delay without the sample incident and with the sample incident. Compute the excessive delay accordingly.

4. With sufficient samples, a regression model can be set up, relating duration reduction to pre-determined parameters as incident duration, traffic volume, number of lanes blocked, total number of lanes, etc.

5. The total delay reduction due to CHART operations can be computed based on above model.

The estimated results with respect to delay reduction are shown in Figure 5. As indicated, all incidents that occurred in Year 2002 may result in a total of 135.23 million veh-hr delays without CHART/MSHA operations. In contrast, due to the efficient response and management of CHART, the total vehicle delay has been reduced to 105.25 million hours, about 29.98 million hours less than without the assistance of CHART/MSHA.

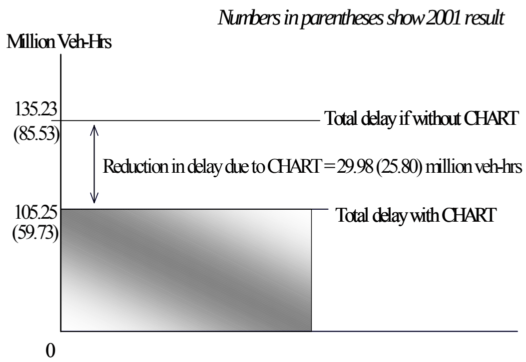

Figure 5. Delay reduction in Year 2002

The reduction in fuel consumption is here converted from delay reduction directly, which is 5.06 million gallons in total for Year 2002. Note that it can also be computed from the simulation results.

4.2 Reduction in emission

The estimated reductions in vehicle emissions were based on the parameters in Figure 6, which were provided by MDOT in Year 2000 (which have been used for air pollution evaluation in both the Baltimore and Washington D.C. areas). Using the total delay reduction of 29.98 million vehicle hours due to CHART/MSHA operations, the estimated reductions in vehicle emissions are : 391.89 tons in HC;4402 tons in CO ; and 187.69 tons in NO.

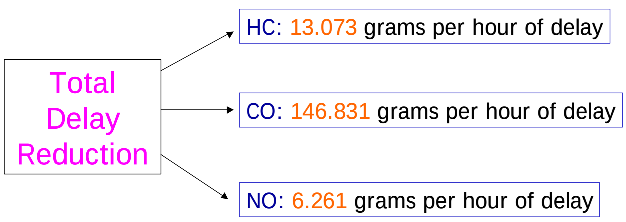

Figure 6. Parameters used for emission reduction

4.3 Reduction in secondary incidents

It has been well recognized that one major accident may incur a number of relatively minor secondary incidents due to dramatic changes in traffic conditions. Grounded on the experience from previous work, this study has adopted a definition for secondary incidents that accounts for incidents caused both by traffic conditions in the same traffic direction and by rubbernecking effects in the opposite direction.

For convenience of comparison, Figure 7 presents the distribution of secondary incidents under different definitions based on the Year 2002 Accident Database provided by the Maryland State Police Department.

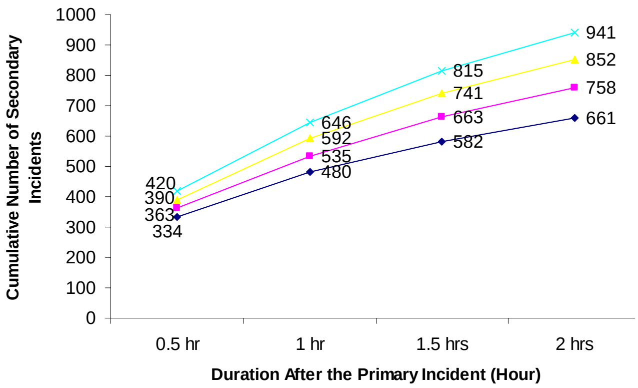

Figure 7. Distribution of reported secondary incidents

The frequency of secondary incidents reveals a clear positive correlation with the primary incident duration. For convenience but without loss of generality, this study assumed such a correlation as linear in nature and estimate the potential reduction in the total secondary incidents due to CHART/MSHA response units as 377, based on a total of 941 secondary incidents observed under our definition

4.4 Reduction in risks at primary incident sites

At primary incident sites, drivers are sometimes forced to perform undesirable lane-changing maneuvers because of lane-blockages. Thus the efficient removals of stationary vehicles in travel lanes may directly prevent some potential lane-changing-related accidents. This study has focused only on those incidents taking place on I-495/95, I-95, I-270, I-695, I-70, I-83, MD-295, US-50 during peak periods.

The estimate of potentially reduced accidents for each freeway is shown in Table 4., based on the estimated number of lane changes for each recorded incident and the ratio between an accident and the number of undesirable lane-changing maneuvers computed from the field observations of lane-changing frequency, flow rate, speed, and density on a segment I-495/I-95 over both peak and off-peak periods

Table 4. Potentially reduced accidents

Road Name		I-495/ I-95	I-95	I-270	I-695	I-70
Acc. No.	2002	107	105	10	71	12
	2001	174	79	13	65	2
Road Name		I-83	MD-295	US-50	Total	
Acc. No	2002	10	5	23	**343**	
	2001	10	7	20	**370**	

4.5 Driver Assistance

Among all 32,814 incident reports available in the CHART Database, it has been found that there were a total of 19,062 incidents associated with requests from drivers for some types of assistance such as flat tire, shortage of gas, or mechanical problems, as shown in Figure 8. This number is higher than the 16,274 assistance requests from drivers in Year 2001. Out of 19,062 assistance requests from drivers, a total of 4,567 were related to "out of gas" and "tire changes" of vehicles, compared with 4,138 cases in Year 2001.

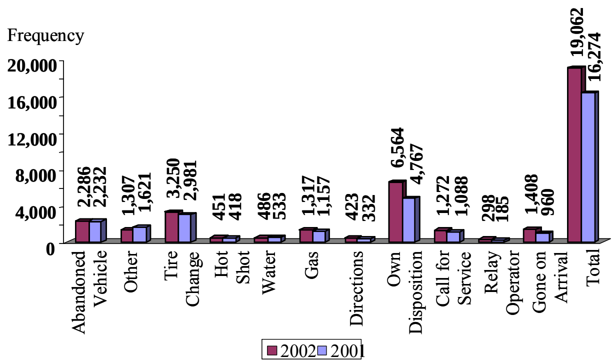

Figure 8. Distribution of reported secondary incidents

Conceivably, the prompt response of CHART incident management units to such requests has not only been greatly appreciated by the general public, but has also contributed directly to minimizing the potential rubbernecking effects on the traffic, especially during peak hours, that could result in excessive delay.

5 Conclusions

This study presents the approximate benefit of the incident management program, CHART, operated by Maryland State Highway Administration. Although some of the parameters, such as the time value of delay, may vary with the sources of data available for analysis, it is clear that the entire society can benefit significantly from an efficient and effective incident management program. This study has also evidenced that more resources should be allocated to incident response and management systems if we intend to effectively contend with ever-increasing congestion in the daily commuting traffic network.

The on-going research issues include the evaluation of benefits associated with secondary incident reduction, the on-line performance evaluation platform for timely system evaluation and adjustments, as well as the integration of incident management system with traffic management system.

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