Chapter 9 Variable Message Sign (VMS)

Traffic management technologies are available, such as electric traffic information signboards, "Variable Message Sign" or "VMS," and traffic video monitoring cameras on roads. The VMS is generally used on highways to display traffic conditions such as traffic congestion conditions, warning information like traffic accidents, road conditions, etc. The traffic video monitoring camera detects and collects the traffic volume.

VMS was deployed at least as early as the 1960s on the New Jersey Turnpike. The NJ Turnpike's signs of that period, and up to around 2012, were capable of displaying a few messages in neon, all oriented around warning drivers to slow down: "REDUCE SPEED," followed by a warning of either construction, accident, congestion, ice, snow, or fog at a certain distance ahead.

As for Japan, the first VMS system has installed on local roads in 1966 and expanded to use VMS for Metropolitan express highways in 1973. The purpose of VMS is mainly to provide traffic conditions, including traffic jams and accidents, and so on.

The system of VMS is the same as that of the original, which means VMS shows the traffic condition information based on monitoring and analysis of the traffic monitoring condition. The system has been upgraded daily according to electronics technology development. The display is changed from a bulb lamp to LEDs with a multi-color diode type. The traffic information is collected through a traffic highway camera, and analysis information is provided by network infrastructure through the traffic control center. The network infrastructure is the most well-developed technology—high-speed transmission and more data capacity to transmit.

Hardware Technologies

1: VMS

The VMS used in this program, multi-color LED type display with a 3G cloud Network communication system is installed in the city (Figure 9-1). The display has two sections;

- No need for a traffic center: Use internet access from the center through the 3G network.
- Digital signage capability by the half of display as commercial use with charge.

The above feature allows cost-effective VMS system in India.

Figure 9-1 Variable Message Sign in Ahmedabad, India

photo by Zero Sum Ltd.

2: Mobile VMS

Figure 9-2 (a)-(e) shows some examples of mobile VMS products in the industry; the others are portable VMS for warning for road works and/or construction notices for drivers.

Software Technology

In terms of road safety, transport policy or software technology is also important, as well as hardware technology. In the previous section, we see several VMS-related hardware technologies. In order to make that hardware technology useful, it is necessary to learn how to use this hardware equipment. Figure 9-3 (a)-(c) shows some examples of road safety operations with mobile VMS. It is necessary to set the appropriate arrow signs, flag-waving notice, color corns setting, etc. This kind of software plays a crucial role in road safety. In other words, road safety hardware preparation is not enough to support road safety operations.

Display Contents

Here is one more important factor for VMS. It displays contents to inform several messages and or pictograms for traffic congestion; road works, weather information, strong wing, slip caution, detour message, etc. Figure 9-4 shows

Figure 9-2 Highway patrol vehicle and Portable VMS for road works

(a) (b) (c)

(d) (e)

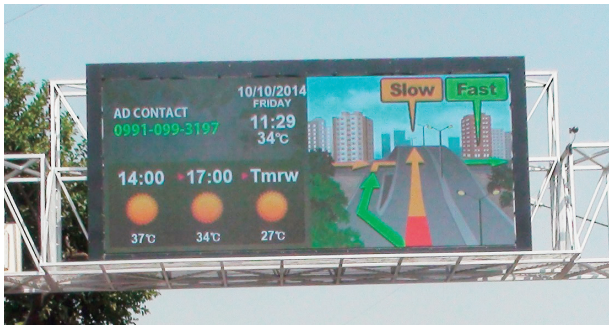
Figure 9-3 Road Safety Operation with Mobile VMS

(a) (b) (c)

Figure 9-4 Display pattern example

Figure 9-5 Road condition display

(a)



(b)

several display patterns used for mobile VMS. This display pattern is defined by each transportation authority of countries and or road operators in general. Sometimes, it is necessary to determine appropriate display contents by own organization. Therefore, it is important for localization with the local municipalities.

In terms of traffic condition display, Figure 9-5 (a) and (b) show one example of a display for road condition. In general, road condition indicates by colors pattern such as heavy congestion in red color, slight congestion in yellow, and smoothness in green. This tree-level road condition is quite common in many countries.

Analysis of Traffic Conditions through VMS

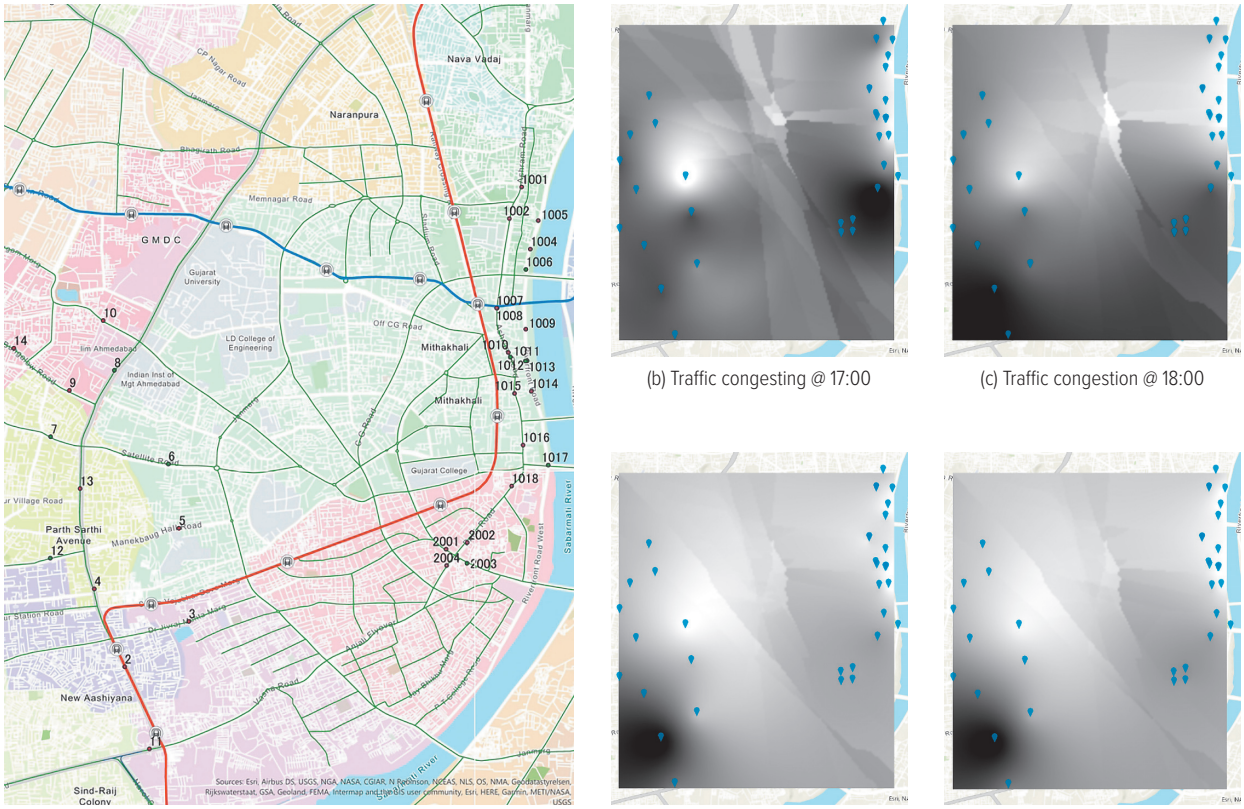
Next point is how to share traffic condition to drivers efficiently through VMS. Here is an important to share traffic information not only current condition but also future prediction, even if the traffic condition forecast is not 100 % guarantee. In case of Ahmedabad city for example, typical traffic congestion will occur in the evening time from 17:00 to 20:00 and its location will same area. One of typical traffic condition in Ahmedabad city, especially west side of the city because the west side of city is new business area and highly crowded by shopping mall, restaurants hotels, and business offices. Figure 9-6 shows traffic condition spatial analysis result from 17:00 to 20:00 in October 2020.

Figure 9-6 (a) is west side of the city, (b) is traffic congestion by occupancy level at 17:00, (c) is at 18:00, (d) is at 19:00, and (e) is at 20:00. All traffic occupancy is collected by traffic monitoring cameras (CCTV). The most congested condition occurs around 19:00. This condition is almost same during our monitoring observation during 2019 to 2021.

In order to identify traffic congested area, it is useful to use spatial analysis method such as Moran's I parameter. Figure 9-7 shows the result of Moran's I at 19:00. The lower part red shadow area is highly congested rerated area which means these area is most congestion area at 19:00 and there is something special reason of the traffic congestion. This Moran's I analysis is based on 1 kilo-meter mesh in this area. When size of mesh is smaller, then it becomes clear for traffic congestion related reason. This kind of traffic monitoring and spatial analysis becomes useful for future traffic congestion forecast and finding traffic congestion reasons. This is recommendation for this traffic congestion spatial analysis in traffic control center and or traffic management center in future.

Here is a interesting additional traffic congestion analysis example from

Figure 9-6 Traffic congestion condition in Ahmedabad in October 2020.



(a) Ahmedabad city west side

(b) Traffic congesting @ 17:00

(c) Traffic congestion @ 18:00

(d) Traffic congestion @ 19:00

(e) Traffic congestion @ 20:00

Figure 9-7 Traffic congestion condition with Moran's I

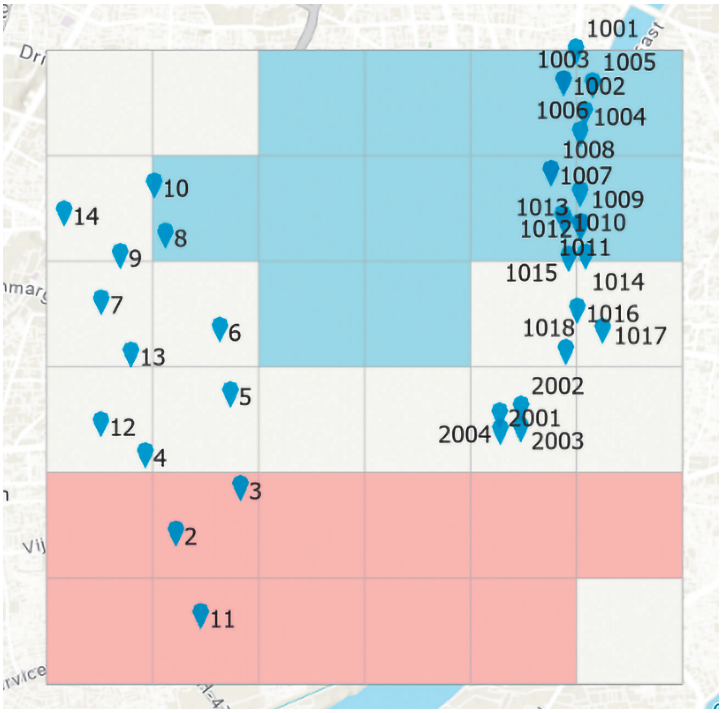


Figure 9-8 Shock Wave model for traffic congestion analysis

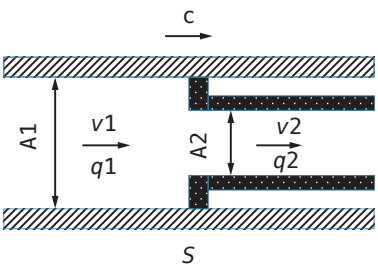
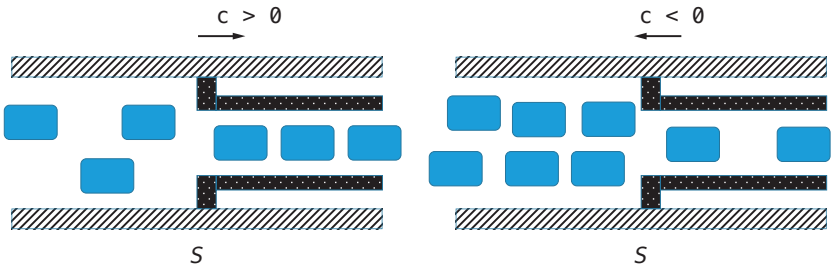


Figure 9-9 Shock Wave Type



(a) Forward forming wave

(b) Backward recovering wave

our project. There are two types of traffic congestion which is well-known in traffic theory. The shock wave model is used as Equivalent situation from wide road to narrow road model shown in Figure 9-8.

As shown in Figure 9-9, one is (a) Forward forming wave and the other is (b) Backward recovering wave, which are categorized by Shock Wave theory of traffic flow analysis. Also, these two types of traffic congestion are illustrated in Figure 9-9. Forward forming wave means forward traffic stream is congested and this happens at the beginning of traffic congestion occurs. On the other hand, Backward recovering wave means an opposite condition and backward traffic is congested after heavy traffic congestion occurred. In another words, there is a dead-lock traffic congestion in Backward recovering wave condition.

In Table 9-1, it shows the typical traffic congestion condition shock wave result based on traffic occupancy parameter. All the data is based on actual measurement in October 2020. From traffic flow theory, the occupancy parameter becomes more than 25% under traffic congestion condition. There are two points of backward recovering wave which are Camera #2 at 22:00 and Camera #11 at 19:00. From this analysis, the followings are concluded. In Ahmedabad, the traffic congestion happens mostly at the evening time frame and the deadlock traffic congestion happens at the dedicated location. This analysis tells us very important message. There is a potential solution of traffic congestion improvement because its traffic congestion occurs at the dedicated time zone frame and dedicated location. And this congestion condition imagines road side parking at the evening time zone and dedicated area.

As a summary of this Chapter, VMS becomes common use for traffic management. There are many kind of VMS equipment in market. On the other hand, it is different story for effective use of these equipment. As it is described, software technology for road management is important as well as hardware technology. This software technology comes from each counties experience. In case of developing countries such as India, it is better to learn from experienced county such as Japan. Japan has more than 60 years' experience to traffic management and fighting with traffic accidents and fatality. Even in Japan, traffic accidents and fatality are still issues. Therefore, as a conclusion in this chapter, we recommend to establish local consortium who manages road safety and traffic condition monitoring including display content and road operation center. There is more related information scenario in Chapter 3 MaaS section.

Table 9-1 Congestion conditions

Time	18	19	20	21	22
Camera No. 2	33	59	47	37	※ 26
Camera No. 4	19	29	24	20	15
Camera No. 9	20	25	21	18	17
Camera No. 11	24	※ 35	25	19	15
Camera No. 1018	19	27	22	19	17

* C < 0 condition