Effective Implementation of Variable Message Sign (VMS) in Dhaka City

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DECLARATION

We hereby declare that this thesis is our own work towards the B.Sc , we took reasonable care to ensure that the work is original, and, to the best of my knowledge, does not breach copyright law, and has not been taken from other sources except where such work has been cited and acknowledged within the text.

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ABSTRACT

Dhaka, the capital of Bangladesh, is the one of the most densely populated city of the world. Bangladesh being one of the third world countries has a high economic growth rate and Dhaka being the capital of the country has a continuously increasing rate of business & commercial activities. The present transportation system being designed decades ago can't cope with the higher mobilizing activities. Besides, with the increasing rate of accidents traffic safety has become an important factor. So, new technology with new designs craved an important position in the integrated transportation system which should be introduced to cope up with this new situation. Variable Message Signs, a way of informing drivers about road conditions and a potential safety measures has already got popularity in different countries like U.S.A, UK, Canada, Japan, Germany, Malaysia, Sweden and other developed countries of the world. Extensive research regarding VMS has been carried out all over the world. Few VMS have been also noticed across the road of Dhaka city with faulty way of installation, erroneous message, poor management and less capability to attract drivers. From our investigation it was found out that no research activities regarding VMS have been carried out during or after installation of VMS. So, we feel the urge to research for the implementation of VMS effectively by finding out the difference in perception among different survey groups with proper reasoning and recommending our findings to the stakeholders and further research works on this topic. However, key stakeholder groups were surveyed with some limitations due to illiteracy, unwillingness and misconceptions of the survey groups. ANOVA method was followed by successful eliminations of these errors during the statistical analysis and inter and intra group differences were found out on the basis of personal interview and interactions with the survey groups. Recommendations on the basis of major key findings were done to the stakeholders and for further research activities on VMS. The study in total, focuses on the differences of perceptions of different survey groups, reasons for the differences to find out an effective way of implementing VMS as an integral part of transportation system in cities like Dhaka.

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CHAPTER ONE: INTRODUCTION

1.1 Background

Dhaka, the capital of Bangladesh is one of the most densely populated cities of the world. Due to rapid industrialization, urbanization and migration of slums the population is increasing day by day. Most of the streets of Dhaka city is designed for only half of the already existing population. So, Dhaka city is in need of a concrete and digitalized transportation system which should comprise of perfectly designed street pattern, signs, signals, street lightening etc. to handle this overburden loads of increased population. Moreover Bangladesh is a developing country, one of the major third world country. And for the development of any country like Bangladesh transportation sector plays an unparallel rule for trade and commerce. Dhaka is the capital of Bangladesh. So an integrated transportation system is an essential element for a city like Dhaka for smooth operation of business and trade. A term called 'Intelligent transportation system' is now rapidly used in different developed country and city. Variable message signs is an integral part of this intelligent transportation system. A Variable Message Sign (VMS) is a sign for the purpose of displaying one of a number of messages that may be changed or switched on or off as required. Variable message signs are used to inform the drivers about road conditions and to educate the divers about proper road use. It is mainly a widely used safety tools. Though variable message signs is now widely used across the world specially in developed country, it is seen in a very less number in Dhaka city where it is of extreme need. Use of increased number of variable message signs in Dhaka city would have been of great benefit to optimize traffic load in roads, to reduce the rate of accidents and to reduce congestion across the road of Dhaka city. In a survey it was found that almost no research related to VMS has been carried out in Bangladesh. Without any research it is very inconvenient to effectively implement variable message signs in the country. As a result a study regarding effective implementation of variable message signs in Dhaka city is a prime need in the perspective.

1.2 Introduction to Variable message sign

1.2.1 Definition

VMS is an abbreviated form of Variable Message Signs. It is a road sign capable of displaying variable messages. In other words, A Variable Message Sign (VMS) is a sign for the purpose of displaying one of a number of messages that may be changed or switched on or off as required.

1.2.2 Types

VMS comprise two types, Continuous and Discontinuous signs. Continuous signs are similar to fixed signs, the only difference being that they can show various messages by some electromechanical means. For example rotating prism signs, roller blinds, etc. Discontinuous signs create messages using individual elements that can be in one of two states (or more) and can thereby create various messages on the same sign face. For example flip-disk signs, fiber optic signs, LED signs, etc.

Most VMS used for Dynamic Traffic Management are of the discontinuous type, and make use of Light emitting techniques (fiber optic or LED signs). Note: In the USA also terms like Dynamic Message Signs (DMS), Changeable Message Signs (CMS) and Blank Out Signs (BOS) are used, where:

- DMS is any sign that can change the message presented to the viewer (VMS, CMS or BOS);
- VMS is the same as the abovementioned discontinuous sign;
- CMS is a sign that can display one of two or more predefined messages, or be blank;
- BOS is a two-state sign (message or blank).

1.2.3 Purpose of Variable Message Signs

In Dynamic Traffic Management, VMS can be used for the following purposes:

a) **Control,** further to be divided in:

Lane Control	lane change/closure
	lane merge by use of crosses and arrows
Speed Control	speed funneling

speed harmonization

by using seed indications, with or without red border

Prescriptions "no overtaking" etc.

VMS for lane and/or speed control purposes are in most cases positioned over the traffic lanes.

Prescription signs are usually placed between two adjacent lanes or at the side of the road.

Figure 1.1: speed funneling

Figure 1.2: speed harmonization and prescription

b) **Danger Warning Messages**, further to be divided in:

Weather Conditions fog

snow

ice

rain

wind

Incident / accident

Congestion / queue

Road works ahead

Road status closures

slippery road

icy road (black ice)

Figure 1.3: UK – Road works ahead

Figure 1.4: Fog

c) **Informative Messages**, further to be divided in:

General Informative Messages useful traffic information

Informative Link Messages

Informative Network Messages

Informative Rerouting Messages

For informative signs many European countries use large text panels with two or three lines of text, sometimes accompanied by a pictogram. When used for Informative Network Messages, these are sometimes called RIPs (Dynamic Route Information Panels).

A new development is GRIPs (Graphical Route Information Panels), where link or network information is presented in a graphical way.

Figure 1.5: General Informative Messages

Figure 1.6: Informative Link Messages

Figure 1.7: Informative Link messages

Figure 1.8: Informative Rerouting Messages

1.3 Effective Implementation

Currently there are only 31 VMS installed across Dhaka city which are mainly classified into two categories: big and small. There are 17 VMS under category big and other 14 are under category small. Sites with category are listed below:

Table 1.1: Locations of VMS installed

Serial no.	Camera site	Category
1	Abdullahpur Check post	Big
2	Gulshan Circle-1	Big
3	Sonargaon Crossing	Big
4	Mohakhali Crossing	Big
5	Progoti Sharani Bisho Road Crossing	Big
6	Farmgate Crossing	Big
7	Agargaon Light Crossing	Big
8	Nightingale Crossing	Big
9	Science Laboratory Crossing	Big

10	Moghbazar Crossing	Big
11	Hotel Sheraton Crossing	Big
12	Gabtali Bus terminal	Big
13	Sydabad Janapath Crossing	Big
14	Sanarpar Check Poing	Big
15	Bangladesh Bank Crossing	Big
16	Joykali Mandir Road	Big
17	East side of Sheraton Hotel	Big
18	Kakoli Crossing	Small
19	Shahbag Crossing	Small
20	Phinix Crossing	Small
21	Manik Mia Avenue (West)	Small
22	Mouchak Crossing	Small
23	Star Gate Crossing	Small
24	Zero Point	Small
25	Dhanmondi 27 no Crossing (West)	Small
26	Mirpur-10 Junction	Small
27	No-1 Buriganga Crossing Check Point	Small
28	Jatrabari Crossing	Small
29	Joykali Mandir	Small
30	Rampura Abul Hotel Crossing	Small
31	Jahangir Road	Small

Out of all these VMSs many VMS board are seen to show faulty messages. Some are totally out of service and one or two has been subjected to theft. All these VMSs are poorly maintained and monitored.

However, only few different messages are shown in all the VMS. The text shown in different VMS are as follows:

- ✓ "Obey the traffic rules"
- ✓ "Do not change the lane frequently"

- ✓ “Motorcycles are prohibited on pavements”
- ✓ “Obey the legal rules of Police”
- ✓ “Speed Limit 30kmph”

Again, no research work related to VMS has been carried out in Bangladesh. The outcome of which is the present poor scenario of VMS already installed and discussed above. So, research work regarding VMS in Dhaka city for effective implementation is of utmost importance.

1.4 Research objective:

The objectives to be achieved by this study are as follows:

1. Study of the perceptions of mainly three survey groups (drivers, pedestrians, highway professionals) about implementation of VMS.
2. Finding out the differences of their perceptions & reasons for the differences.
3. Study of drivers’ behavior, attitude and concern about VMS which determines the proper way of implementing VMS.
4. Giving recommendations to the stakeholders with our key findings for the effective implementation of VMS.

CHAPTER TWO: LITERATURE REVIEW

VMS is being included as an integral part of transportation system in the developed countries for a long time. Its effectiveness has been proven through many researches held in different countries unlike Bangladesh. VMS used thus for several purposes like speed, travel time, road works ahead, congestion, accidents, lane shift, weather, route guidance etc. is deliberately helping in solving various traffic problems. An effective VMS needs several factors to take into consideration which are discussed in researches. As an example studies at the Institute for Transport Studies at the University of Leeds, UK, resulted in that increased numbers of lines on VMS (as with bilingual messages) tended to have a strong effect on driver behavior. Again Using different colours or type fonts separating the two languages were recommended from

this study. In terms of Bangladesh VMS has been introduced quite recently but to make an effective implementation of it no research has been carried out yet.

2.1 Definitions related to VMS

According to Vägverket (2003), some definitions related to VMS:

• Message: A configuration of sign symbols and/or characters.
• Pictogram: A message consisting of stylized pictures.
• Active message: When the road sign is in operation and the appropriate message is completely visible. The appropriate message can be that no message is shown (Blank message space).
• Variable Message Sign, VMS: A road sign which by active message can show alternate messages which can be altered when required.
• Continuous VMS: A variable message sign that can present messages in the shape of intact sign images or intact characters or both. Continuous road signs are from a distance perceived in the same way as stationary road signs.
• Discontinuous VMS: A variable message sign based on pixel technique.
• Display surface: The visible part of a variable message sign which incorporates the pixels or the variable parts demanded for a message to be presented.
• Color inversion: By color inversion is meant a color scheme of the sign image based on luminous symbols, border and characters shown on a dark ground. Color inversion can only be made on luminous discontinuous VMS.
• Luminance: A measure of how much light an area emits and which indicates how bright the human eye perceives a surface. Measured in cd/m
• Visibility: The visual range of a road sign.
• Visual performance: A measure of visibility and legibility for a variable message Sign under varying visual conditions and when considering human ability.

VMS messages may be reactive incident messages e.g. advance warning of a crash; or proactive messages e.g. estimated travel time. VMS comprise two types, Continuous and Discontinuous signs. Continuous signs are similar to fixed signs, the only difference being that they can show various messages by some electromechanical means. For example rotating prism signs, roller blinds, etc. Discontinuous signs create

messages using individual elements that can be in one of two states (or more) and can thereby create various messages on the same sign face. For example flip-disk signs, fiber optic signs, LED signs, etc.

2.2 Driver's attitudes towards VMS

NZ and International research shows VMS message content has great relevance to drivers, delivering expectations and warnings in advance (McBride, C. & Wee, L., 2010). Variable message signs has been widely installed across Canadian roads and in many jurisdictions around the world (Richard & Alexandre , 2007).

The use of VMS to display travel time information while travelling on motorways is widespread, particularly in the United States and United Kingdom with very positive customer feedback (89% in UK) (McBride, C. & Wee, L, 2010)

On several places in England, a large test on vehicle-activated signs was carried out (Winnett & Wheeler, 2002).

Nygardhs and Helmers (2007) conducted an extensive literature review of VMS in European countries, focusing on driver's behavioral responses to VMS. This included the foundation for a basic behavioral model based on widely cited 1938 research by Gibson and Crooks. Walking, riding a bicycle and driving are all "extensions of ourselves". Once learnt these extensions become subconscious activities.

Chatterjee et al (2002) conducted a survey in London determining response to VMS (not displaying travel time). This survey showed that 80% of drivers considered the information presented on VMS to be useful, 95% correctly understood the abbreviations. A survey of drivers' actual responses to a message activation showed that only one third of drivers saw the information presented to them and 20% of drivers whose survey responses indicated they should divert did divert, although many found the information useful.

De Craen and De Niet (2002 cited in Nygardhs and Helmers) provided a further finding in the Netherlands that: drivers did not pay much attention to general VMS messages for example "drive with consideration" and please be a courteous driver", however there did not seem to be any negative road safety effects.

In one of the few surveys on this topic, drivers in the United Kingdom reported moderate support for other uses; with 21%, 19% & 18% of the respondents respectively suggesting that messages displaying 'keep distance', 'lane discipline' and 'general safety' should be included in future DMS messages, compared to 50% suggesting 'traffic related' messages and 11% who do not want any type of messages (Cooper & Mitchell, 2002).

This means appropriate way of presenting VMS will lead the road users to follow the mentioned messages and use this safety factor more effectively.

In Paris there are over 350 VMS on the ring motorway. Kronborg (2001) found that 80% of the drivers preferred to be informed of the travel time rather than queue lengths. Another survey conducted in Paris (MV2, 1997 cited by Lai) revealed that:

- 97% of drivers were aware of the existence of VMS
- 62% of drivers completely understood the information presented on VMS
- 84% considered the information presented to be useful
- 46% had on at least one occasion diverted in response to the travel time information

2.3 Preferred message

Chen (2004) conducted research as part of the California PATH Program into displaying real time travel times on VMS normally used to communicate information about traffic diversion, incidents, and delays. Chen (2004) suggests that continued operation of VMS in the United States indicates widespread acceptance by the public.

However, In the Netherlands VMS may be used for information about incidents and for general advice (de Craen & de Niet, 2002). Interviews with and observations of car drivers indicate that not much attention is paid to the general messages.

In Norway empirical studies were carried out by Erke et al. (2005), cited and translated in Nygardhs and Helmers (2007). Two VMS sites alternated between blank

and road closure with alternative route messages in 15 minute intervals. Around 20% of drivers that would normally choose the closed route changed their route to follow the recommendation.

Furthermore, Kronborg (2001) found that in Paris where there are 350 VMS on the ring motorway, 80 % of the drivers preferred to be informed of travel time rather than queue lengths. 82 % of the questioned drivers regularly using the VMS road network in Scotland say they follow the information from the VMS although it doesn't agree with other information. Investigations in Japan show that, in the following order, experience, feeling, VMS and radio information, respectively, are the decision grounds having the largest impact when considering choosing an alternative route.

Sara Nygårdhs (2011) found during 2006–2009 a large number of studies along with mentioned studies regarding VMS have been completed. The main results from these studies are:

- Graphic-aided signs should be preferred to text signs.
- The number of lines on a VMS should be kept to a minimum, with respect to comprehensibility.
- Pictograms and messages must be evaluated before they are used in practice.
- The typeface "Tern" is recommended for use within Europe.
- Bilingual signs should be avoided.
- A VMS activated only when speeding leads to reduced speed, i.e. better compliance.
- Supplementary information to an activated VMS may not enhance behavior concerning compliance.
- Reading and processing a text message on a VMS lead to reduced speed.
- The current speed limit is ignored if it is not motivated by the traffic situation, which means that the VMS should be activated only when conditions deteriorate.
- It is essential that a VMS works correctly and reflects the actual conditions, which puts a high demand on equipment and central control.

- Reading time is better correlated to the number of information units than to the number of lines.
- A blank “off-screen” may enhance information processing when successive VMS are shown.
- High luminance is preferable for symbols on VMS.
- A three diode symbol thickness leads to better legibility than one or two diodes symbol thickness.

2.4 Effectiveness of VMS:

Moreover in different studies it was found that color, font size, language, installation location, installation height and clear sight distance impose a significant impact on effectiveness of VMS.

Chien-Jung Lai (2010) in his study found that color scheme and number of message lines are significant factors for participants’ response time to VMS. Participants responded faster for two-color than for one- and three-color scheme. Participants also took less response time for double line message than for single and triple line message. Both color scheme and number of message lines had no significant effect on participants’ response accuracy.

Again it has been seen that inn India, graphic messages instead of text messages posses a improve comprehension (Ravinder, Velmurgan, & Gangopadhyay, 2009). Different types of visualization for traffic information in different driving scenarios showed shat both text and graphics combination is preferred by majority of drivers Meng, Zhang & Mustafa (2009).

This literature review is primarily aimed at describing studies that deal with the interaction between driver behaviour and VMS in Dhaka city. The collected references are, for the most part, published in Europe or studies about European conditions, published during various times.

CHAPTER THREE: METHODOLOGY

The objective of our study is to analyze the difference of perceptions of different groups of people. Three groups were selected mainly for the survey purpose. These survey groups are the major stakeholders. In fact variable message signs are not familiar to most of the people of the country. Very few have ever noticed any VMS board. So the study also draws the attention of the survey groups.

3.1 Survey Methods:

Statistical Surveys are undertaken in order to gain inferences of statistical data from a selected group of people or population. This inferences are reflected through the questions used in survey.

Survey Methods and Practices", published by Statistics Canada in 2003 revealed survey this way ‘’A survey is any activity that collects information in an organized and methodical manner about characteristics of interest from some or all units of a population using well-defined concepts, methods and procedures, and compiles such information into a useful summary form”. Survey is conducted through series of steps like

- ✓ Formulation of the Statement of Objectives
- ✓ Selection of a survey frame
- ✓ Determination of the sample design
- ✓ Questionnaire design
- ✓ Data collection
- ✓ Data capture and coding
- ✓ Editing and imputation
- ✓ Estimation
- ✓ Data analysis
- ✓ Data dissemination
- ✓ Documentation

Our study includes a simple questionnaire survey and will focus on the steps that are directly relevant to this research.

3.2 Survey Frame Selection

In a sample survey, data are collected for only a fraction (typically a very small fraction) of units of the population. One of the ways to identify and contact the units of survey population is a survey frame which is called sample frame for a sample survey (Statistics Canada, 2003). Ultimately, it defines the survey population through a set of information. A frame should include some or all items which are listed below:

• Identification data (name, address, identification number)

• Contact data (mailing address, telephone number)

• Classification data

• Maintenance data

• Linkage data

3.3 Selected Groups

In this study three survey groups are selected n the basis of their involvement to VMS. These three survey groups will represent the overall perceptions and response towards VMS. These three survey groups are:

- Drivers
- Highway professionals
- General public.

Selecting this three groups of people have some special reasons. For example in the case of Highway professionals, they are the police makers. They control the overall visualization, placement of massages of traffic information including operating and maintenance facility.

Again majority of people are remained and considered important are drivers and general publics. Their requirement and perceptions need to be reflected in VMS for an effective implementation. In this study the target population consists of drivers, highway professionals and general public of Dhaka city as Dhaka is our targeted area.

3.4 Design of Questionnaire

Questionnaire is a set or group of questions formed to gather information from respondents on particular matter or subject. Questionnaires play a vital role in the data collection process since they have a major impact on data quality and influence the image that the statistical agency projects to the public.

Questions can be raised by two ways. Open ended questions and close ended questions. Open ended questions allows the responded to answer independent of any limitation. Respondent does not have to be confined on given options. On the other hand close ended questions are provided along with several options. This limit the answer of the respondent but on the contrary helps to gather the required piece of information in a rational way.

In this study design of close ended questionnaire was based on factors of VMS that has been deliberately placed and discussed in several researches. These factors convey the effectiveness of VMS. Set of questions were based on these factors. Our set of questions were divided into four groups. First set of questions were on socio-economic conditions of the respondent. And the last three sets of questions was on factors which have been considered in our study.

3.5 Data Collection

In this study collection of data for questionnaire is made through personal interviews. Other methods of interview like Telephone interview was not possible as conducting and explaining questions having several transportation engineering terms was bit difficult. Personal interview helped to collect actual data and response from the respondents. Data has been collected from several places. Data from drivers were collected from places like

- BRTC training center
- Sydabad Bus depot
- Farmgate Bus-stand

Data from Highway professionals were collected from

- Bridge Authority Bangladesh
- Roads & Highway Department
- Local Government Engineering Department (LGED) Dhaka branch

Data collections for general public were done at random placed in Dhaka city.

Several information and Data are being collected from Traffic Control Board, Dhaka.

3.6 Data Coding

Data coding comprises assigning numerical values to collected responses which is further used to facilitate analysis by putting the numerical values into an analysis method. Upon coding text material for content analysis, raters must classify each code into an appropriate category of a cross-reference matrix. Relying on computer software to determine a frequency or word count can lead to inaccuracies. Our study used Likert scale for assigning values to responses that are achieved through questionnaire. As our questions were close ended 5 different values according to Likert scale has been assigned. Starting from 1 to 5, strongly disagree is represented by 1 while 5 represents strongly agree for responding to a question respectively. Further analyses might be appropriate to discover the dimensionality of the data set or identity new meaningful underlying variables.

3.7 Data analysis

Data analysis is a body of methods that help to describe facts, detect patterns, develop explanations, and test hypotheses. It is a systematical process of applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data. According to Shamoo and Resnik (2003) various analytic procedures "provide a way of drawing inductive inferences from data and distinguishing the signal (the phenomenon of interest) from the noise (statistical fluctuations) present in the data". It is used in all of the sciences. It is used in business, in administration, and in policy. (Macintosh HD:DA:DA XI:Volume I:006 Intro, June 10, 1996)

Data analysis is one of the most critical steps of a survey, since the quality of the analysis and how well it is communicated can substantially affect the significance of

the whole survey. Data analysis should relate the survey results to the questions and issues identified during the first step of the survey. The form of the analysis is determined by the specific qualitative approach taken (field study, ethnography content analysis, oral history, biography, unobtrusive research) and the form of the data.

Depending on the questionnaire survey performed One-way Analysis of Variance (ANOVA) has been selected.

One-way Analysis of Variance (ANOVA):

The statistical procedure outlined here is known as "one way analysis of variance" or more commonly by its acronym "ANOVA". ANOVA analyzes sample variances to draw inferences about population means.

There are four basic assumptions used in ANOVA.

- Observations were randomly and independently chosen from the populations;
- Population distributions are normal for each group; and
- Population variances are equal for all groups.

Independent variable should consist of two or more categorical, independent groups. Typically, a one-way ANOVA is used when you have three or more categorical, independent groups, but it can be used for just two groups (but an independent-samples t-test is more commonly used for two groups).The error from one observation should not be related to the error from any other observation. Second assumption is needed to combine or pool the variances within the groups into a single within group source of variation (denoted as SSW). Independence of error, which means that there is no relationship between the observations in each group or between the groups themselves. Dependent variable should be approximately normally distributed for each category of the independent variable. If sample sizes are equal, inferences based on F distribution may not be seriously affected by unequal variances. However, unequal samples can have serious effects on drawing such inferences and adjustments have to be made to test if the variances are not equal.

In general, whether several groups (c = 3 or more) have same population average, the null and alternative hypotheses related to this research would be stated as follows:

Ho: mean of responses of driver group = mean of responses of general public = mean of responses of highway professionals.

H1: not all means are equal.

$$\text{SST} = \sum X^2 - \frac{(\sum X)^2}{N}$$

Which is the fundamental equation of ANOVA—the unique partitioning of the total sum of squares (SST) into two components: the sum of squares within groups (SSW) plus the sum of squares between groups (SSB). The sum of squares total is exactly that: it is the sum of the sum of squares between and the sum of squares within.

In Analysis of Variance, scores may differ from each other because they are from different groups. This is variance between groups. If null hypothesis is true, then SSB will estimate population variability as well as SSW. If null hypothesis is false, then SSB will be larger. To calculate the variance between groups:

$$\text{SSB} = (\sum X1)^2/\text{n1} + (\sum X2)^2/\text{n2} + (\sum X3)^2/\text{n3} + \ldots\ldots\ldots + (\sum Xa)^2/\text{na} - (\sum X)2/\text{N}$$

In Analysis of Variance, scores may differ from each other even when participants are in the same group. This is variance within groups. To calculate the variance within groups:

SSW= SST - SSB

Where,

N = no of observations in the experiment

n = no of observations in individual groups

X = individual data of each groups

Sums of squares are not much use in and of themselves because their magnitudes depend inter alia on the number of scores included in producing them. As a consequence, we normally use the mean squared deviation or variance. As variance is estimated by diving sum of squared deviations by its appropriate degrees of freedom, it is calculated as an average squared deviation and hence, called as mean square. Two mean squares are associated with SSB and SSW and they are mean square within, MS

W and mean square between, MSB. In Analysis of Variance, we compare the results between groups with the mean of all groups, so the mean square between reflects the inherent variability between groups in the study. Therefore, the mean square between groups is a measure of how much the means in a factor differ from each other. Comparing the results in each group with the mean of that group, so the mean square within reflects the inherent variability between scores due to individual differences or other random factors. Degrees of freedom and mean square equations to estimate are:

$dfW = N - a$

$dfB = a - 1$

$MSW = SSW / dfW = SSW / (N - a)$

$MSB = SSB / dfB = SSB / (a - 1)$

Where,

a = no of groups.

F (d fB, dfW) = MSB/MSW

If the null hypothesis is true, then this ratio should be approximately 1.0. Otherwise, the ratio will be greater than 1. The decision rule is to reject the null hypothesis of no difference between the groups if:

F (d fB, dfW) = MSB/MSW > F critical (dfB, dfW)

Where F critical (dfB, dfW) of F distribution is estimated for dfB and dfW using table.

In this research the results are compared with "P" value. There is a wide range of statistical tests available, depending on the nature of the investigation. However, the end result of any statistical test is a "P" value. The "P" value stands for probability and measures how likely it is that any observed difference between groups is due to chance. In other words, the P value is the probability of seeing the observed difference, or greater, just by chance if the null hypothesis is true. Being a probability, P can take any value between 0 and 1. Values close to 0 indicate that the observed difference is unlikely to be due to chance, whereas a P value close to 1 suggests there

is no difference between groups other than that due to random variation. The interpretation of a P value is not always straightforward and several important factors must be taken into account, as outlined below. Put simply, however, the P value measures the strength of evidence against the null hypothesis. Comparing "p" value with Significance level, α is estimated as:

If "P" value> α - Do not reject null hypothesis.

If "P" value< α - Reject null hypothesis.

For the example below we would reject the null hypothesis at the 5% significance level and conclude that the means are not equal since 'p'-value < significance level (α):

Blinking of message is attractive than Stable message:

Driver	General Public	Highway Professional
2	4	2
4	2	5
4	2	5
4	4	2
2	4	1
3	4	1
4	5	2
2	4	2
4	2	2
4	1	2
4	3	2
5	3	1
2	2	1
3	4	1
4	2	1
2	4	2
4	4	2

4	5	5
4	4	1
.	.	.
.	.	.
.	.	.

. .

. .

The one way analysis of variance procedure can be performed using the program Microsoft Excel. The output of the test is shown below:

ANOVA: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Driver	100	296	2.96	1.089293
General public	100	337	3.37	1.609192
Highway professionals	72	148	2.055556	1.602504

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	73.56855	2	36.78427	25.97597	4.85E-11	3.029343
Within Groups	380.9278	269	1.416088			
Total	454.4963	271				

Figure 3.1: ANOVA Analysis in Microsoft Excel

CHAPTER FOUR: RESULTS

The effectiveness of Variable massage sign in Dhaka city has been observed by studying the Questionnaire survey administered within three survey groups. These are

Driver, General public and Highway professionals. A significant variation among the responses has been observed. The prevalent causes of variation are analyzed by personal interviews and responses.

4.1 Surveyed groups:

Selection of survey groups was a significant portion of this research. The aim was to achieve relevant information about responses regarding the existing facilities regarding VMS and also understand the need of road users. Most of the people who rely on the current traffic facilities are drivers and general publics. As VMS is totally a new concept for controlling traffic in Dhaka city, comparing the behaviors and attitudes towards it was necessary. For achieving a safer driving environment, thoughts and attitudes of these two survey groups was also necessary for an improved comprehension. Among Driver group a certain majority portion were car drivers. Other respondents of surveyed driver group were Bus, truck, tempo, Bike and CNG drivers are surveyed in different portion. The major surveyed general public group included pedestrians. Students, job oriented people, businessmen, workers and shop owners are among the examinee.

Highway professionals are the police makers. They control the placement, visualization of massages of traffic information in different traffic scenario and the proper operating and maintenance facility. The implementation of an effective VMS is in their hands. So selection of this survey group was a vital necessity.

To get the proper outcome from the questionnaire survey, assigning of these following three category survey groups was needed:

- Driver
- General Public
- Highway Professional

4.2 Characteristics of Respondent Groups:

About 272 people are surveyed among which hundreds of drivers and general public individually and about seventy two highway professionals. A detailed questionnaire

was organized to get the relevant and personal information about the respondents. All the people surveyed in driver category were male due to lack of female drivers in our country. In General public and highway professional groups about one third of the people surveyed were female respectively.

Table 4.1: Respondents Profile of Socio Economic questions (in %)

		Driver	General Public	Highway Professionals
Age	Below 25	28	41	0.00
	25-34	46	26	19.44
	35-44	21	27	41.67
	45-54	2	4	36.11
	over 55	0	0	2.78
Education	No Edu	20	5	0.00
	Primary	53	9	0.00
	Secondary	17	30	43.06
	Post-Secondary	7	54	56.94
License Type	Heavy	25	0	6.94
	Medium	17	4	0.00
	Light	45	29	44.44
	Motorcycle	9	14	4.17
Know Driving	Yes	100	70	52.78
	No	0	28	47.22
Drive Frequently	Yes	100	38	44.44
	no	0	60	55.56
License Taken	No License	0	56	52.78
	Below 1 yr	9	13	0.00
	2-5 yr	40	19	31.94
	6-10 yr	33	5	9.72
	Over 10 yr	15	5	5.56
Driving Experience	<1 yr	0	20	31.94
	<3 yr	13	20	13.89
	<5 yr	27	16	19.44
	<10 yr	27	5	13.89
	>10 yr	30	5	5.56
Any Collision	NO	13	49	76.39
	Within 1yr	19	25	4.17
	Within 2yr	29	9	12.50
	>3yr	19	3	2.78
	>5yr	17	0	4.17

Income	**<5k**	**2**	**33**	**0.00**
	<10k	43	16	4.17
	<25k	42	21	51.39
	<35k	10	20	37.50
	<50k	0	4	1.39
	>50k	0	4	0.00
Vehicle	Car	56	37	55.56
	Bus	15	2	0.00
	Truck	12	0	5.56
	Tempo	5	0	0.00
	Bike/CNG	9	21	6.94
Saw any VMS yet?	No	37	1	1.39
	<2	32	46	52.78
	<4	19	46	36.11
	>4	9	5	0.00
Dwelling Condition	Personal	10	53	59.72
	Rental	73	29	23.61
	Office/Govt. quarter	11	8	16.67
Saw what type of MSG?	Traffic Related	8	24	20.83
	Weather	0	0	0.00
	Safety	38	69	77.78
	Others	5	0	0.00

A lot of variation has been found among the groups including age, education, driving experience etc. in percentage. This result shows that there is a significant variation among the surveyed people which provide more logistic and demographic data for analysis.

4.2.1 Driver age:

Most of our drivers are within the age of 20-45years as shown in figure and majority of them have five to ten years experiences. These category of drivers are mainly the road users in our country and their responses provide a significant knowledge about the current scenario about the effectiveness of VMS in Dhaka city.

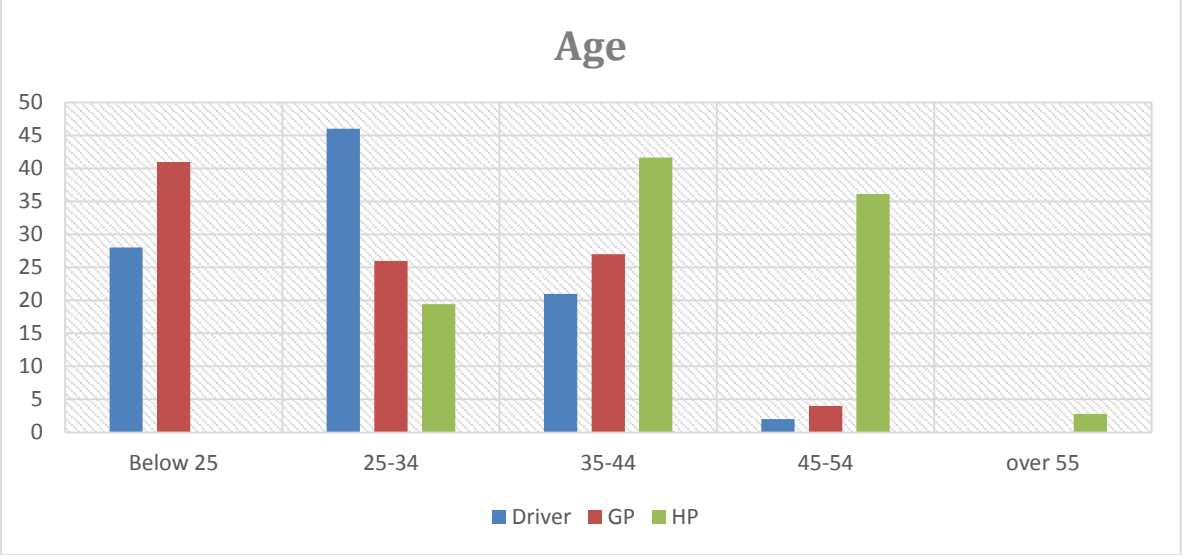

Figure 4.1: Distribution of Age of Surveyed Groups

Larger portions of general public are below 25 to 25 years old because the workers and the students cover a significant portion of road users in Dhaka city. The Highway professional surveyed are experienced that's why a major portion of them are within the age of 35-44years (figure 4.1)

4.2.2 Education:

It is observed from the results of questionnaire survey that a larger portion of our surveyed people is educated and having secondary to post-secondary education (figure 4.2). Drivers whom are interviewed have primary education and a minimum portion of them have no education (figure 4.2).

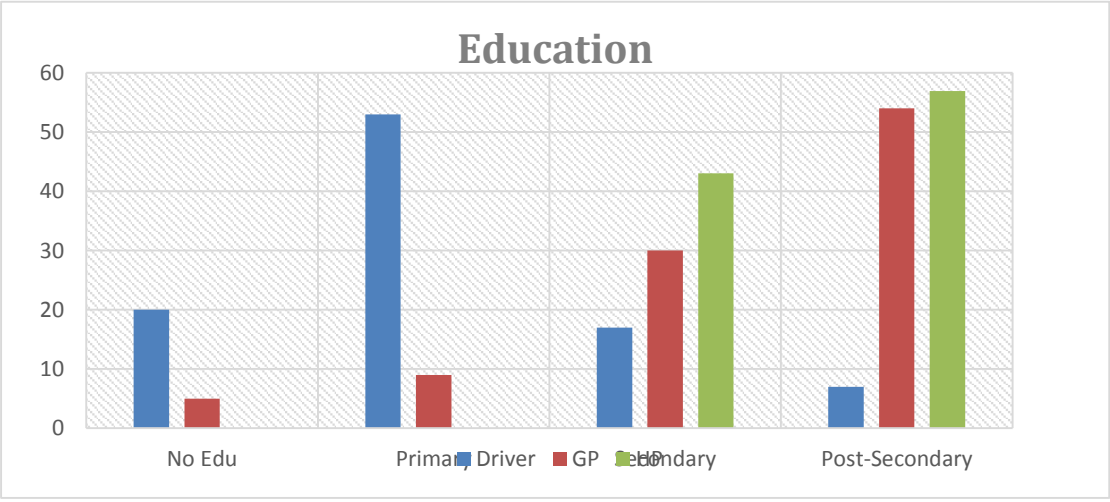

Figure 4.2: Education distribution of Surveyed Groups

From the personal interview it is found that majority of the drivers were studied class V level of primary school and a few of them completed secondary education and a negligible portion of them get the opportunity of completing post-secondary education. So these categories of surveyed people can provide valuable information about the significance of VMS in roads of Dhaka city.

4.2.3 License type:

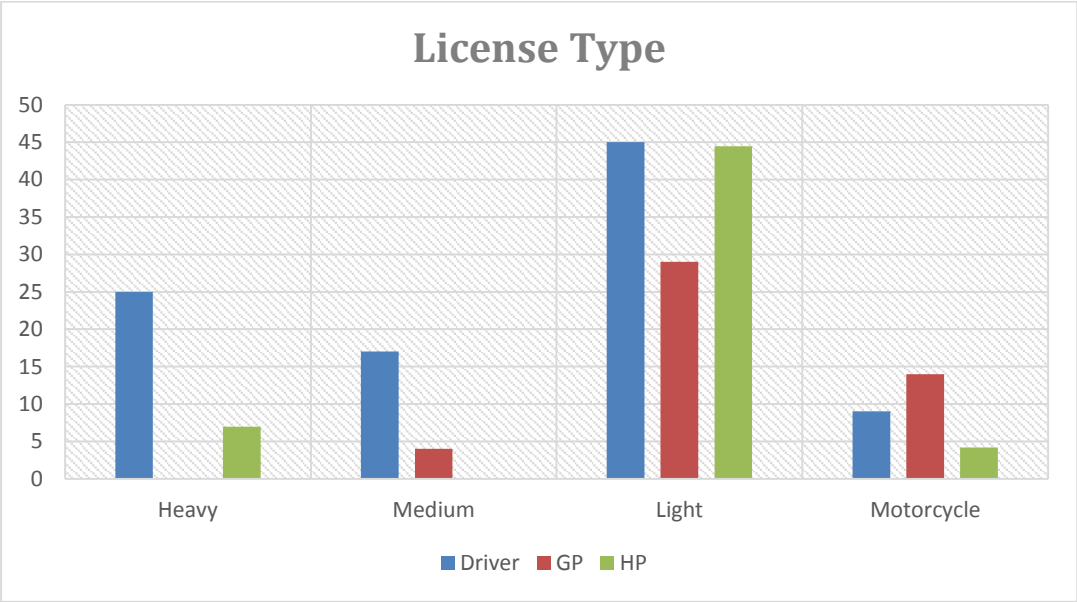

Figure 4.3: Distribution of License type among Groups

A major portion of our surveyed people had light category licenses. About 25% of interviewed drivers were experienced and they had heavy category licenses. There was also motorcyclist and had licenses among the three surveyed groups.

4.2.4 Driving experience:

A significant variation has been found among the three surveyed group in driving experience category. The drivers had two to more than years of experiences in their profession.

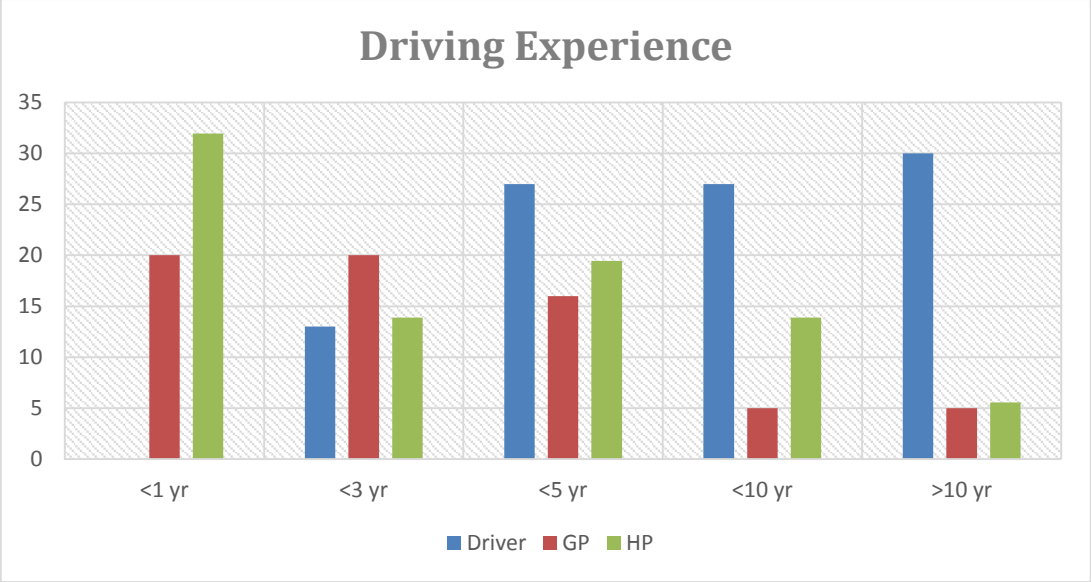

Figure 4.4: Distribution of Driving Experience

About 30% of them have experience of more than ten years (figure 4.4). There is a variation of experiences among the general public and highway professionals and a majority of surveyed highway professionals have less than a year of driving experiences.

4.2.5 Collision:

Due to the results found from the questionnaire survey it is observed that about 30% of the interviewed people have collision within 2years (figure 4.5). Any collision within 1 year is 20% (figure 4.5).

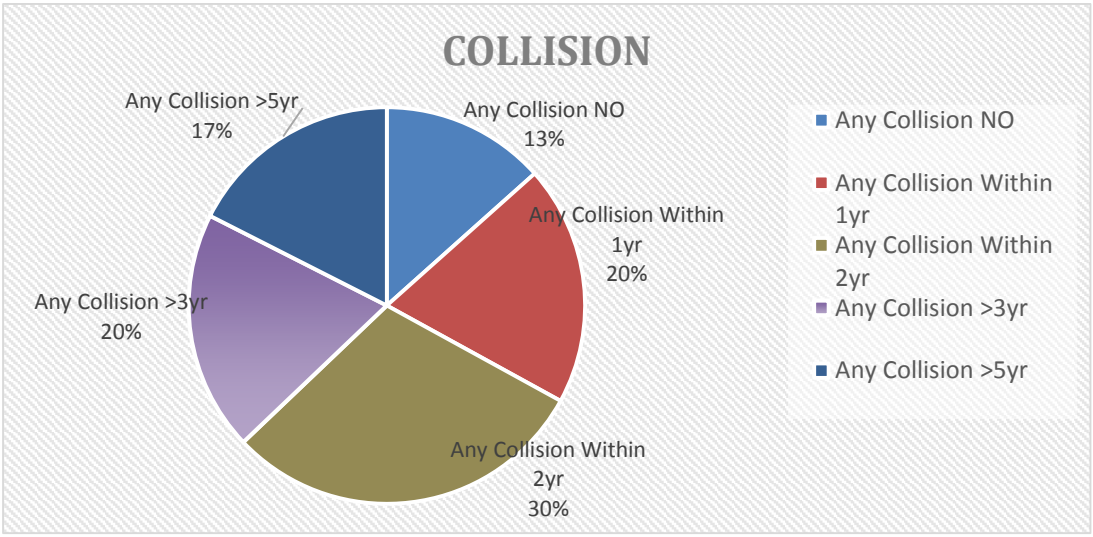

Figure 4.5: Collision pattern

No collision category is less among all. So these results provide the actual scenario we are facing in roads of Dhaka city due to lack of traffic controlling. Whereas Variable message sign is properly implemented, then it can play a significant role in reducing collision.

4.2.6 Vehicle type:

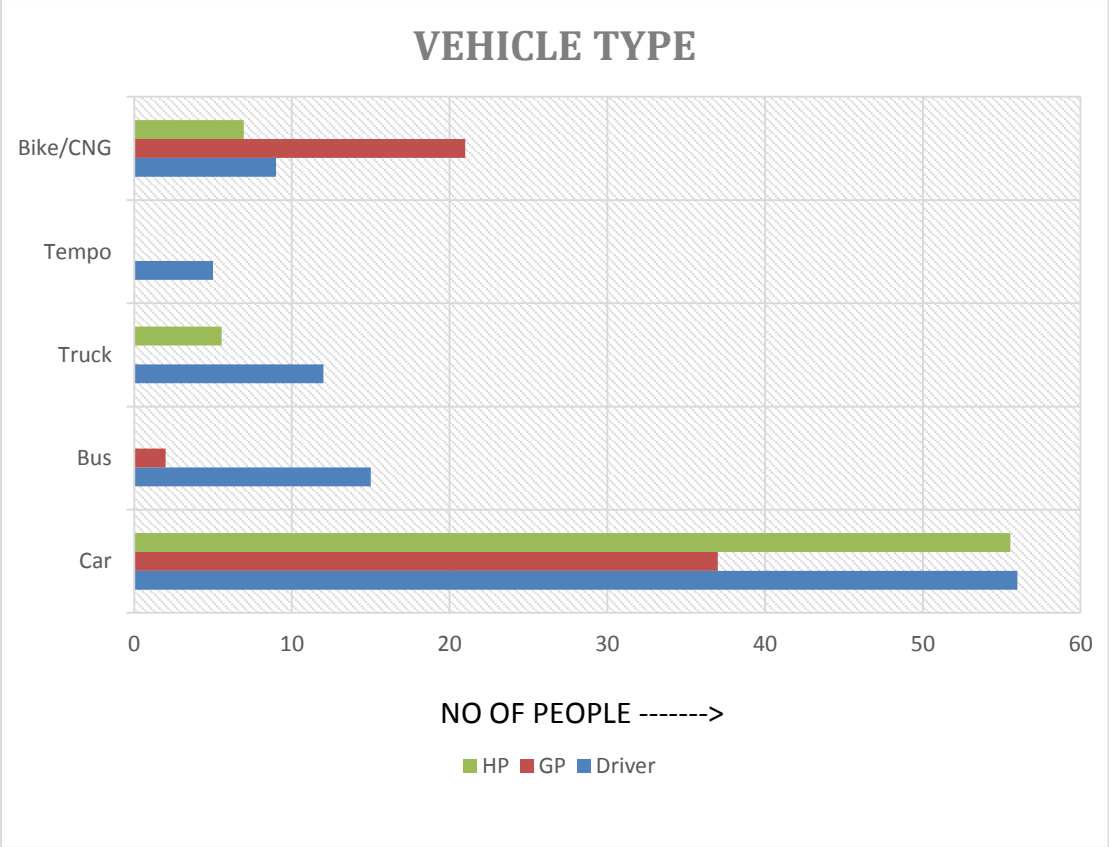

Figure 4.6: Variation of Vehicle type among Surveyed Groups

As a figure 4.6 shown that more than half of surveyed people drive cars in driver category and a major portion of general public and highway professionals owned car and drive often. There are also bus, truck, tempo and bike drivers. A great portion of the surveyed general public owned and ride bikes among the interviewed people.

4.2.7 VMS noticed:

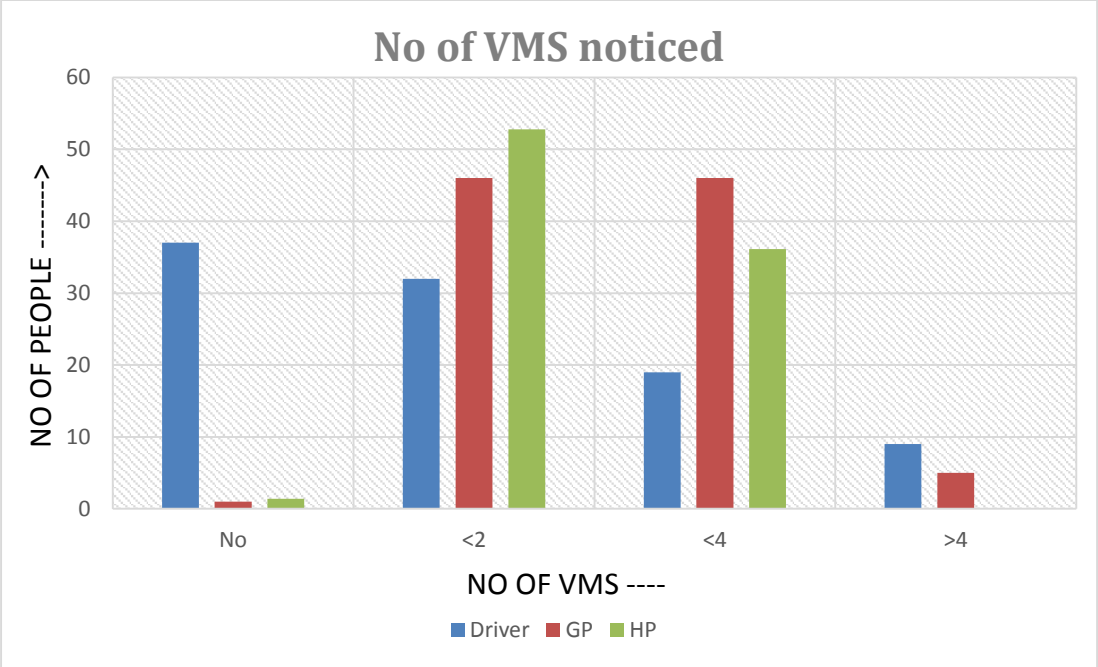

Figure 4.7: Noticed VMS among the groups

Though VMS are mainly implemented to help drivers, it has been from the survey results that a significant portion of drivers didn't notice it at all in road (figure 4.7). About 31 VMS (table 1.1) has been installed in Dhaka city but a major portion of the surveyed people has noticed less than two in roads. Some of them has noticed less than four and a minimum portion of them noticed more than four VMS in roads of Dhaka.

4.2.8 Messages type noticed:

As VMS can be used for several purposes in its premises but the greater number of surveyed people only noticed messages related to safety issues. From the figure… it is observed that safety related messages are mainly displayed in the VMS used in Dhaka city.

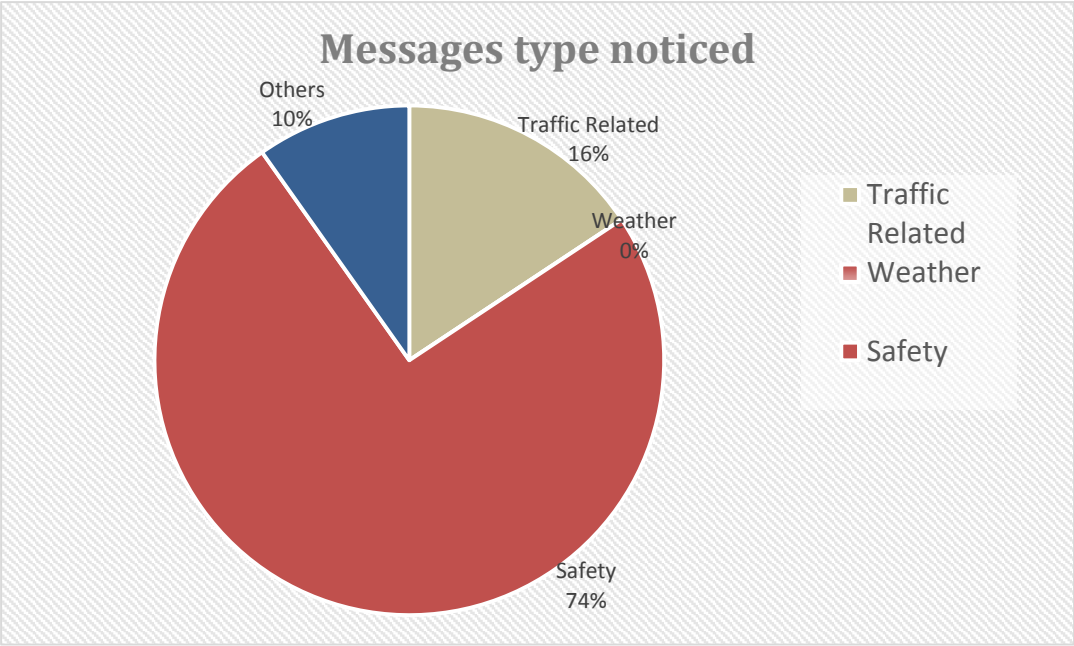

Figure 4.8: Noticed Message type among the Groups

4.3 Respondent attitudes towards VMS:

The increasing traffic on Dhaka city motorways and different national approaches lead to an excessive workload for drivers. Congestion and accidents has been rapidly increased. Due to which a project of digitalizing the traffic control system of the city has been taken and under which the Variable message sign (VMS) has been implemented. So the workability of these digital boards towards the road users needed to be observed.

As the questionnaire was mainly prepared to identify the responses of people towards VMS and to get their attitudes, three categories were selected. These are:

- Message Type
- Location
- Display

The respondents' attitude shows their belief and behavior. The three surveyed groups were interviewed and their responses towards these three major factors have been rationally observed. The survey was demonstrated in person so the actual valuable responses were observed and analyzed.

4.3.1 Message type:

The messages displayed in VMS mainly encourage thinking about the risks involved in speeding and obeying the speed limits. In Bangladesh the literacy rate is low so the responses of people vary in some questions as they have different attitude towards the messages and information providing in VMS.

Table 4.2: Summary of questions on Message Type

Questions	Driver		GP		HP	
	Sample- 100		Sample- 100		Sample- 72	
	Mean	STDEV	Mean	STDEV	Mean	STDEV
Display advance warnings of accidents/road works:	4.16	0.37	4.42	0.50	4.47	0.50
Display weather information on the highway message boards:	3.69	0.63	3.36	0.90	3.04	0.85
Display real time traffic information on highway message board:	4.11	0.84	4.30	0.61	4.28	0.45
Display general safety messages on the highway message board:	3.84	1.08	4.32	0.71	4.36	0.48
Displaying Origin-Destination distance should be included in Highway:	3.35	1.05	3.80	1.03	4.17	0.44
Displaying accident occurrence messages on the VMS installed road:	3.73	1.06	4.13	0.81	3.88	0.73
Displaying congestion message helps me to change the road direction:	4.24	1.05	4.64	0.63	4.28	0.48
VMS message board should be used for Commercial advertisement purpose:	2.83	1.06	3.40	1.21	3.01	1.23
Interesting messages are more attractive than informative messages:	3.92	0.95	3.85	1.04	3.90	0.81
Messages on Amber alert:	3.91	0.57	4.03	1.06	3.96	0.66

Messages on Special event:	3.37	1.02	3.80	0.75	3.71	0.80

All survey groups holds similar perception of installing VMS in front of all accident prone area or site under construction or repairing work because VMS may help them to follow alternate route or share one way road for two direction flow to reduce congestion and they also holds similar kind of responses in the questions related to interesting messages and messages related to amber alert. According to the entire groups amber alert which is a new addition in VMS may help to reduce crimes in roadway

A small variation in mean values but significant variation among groups has been found according to "p" -value in some questions related to displaying real time traffic information which is probably due to traffic information may increases predictability of journey time or possible delay which is preferred by all groups.

Table 4.3: Summary of "*P" values for questions on* Message Type

Questions	P-Value	
Display advance warnings of accidents/road works:	7.08E-06	<0.05
Display weather information on the highway message boards:	1.67E-06	<0.05
Display real time traffic information on highway message board:	1.01E-01	0.1
Display general safety messages on the highway message board:	1.45E-05	<0.05
Displaying Origin-Destination distance should be included in Highway:	1.27E-07	<0.05
Displaying accident occurrence messages on the VMS installed road:	6.65E-03	<0.05

Displaying congestion message helps me to change the road direction: (i.e. CONGESTION AHED, USE ALTERNATIVE ROUTE)	5.51E-04	<0.05
VMS message board should be used for Commercial advertisement purpose:	2.29E-03	<0.05
Interesting messages are more attractive than informative messages:	8.65E-01	0.87
Messages on Amber alert:	5.71E-01	0.57
Messages on Special event:	1.56E-03	<0.05

Responses vary in displaying weather information on the highway message boards. Possibly some drivers want weather information in the message board to predict the level of comfort during driving and out of curiosity. They may think that weather information like rainfall duration would help them to predict and interpret travel time and used for safety purposes. Most highway professionals hold a neutral view in implementation of such messages. They probably think it doesn't matter whether such VMS installed or not. It's not mandatory but could be helpful in some cases. Some people may think they would be benefited by the information where others may think it's useless.

Responses towards displaying general safety messages on the highway message board varies among the groups according to "p" value because drivers might probably want more useful information like real time traffic information, congestion notification rather than conventional safety messages like "Obey traffic rules" or "Drive slowly" etc. Whereas public and highway professionals possibly want to use safety messages into VMS to the highest extent to remind drivers about their safety and responsibilities to traffic rules.

The variation in responses is significant in displaying origin destination data in highways of Dhaka city and the driver's response towards it is the lowest. Though it has been found from other researches that most of the VMS used in other countries are displaying origin destination information, the probable reason would be the drivers of Bangladesh are not used to with this modern technology moreover origin

destination distance already exists beside the highway. But highway professionals want the whole transport system to be digitalized. So, they may prefer to provide this kind of information.

VMS message board is using for Commercial advertisement purpose in many countries as an extra facility as an earning source. In this issue variation exists among the respondents. Drivers perhaps discourage use of VMS for commercial purpose because it will probably be no use to them in driving. Rather it will only interrupt them by drawing unnecessary attention disturbing their driving. But public may take it to be helpful by being informed about commercial daily use products. On the other hand highway professionals may take it to be of less importance but can be used as an earning source for money used in maintenance of VMS.

Especially the general public and the highway professionals like the idea of digital way of celebrations so they prefer messages on special event should be displayed but almost half the drivers take it as a potential disturbance hazard and they provide neutral responses.

4.3.2 Location/placement related responses:

Table 4.4: Summary of questions on Message Location

Questions	Driver		GP		HP	
	Sample- 100		Sample- 100		Sample- 72	
	Mean	STDEV	Mean	STDEV	Mean	STDEV
Messages should be located at curve:	4.63	0.73	4.02	1.05	4.44	0.77
Messages should be placed at Intersection:	4.60	0.51	4.52	0.56	4.44	0.67
Messages should be placed at midway:	3.99	1.17	3.35	1.04	3.79	0.82
Messages should be placed at national highway also:	3.25	1.10	4.07	0.78	3.94	0.65
Message should be placed at arterial road:	3.40	0.86	3.78	0.88	3.33	0.99
Messages should be placed at Regional Highway:	2.51	0.83	3.48	1.15	3.42	0.73

Messages should be placed ahead of narrow road:	**2.85**	**1.10**	**3.18**	**1.02**	**4.33**	**0.50**
Messages on diversion on Main road to sub road:	2.57	0.97	3.84	0.97	3.61	0.90
Messages on Important road:	4.23	0.74	4.79	0.41	4.18	0.72

Table 4.5: Summary of *P values for questions on* Message Location

Questions	P-Value	
Messages should be located at curve:	5.37E-06	<0.05
Messages should be placed at Intersection:	2.13E-01	0.21
Messages should be placed at midway:	7.27E-05	<0.05
Messages should be placed at national highway also:	2.25E-10	<0.05
Message should be placed at arterial road:	1.73E-03	<0.05
Messages should be placed at Regional Highway:	3.47E-13	<0.05
Messages should be placed ahead of narrow road:	1.14E-20	<0.05
Messages on diversion on Main road to sub road:	5.11E-19	<0.05
Messages on Important road:	2.16E-11	<0.05

Similar response was observed in placing VMS at Intersection among the three surveyed groups. Responses of general public regarding placement of VMS at midway is almost neutral and varies from other two groups because they might have lack of driving experiences though VMS installed in the middle of two way road are easily visible from both the direction.

Though responses among the groups in the question related to locating VMS at curve are positive but there is a small variation according to "p" value. Messages in front of curves can be extensive use to the drivers. It helps them to carry on shunting operation. Again they get additional time to perceive vehicle maneuvering or turning pattern or overtaking/restrict from overtaking another vehicle. General public lacks knowledge regarding vehicle maneuvering /turning/overtaking in a whole about driving. So, they don't feel the urge of installing VMS in the curve to that extent as the drivers or highway professionals do.

VMS are mainly placed at national highway in developed countries. As the drivers in Bangladesh are not compatible with this modern technology yet, so for drivers, placing VMS in national highway probably seems unnecessary as the have to maintain a high speed in highways and they get less chance to notice a VMS properly. But according to GP and HP VMS in national highways may reduce the accident to a significant level like the VMS helps to reduce in City streets.

The drivers provide almost neutral responses in context of placing VMS in arterial roads due to the same probable reason showed in responses placing VMS on national highway. In perspective of responses from drivers, it might create disturbance to them if there is too much VMS in roads, especially in regional roads. According to Highway professionals and general public, they have provided neutral responses due to navigate the drivers to their destination. Drivers may think, a small conventional traffic sign ahead of narrow road seems to be enough for them to understand. But for Highway professionals the possible reason of their positive response would be reducing the number of accidents in the diversion from main road to narrow road and provide more awareness to drivers.

Perhaps for drivers, a VMS on diversion road seems to be unnecessary in case of Dhaka city as Dhaka city has tons of diversion roads and implanting VMS on major places is more important to them. Highway professionals and general public expressed a slightly positive response as they think it may provide guidance to drivers.

General public would be allowed to predict about their journey or obstruction to journey in VIP roads. That's why may be public are more keen to implement VMS on important roads like Jahangir gate road in front of Prime Minister's office. Drivers

and highway professionals also hold almost the same view about these messages but they don't prefer it as the general public do. Because drivers and highway professionals are also aware of aspect other than journey time and obstruction only.

4.3.3 Display:

2 color combinations seem to be more preferable to Drivers and GP and this is the most standardized format of VMS used worldwide. Again for HP, there is a significant variation probably color combination has less importance in effectiveness. Drivers responded in favor of the question related to multiple color combination because they might probably think that multiple colors of VMS will attract them more. But their responses towards two color combination are higher. But for GP and HP this multiple color of VMS probably bear less importance in effective implementation.

A significant finding of this questionnaire survey is almost similar responses have been found from all three groups regarding slower transition of messages in VMS. Slow rate of the message transition helps a lot to read the whole text and clear perceive the meaning of the text. Speedy transition of letter seems less interesting to all group of participants. Because while taking interview to drivers and others it revealed that the speedy transition may not allow them to visualize the whole message.

Table 4.6: Summary of questions on Message Display

Questions	Driver		GP		HP	
	Sample- 100		Sample- 100		Sample- 72	
	Mean	STDEV	Mean	STDEV	Mean	STDEV
2 color combination is attractive:	4.79	0.41	4.33	0.67	3.47	0.80
Multiple color combination is attractive:	4.25	1.13	3.71	1.19	3.43	1.10
Slower transition of letter is more effective:	4.18	0.87	4.44	0.80	4.33	0.47
Speedy transition of letter helps to read full message:	2.12	0.82	2.35	0.90	1.93	0.48
Pictorial message is more effective:	4.18	0.81	4.70	0.46	3.53	1.07

Combination of both pictorial and textual message is more effective :	**4.19**	**0.61**	**4.34**	**0.62**	**3.75**	**1.16**
Two or multiple line display of message is effective:	4.10	0.64	3.90	1.38	3.13	0.89
Blinking of message is attractive than Stable message:	2.96	1.04	3.37	1.27	2.06	1.27

Table 4.7: Summary of P values for questions on Display Type

Questions	P-Value	
2 color combination is attractive:	2.93E-31	<0.05
Multiple color combination is attractive:	1.41E-05	<0.05
Slower transition of letter is more effective:	5.20E-02	0.05
Speedy transition of letter helps to read full message:	2.34E-03	<0.05
Pictorial message is more effective:	5.76E-18	<0.05
Combination of both pictorial and textual message is more effective :	1.11E-05	<0.05
Two or multiple line display of message is effective:	7.91E-09	<0.05
Blinking of message is attractive than Stable message:	4.85E-11	<0.05

In case of Driver and General public they probably think, a short pictorial message may express required message within a short period of time at a glance. But for Highway professionals they might think a single pictorial message may not convey all necessary information to provide with in case of VMS. A combination of both pictorial and textual messages may be a best option in visualization to drivers. Because it probably helps drivers to understand the information in the least possible time.

Drivers and general public take two or multiple line display would be more effective, easily readable and perceive the meaning of the message. It may be helpful to them to get an overall understanding of the message very easily. Where highway professionals hold a neutral view about this display type, as they take it to be of less importance in visualization.

A significant portion of the surveyed people provide negative to neutral responses in context of displaying blink messages. Blinking of messages may be of great obstruction in visualization for the drivers, because drivers not only follow the messages but also drive at the same time. Blinking negatively affect in perception of messages to drivers. Highway professionals are also aware of the fact that blinking obstructs perception of meaning of VMS and takes extra time to read the whole text. Whether general public may not be aware of the fact rather some of them think it may prove to be 'eye catching' to them. So, in total, they hold a neutral view.

CHAPTER FIVE: CONCLUSION

5.1 Research outcomes:

5.1.1 Background Rationale:

Intelligent transportation system have been widely used to increase efficiency in transportation system and provide more safety. This study develops results and recommendations for effective implementation of VMS in terms of Dhaka city to contribute controlling and facilitating a hazard free traffic system by using VMS as a part of intelligent transportation system. Researches shows that VMS can be an effective tool in several purposes i.e. route guidance and can increase driver's diversion rate significantly by providing warning messages about the traffic conditions on the road. Once installed VMS acts as a communicating device by which transportation authorities can transform useful messages to drivers on a particular road (Richard Tay & Alexandre G. de Barros, 2007).

5.1.2 Aim and Scope of study:

This study aims to implement VMS effectively as an integral part of transport system in Dhaka city which includes study of the perceptions of mainly three survey groups (drivers, pedestrians, highway professionals leading to find out differences in their perceptions, finding out reason for different perception and finally suggesting recommendations with our findings through this study. Thus this study will help to implement VMS more effectively considering the perceptions of different groups. As there were no significant study on VMS in terms of Bangladesh our study seek the scope to reveal effectiveness to integrate VMS more effectively. Only a total no of 31 VMS are installed as a part of Digitalization of existing traffic management system for a test purpose only. That is why current VMS possess only a few different types of messages which have mentioned earlier. Considering the above facts our study recommends possible solution and suggestion for implementing an effective VMS system in Dhaka city.

5.1.3 Methodology:

With accordance to the aim of this study collecting data and perception of roaduser was mandatory to conduct analysis and bring out a final result with suggestion. For collecting data questionnaire was made as described before based on Socio economic condition of the survey groups and three different factors extracted from previous researches. Our main targeted survey groups were Drivers, General Public and Highway professionals. Responses from the survey groups were coded by Likert scale. One-way Analysis of Variance (ANOVA) was used as analysis method to find the possible variances in response of the survey groups. Analysis was conducted both in Excel with direct formula and also with hand calculation using formulas of ANOVA to find similarities in answers in both way to reach more accurate result.

5.1.4 Discussion on result:

Several statistical data has been accumulated from socio-economic questions of questionnaire survey. It has been seen that among the surveyed drivers majority of the drivers are within the age of 20-45 years. Again among general public a significant

portion was 25-35 years old. In terms of education Drivers are mostly educated up to primary stage. Even a noticeable amount do not have any standard education at all. Survey data has also given an idea of license type of survey groups. Maximum respondent were a light license holder. An important outcome from our survey was the collision status. Most of the drivers found having at least an accident within 2 years. These represents existing transportation facilities are not sufficient enough to cope with the huge traffic volume in Dhaka city. It has also been seen that only a few no of VMS has been noticed by drivers. This represent current no of VMS in Dhaka city is not sufficient too to meet the requirement of huge traffic volume. Even though very few VMS is being noticed, drivers were able to perceive only a few different types of messages among which most of them are safety messages. This reveals current VMS have only a few different types of messages as mentioned before. For analysis of responses gained from questions on different factors it has been seen that after comparing the hypothesis in the case of most of the questions, variation does exist. In total of 28 questions only four of them have no variation in answer or response of the respondents. On the basis of this variation and no variation this study aimed to bring possible recommendations for the effective implementation of VMS.

5.1.5 Recommendations:

An effective VMS for Dhaka city requires several factors to consider along with existing facilities. The current facilities are obviously not sufficient enough as the sole purpose of a VMS system in comparison with the VMS in the developed countries. Implications of this research are to provide necessary suggestion to comply with existing facilities of VMS in a wider manner to offset several problems regarding traffic congestion. The recommendations relate with the factors considered in several researches and perception of the survey groups. The recommendations can be presented from three perspectives.

- Issues to be included in VMS

  These are the issues possess almost similar perspective and view among survey groups
- Issues to be avoided in VMS

Like above issues these issues also have same perspective and view among survey groups

- Special Considerations

  Unlike the above issues these issues have variation in perspective and view of survey groups

Issues that can be included in VMS:

- Display of advance warnings of accidents/ roadwork messages. Ex: ‘’Road Work Ahead’’

  Most common and effective type of message which is quite usually integrated in VMS. Displaying this type of messages possibly hold more effectiveness.

- Display of Congestions messages to choose alternative routes.

  Helps drivers and road users to avoid already congested roadway and thus reduce pressure on congested roadway.

- Interesting messages rather than conventional messages.

  Interesting messages shows to attract more than conventional less attractive messages.

- Slower transition of letters is more effective.

  A little slower transition of messages or letters is expected among survey groups as rapid transition is more prone to missing of any part of message.

- Messages should be placed at intersection and midway.

  A centered place VMS hold more possibility to draw attention of drivers from both side of the roadway. This is also economical as it reduce need of placing VMS at many parts of roadway.

- 2 or multiple lines of messages can be applied.

  2 or multiple lines of messages helps to read the whole message at a glance rather than waiting for the full transition of the messages.

Issues to be avoided in VMS:

- Placing messages at Regional Highway

  In terms of Dhaka city placing VMS in enormous no of regional highway is less economical. Selecting important points of transportation network and main roads may possess the more importance to convey VMS at initial stage.

- Speedy transition of letter.

  Slower transition of letter is required by majority of the survey groups. That is why speedy transition of letter needs to be avoided for the same reason.

- Blinking of messages.

  Blinking of messages may be of great obstruction in visualization of the whole message.

- Messages on diversion to sub roads.

  This possess the same reason of economical perception like placing messages at regional highway.

Special considerations:

- Messages for commercial purposes

  Messages may be used for commercial purposes but this certainly rely on the decision maker and existing situation.

- Messages on amber alert.

  This type of messages is also possess variation in perception of groups. This may or may not be included in VMS.

- Messages on Special events can be added.

Like messages on amber alert messages on special events may or may not be added. Adding this type of message convey an extra advantage but excluding this will not hamper the effectiveness of VMS

- Messages to be placed on important roads.

  This is also an extra add on to VMS. Messages on important roads may be considered an extra advantage of VMS.

5.2 Limitation of the Study:

Our study possess a few limitations that needs to be acknowledged. Starting with limited scope for reviewing past studies as there were almost no study regarding VMS in Bangladesh. This intrudes few lacking in an effective study. Again most of the drivers of our country are not literate. This leads to misunderstand or even not to understand at all of several transportation engineering terms while conducting our questionnaire survey for drivers. That is why sometimes they adopted a different expression rather than presenting the right expression towards a question.

Again our study involves single analysis method to evaluate data analysis. A few more method of analysis could have given a more accurate approach to result.

5.3 Future scope of study:

In this study, there are several proposals for future research. Many new technologies and methods of VMS are emerging day to day. For example a new type of VMS named the swap sign, has been developed by the Danish Road Directorate (Vithen & Sillesen, 2009). Again in England, predictive traffic information is given to road users by VMS (Burton, Crosthwaite, Simpson, & Billington, 2008). Thus future research should concentrate to work on several factors that may emerge due to new technologies and methods of presenting VMS and conduct to collect views and perceptions of more effective groups of people if exist any. In a report published by Vägverket (Bylin et al., 2004) a knowledge base on how roadusers experience VMS is wanted, along withmore knowledge about how the operators experience managing the signs. What problems and possibilities do the operators perceive? What kind of

support do the operators need for managing the VMS in the best way? Thus answers of such further questions can be placed in further analysis and study.

5.4 Concluding Remarks:

Over decades VMS is constantly being used as an integral part of transportation system in many countries. Our country has started to get the glimpse of benefits from VMS very recently. Although very few VMS are installed in Dhaka no significant research is made on this. As increasing traffic volume is constantly making a huge problem in transportation system in Dhaka, VMS should be implied to help reducing this problem in great extent. A number of VMS is installed in some important points of Dhaka city. Most of them show only speed limit informative message without following an interesting way of displaying which may attract the road users to follow. Some other factors are come also aside to consider like font size, visibility, screen size, light intensity, height of the display etc. which are deliberately become the reason for improper VMS.

In USA, UK along with some other European country many significant researches were carried out on VMS whereas Bangladesh is still lacking behind on this research. So our study mainly focuses on effective implementation of VMS in Dhaka city and discuss the factors in a rational way along with some surveys and case studies.

To make it effective and increase the efficiency of the road network several factors should be considered with proper solution. Our study proceed through a series consisting collecting data of existing VMS facility in Dhaka city, conducting a survey among three major groups that relate to transportation system inherently, analyzing their perception with a statistical analysis method, bring out possible reasons of variations in perception and thus finally suggesting final recommendation. Our recommendation sthat has been constructed from our analysis is based on three points. Issues that have to be included, issues that should be excluded and finally some special considerations. This recommendation would help extract the benefits from implementing VMS in Dhaka city. Our study thus pose a guideline inducing the perceptions and requirement of the road users to the decision makers consisting transportation authorities and others for implementing an effective VMS system in Dhaka city.

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APPENDIX

Appendix A: Questionnaire and Data Coding

Socio-economic aspects:

- Age:

  a) Below 25 b) 25-34 c) 35-44 d) 45-54 e) over 55
- Education:

  a) No education b) primary c) secondary d) post-secondary
- Profession:

  a) Driver b) General Public c) Transportation professional

  If Driver then License type:

  a) All tests taken b) Some tests taken c) No tests taken.
- Know driving:

  a) Yes b) No
- Drive frequently:

  a) Yes b) No
- License taken:

  a) no license b) below 1 years c) 2-5years d) 6-10years e) over 10 years
- Experience:

  a) less than 1 years b) Less than 3 years c) Less than 5 years d) Less than 10 years e) More than 10 years.
- Any Collision:

  a) Yes b) No

  If YES then when?

  a) within last 1 years b) within last 2 years c) 3 years or more d) 5 years or more
- Income:

  (Personal) a) Less than 5000 b) Less than 10000 c) Less than 25000 d) More than 25000
- Income (Family):

  a) Less than 12000 b) Less than 25000 c) Less than 35000 d) less than 50000 e) More than 50000
- Vehicle type:

  a) Car b) Bus c) Truck d) Human haler/Tempo e) Motorcycle/CNG

- Dwelling Condition:

  a) Personal b) Rental c) Slum d) Office quarter

- Do you remember seeing any messages on highway message board?
  a) Yes b) No
- How many VMS have you seen in different roads of Dhaka city?
  a) None b) Less than 2 c) Less than 4 d) more than 4

If yes then what type of messages?

a) Traffic related (accident, congestion) b) weather c) Safety (speed, life) d) others

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

MESSAGE TYPE

Questions	*5*	*4*	*3*	*2*	*1*
Display advance warnings of accidents/road works: (i.e. ROAD WORK AHEAD)					
Display weather information on the highway message boards: (i.e. TEMPERATURE TODAY 34°C)					
Display real time traffic information on highway message board: (i.e. 20 mins to Banani/ Speed limit 40KMPH)					
Display general safety messages on the highway message board: (i.e. DRIVE SLOWLY/ DO NOT OVERSPEED)					
Displaying Origin-Destination distance should be included in Highway: (i.e. DHAKA 250KM)					
Displaying accident occurrence messages on the VMS installed road: (i.e. 70 deaths in last year in this road)					
Displaying congestion message helps me to change the road direction: (i.e. CONGESTION AHED, USE ALTERNATIVE ROUTE)					
VMS message board should be used for Commercial advertisement purpose: (i.e. 50% SALE ON …….)					
Interesting messages are more attractive than informative messages: (i.e. DON'T SAVE TIME)					

Messages on Amber alert: (i.e. CHILD ABDUCTION BLUE HONDA CIVIC)					
Messages on Special event: (i.e. Eid Mubarak)					

LOCATION

Questions	*5*	*4*	*3*	*2*	*1*
Messages should be located at curve:					
Messages should be placed at Intersection:					
Messages should be placed at midway:					
Messages should be placed at national highway also:					
Message should be placed at arterial road:					
Messages should be placed at Regional Highway:					
Messages should be placed ahead of narrow road:					
Messages on diversion on Main road to sub road:					
Messages on Important road:					

DISPLAY

Questions	*5*	*4*	*3*	*2*	*1*
2 color combination is attractive:					
Multiple color combination is attractive:					
Slower transition of letter is more effective:					
Speedy transition of letter helps to read full message:					

Pictorial message is more effective:					
Combination of both pictorial and textual message is more effective :					
Two or multiple line display of message is effective:					
Blinking of message is attractive than Stable message:					