Smart Traffic Management Model : An Analytical View

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Abstract —

There has been a continuous and ever-growing requirement of traffic management in cities around the world. Traffic management is a crucial factor in the development of smart cities, for growth of business across all verticals as well as comfort of citizens. Effective traffic management can lead to saving of money, time, fuel and energy. In this research paper, we have studied the various factors which are responsible for the flow of the vehicular traffic. The analysis of the parameters is also presented in the paper.

Keywords— Traffic Management, Traffic Flow Intensity (TFI), Traffic Control, Traffic Congestion

I.INTRODUCTION

There has been an ever-growing demand for traffic management from developing and developed countries. The population of the cities has been increasing tremendously which is leading to increase in the traffic volume on the roads and highways. The number of the vehicles for the personal travelling and transportation of goods and services are increasing at a fast pace. This requires better traffic management on the roads and civil infrastructure has not grown at the required pace. Lack of the proper upkeep of roads and streets leads to further increase in traffic congestion. The problem of traffic congestion can be dealt with better traffic management. In this research paper, we have studied and analyzed the traffic flow intensity on the roads and the factors affecting the same [1] [2] [3] [4].

The organization of this research paper is as under: Section II covers the literature review. Section III provides the Theoretical Background. Section IV & V give the System Model Design and Results and analysis respectively. Section VI outlines the conclusion.

II. LITERATURE REVIEW

The authors have reviewed and studied the research papers and other literature on traffic management till date. In [1], the author has proposed a transport model using the OmniTRANS program. The comparison of the existing transport model with the revised version (which has been proposed) has been presented. In [2], the authors have presented the performance analysis considering practical scenario by integration of the tools like NS2,SUMO,OpenStreatMAP (OSM) and MOVE tool. In [5], the authors have presented Handover algorithm considering the vehicular traffic. In [6], a Smart Traffic Management System is proposed. The solution is based on IOT sensors, image processing and GPS & data analytics. In [7], the authors have proposed IOT based smart traffic management system. [8] focuses on the charging and energy components of the Electric Vehicles. [9] is a review paper in which the authors have reviewed the intelligent traffic system for avoiding the traffic congestion on the roads. [10] is a review paper in which the authors have presented their study on the traffic and traffic control devices. In [11], the authors have proposed an intelligent traffic control system which utilizes sensors and embedded technology. In [12], the author have evaluated various traffic control systems. The use of image processing methods have been done in order to control the traffic. In [13], a survey of the measures for avoiding the traffic congestion has been presented. In [14], the authors have presented a traffic management solution which is based on IoT. The method of estimating the traffic density is also mentioned for the seamless movement of traffic. In [15], the authors have performed the study for setting of the public transport in the “green wave” mode in conditions of no traffic so as to have the speed of the public transport approximately similar to the speed of the cars. In [16], the authors have proposed a traffic monitoring system based on video image processing. In [17], the authors have presented a traffic management model based on Internet of Vehicles (IoV). In [18], the authors have presented the architecture of Intelligent Traffic Management system & Smart Traffic Signal Controller. In [19], the authors have presented an integrated green traffic

strategy. The approach is focused on the principle of "people first". In [20], the authors have presented a method to avoid the traffic congestion using Radio Frequency Identification (RFID). In [21], the performance analysis of vehicle tracking strategies is presented. In [22], the authors have presented review of the various traffic management systems using IoT. In [23], the authors have examined the air quality effectiveness of the various traffic management steps that have been implemented in various cities of Europe. In [24], the authors have examined the traffic management system for Abakpa in Enugu state. The primary data collection has been performed using questionnaires and secondary data has been extracted from documents. [25] is a review paper in which the authors have reviewed the traffic control system. In [26], the authors have presented an approach of integration of Automated Traffic Management System (ATMS) for improvement and efficiency of traffic management and safety. In [27], the authors have studied quality of the calibration process of HSM freeway facility.

III. THEORETICAL BACKGROUND

The traffic flow intensity on the road is provided from the following equation

$$TFI = A * B * C * D * E \quad (1)$$

Where

TFI denotes Traffic Flow Intensity. It is the described as the permitted flow of the traffic. It is measured in vehicles/hr

A : The basic value of the permitted TFI. It is measured in vehicles/hr

B : Traffic signal factor

C : Coefficient of the vehicle width

D : Coefficient for maneuvering

E : Coefficient for the vehicle moving with the slow speed [1]

IV. SYSTEM MODEL DESIGN

Figure 1 describes the system model design.

Input :

i. **Basic Value of permitted traffic,**
ii. **Factor for Traffic signal,**
iii. **Coefficient of vehicle width**
iv. **Coefficient of maneuvering**
v. **Coefficient of vehicle moving with slow speed**

Output : Value of the traffic flow intensity

Steps to be followed :

i. **Select the area**
ii. **Perform the study of the roads in area**
iii. **Perform the study of the civil infrastructure in area**
iv. **Perform the survey of the vehicular traffic in the selected area**
v. **Calculate the value of TFI**
vi. **Review the results**

End

Figure 1 Design of System Model

V. RESULTS & ANALYSIS

The values of the factors which have been considered is shown in Table I [1].

Table I Values of the factors

S. No	Factor	Values
1	A	450 to 1150 (in intervals of 50)
2	B	0.55,0.65, 0.75, 0.85, 0.90
3	C	0.7, 0.8, 1.8, 1.9
4	D	0.4,0.5.0.6,0.7,0.8,1.0
5	E	0.8,0.9, 0.95, 1.0

The cameras have recorded the number of vehicles at the signals (vehicular density). For the recording of the numbers of cars the techniques for object detection & identification like image processing or computer vision can be used. We have performed analysis of the factors

affecting TFI. While analyzing one factor affecting TFI all the other factors have been kept constant.

We have calculated the variation of TFI with respect to A while keeping all other parameters (B,C,D and E) as constant. The equation of the TFI vs A is also shown in table. It represents the equation of straight line passing through origin.

$$y = mx \quad (2)$$

Figure 2 represents the variation of TFI with respect to A for minimum values of the parameters. In the figure, y axis represents TFI values while x axis represent values pertaining to A.

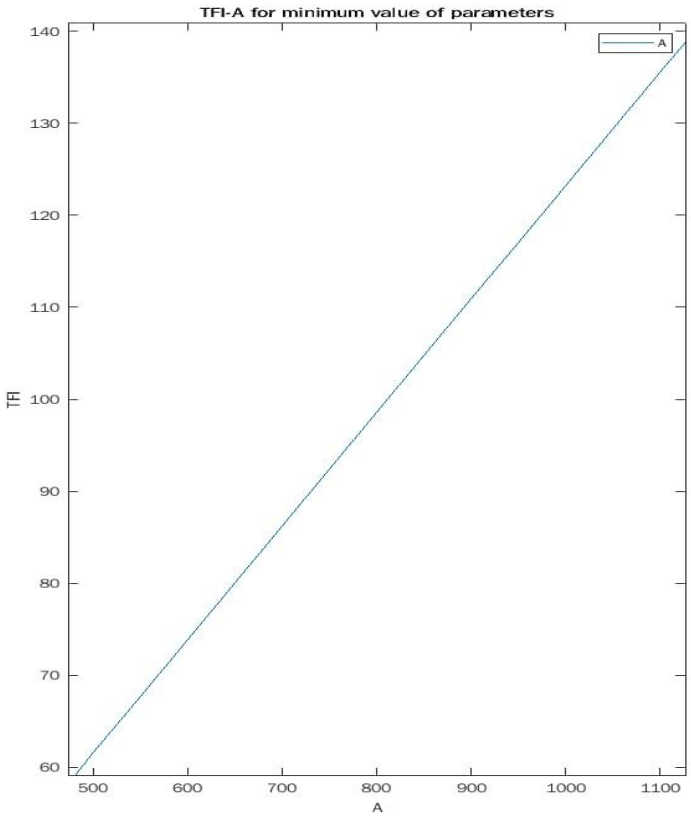

Figure 2 Variation of TFI w.r.t A for Min values of parameters

Figure 3 represents the variation of TFI with respect to B for minimum values of the parameters. In the figure, y axis represents TFI values while x axis represent values pertaining to B.

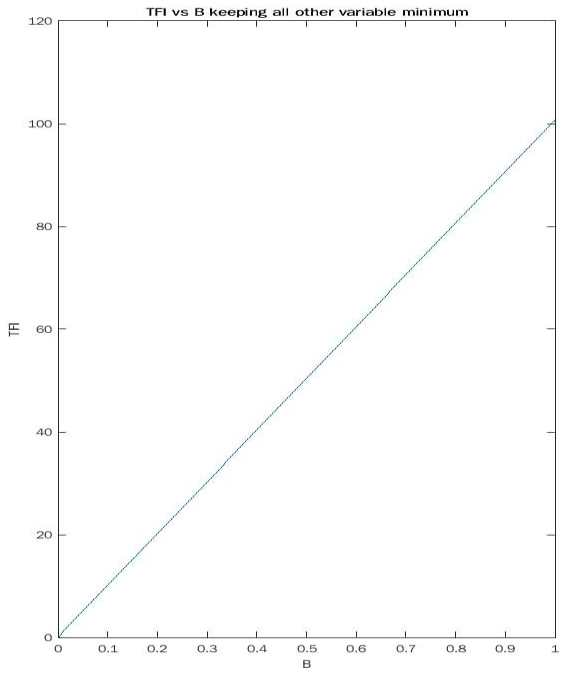

Figure 3 Variation of TFI w.r.t B for Min values of parameters

Figure 4 represents the variation of TFI with respect to D for minimum values of the parameters. In the figure, y axis represents TFI values while x axis represent values pertaining to D

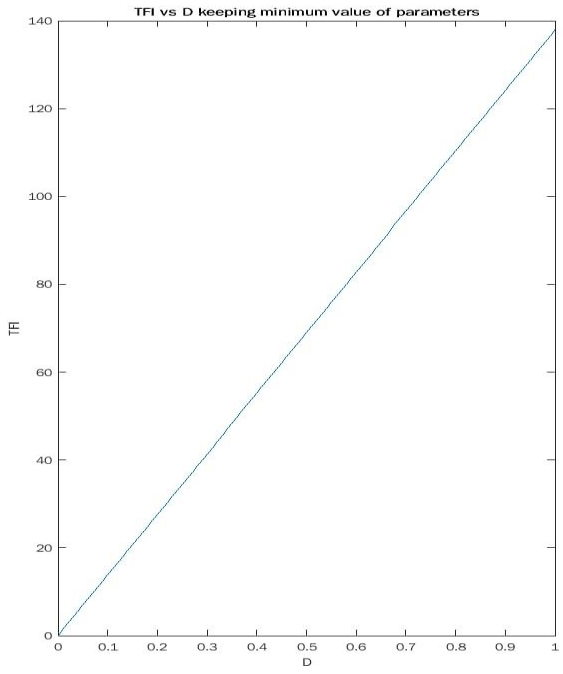

Figure 4 Variation of TFI w.r.t D for Min values of parameters

In the similar way we have analyzed other parameters (keeping other remaining parameters as constant). Table II shows the values of slope for Min values of the parameters. In this table minimum values of the all the parameters (as shown in Table I) have been considered.

Table II Values of m for Min. values of parameters

S. No	Equation for TFI	Value of m	Constants
1	TFI = 0.1232 *A	0.1232	B,C, D,E
2	TFI = 100.8* B	100.8	A, C,D,E
3	TFI = 79.2 *C	79.2	A,B,D,E
4	TFI= 138.6 * D	138.6	A,B,C,E
5	TFI = 69.3* E	69.3	A,B,C,D

In Figure 5, we have plotted the values of slope (m) for the Minimum values of the parameters. In the figure, y axis represents the value of slope and x axis represents the various factors.

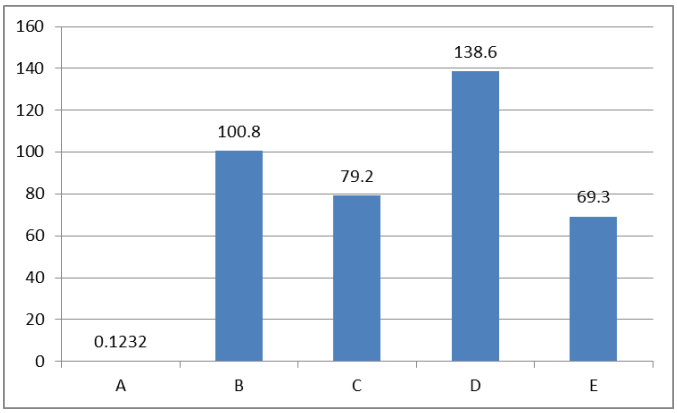

Figure 5 Values of m for Min Values of parameters

Table III shows the values of slope for Average values of the parameters. In this table average values of the all the parameters (as shown in Table I) have been considered.

Figure 6 represents the variation of TFI with respect to A for average values of the parameters. In the figure, y axis represents TFI values while x axis represent values pertaining to A.

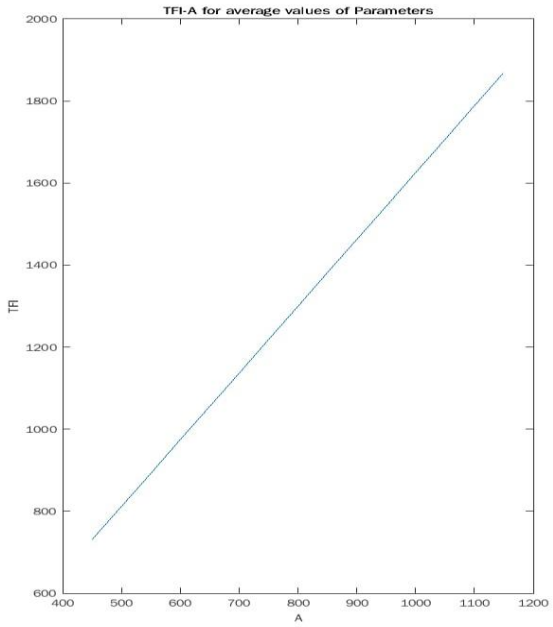

Figure 6 Variation of TFI w.r.t A for Average values of parameters

Figure 7 represents the variation of TFI with respect to B for average values of the parameters. In the figure, y axis represents TFI values while x axis represent values pertaining to B.

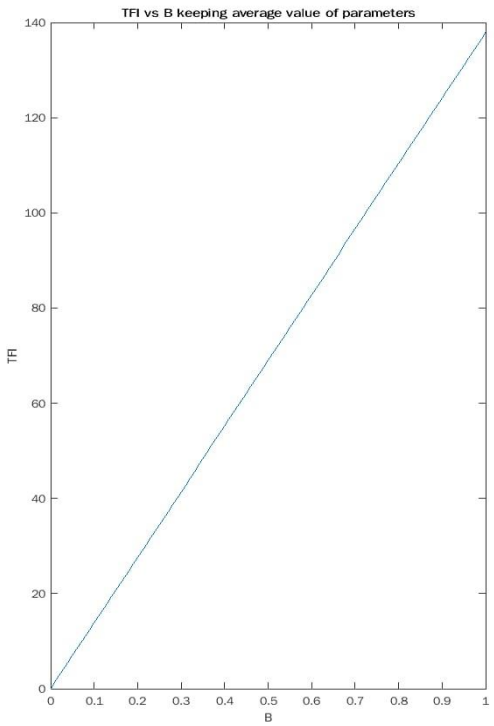

Figure 7 Variation of TFI w.r.t B for Average values of parameters

Figure 8 represents the variation of TFI with respect to D for average values of the parameters. In the figure, y axis represents TFI values while x axis represent values pertaining to D.

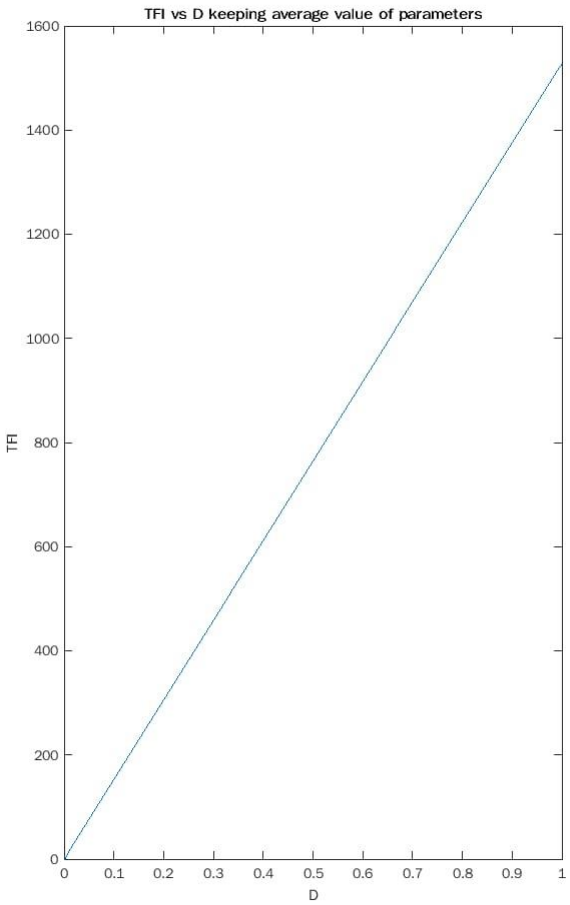

Figure 8 Variation of TFI w.r.t D for Average values of parameters

In Figure 9, we have plotted the values of slope (m) for the Average values of the parameters. In the figure, y axis represents the value of slope and x axis represents the various factors.

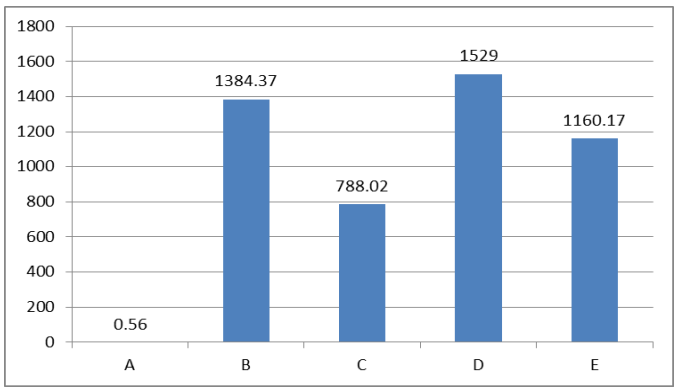

Figure 9 Values of m for Average Values of parameters

Table III Values of m for Average values of parameters

S. No	Equation for TFI	Value of m	Constants
1	TFI = 0.5691 *A	0.5691	B,C, D,E
2	TFI = 1384.37* B	1384.37	A, C,D,E
3	TFI = 788.02 *C	788.02	A,B,D,E
4	TFI= 1529 * D	1529	A,B,C,E
5	TFI = 1160.17* E	1160.17	A,B,C,D

Figure 10 represents the variation of TFI with respect to A for maximum values of the parameters. In the figure, y axis represents TFI values while x axis represent values pertaining to A.

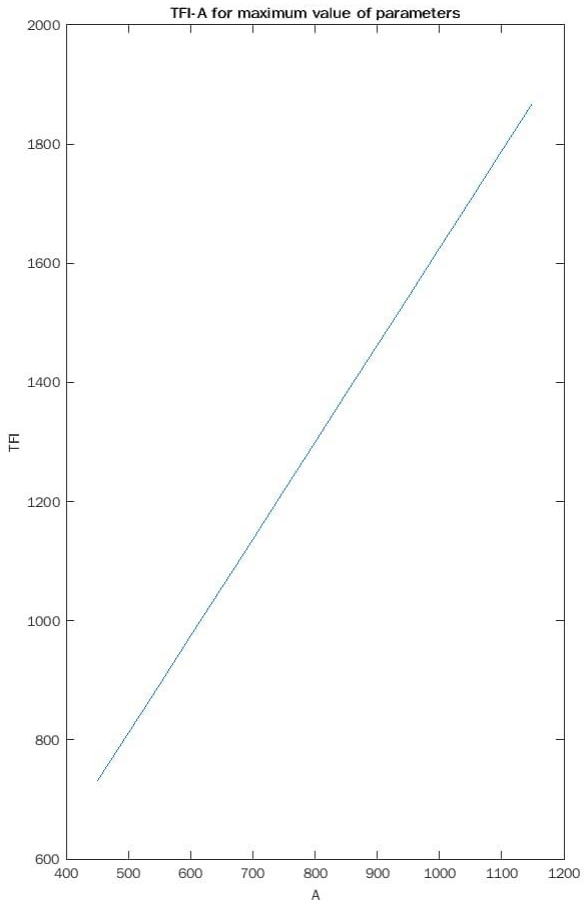

Figure 10 Variation of TFI w.r.t A for Maximum values of parameters

Figure 11 represents the variation of TFI with respect to B for maximum values of the parameters. In the figure, y axis represents TFI values while x axis represent values pertaining to B.

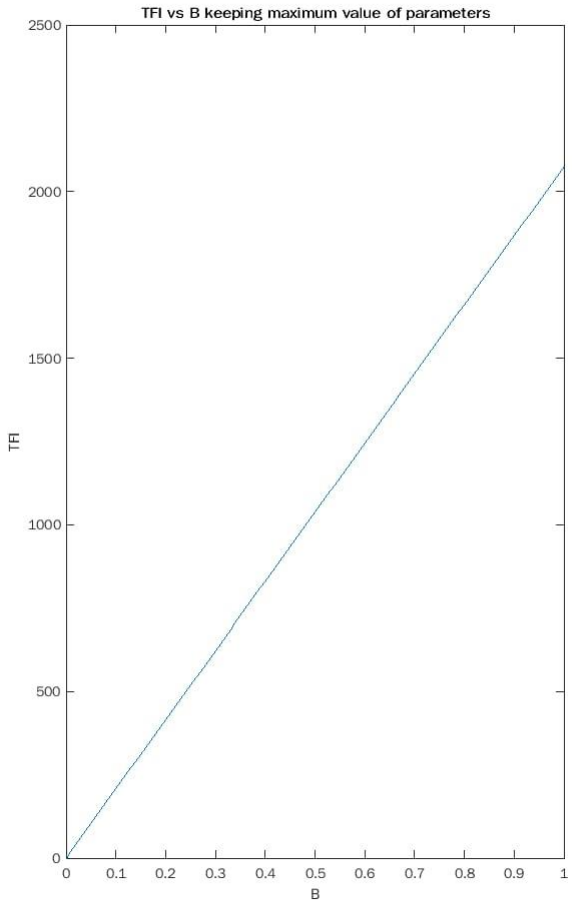

Figure 11 Variation of TFI w.r.t B for Maximum values of parameters

Figure 12 represents the variation of TFI with respect to D for maximum values of the parameters. In the figure, y axis represents TFI values while x axis represent values pertaining to D.

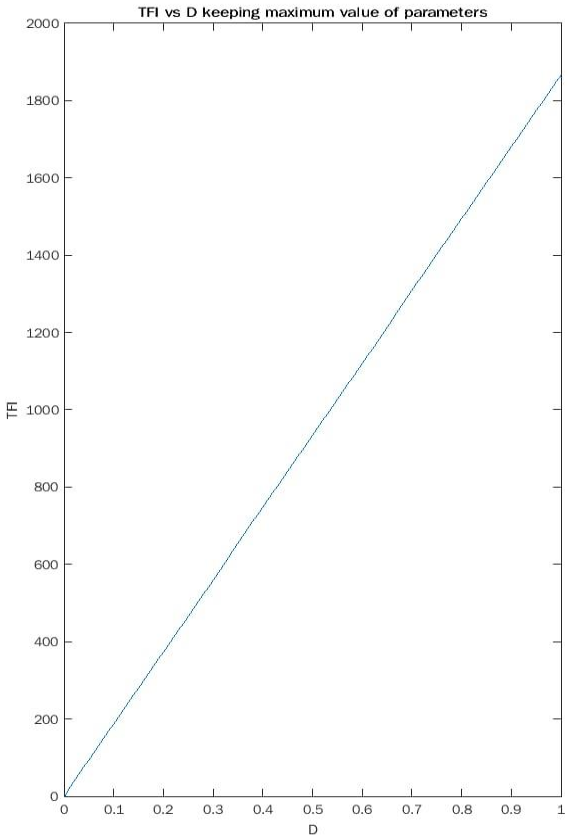

Figure 12 Variation of TFI w.r.t D for Maximum values of parameters

Table IV shows the values of slope for Maximum values of the parameters. In this table maximum values of the all the parameters (as shown in Table I) have been considered.

Table IV Values of m for Max. values of parameters

S. No	Equation for TFI	Value of m	Constants
1	TFI = 1.6245 *A	1.6245	B,C, D,E
2	TFI = 2075.75* B	2075.75	A, C,D,E
3	TFI = 983.25 *C	983.25	A,B,D,E
4	TFI= 1868.175 * D	1868.175	A,B,C,E
5	TFI = 1966.5* E	1966.5	A,B,C,D

In Figure 13, we have plotted the values of slope (m) for the Maximum values of the parameters. In the figure, y axis represents the value of slope and x axis represents the various factors.

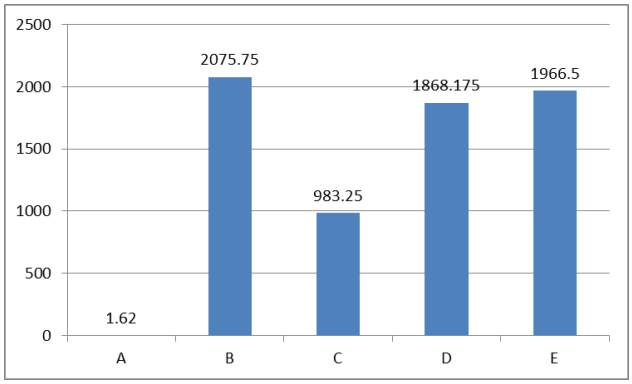

Figure 13 Values of m for Maximum Values of parameters

Observations from Table II, III & IV: We observe from the above tables that the slope of factor B & D is very high as compared to other factors. Thus it can be inferred that the impact of the factor B & D is very high on the traffic flow intensity of the road.

VI. CONCLUSION AND FUTURE SCOPE

In this research paper we have studied and analyzed the factors which are affecting the traffic flow intensity on the road. We have studied and analyzed the relative impact of the factors, which can be incorporated in the design/modification of number and width of traffic lanes, signal durations and other related road and highway design aspects. As per the analysis, the two main factors affecting the traffic flow intensity are traffic signal and maneuverability of the vehicles. This is the case in majority of the traffic scenarios.
In future, we intend to study the impact of factors using neural networks and ant colony optimization.

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