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SUSTAINABLE ROAD LAYOUT DESIGN FOR LIVE ABLE AREA (TAMBARAM) WITH THE AID OF FUZZY LOGIC SYSTEM

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ABSTRACT

When the transport system convinces four criteria such as transport management, safety management, environmental management and energy management with cent percentage, then the transport system is believed to be sustainable transportation. To offer such road layout, road width, human population in that region, Average number of vehicles considering of all four types such as LMV, HMV, Auto and two wheelers passes is taken into concern with the land use and accident case of 2013. Along with the accident management and transport management, the related layout will be presented and the contribution of all the 4 major parameters will be underlined. In this suggested work I have intent fuzzy logic system for this practice and have select the Tambaram region which will select sustainable road layout plan and furthermore the individual input of each factors involve in sustainable transport for a particular area. Tambaram Town is located 24 K.M. south of the Capital City of Chennai. Tambaram is expressed as Gateway of the Beautiful Metropolitan City, Chennai which is the Municipal Town. Tambaram has an excellent transport network. It has both the train and road modes of transports which every day carry a large volume of traffic and furnish to the necessitates of people. As a result by our suggested method we have raised the existing lanes with 77% in total and so the total combination due to traffic will be decreased, thus sustainability is created.

Keyword: *Sustainable Transport, Congestion, Fuzzy Logic, Energy Management, Environment Management, Transport Management, Safety Management*

1. INTRODUCTION

There are no two opinions on the fact that the world as we behold today is made possible only because of the sequences of innovations brought about in the ever zooming field of transportation. In essence, transport can be treated as the lifeblood of economic activity in the swiftly changing scenario of technological advancement. In economic, sustainability is just defined in a water-tight compartment, with focus mainly on ensuring the utilization potentials of the posterity [1]. Urban transportation is predominantly the carrier of citizen flow, logistics and information flow. Urban traffic jamming, traffic contamination, high resource utilization and traffic protection have thrown drastic challenges and put insurmountable roadblocks in the pathway of sustainable development of urban transport. It is a well-known fact that urban road area, road rank and traffic mileage have grown up at a rocketing pace [2]. Road resources may be grouped in to several diverse kinds like spatial and environmental resources; still, space continues to remain as the, the most vital resource. The allocation of road space resources is mainly dependent on the traffic rules created by the government and road engineers [3]. It is a disturbing fact that traffic jamming is extensively prevalent in big cities and on major highways and it causes a considerable trouble in terms of lost time, annoyance for passenger and freight transportation. Therefore, many nations have introduced regional or national road-pricing techniques, partly to internalize overcrowding and similar traffic externalities [4]. Specially, the spatial correlations are symbolized by a permanent

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set of matrices, which is mainly dependent on the distances between links. Anyhow, on transportation system, depending upon whether a link is crowded or not, the other network links influence its traffic flow which changes considerably [5]. Bus precedence continues to mount as cities devote more attention to the requirements of buses to furnish quick, regular, and consistent services, thereby playing its commendable part in achieving a sustainable transport system. Bus precedence at traffic signals is especially preferential at places where road space is narrow and traffic signal solidity is considerable [6]. An outstanding traffic control result for freeway traffic issues is a regulator that takes the present and upcoming traffic condition into consideration and forecasts the results of its control measures [7]. Moreover, road traffic is notorious as one of the most horrible ecological noise offenders, humiliating the health and well-being of a community. Alternatively, exposure to road traffic toxins can be decreased by means of efficient urban development or traffic administration [8]. Adaptive replication management methods can reduce the traffic in reaction to jamming, but they are not able to adaptively rid the traffic from the more crowded to less crammed parts of the system. This phenomenon is a clear indicator of the utter incompetence of these methods to effectively emergent scenarios in which overcrowding is restricted certain segments of the transport system, without having any adverse effect on the remaining areas [9]. It is a fact that the chore of driving an automobile is a challenging one, especially when those plying the work are expected to perform the task of carrying out lateral-directional and longitudinal loop closures, data collection, and risk recognition. Simultaneously, they have to take care of supplementary in-vehicle functions linked with the instrument panel and associated ease/expediency stuff [10]. The much-needed concentration on casualties is principally prompted by a superior level of self-confidence that this dimension of protection is conveyed more robustly and precisely across manners and time intervals. Generally fatal accident information is challenging for investigative ends as these cases are normally very limited in the frequency with which they occur, and occur in certain ways in extremely uncommon multi-fatality incidents [11]. The human health overheads of direct contacts with vehicle discharges for a local population have earlier been calculated as an externality of overcrowding. But it is unfortunate that the adverse health influence of in-vehicle contamination experience for travelers is not, yet, treated as a part of secondary jamming overheads [12]. The traffic system has emerged, nowadays as the cynosure of modern investigation on intricate networks. Especially, the traffic jamming trend on account of intricate networks has been extensively investigated in terms of jamming stage changeover procedures and the self-adjusting jamming prevention techniques [13]. The significance of the urban style on sustainable progress has been well-acknowledge of late and it is a vital factor estimating transportation needs, with its straight effect on noise and air contamination [14].

1.1 Overview of Tambaram

Tambaram is a located in Chennai Metropolitan Area Tambaram taluk of the Kanchipuram district in the Indian state of Tamil Nadu. Tambaram is a suburb of Chennai situated 27 kM south of the city in Tamil Nadu, India. The famous Grand Southern Trunk Road and Railway route from Chennai Egmore to Kanyakumari divide the town into east and West.

Tambaram is very popular because of the existence of Madras Christian College, IAF training center, and the first commissioned suburban trains from Tambaram to Chennai Beach. There are many industrial units established at the Madras Export Processing Zone (MEPZ). The units in the MEPZ export various items to several foreign countries thereby earning foreign exchange for the country. Tambaram is part of the Metropolitan Transport Corporation (Chennai) bus network, with a bus shelter located outside the Tambaram Railway Station. Tamil Nadu State Transport Corporation Ltd Villupuram (Kancheepuram) Branch bus network to covers nearby village and town also long distance destination Bengaluru, Thirupathi, Thirupathur, Arani, Kancheepuram, Mamallapuram, Tindivanam.

2. RELATED WORKS

In 2013, Raja Noriza Raja Ariffina *et al.* [15] have resourcefully introduced a paper to analyze the features that had an immense influence on the status of the city transport system in the Klang Valley. It scrutinizes the manner in which the policy schedule is adversely affected by the customs, behaviors and viewpoints of those employed in the transport-linked areas. The preliminary records are collected through semi-structured interviews. Government credentials and archival data furnish the vital source for resultant data. The philosophy and attitude of the transport

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communities appear to have a significant effect on sustainable transport agenda in the Klang Valley.

1n 2013, Gang Xiong *et al.* [16] gallantly gave birth to the Parallel Traffic Management System (PtMS). It came out with flying colors by extending a helping hand to attain softness, security, competence, and consistency of public transport management during the 2010 Asian (Para) Games held in Guangzhou, China, according to the artificial techniques. It enabled public traffic organization and decision making, and gave the required backing to upgrade the public traffic administration level from experience-based policy making and manual accomplishment to scientific computing-based policy evolution and execution. In this regard, it's worth mentioning that The PtMS was a significant and novel landmark in finding solutions to the administration hassles of concurrent complicated techniques.

In 2013, Kibrom Abay [17] industrially investigated the injury harshness of pedestrians taking into account comprehensive road user features and substitute model design by means of superior-quality Danish road mishap information. This kind of approach went a long way in estimating the sensitivity of experimental deductions to the selection of these brands. The experimental scrutiny exposed the fact that overall road user features like criminal record of drivers and temporary behavior of road users at the time of the mishap indicated an interesting insight in the injury intensity investigation. Similarly, the substitute investigative design of the models brought to light that certain traditionally used set-constraints injury harshness models were in a position to underrate the influence of several crucial attitudinal attributes of the accidents.

In 2013, Gail Blattenberger *et al.* [18] have gallantly gifted numerical models by means of a rich set of panel information for the period 1980 to 2007 in respect of the state and the District of Columbia. Their selection of variables is prompted by a widespread literature focusing the significance of strategy, security, demographic, and monetary determinants of casualty paces. Motor vehicle accidents are the major source of a significant numbers of deaths every year and they account for the principal grounds of death for youngsters. The evaluation methods employed in this paper are aptly aware of the fact that normal econometric implication centers on constraint ambiguity. Models are evaluated provisionally on the hypothesis that the model to be analyzed and informed is the "true" model. Investigations are thereafter conducted on a number of substitute models, each successively presumed to be the "true" model. Model ambiguity is illustrated in this process, though it is more often than not disregarded in practice. This paper employs three Bayesian techniques such as Extreme Bounds Analysis, Bayesian Model Averaging, and Stochastic Search Variable Selection to take care of model and constraint ambiguity in models evaluating the determinants of motor vehicle accident deaths.

In 2013, Youngguk Seo *et al.* [19] intelligently carved out in his research work the details of the vital and fundamental materials for road, bridge and tunnel constructions. The materials were found to stimulate CO2 emissions which were assessed by using the quantity of materials utilized and the resultant CO2. A simple linear relation was evolved between unit price and emission factor for certain essential materials whose discharge factors were not accessible. To reveal the entire and the element emissions, twelve express way segments created between 2006 and2007 were chosen and utilized materials were calculated. The unit discharges were employed to assess the overall emissions that were discharged from all kinds of roads (express ways, national high ways and local roads) up to the year2007. One of the outcomes illustrated that bridges instigated the greatest discharges per meter (120.1tCO2/m), followed by tunnels (29.6tCO2/m) and road-only sections (7.5tCO2/m) because of the utilization of core construction materials.

3. PROPOSED METHODOLOGY

Road transport is vital to the economic development and social integration of the country. To make road transport a sustainable one we focus mainly on four critical factors such as transport management, safety management, energy management and environment management. All these must contribute jointly to get a sustainability of 100% in road transport system management. To provide a sustainable transport, the criterion that is to be concentrated is the layout of the road, which when selected, must provide an optimal design. So in the proposed work, we are designing a road by concentrating on the major parameters factors like road layout, road width, population of the area concerned and the Average number of vehicle movements with each LMV, HMV, Auto and two wheelers passes is taken in to consideration with the land use and accident case of 2013 by using them we are designing four road layouts. In this proposed work I intend to employ fuzzy logic

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system for the process which chooses optimal road layout design and also the individual contribution of each and every factor involved in the sustainable transport for a specific area.

3.1 Flow chart of the proposed method

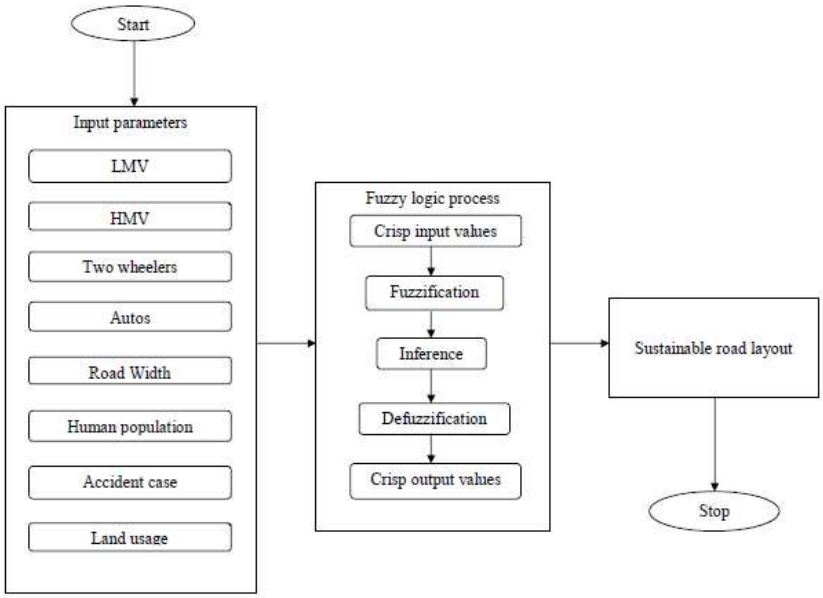

Fig1: Flow Chart Of The Proposed Method

The Current Road network is grossly insufficient to handle the present Traffic volume and hence a new, widespread Road system is required. In the proposed work a design of roads with proper lanes for LMV, HMV, TW, pedestrian path, Auto along with adequate footpath width is being envisaged for the major part of Tambaram area. The main congestion in widening of the roads is the lack of space and the allocation for commercial area for the humans to survive. This flow chart explains the course of our proposed methodology by means of fuzzy logic process for the present road system with appropriate lane allocation.

3.1.1 Input parameters

a) Motorization

The average number of vehicle in that specified area is also a factor affecting in sustainable transport. The vehicles are broadly divided into 4 major categories they are, LMV (Low Motor Vehicles), HMV (Heavy Motor Vehicles), Auto and Two wheelers. The number of all these values is given and based on this values the corresponding output layout are be mentioned

b) Road width

To design an optimal road, the first factor to be considered is the width of the existing roads. The Main Arterial Road in Tambaram is the GST Road. The Current Width of the road is 21m with no lane Demarcation. Hence to Improve Traffic Flow, a proposed method is designed with fuzzy logic to provide an optimal layout of the existing road to ensure a sustainable transport.

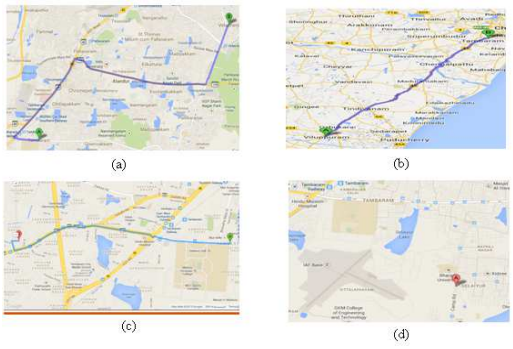

Fig2: (A) Road Map From Tambaram To Velachery (B) Road Map Of GST Road (C) Road Map From Tambaram To Mudichur (D) Road Map Of Camp Road

c) Average population in the specified area

In the particular area, the subsequent factor to be taken into report is the amount of average population. The intensity and sample of traffic depend mainly upon land use arrangements. For development purposes, an accurate definition and

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inventory of the presented use of all lands are necessary as every alter in the use of the land causes a modify in the intensity of traffic. There is no population in the national highway roads in many cases. Therefore we have to spotlight on the region where the population rate is high. Hence we are categorizing the population in the shape of percentage from zero to hundred in our suggested method.

d) *Accident case management*

Road accident costs are an imperative component of outside costs of traffic, a considerable part is connected to fatal accidents. The assessment of fatal accident costs critically depends on the accessibility of an estimate for the economic value of an arithmetical life. 35% of people are harmed by accident in the total population of Chennai.

e) *Land usage*

The intensity and sample of traffic depends upon land use arrangements. A proper definition and inventory of the presented use of all lands are necessary for development purposes as every alter in the use of the land causes a modify in the intensity of traffic.

The road is planned by erecting the approximate lanes across the road by considering all these reasons as the input parameters. All these input parameters are united and delivered as single input to the fuzzy logic system for more process. Pitiable traffic management particularly in respect of the uncontrolled driving of buses, Share auto and autorickshaws, incompetent traffic control at intersections, deprived road geometrics, lack of public understanding, road users' disorderliness and incompetent movement, indeterminate bus stops, etc. are the most important causes of road accidents. For our suggested method, the total road accident happened in Tambaram area is of 1472 and it is specified as input in 2013. The accident management case can be afforded based on the dissimilar layout.

3.1.2 Fuzzy logic system

It is the procedure of nonlinear mapping of input data cluster to an output scalar data cluster. In essence, a fuzzy logic system comprises four vital segments such as crisp input values, fuzzification, inference, de-fuzzification and crisp output values

Crisp input values

At the outset, the input constraints are pooled together and furnished to the fuzzy logic mechanism. As they are not capable of being treated straight in the FLS, fuzzification of the input constraints is performed.

Crisp data for input parameters

Table 1: Crisp Input Data

Vehicle type	Road width	Average population	Crisp data
Low	Low lying	Minimum	1
Medium	Average	Normal	2
High	Large	Maximum	3

Fuzzification

Fuzzification is the procedure of change of the crisp set of input to fuzzy set by means of fuzzy linguistic variables, fuzzy linguistic terms and membership functions. A linguistic variable can be in the shape of words or sentences which signify a normal or simulated language. A linguistic variable is usually decayed into a group of linguistic terms. In our procedure width (low lying, average, larger), number of vehicles (low, medium, high), number of population (zero, minimum, maximum) are the linguistic variables and their parallel linguistic term. Membership functions are employed in the fuzzification, to map the non-fuzzy input values to fuzzy linguistic terms. A membership function is made use of to measure a linguistic term.

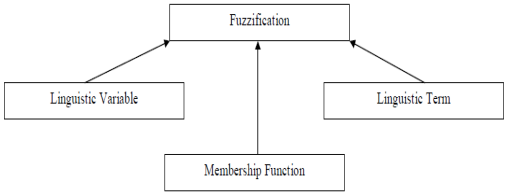

Fig3: Factors Influencing Fuzzification

Inference

It is the procedure of devising the mapping from a pre-defined input to an output by means of fuzzy logic. Usually the fuzzy inference is based on the fuzzy rules which are saved as the data base. The estimates of the fuzzy rules and the blend of the outcomes of the distinct rules are executed by means of fuzzy set functions. The functions on fuzzy sets are not the same as those on the non-fuzzy sets. In accordance with the fuzzy values for every characteristic that are produced in the Fuzzification procedure, the Fuzzy Rules are also created.

General form of Fuzzy Rule

"IF A THEN B"

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The "IF" part of the Fuzzy Rule is known as the "antecedent" and also the "THEN" part is called as the "conclusion" in fuzzy rules.

Table 2: Fuzzy Rules

Vehicle	Width	Population	Layout
Low	Low lying	Minimum	S
Low	Low lying	Normal	S
Low	Low lying	Maximum	S
Low	Average	Minimum	S
Low	Average	Normal	Q
Low	Average	Maximum	Q
Low	Large	Minimum	S
Low	Large	Normal	Q
Low	Large	Maximum	Q
Medium	Low lying	Minimum	S
Medium	Low lying	Normal	S
Medium	Low lying	Maximum	Q
Medium	Average	Minimum	S
Medium	Average	Normal	Q
Medium	Average	Maximum	Q
Medium	Large	Minimum	S
Medium	Large	Normal	Q
Medium	Large	Maximum	R
High	Low lying	Minimum	P
High	Low lying	Normal	R
High	Low lying	Maximum	Q
High	Average	Minimum	P
High	Average	Normal	R
High	Average	Maximum	R
High	Large	Minimum	P
High	Large	Normal	R
High	Large	Maximum	R

Defuzzification

After the inference step is complete, the general outcome obtained is treated as a fuzzy value. The outcome thus obtained is de-fuzzified to arrive at the ultimate crisp output. The input furnished for the De-fuzzification process is the fuzzy set and the output achieved is a solitary number. De-fuzzification is executed in accordance with the membership function of the output variable.

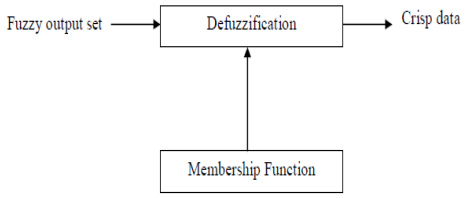

Fig4: Defuzzification Process

Crisp output value

At last the fuzzy outputs are transformed to crisp data by means of appropriate member ship function.

Crisp data for sustainable road layout

Table 3: Crisp output data

Sustainable road layout	Crisp data
P	1
Q	2
R	3
S	4

Calculation of capacity of roads

cap = (1000 * M) / Spacing
M = Speed in kMph
A = Length of Vehicles in m
Spacing = Average spacing between successive moving vehicle
Spacing = A + 0.78*M*t + (M^2/254f)

Calculation for GST road

Spacing = 5 + 0.78*2.5*80 + (80^2/254*0.5) = 110.99 m
cap = (1000*80)/110.99
= 720.76 Vehicles per hour per lane

3.2 DATA FOR ARTERIAL ROADS

Table 4: GST Road Towards Chrompet

S.no	Timing	LMV	Auto	HMV	TwoWheelers	Total
Peak hours						
1.	8-9 am	1172	291	338	1989	3790
2.	9-10 am	1253	328	266	2412	4259
3.	4-5 pm	1445	224	435	2115	4219
4.	5-6 pm	1509	254	309	1943	4015
5.	6-7pm	1683	246	298	2360	4587
6.	7-8 pm	1691	231	384	2265	4571
Non peak hours						
7.	10-11 am	1157	287	289	1844	3577
8.	11-12 am	1065	242	257	1689	3253

Table 5: GST road towards Vandalur

S.no	Timing	LMV	Auto	HMV	TwoWheelers	Total

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Peak hour						
1.	8-9 am	558	209	419	1721	2907
2.	9-10 am	782	258	224	2444	3708
3.	4-5 pm	510	247	222	802	1781
4.	5-6 pm	785	221	253	1058	2317
5.	6-7 pm	1108	263	288	1620	3279
6.	7-8 pm	1602	237	345	2488	4672
Non peak hour						
7.	10-11 am	875	216	223	1851	3165
8.	11-12 am	823	199	277	1512	2811

Table 6: Velachery Road Towards Tambaram

S.no	Timing	LMV	Auto	HMV	TwoWheelers	Total
Peak hours						
1.	8-9 am	490	236	230	1280	2236
2.	9-10 am	574	249	217	1061	2155
3.	4-5 pm	398	214	184	910	1706
4.	5-6 pm	421	224	211	874	1730
5.	6-7 pm	558	231	247	1088	2124
6.	7-8 pm	569	224	260	1167	2220
Non peak hours						
7.	10-11 am	440	195	196	760	1591
8.	11-12 am	405	201	200	866	1672

Table 7: Velachery Road Towards Madippakam

S.no	Timing	LMV	Auto	HMV	TwoWheelers	Total
Peak hours						
1.	8-9 am	564	229	235	1084	2112
2.	9-10 am	595	246	279	1195	2315
3.	4-5 pm	386	217	190	794	1587
4.	5-6 pm	400	232	223	811	1666
5.	6-7 pm	578	240	271	1109	2198
6.	7-8 pm	502	226	294	1214	2236
Non peak hours						
7.	10-11 am	433	219	201	976	1837
8.	11-12 am	429	223	214	735	1601

Table 8: Mudichur Road (SH 119) Towards Tambaram

S.no	Timing	LMV	Auto	HMV	TwoWheelers	Total
Peak hours						
1.	8-9 am	543	258	295	1211	2307
2.	9-10 am	608	266	305	1357	2536
3.	4-5 pm	340	269	280	865	1754
4.	5-6 pm	376	230	297	810	1713
5.	6-7 pm	487	253	315	1085	2140
6.	7-8 pm	453	244	329	1133	2159
Non peak hours						
7.	10-11 am	500	233	256	954	1943
8.	11-12 am	408	241	267	765	1681

Table 9: Mudichur Road (SH 119) Towards Mudichur

S.no	Timing	LMV	Auto	HMV	TwoWheelers	Total
Peak hours						
1.	8-9 am	543	258	295	1211	2307
2.	9-10 am	608	266	305	1357	2536
3.	4-5 pm	340	269	280	865	1754
4.	5-6 pm	376	230	297	810	1713
5.	6-7 pm	487	253	315	1085	2140
6.	7-8 pm	453	244	329	1133	2159
Non peak hours						
7.	10-11 am	500	233	256	954	1943
8.	11-12 am	408	241	267	765	1681

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Table 10: Data For Collector Roads

S.no	Timing	LMV	Auto	HMV	TwoWheelers	Total
Camp road						
1.	10-11 am	117	131	20	972	1240
Gandhi road						
1.	11-12 am	145	79	21	969	1214
Rajaji road						
1.	1-2 pm	219	136	43	844	1242

(a) (b)

(C) (D)

Fig5: A) Shows The Traffic Flow In One Of The Area In Tambaram With Existing Lanes, (B) Shows Allocation Vehicles In No Parking Area, (C) Subway Which Is Allocated With Platform Shops, Fig(D) Shows Roads Which Are Left Unconstructed.

The images given in Fig 5(a) to 5(c) are obtained from the concurrent research in the Tambaram area for the project work and highlighted to develop the area by effectively applying our project outcomes. Table 4-10 contain the data gathered from the concurrent investigations.

3.3 Suitable road layout

Road layout design 1

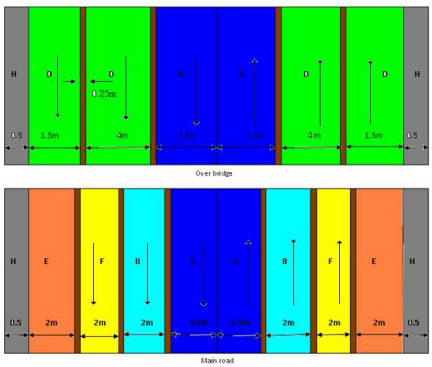

Fig6: 21m Road Layout

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This road layout represents the 21m road which is mentioned as P. This is the sustainable layout for the GST road which is considered as the heart of Tambaram area. In this road layout, there are two separate sections which are considered as over bridge and main road. All together there are 12 lanes considering both over bridge and main road with each lane capacity of 720 vehicles per lane and two lanes are allocated for the convenience of the people who walks out through the small path. D represents allocation for two wheelers with 1.5m and 4m wide respectively on both sides of the road, G represents allocation for LMV+Auto+Two wheelers. Now considering on the main road, there are 8 lanes including two pedestrian paths where E is allocated for the pedestrian path on both side of the road with 2m each. B represents allocation for HMV with 2m wide on both side and F represents allocation for LMV+Auto with space allocation of 2m wide. The spacing between each road is 0.33m wide and H represents area for bridge construction. In over bridge the gap between the two roads is 0.25m and in main road the gap is of 0.366m between each road.

Road layout design 2

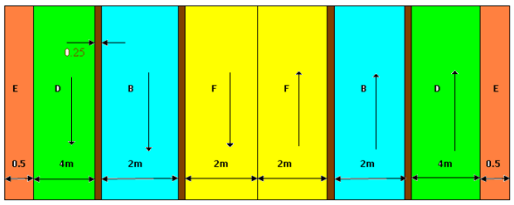

Fig7: 18 M Road Layout

The layout of the road in Fig 7 represents 18m wide road which is mentioned as Q. In this layout the allocation for the pedestrian path is at the left most side and at the right most side of which is represented by E with a width of 0.5m, followed by allocation of road for two wheelers with a width of 4m and it is represented by D on either side of the road. F represents the road allocation for LMV + Auto with a width of 2m each sides. Finally B, which is allocated for HMV with a width of 2m.and LMV+ Auto is allocated in two lanes due to the increase in the number of vehicles. Due to the increase in the width of the road the allocation for each lane is highly spaced. The capacity of each lane is around 520vehicles/lane. The spacing between each road is 0.25m for easy mode of traffic.

Road layout design 3

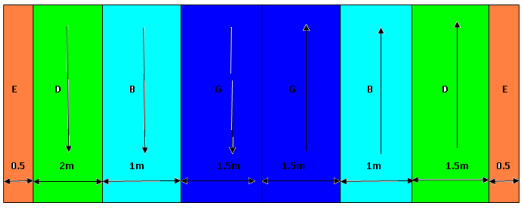

Fig8: 9 M Road Layout

The road layout in Fig 8 represents 9m road which is described as R. In this layout, E represents the path for pedestrian with a width of 0.5m and located in both the end of road layout. Mostly the pedestrian path is allocated only where the population is present or in the area where the distance between the starting point and designations is very small. Followed by the pedestrian path there are two lanes for two wheelers with a width of 2m and 1.5m respectively. G represents road allocation for LMV+Auto+Two wheelers with a width of 3m and finally B with width of total 2m which represents HMV. The capacity of each lane is about 421vehicles/hour.

Road layout design 4

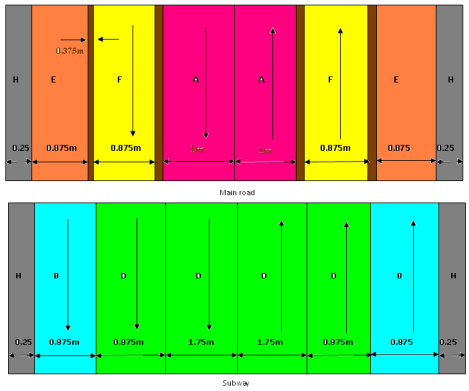

Fig9: 7.5m Road Layout

Fig 9 illustrates the road layout with a road width of 7.5m which is represented as S and to modify this road we have suggested the road plan with twin ways comprising the main road and the subway. In the sub way there are 6 lanes which are allocated only for two-wheelers and heavy moving vehicles. H represents the area for the construction of the bridge and D, A, B and F represent the road allocations for Two wheelers, LMV, HMV, LMV+Auto respectively. The capacity of each lane is 721vehicles/lane. As the subway is allocated, the traffic flow will be easy and larger number of traffic can be made to allow without any distortion or congestion.

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Description

LMV – light motor vehicles, HMV – heavy motor vehicles, TW – tow wheelers, PP – pedestrian path

Let,

LMV – A, HMV – B, Auto – C, TW – D, PP – E, LMV+Auto – F, LMV+Auto+TW – G, Bridge work – H. Then the sequencing order for each road layout is

Table 11: Sequence Of Road Layout

Road layout	Width of road(m)	Sequence
P	21	HDDGGDDH+HEFBGGBFEH
Q	18	EDBFFBDE
R	9	EDBGGBDE
S	7.5	HEFAAFEH+HBDDDDBH

To obtain the sustainable layout, all the four criteria such as transport management, safety management, energy management and environment management which affect the sustainability must be satisfied. Urbanization and motorization are the twin objectives of effective transport system management system and our focus is mainly centered on reducing traffic congestion during peak hours. We intend to design an optimal road based on input specification (road width, population of the area and Average number of vehicle passes on the road) in order to ensure unhindered traffic. If these inputs tend to fail during peak hours, then a part of the traffic may be diverted to another route which is in a nearby location. To ensure environmental management, alternate fuels such as natural gas, propane, methane, and biogas may be provided. In the future one of the sources of fuel is hydrogen, which is converted to liquid fuel. Hence, in this investigation, we put forward an innovative layout with maximum optimal solution leading to sustainability by means of the fuzzy logic system. Thus, with the help of this technique we arrive at an optimal road layout where each individual factor contributes to a specified level.

Table 12: Roads With Its Layout And Contribution

Road Names	Input parameter			Output	
	Average no of vehicles	Road width	Average no of population	Sustainable road	Contribution
G.S.T Road	2870	21	10	P	TM-50% SM-30% EM-10% Egm-10%
Camp Road	2877	9	40	R	TM-20% SM-10% EM-10% Egm-40%
Velachery Main Road	2000	18	80	Q	TM-20% SM-10% EM-40% Egm-30%
Mudichur Road(SH 110)	1434	7.5	10	S	TM-10% SM-50% EM-20% Egm-20%
Velachery Side Road	1478	10	60	Q	TM-20% SM-10% EM-40% Egm-30%
MEPZ to Camp Road	2700	7.5	10	S	TM-10% SM-50% EM-20% Egm-20%
Rajaji Road	2100	7.5	5	S	TM-10% SM-50% EM-20% Egm-20%
Agaram Road	1975	7.5	39	S	TM-10% SM-50% EM-20% Egm-20%

The above table represents the roads which are used in the experiment to calculate the sustainability and also the input parameters such as average number of vehicles, road width and average number of population of the specified road. Depending on these parameters the optimal road is

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designed and the contribution of Transport Management (TM), Safety Management (SM), Energy Management (EM) and Environment Management (Egm) are found out.

Land use in 2013:

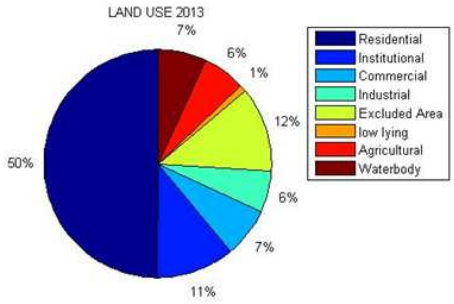

Fig 10: Land Usage Allocation For Different Parameters In 2013

This pie chart describe the land allocation of tambaram with different parameters such as agriculture, water body, residential, industrial, low lying area commercial, institutional, excluded area. In the future space has been allotted for mixed residential, continuous building area and resulting in lesser space allotted purely for residential purposes. With the some part of residential land being allotted to mixed residential and other land use like continuous building the population is going to increase and the traffic is bound to increase in these places due to Commercialization of Existing Residential Plots.

In our method the input for the land usage is given by the numerical value 0.1, 0.2, 0.3, 0.4, where each value represents for different P, Q, R, S road layouts respectively. Each numerical value has its own standards and if the value is given in different format the chart for the corresponding layout will not be displayed and will display out of limit in command window during processing.

4. RESULT AND DISCUSSION

Output for the Road layout P

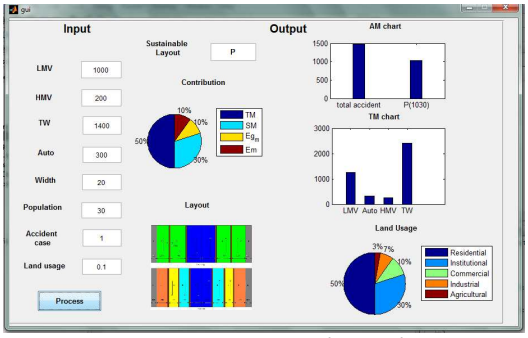

Fig11: MATLAB Output For The Road Layout P

Fig 11 shows the GUI output for the layout of P. Here the input parameters are assigned and the corresponding road layout is obtained. The contribution of TM and SM are of 50% and 30% each. EM and Env contributions are 10% each. The model diagram shows the model output for our proposed method. Here we have to furnish the input parameters such as vehicles, width, population, accident case, land usage and by means of the process we achieve appropriate layout with layout design and the individual contribution of each and every distinct criterion.

In Fig11 the average number of vehicle is given by splitting in 4 different types as LMV, HMV, two wheelers and auto and the input is given as 1000, 200, 1400, 300 and width as 20 and population as 30 which lies under the sequence HDDGGDDH+HEFBGGBFEH and the corresponding output will be layout P. In this layout the contribution for TM and SM are 50% and 30% each. In this layout the capacity of each lane is 720vehicles/lane. Hence this layout has two sections so the traffic can flow through the perceptive lanes without any disturbance. So the safety management will be high so its contribution will be low. Highlighting on energy and environment management, both seeks the same level of distribution. Accidental management (AM chart), Transportation Modal (TM chart) and its corresponding land usage is shown in the GUI output. In TM chart 1,2,3,4 represents LMV, HMV, Auto, and two wheelers.

Output for the Road layout Q

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Fig12: MATLAB Output For The Road Layout Q

This GUI output shows the output of Q layout. Here the input for vehicle is LMV, HMV, tow wheelers and auto are 175, 279, 500, 246 respectively and width is 15 and population as 75 which lies under the sequence EDBFFBDE and the corresponding layout is Q and the capacity of each lane is 520vehicles/hour. So the input for vehicle is given less than the capacity of total vehicles of all lanes. The contribution for each criterion is also described. As the amount of total vehicle is less hence the contribution will be more in the transport management and it is given as 20%. The accident case will be high and its contribution will be low and it is gives as 10%. Here the path for the pedestrian is allocated separately so the two wheelers can be reduced and hence energy consumption will be reduced and the environment pollution will be reduced. Hence both contribute to an average amount of 30% and 40% each. Among our road layout velachery main road and velachery side road satisfies this case. The lanes allocated for two wheelers are two and the vehicles per lane will be reduced by using the pedestrian path. Accidental management (AM chart), Transportation Modal (TM chart) and its corresponding land usage is shown in the GUI output. In TM chart 1,2,3,4 represents LMV, HMV, Auto, and two wheelers.

Output for the Road layout R

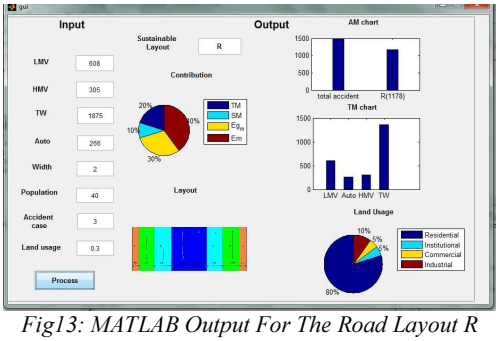

Fig13: MATLAB Output For The Road Layout R

This output provides for the layout of R. here the input of vehicle given as LMV, HMV, tow wheelers and auto are 608, 305, 1875, 266 respectively and width as 10 and population as 40 which lie under the sequence EDBGGBDE. The sustainable layout design is also given in the output. The capacity of each lane is 421vehicles/hour. The contributions for each factor are also given with transport management as 20%. Since the vehicles are to be diverted in another area, the corresponding area allocation has to be managed in advance. The safety management will be 10% because the traffic conjunction will be low. On focusing energy and environment management there will be 30% and 40% respectively. Since there is separate allocation for pedestrian path the environment will be not so polluted and the energy will be reduced in very small amount. Accidental management (AM chart), Transportation Modal (TM chart) and its corresponding land usage is shown in the GUI output. In TM chart 1,2,3,4 represents LMV, HMV, Auto, and two wheelers.

Output for the Road layout S

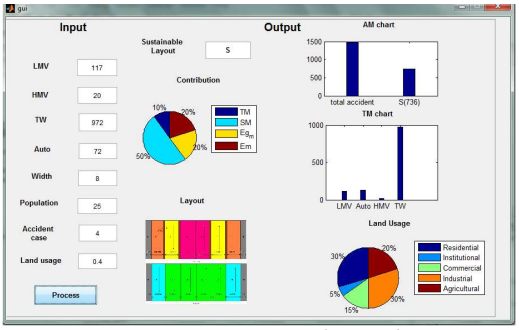

Fig14: MATLAB Output For The Road Layout S

This GUI output is given for layout S. here the input given for vehicle as LMV, HMV, tow wheelers and auto are 117, 20, 972, 131 respectively and width as 7.5 and population as 25 which lies under the sequence HEFAAFEH+HBDDDDBH then the output with corresponding layout is provided. Even the contribution of each factor is also given with a pie graph. In this layout there are two roads as divided into main road and subway. The contribution for transport management is 10% because large amount of traffic can be diverted to subway and hence the main road will provide more area for the movement of vehicles freely. In subway there are 4 lanes for two wheelers during peak hour: during non-peak hour among 6 lanes, 2 are for two wheelers and HMV. Hence the safety management will be at a percentage of 50. Hiring on energy management

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will be at 20% as no other sources are allowed for the traffic and environment management will be only 20%. Mudichur Road, MEPZ to Camp Road, Rajaji Road and Agaram Road satisfies this condition. Accidental management (AM chart), Transportation Modal (TM chart) and its corresponding land usage is shown in the GUI output. In TM chart 1,2,3,4 represents LMV, HMV, Auto, and two wheelers. Figure 9, 10, 11 also explains each road layout and produces each with different contribution. The table below shows each layout with different contribution.

Table 13: Contribution Level For Different Parameters

Road layout	Transport Management	Safety Management	Energy Management	Environment Management
P	50	30	10	10
Q	20	10	40	30
R	20	10	30	40
S	10	50	20	20

Accident case

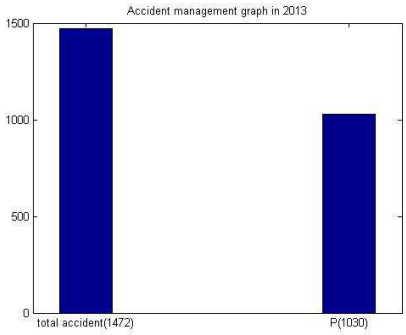
Cost of accident is an important parameter in the economic appraisal of transportation projects. Even though there are several methods of calculating the accident costs the choice of a particular method primarily depends on the objectives of the intended project and largely with national objectives. In India, very few studies have been carried out on the subject and the studies already undertaken lacked in area coverage and precise cost estimation. International analysis showed a high degree of variation in cost of accidents. It is felt necessary to carry out detailed accident cost studies for Chennai city. Accident cost need to be estimated for urban and rural areas separately.

In average the total number of accident in 2013 is 1472 for the estimated area in Tambaram. The graph below describes the accident detail which contributes due to the traffic conjunction and it is represented separately for four different layouts of the developed roads. The values of contribution for layout P, Q, R, S is given as 1030, 1324, 1178, 736 respectively.

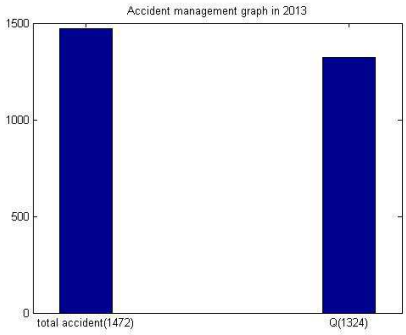
The value is determined by the following equation as,

Accident case = Total number of accident – ((total number of accident ×SM contribution)/100)

In our method the input for the accident case is given by the numerical value 1,2,3,4, where each value represents for different P, Q, R, S road layouts respectively. Each numerical value has its own standards and if the value is given in different format the chart for the corresponding layout will not be displayed and will display out of limit in command window during processing.Here SM stands for Safety Management contribution of each separate layout and hence 4 different graph is obtained



(P)



(Q)

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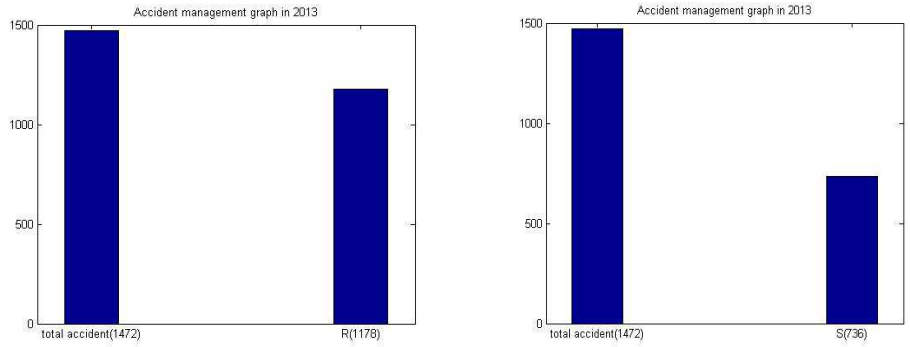
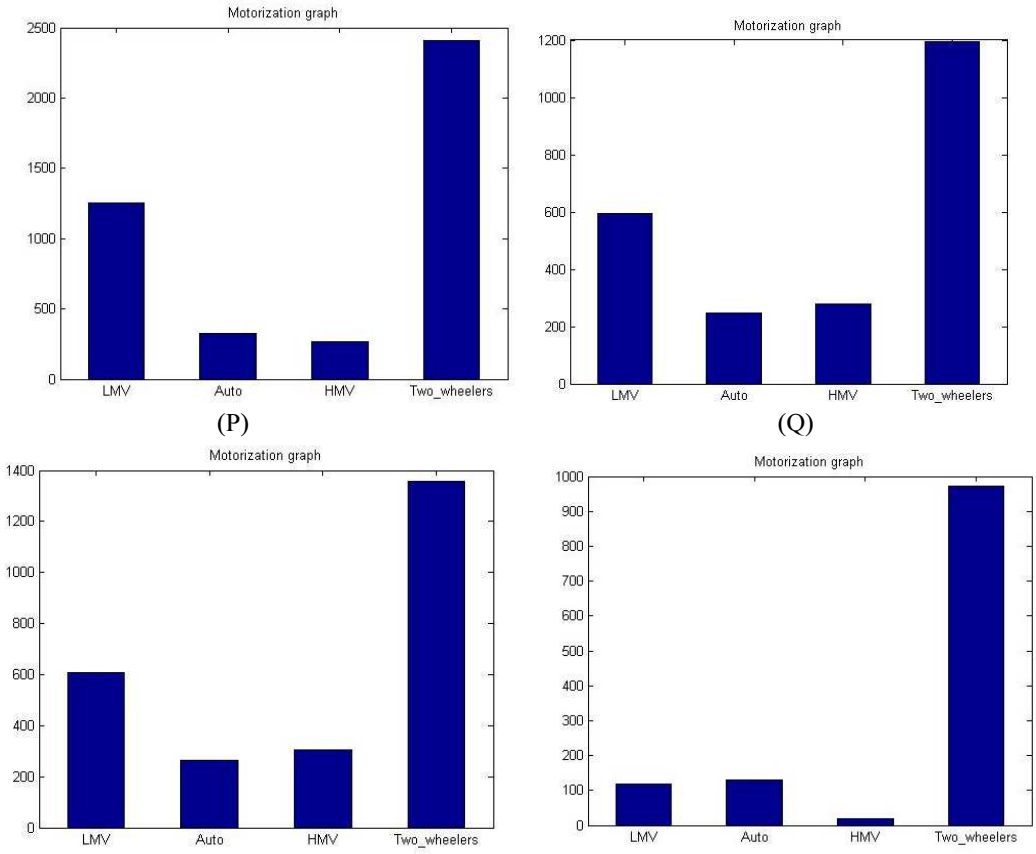


(R) (S)

Fig 15: Accident Management Graph For 4 Different Layouts Of 2013 In Tambaram

Motorization

Motorization refers to the type of traffic which flows in the lanes of 4 different type of road layout. Here the Low Motor Vehicles (LMV), Auto, Heavy Motor Vehicles (HMV), Two-wheelers are described and it is represented in the graph format. These are the data retrieved from the real time experiment and utilized to produce a bar graph.



(P) (Q)

(R) (S)

Fig 16: Motorization For 4 Different Road Layouts

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5. CONCLUSION

Attention must be given on the population in the precise area, width of each and every accessible road and their facility etc for the assessment of the sustainable transport in a particular urban area. However it is a hard assignment. The numbers of vehicles that pass through the road normally determine the capacity the road. We have focused on eight roads of Tambaram area, located in Chennai in our proposed paper. Width of each road, population around the particular area, average number of vehicles in the road during peak hours, accident case and land usage in 2013 has been found out regarding these eight roads. We have acquired through the utilization of our proposed method sustainable road layout and its corresponding contribution for each and every factor such as transport management, safety management, energy management and environment management etc. The fuzzy logic concept is made use of in our procedure to provide optimal road layout. There are a total of 19 lanes in existing roads but in our proposed method there are total of 42 lanes including the pedestrian path. Consequently by our proposed method there is an increase of 23% in total lanes. A change in the mode of travel must be taken into account which focuses on increasing the pedestrian path and reducing two wheelers to travel in a short distance, and the spatial pattern of travel which is anticipated to increase the area for travelling. If we put it in another way, the spatial separation of activities and the distribution of land-uses increase the need to travel. As a result, it is essential to consider a spatial layout that can facilitate to support a better eco-friendly transport choice. The future work can be focused on developing a road which provides better contribution for all the four factors such as transport management, safety management, energy management and environment management are to be considered in our future road projects. So special attention must be paid for this purpose. The existing largest road width is 21m in Tambaram area. This road width can be increased by widening the road by removing unnecessary buildings, unwanted parking areas, roads which are left unconstructed, road side shops etc from the road. Accordingly the sustainability can be enlarged further in the future for making higher contribution in all the four parameters such as transport management, safety management, energy management and environment management. Only the government can help doing this so that the involvement for each factor can be greater than before.

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