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Application of Its In Parking Management for Madurai City

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Abstract: Madurai city is third largest city in TamilNadu state and hosts 1.5millon (2011) population and 3 lakh floating population in a day with the area of 51.96 Sq.km. Number of motor vehicles increased 68.85% over a six year period (2008-13), accompanying this vehicle growth, land use and economic activities of the city drive the parking demand to its peak. 6.80 lakh registered vehicles in the city not only required space of movement but space for parking. On street and illegal parking activities hinders the central business district area of the city. As an attempt in this study, 21 stretches were identified inside the CBD as more suffering area due to peak parking crisis. Present parking scenario was surveyed and analyzed. Various ITS applications, technologies for parking management and other state of art parking management techniques were studied. From the global reviews and studies, it is clear that the issue cannot be solved by ITS alone, and implementation of ITS faces lot of challenges in the city.
Keywords: Intelligent Transport systems, Applications of ITS, Parking crisis, policies, parking management

I. INTRODUCTION

Parking is both a noun and a verb. For example, when we look for a car park, or when we park our car on the street. It also qualifies various nouns, as in parking area, parking lot, parking ticket etc. As per Valleley.M there is a fundamental distinction between the use of the word “parking” to describe the infrastructure provided for the storage of vehicles and “parking” is an activity forming part of the overall process of travel. His argument stood where more weight should be attached to the view of parking as a process embracing all these meaning of parking.

The vehicles not only require space for movement, also space for parking. The provision of parking constitutes a major component of a transportation system in any urban area. Most Private vehicles are driven for only a small proportion of their life; rest of the time they are simply parked (23 Hrs. /Day). Parking takes up lot of value land and it costs money to provide and maintain

A. Parking Management

Parking management refers to policies and programs that result in more efficient use of parking resources. Parking management includes several specific strategies; nearly 10 are described in this study. When appropriately applied parking management can significantly reduce the number of parking spaces required in a particular situation, providing economic, social and environmental benefits. When all impacts are considered, improved management is often the best solution to parking problems. (Litman, 2006)

B. Need and Goal of Parking Management

1) To create and improve healthy economic climate, and a business community able to support local employment needs
2) Most efficient use of existing transportation, land, and other public resources
3) Ease of mobility and accessibility of parking resources
4) Equity of resource distribution and preferential allocation of some resources
5) Environmental goals, especially reduced air pollution and the related goal of minimized energy consumption
6) Enhanced amenity and cultural attractiveness; preservation of a city's unique character

C. Intelligent transport systems

Intelligent Transport Systems (ITS) refers to the integration of information and communication technologies with transport infrastructure to improve economic performance, safety, mobility and environmental sustainability.

Addressing traffic congestion was one of the initial motivations to look at ITS solutions for a better utilization of transport capacity through the exchange of real-time information on infrastructure and traffic conditions. Since then, new transport applications based

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on information and communications technologies (ICT) have emerged and continue to emerge, ranging from basic traffic management systems (e.g. navigation, traffic control) to management of containers; from monitoring applications such as closed-circuit television (CCTV) security systems to more advanced applications integrating live data and feedback from a variety of information sources (e.g. parking guidance, weather information). (Vanajakshi, Ramadurai, & Anand, 2010)

D. Major technological constituents of ITS

1) Various forms of wireless communication for both short-range and long-range data exchange (UHF, VHF, WiMAX, GSM, etc.);
2) Computational technologies – the present trend is towards fewer and more costlyMicroprocessors, allowing more sophisticated applications such as model-based process control and artificial intelligence;
3) Sensing technology – employing sensors to feed control systems with both vehicle-based data (from devices such as radar, RFID readers, infrared- and visible-band cameras) and infrastructure-based data (from similar devices, as well as inductive or pressure sensors installed or embedded in and around the road). (Vanajakshi, Ramadurai, & Anand, 2010)

II. STUDY AREA DESCRIPTION

A. Introduction

Madurai is one among the seven largest cities in the State of Tamil Nadu. The geographical setting of Madurai city is unique with its location as Growth Pole in the Southern part of the State of Tamil Nadu. It is located at a distance of about 450 km south-west of Chennai, the Capital of the State of Tamil Nadu and is on 9° 55" 59'North Latitude, 78° 7" 0'East Longitude. And it is 100 mts. above mean sea level. The perennial river Vaigai passes through the city and the area spreads on both sides of the river.

The city is strategically located at the junction of National Highways No.7, 45B and 49 etc., Trade, tourism and pilgrimage have been driving forces for such developments. There is always a heavy inflow / outflow of floating population (3 lakh/day). The city surrounded by elegant natural plantations. Technical institutes and textile mills are in good numbers. (District Administration, 2017)

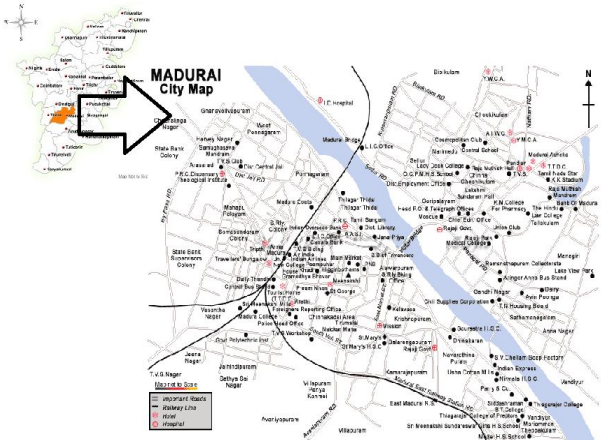

Fig.1Madurai city location map

B. Central business district

The entire network within CBD is named as “Street”. While the streets of the CBD do provide the necessary access to a large number of properties, the intrusion of vehicles both fast and slow moving vehicles on a large scale has tampered not only easy movement of people but also defeated the very basic function of the street.6.80 lakh registered vehicles in the city not only required space of movement but space for parking., Accompanying this tremendous vehicular growth, land use and economic activities of the city drive the parking demand to its peak.

About 18 stretches were identified for the purpose of conducting survey based on the previous studies done. The stretches or street networks surrounding the Meenakshi Amman temple, namely Avani Moola Street, Masi Streets, Marat streets, Veli streets, Nethaji road, Town hall road. Parking of vehicles pose a serious threat to the effective utilization of road and street space particularly in the CBD of Madurai.

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Fig.2 Central business district of the city

III. METHODOLOGY

Based on a detailed literature review the following methodology was formulated, and been adapted, Approach to the study for this particular project was derived based on the related work to the city, from various thesis works with respect to Madurai city.

Literatures related to intelligent transport systems, and their various application with respect to parking management was collected and studied, And also parking management strategy and management techniques related literatures were also studied, and reviewed.

The study area was the central business district area of the city, parking characteristics of the identified areas was collected and reported.

IV. APPLICATION OF ITS IN PARKING MANAGEMENT

A. General

Multi-level car parking system (MLCPS) is one such technology which is implemented in India. It is used for optimum utilization of parking space by utilizing vertical space rather than horizontal space

Automated smart parking uses sensors, wireless communication technology, data analytics etc. to solve parking issues. Smart parking solutions can be used to locate available parking space with the help of sensors. This saves customer's time as well as minimizes wastage of fuel. Various technologies are being used to ease parking problems in public places. For example using RFID technology, the check in and checkout time for the vehicle can be reduced and also the payment system can be automated. (Jog, Sajeev, Vidwans, & Mallick, 2015)

B. Advance parking management systems

ITS applications involving APMS have been employed in Europe and Japan for several years and are beginning to be deployed in the U.S. Advanced parking management systems maintain real-time parking space inventories across a set of participating facilities. These data are used to generate parking availability messages that are distributed to travelers through several different means. Such data also help facility owners track demand. (Jog, Sajeev, Vidwans, & Mallick, 2015)

*1)Benefits of APMS*The benefits of APMS are specific to the stakeholders involved

a) *Travelers:*easier access, reduced time spent looking for parking, and reduced frustration
b) *Venue operators***:** increase in accessibility and associated increase in patronage and customer satisfaction
c) *Parking operators:*increased space occupancy and associated increase in revenue
d) *The jurisdiction and nearby neighborhoods:*reduction in the number of patrons circulating through the street network looking for a parking space and fewer vehicles parked illegally on local streets. (Mendoza & Davidsson)

2) There are several different types of advanced parking management systems currently in use.

a) Pre-trip parking information system
b) Lot-specific system
c) Floor, Aisle, and Space Specific Parking Information System
d) Parking reservation systems (The U.S. Department of Transportations' Intelligent Transportation Systems (ITS) , 2007)

C. Technologies used in APMS

1) Counting systems: There are two types of counting systems: entry/exit counters and space occupancy detectors. (The U.S.

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Department of Transportations' Intelligent Transportation Systems (ITS) , 2007)

2) Communication Systems: Each ITS-based parking management solution is different, requiring a carefully chosen architecture that meets the needs of the various stakeholders. Factors that should be considered when deciding among these options include:

a) Availability of mounting space for detectors
b) Operational environment in which the components will be used
c) Communication channels
d) Electrical power supplies. (The U.S. Department of Transportations' Intelligent Transportation Systems (ITS) , 2007)

D. Challenges to APMS implementation in Indian Scenario

India's ITS cannot be entirely modeled on the existing successful ITS of other nations due to basic cultural, geographic and practical differences amongst the countries. The existing concepts have to be thoroughly understood in order to modify them to fit the Indian traffic scenario (Vanajakshi, Ramadurai, & Anand, 2010). The design of an intensive ITS and APMS program hinges on the following developments:

1) *Technology:* The development and implementation of advanced technologies is important to the successful management and operation of ITS in India. These technologies include electronic equipment such as sensors, Detectors and communication devices and application of global navigation satellite system (GNSS). This in turn hinges in cooperative work between the government, academic research institutions, and industry. (Vanajakshi, Ramadurai, & Anand, 2010)
2) *Technology Challenges:*Limited number of vendor triggers the lack in resources which will lead to the operation and maintenance of the technology and analytical issues. (Vanajakshi, Ramadurai, & Anand, 2010)
3) *Static Sensing :*Vehicle detection and counting using magnetic sensors or loops under the road surface are generally used, Video surveillance to monitor traffic states and detect incidents and hotspots is a common phenomena. However as developing country like India have Heterogeneous traffic model hence Sensing technologies have to adapt themselves. New Sensing methodologies have to answer some Key Questions - what to sense; how long to sense and handle the real time data Vs. Accuracy trade off; and how to build sensing models for different road widths and vehicle types with minimum manual supervision. (Vanajakshi, Ramadurai, & Anand, 2010)
4) *Mobile Sensing*: Many transport companies in India have GPS installed in their vehicles for real time tracking. However, GPS is known to have Localization Errors thereby providing wrong information of real time traffic. Ordinary Mobile phone penetration is very high in India. Cell Phone operators can give approximate vehicle densities in the neighborhood of a given Cell Tower based on Subscribers seen in that area. However, designing proper Incentive models for participatory sensing in an active area of research.Thus we can see that India specific challenges provide a multitude of opportunities for the evolution of ITS technology. The characteristics of Indian roads and traffic type provide an interesting case for the design of ITS systems specific to India. (Vanajakshi, Ramadurai, & Anand, 2010)
5) *Modeling of Indian traffic:* A proper understanding of the traffic system is important in the successful implementation of any reliable ITS systems. The existing models developed for the western traffic condition may not be suitable for the Indian traffic and hence there is a need to modify or develop models that can characterize the Indian traffic in a better way (Vanajakshi, Ramadurai, & Anand, 2010)
6) *Supply Chain :*Supply chain seamless interconnectivity of the various branches of the transportation sector is essential to provide effective, efficient and secure movement of goods and services while improving the conservation of natural resources and reducing environmental impacts such as the effects of carbon emissions (Vanajakshi, Ramadurai, & Anand, 2010).
7) *Energy and Sustainability :*The ITS in India should closely work with the energy sector in the promotion of fuel efficient transport policies and practices, including the use of alternative transport fuels. Fuel efficient policies and practices will assist the country in achieving sustainable economic and environmental benefits through the application of ITS. (Vanajakshi, Ramadurai, & Anand, 2010)
8) *Human Capital Development:*Human skills are important to ensure the development of seamless transportation systems. Given the population density of India and the varied skill sets available in the country, the ability of the work force to develop, manage and safely implement existing and emerging technologies is essential for ITS design and implementation. (Vanajakshi, Ramadurai, & Anand, 2010)
9) *Multilevel Dilemma :*APMS implementation solely depends on Multilevel parking facility or surface parking facility with full furnishing. Parking deficit is cited as a reason to argue for more multilevel parking structures. All cities like Delhi think that with proliferation of these structures the problem of parking crisis and congestion will go away. Most city governments are

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finding it difficult to make the multi-level cars parks work and deliver on their intended benefits. There are examples of things going awry across cities. In Delhi the Eros parking in Nehru Place remained grossly underutilized for a long time and till the time enforcement in surface parking improved. Similar fate awaited Nariman Point parking structure in Mumbai. Global reviews have shown that it is erroneous to think that plentiful supply of off street parking will automatically reduce and eliminate on street parking and congestion.

10) *Contracting :*Awarding of ITS contracts purely based on the lowest costing proposals rather through a quality and cost-based criteria, So there is a possibility that quality may be not promised. (Vanajakshi, Ramadurai, & Anand, 2010)
11) *Cost:*Introducing a new facility and technology involving huge amount of investment, this will be a hindrance for free supply of parking to the public, in the case of Madurai city where % of low income people lives, heavy charge for usage will demotivate people to use the facility (Vanajakshi, Ramadurai, & Anand, 2010)It is vital to plan key initiatives and activities which advance and improve the development and use of ITS in India These include activities addressing the Global Navigation Satellite System (GNSS), encouragement of international standards development through liaison with the International Organization for Standards, work force development/training, and improved supply chain management processes in a sustainable fashion. (Vanajakshi, Ramadurai, & Anand, 2010)

V. STATE OF ART PARKING MANAGEMENT SOLUTIONS

A. General

Implementing ITS in parking management involves introduction of Multilevel structured car parking, Global reviews have shown that it is erroneous to think that plentiful supply of off street parking will automatically reduce and eliminate on-street parking and congestion. Parking strategy will have to be designed differently and conjoined with other demand management measures to make a difference. Although each neighborhood is unique, several parking issues and potential solutions are the same. The following techniques outline several parking solutions to consider in order creating a parking management system capable of solving existing and future problems. (Banerjee and associates, 2003)

1) *Prioritizing funds:* Devoting land and funds to automobile parking often reduces the resources available to support other non-auto modes. As a result, policies that increase parking supply tend to reduce overall transportation choices.
2) *Consider long term commuter parking needs versus short-term:*A functional and financial analysis of constructing a parking garage or long term surface lo
3) t would yield important information for the area as it plans for new development rather than solving the existing condition.*Improve information for motorists*
4) Create sign, brochures and other information resources indicating parking availability and pric:Reduce automobile dependency and encourage transportation alternatives Improve availability and accessibility of public transport including bus stops and discounted bus fares.Increase the range of parking convenience and price levels available to consumers. Strengthen parking enforcement by developing more convenient payment and time options.
5) *Share parking facilities :*Parking can be shared among different business in an area to take advantage of different peak periods. Encourage businesses to share parking. For example, businesses with no night-time hours can make their parking available for those that have night-time hours.
6) *Park once and walk:*Focused on centralized, shared parking that will create a “park once, and then walk” environment. This is the key in promoting businesses in cities, particularly within CBD which allows multiple users to reach multiple destinations.
7) *Mixed-Use parking:*Require shared parking in mixed use developments and in mixed use areas, since peak demand periods occur at different times. For instance, churches often address their parking needs by sharing parking with nearby commercial establishments since most churches co-exist with single family residences and commercial structures. This works well because religious and commercial uses typically have peak parking at different times.
8) *Explore opportunities to make greater use of remote parking location and shuttle services.*The objective is to have a bus system that would transport a group of people from a remote parking structure to their destination. A great example of this is the partnership between a zoo and a shopping mall. During the mall’s peak shopping seasons, shoppers have the option to park their cars at the zoo and take the shuttle provided by the shopping mall to the stores.
9) *Provide and Advertise shuttle services to parking facilities*:In some situations (airports, large entertainment centers, and large commercial center), shuttle buses may allow longer distances between parking facilities and destinations.It is important to publicizing shuttle services by posting on the Internet, on other nearby community buses and though media targeted to the users groups.

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10) *Foster coordination and cooperation with businesses, residents, and other governmental agencies to address parking needs:*Obtain participation from businesses and parking management companies with the validation approach where people generally revive either a reduced rate for parking of free parking for a specified time. This option is attractive when the demand is in off peak parking hours.

VI. PRIMARY DATA COLLECTION

Parking survey was carried out to provide information on parking demand, extent of usage of parking facility and availability of parking space. In the present study, parking survey at 21 stretches was conducted to assess parking demand characteristics in terms of parking accumulation, parking duration and composition of parked vehicles. Parking survey was conducted on Veli streets, Marrat Street, Masi streets, Avani Moola streets, Town hall road, Nethaji road, Scott road, Chithirai streets, Muni salai, Amman sannathi, Kamarajar Street and Palace road etc

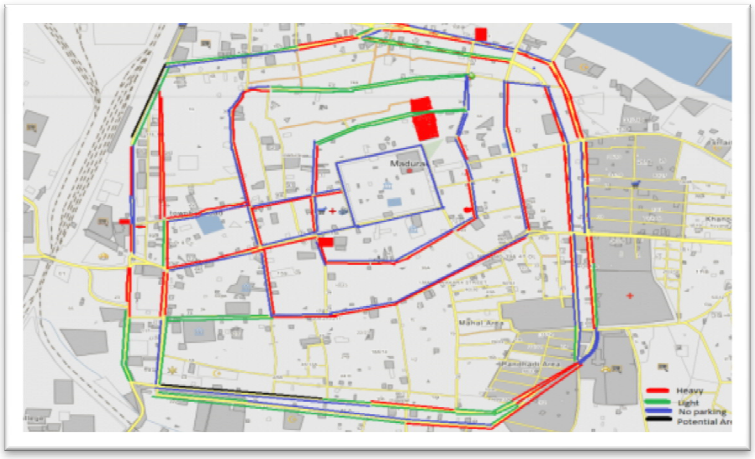

Fig.3 Identified stretches and their characteristics

A. Parking characteristics

Data on peak hour parking accumulation, composition of parked vehicle and parking duration along various road sections have been collected using patrol method or parking beat data collection method.

1) Velistreet: Veli streets form the outermost ring in the CBD area. On Veli streets, parking is predominant on East Veli Street. It can be seen that peak parking accumulation varies between 368 vehicles at East Veli Street (between Muthoot bank to church) to 135 vehicles at North Veli Street (SakthiSivam Junction to Narasus coffee).. The peak hour period for parking generally occurs between 14:00 - 19:00 hrs. Figure 4 shows the maximum parking accumulation at various locations in the form of a bar chart.

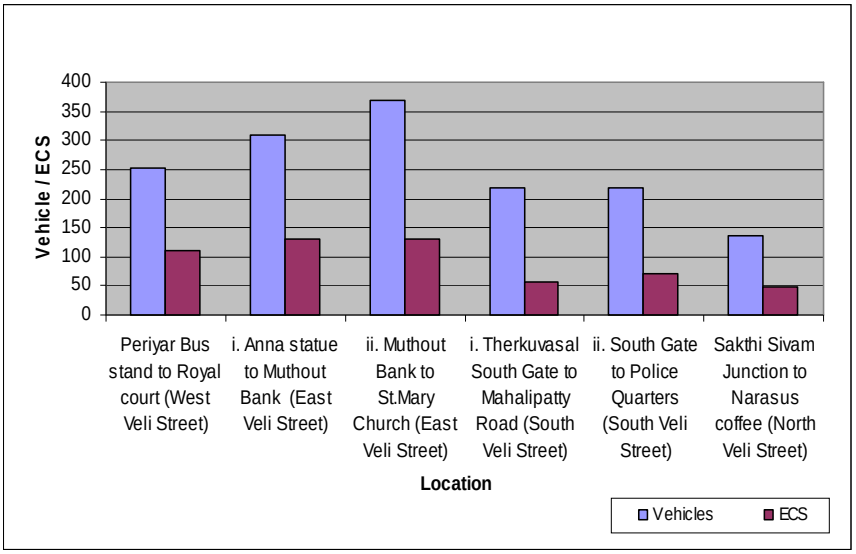

Fig.4 Maximum parking accumulation at Four Streets of Veli Street

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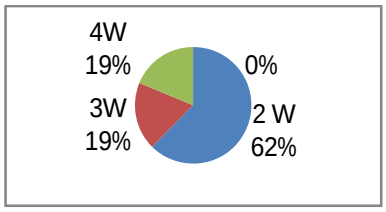

Fig.5 Composition of vehicles Periyar bus stand to royal court stretch

2) Composition of parked vehicles: Generally two wheeler accounts for a share varying from 63% at Periyar Bus stand to Royal court stretch along West Veli street to 99% at Therkuvasal south Gate to Mahalipatty Road stretch along South Veli street. Maximum cars (19%) and auto rickshaws (19%) were parked at Periyar Bus stand to Royal court stretch along West Veli Street.

3) Parking duration: The average parking duration for two wheelers varies from 34 min. at Periyar Bus stand to Royal court along West Veli Street to 115 min. at Therkuvasal south Gate to Mahalipatty Road along South Veli Street. Similarly the average parking duration for cars varies from 30 min. at Therkuvasal south Gate to Mahalipatty Road along South Veli Street to 61 min. at Muthoout Bank to St. Mary Church along East Veli Street.

B.Marretstreet

Marret streets form the second tier ring of the CBD area, next to Veli Street. Parking was observed on West and East Marret Street. Parking is predominant on East Marret Street. It can be seen that peak parking accumulation varies between 206 vehicles at East Marret Street (between Lakshmi trades - Yanikal junction) to 94 vehicles between Kamarajarsalai to Chithrakara 2nd Street. The peak hour period for parking generally occurs between 12.30 - 13.00 hrs. Figure 6 shows the maximum parking accumulation at various locations in the form of a bar chart.

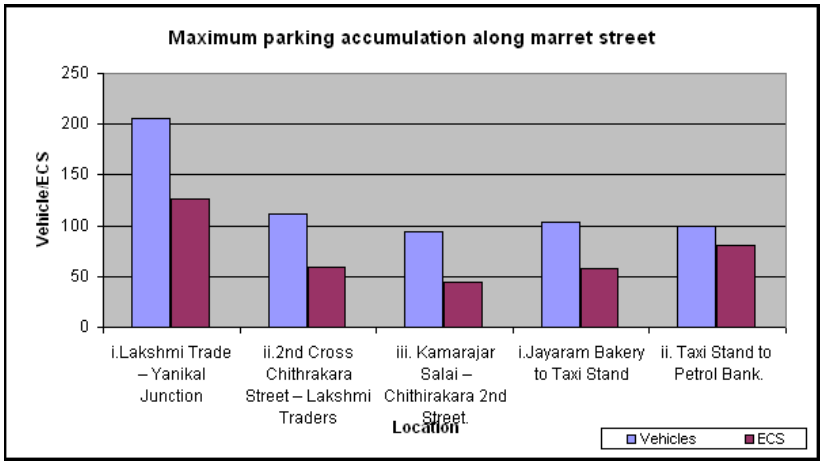

Fig.6 Maximum parking accumulations at Streets of Marret Street

1) *Composition of parked vehicles:*Generally two wheeler accounts for a share varying from 35% at Taxi Stand to Petrol Bank stretch along West Marret Street to 78% at KamarajarSalai – Chithirakara 2nd Street stretch along East Marret Street. Maximum cars were parked at Jayaram Bakery to Taxi Stand (48%) while auto rickshaws are predominant at Taxi Stand to Petrol Bank stretch with a share 20% along West Marret Street.

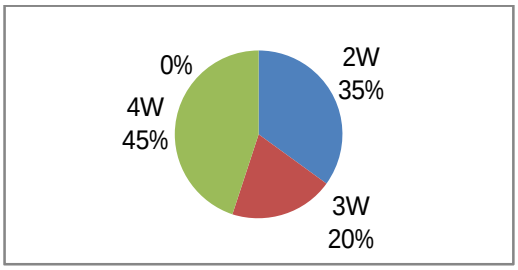

Fig.7Composition of vehicles-Taxi stand to petrol bank

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2) Parking duration: The average parking duration for two-wheelers varies from 52 min. at Jayaram Bakery to Taxi Stand along West Marret Street to 107 min. at Lakshmi Trades – Yanikal Junction along East Marret Street. Similarly cars varies from 44 min. at 2nd Cross Chithrakara Street – Lakshmi Trades along East Marret Street to 112 min. at Taxi Stand to Petrol Bank along West Marret Street.

C. Masi Street

Masi Street forms the next ring of connectivity after Marret Street. It can be seen that peak parking accumulation is along Harish Bakery to Amman sannathi corner in East Masi Street amounting to 565 vehicles with 699 vehicles in North & East Masi Junction to Sri Raja Rajeswari Temple along North Masi street. Similarly, peak parking accumulation is along VeeraiyaPerumalkovil to Junction (West Masi street) of South Masi street amounting to 299 vehicles and the West Masi Street has maximum parking accumulation along the South Masi to AryaBhavan with 257 vehices.

The peak hour period for parking has been varying for the different Masi streets, based on the type of activity involved in those stretches. Figure 8 shows the maximum parking accumulation at various locations in the form of a bar chart.

1) *Composition of parked vehicles:* The composition attains maximum percentage (100%) for two wheelers in City ceramics to ArasamaramPillaiyarKovil Stretch of North Masi Street with its least (41%) in Om Murugasarees to Amman sanathi corner along East Masi Street. The cars are found to be nil in many of the locations in Masi Street as is seen in
2) Chinnakadai Street to VP street along South Masi Street
3) VeeraiyaPerumalkovil to Junction (west Masi street) along South Masi Street City ceramics to ArasamaramBilaiyarkovil along North Masi Street

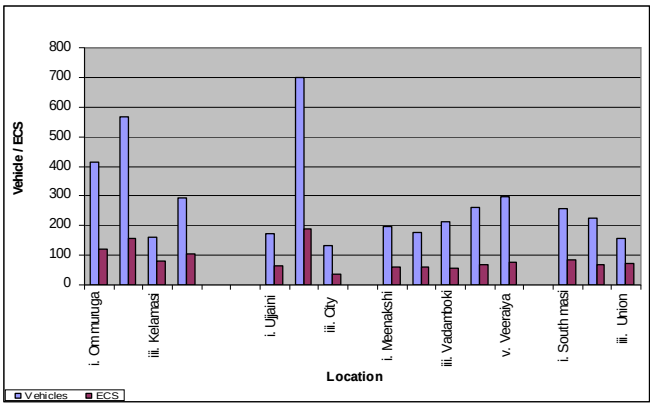

Fig.8 Maximum parking accumulation at Streets of Masi Street

The cars form a maximum composition (50%) in the stretch from Om Murugasarees to Amman sanathi corner along East Masi Street. Three wheelers form a negligible percentage of around 1% - 9% in Masi Streets.

4) *Parking duration:*Masi Street to 119 min. at BSNL- Amman sannathi along East Masi Street. Similarly the average parking duration for cars varies from 30 min. at VP Street - West Masi Street of South Masi Street to 98 min. at Om murugasarees - Amman sannathi corner of East Masi Street. The three wheelers stay in for a maximum duration of 109 min. in Ujjaini Amman Kovil - City Ceramics along North Masi Street.

D. Avanimoola street

The AvaniMoola Street gives connectivity to the CBD area, next to Masi Street. It can be seen that peak parking accumulation varies between 98 vehicles at Melakopuravasal to junction (North & West AvaniMoolaVeethi) along West AvaniMolaveethi to 357 vehicles at Amman sannathi to JadamuniKovil Street along East AvaniMolaveethi.

The peak hour period for parking generally occurs between 8.00 - 10.00 hrs. Figure 9 shows the maximum parking accumulation at various locations in the form of a bar chart.

1) *Composition of parked vehicles:*Generally two wheeler accounts for a share varying from 75% at Melakopuravasal to junction (North & West AvaniMoolaVeethi) along West AvaniMoola street to 98% at M.M.S Jewellery to Rajmahal along AvaniMoola street. Maximum cars and three wheelers were parked at Melakopuravasal to junction (North & West AvaniMoolaVeethi) along West AvaniMoolastreet.

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2) *Parking duration:*The average parking duration for two-wheelers / three wheelers varies from 40 min / 30 min. at M.M.S Jewellery - Raj Mahal along South AvaniMolaVeethi to 154 min / 132 min. at Melakovaravasal to Chruch along West AvaniMolaVeethi. Similarly the average parking duration for cars varies from 31 min. at LKS Jewellery – Thanga mail Jewellery along South AvaniMolaVeethi to 109 min. at Amman sanathi - JadamuniKovil Street along East AvaniMolaVeethi.

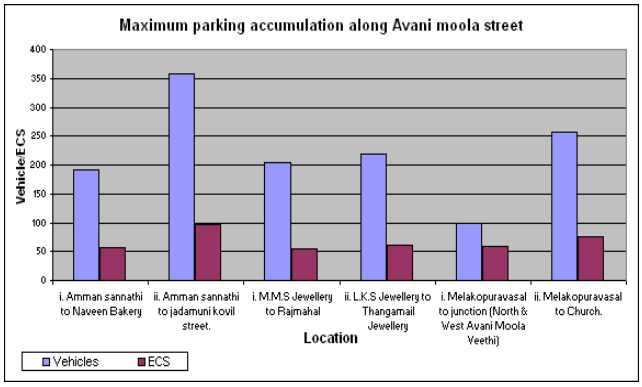

Fig.9 Maximum parking accumulation at Avanimoola

E. Town Hall road, Nethaji road, Scott road and South Chithirai Street

Chithirai Streets forms the immediate ring around the temple area. Town Hall road connects the West Veli street (Railway station) and West Chithiraiveethi (West Gate). Nethaji Road connects TPK Road and junction of South & West Chithirai Street. Scoot road connects Veli Street to Tamil Sangam Road.

It can be seen that peak parking accumulation is maximum at 432 vehicles in AryaBhavan to YMCA Complex stretch of Nethaji Road, due to the types of land use there. In other stretches, it varies between 118 vehicles at Tamil Sangam to Meenakshi Bazaar in Scott Road to 208 vehicles at Police quarters (S E) to Archana's shops (S W) along South Chithirai Street. Table 6.13 gives the details of maximum parking accumulation along Town Hall road, Nethaji road, Scott road and South Chithirai Street. The peak hour period for parking generally occurs between 11.00 – 11.30 hrs. Figure 10 shows the maximum parking accumulation at various locations in the form of a bar chart.

*1) Composition of parked vehicles:*Generally two wheeler accounts for a share as high as 94% at Meenakshi Bazaar to Tamil Sangam stretch along Scott Road to 74% at Police quarters (South East) to Archana's shops (South West) stretch along South Chithirai Street. Maximum cars (21%) are found along Police quarters (South East) to Archana's shops (South West) stretch along South Chithirai Street while auto rickshaws (8%) were parked at AryaBhavan to YMCA Complex stretch along Nethaji Road and West veli street (Railway station) to West masi street (Sharp electronic) stretch along Town Hall road.

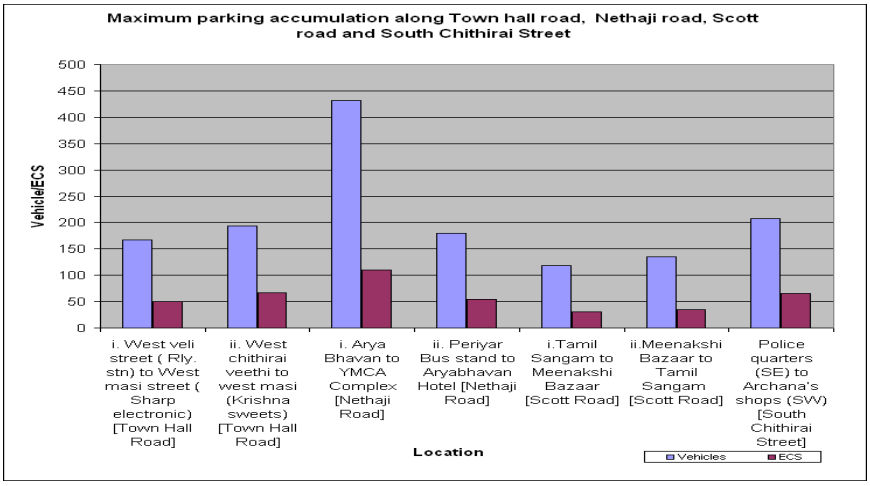

Fig.10 Maximum parking accumulation at various locations along Town hall road, Nethaji road, Scott road and South Chithirai Street

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2) Parking duration: The extremities in parking duration for two-wheelers & three wheelers are seen once again in Nethaji Road and it varies from 59 min. to 103 min. for Cars and 30 min. to 83 min for three wheelers. The average parking duration for cars varies from 30 min. to 76 min at Nethaji road. Both the extremities of high and low parking duration are seen in Nethaji Road.

F. Muni salai, Palace road, Amman sanathi and Kamarajarsalai

Muni Salai connects East Veli Street to Muni Salai Junction. Palace Road connects East Veli Street to Kamarajar Street. Amman sannathi Street connects East Gate to East Masi Street. Kamarajar Street connects Villakuthun to East Veli Street.

It can be seen that peak parking accumulation is on the higher side in Amman sannathi road (525 vehicles). On an average around 208 – 260 vehicles are found in these stretches of Munisalai Road. Extremities of traffic are found in Palace Road with 149 vehicles in one stretch and 235 vehicles in another stretch of Palace Road. Medium level of traffic is observed in Kamarajarsalai. Table 6.16 gives the details of maximum parking accumulation along Muni salai, Palace road, Amman sanathi and Kamarajarsalai. The peak hour period for parking generally occurs in the afternoon time. Figure 11 shows the maximum parking accumulation at various locations in the form of a bar chart.

*1) Composition of parked vehicles:*Two wheeler accounts for a share varying from 67% at Munisalai Road to 89% at Vadampoki Street to Palace Road stretch along Kamarajar Street. Maximum cars (21%) were parked at East masi street to Palace Road of Kamarajarstreet while auto rickshaws are predominant at Munisalai Road with a share 20%.

2) Parking duration: The average parking duration for two-wheelers varies from 59 min. in Palace Road to 127 min. in Amman Sannathi Road. Similarly the average parking duration for cars varies from 30 min. in Palace Road to 100 min. in KamarajarSalai. Three wheelers vary from 46 min in MunisalaiSalai to 84 min. in Amman Sannathi Road.

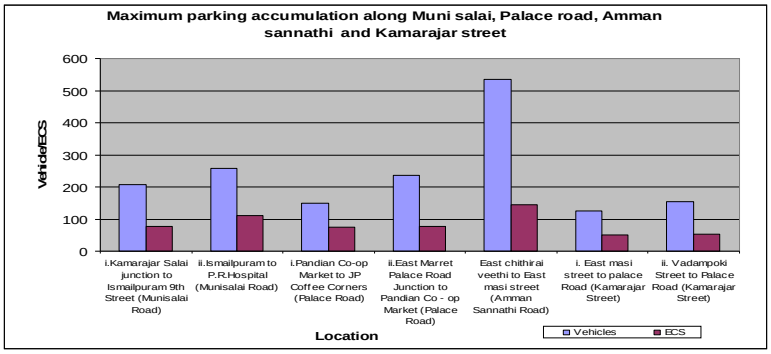

Fig.11 Maximum parking accumulation at Muni salai, Palace road, Amman sanathi and Kamarajarsalai

G. Off Street Parking Facilities

*1) Railway stationparking:*The area covered is 360sqm and it was operated by Public party through southern railway, Not paved and marked facility. Only dedicated to 4W, Peak parking hours are between 6 to 10Am with average 40 no of 4w.

*2) Old Central marketparking:*This area was Central vegetable market before, Madurai LPA shifted the market from here and using this as a parking lot, especially for the Tourists who are coming to Meenakshi Amman Temple, Approximately 5000sqm area hosting daily averagely 400to 600 4W. Accumulation depends upon the season and duration. Prizing policy is fixed by the authorities, and the rates are Rs.35/12hrs, Rs. 60/12hrs. Area is not paved, and lane marked. Figure 12 shows Off street garage lots.

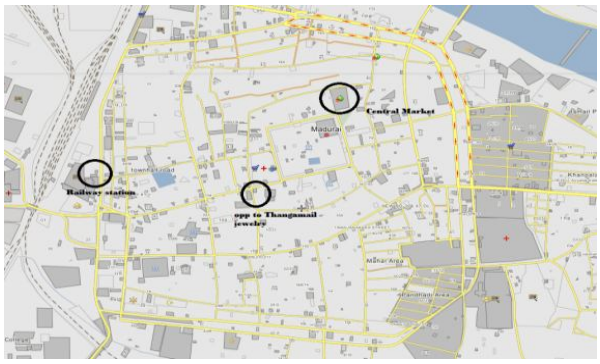

Fig.12 Off street parking facilities inside CBD area

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H. Findings

1) Parking is observed to be one of the major problems in the CBD of Madurai city, because of large scale wholesale retail and religious activities
2) All the streets surrounding the temple are being used for parking indiscriminately without any defined space for parking.
3) Parking demand is approximately 200% more than actual supply on-street condition.
4) More than 50% of the road space on all streets is utilized for parking and the rest is utilized for movement of vehicles along with the pedestrians.
5) On many streets, the available pedestrian path way is negligible because of encroachment by the shop keepers exhibits
6) Parking fees is collected at flat rate basis, Rs.10 for Two wheelers, Rs. 30 for cars irrespective of the duration of parking.
7) Private shopping centers and traders are well aware of the Importance of parking Provision
8) There are no sign boards leading to parking facility anywhere in the CBD area.
9) Illegal parking regulations and enforcements are carried out by Traffic police of the city.
10) Most of the on street parking are free of charge, this motivates the commuters.

VII.CONCLUSION

A. Summary and Conclusion

From detailed study of literatures it is understood that applying Information and communication technology into Transportation engineering especially parking management for Madurai city need a fresh start from the scratch. Regional wide ITS architecture has to be implemented including data archive, communication and commanding center. (Vanajakshi, Ramadurai, & Anand, 2010) It will be a green field project which requires huge amount of investment and coherent cooperation between various institutions like City Corporation, Local planning authority, PWD, Research Institutions and other stakeholders

Here comes the state of art parking management techniques which is so efficient and promising for the city, which is having so much of heritage. Some of the techniques were identified as a part of this study. Surplus supply and data dissemination alone cannot solve the issues in the CBD area of the city. Introduction of new facilities, Integration between facility and On-street parking plays important role to manage parking management. This conclusion from this study motivates to concentrate on other state of art techniques, parking solution have to be designed differently and conjoined with other demand management measures to make a difference.

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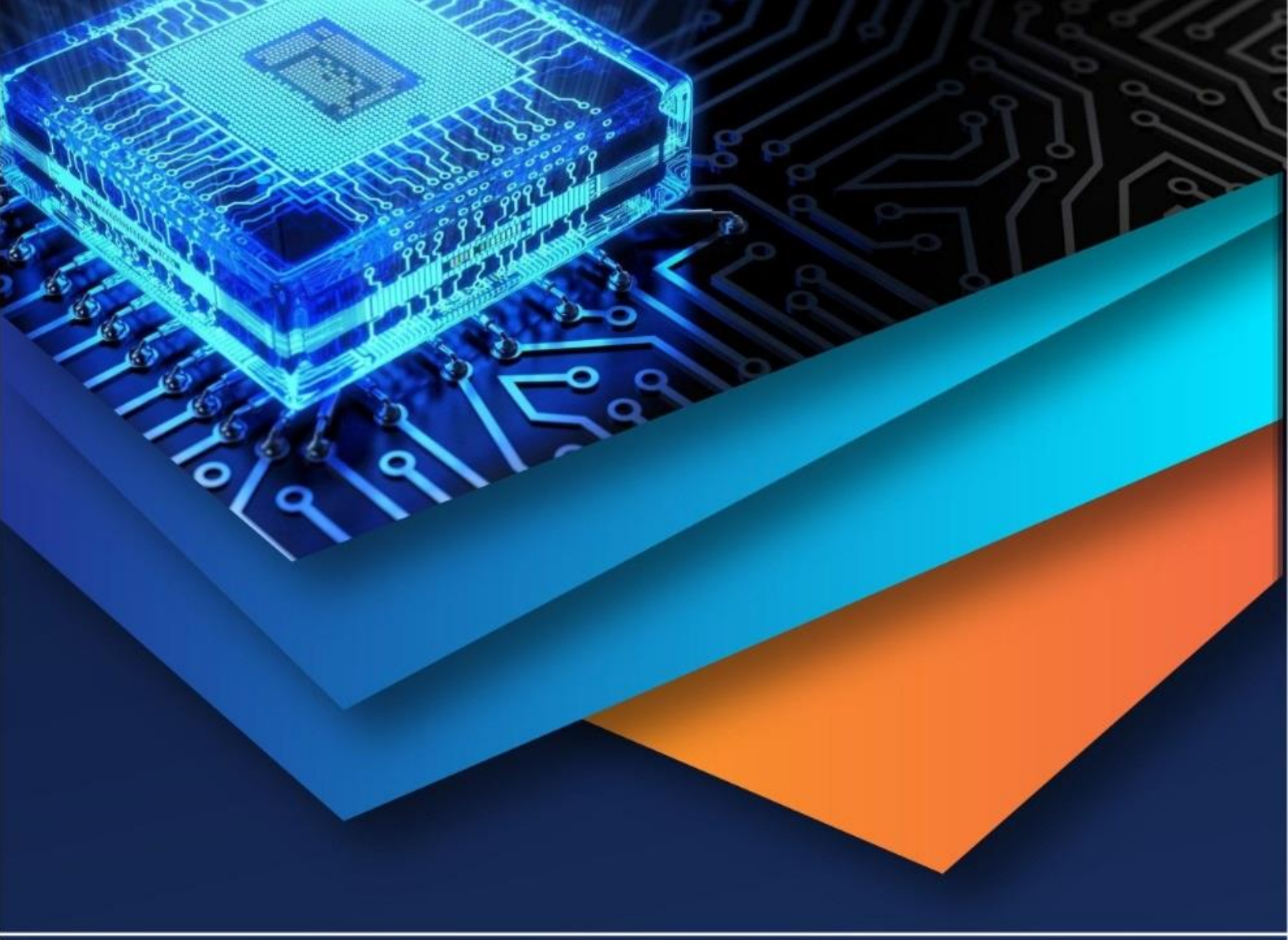

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