International Journal of Marketing and Management Research
Vol. 7, Issue 10, October 2016, Impact Factor; 4.596 ISSN: (2229-6883)
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A Critical Analysis to Traffic Management System

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Abstract: Congestion is a difficult issue to tackle in cities where vehicles are constantly increasing faster than the available infrastructure for traffic support. This problem affects many facets of contemporary society, including economic growth, transportation accidents, greenhouse emissions increases, spending time and health problems. Modern communities can therefore rely on the system of traffic management for minimising congestion and its adverse impacts. A number of application and management tools are included in traffic management systems to enhance traffic systems' overall efficiency and safety. Furthermore, traffic management systems collect information from heterogeneous sources to overcome this problem and utilise this information to identify risks that could impair traffic efficiency and give services for controlling traffic effectiveness. This article provides a classification, review, challenge and prospects for implementing a traffic management system, considering this issue.
Keywords: Traffic Management Systems; Congestion detection; Route suggestion; Traffic efficiency.

Introduction:

Fast mobility is one of the most fundamental necessities in modern civilisation. People can therefore use various transit facilities, such as cars, metro and bicycles. However, automobile vehicles are still the most popular of these transit installations because of their convenience and practicality. In this fashion, assuming a continued population growth, the number of automobiles in large cities will expand as well, but much faster than transportation infrastructure; accordingly, traffic congestion will become an urgent issue. It produces a lot of negative environmental and social concerns, such as increased traffic accidents, economic repercussions and excessive carbon emissions.

Traffic congestion may have three primary sources, according to the U.S. Department of Transport (DoT). The first relates to events affecting traffic, such as incidents, working areas and severe weather. The second concerns traffic demand, meaning that typical traffic and exceptional events are subject to changes. The last source is the traffic control infrastructure and physical bottlenecks. The transport infrastructures. Furthermore, these bottlenecks account for 40% of the total traffic congestion and traffic events, such as car accidents of 25%, terrible weather conditions of 15%, work zones of 10% and inadequate signalling time, special events of 5%.

In this approach, many cities rely on traffic management systems (TMSs), which attempt to alleviate traffic congestions and their associated problems, avoid traffic congestion, and increase traffic efficiency overall [3]. TMSs consist of an array of applications and management tools for integrating technology for communication, sensing and processing. In short, TMSs collect traffic information from a variety of sources, including automobiles, traffic lights and roadside and on-road sensors. In addition, a number of traffic dangers can be discovered and therefore controlled by aggregating and co-operatively utilising traffic-relating data (for example among vehicles) or in a cloud-controlled traffic management centre (TMC) and ensuring a smooth traffic flow [1].

The Vehicle ad hoc networks (VANETs), which exchange data between vehicles, roadside units (RSUs), and TMC, are one of the building blocks of TMS. In VANETs, mobile nodes with an OBU that features embedded sensors, processing devices and wireless interfaces in which vehicles can connect to build an ad hoc network are mobile nodes (Figure 1). VANETs rely on dedicated short-range communication (DSRC), expressly created for this purpose, to support these communications. However, RSUs are unnecessary, they can be used to improve network capacity, better administration and access to the Internet and other communication technologies such as 4G and long term development (LTE).

But focussing on handling and dealing with the associated problem of traffic congestion, numerous TMSs have been developed that focus on speed adjustment of cars to reduce the time spent in traffic lights, detect traffic congestion, prevent it, and recommend alternate routes [2]. Successfully, since road congestion is a daily worry, researchers from several fields developed TMS. However, difficulties remain to be addressed. In this way, this paper aims to present a study that provides researchers with in-depth information about the main foundations and obstacles of the TMS from communication to application. Thus, (1) an extensive overview of state of the art in TMS, (2) an in-depth classification, evaluation and qualitative analysis of specific TMS applications and (3) the main obstacles and future perspectives are the major contributions of this work. The rest of this essay is as follows structured. A TMS summary can be found in Section "TMS'.' We give the classification, review and qualitative analysis of certain associated TMSs in the section "A classification, review and qualitative analysis of TMSs.' The "Difficulties and Potential Outlook" section presents some open challenges and future prospects for TMS. Lastly, the article is closed in section "Conclusion'.'

Traffic management systems(TMS):

Two communication types can be activated in TMS thanks to VANETs. The first is communication between vehicles (V2Vs) utilised when cars communicate with each other without infrastructure. The second is communication via vehicle infrastructure(V2I), when a vehicle must send or ask a central body for information and also when a vehicle has to access certain Internet content. Furthermore, for any sort of communication, several communications technologies might be utilised. The two most frequently utilised are the IEEE 802.11p protocol pile (DSRC) for short-range communication and the V2V, and the LTE for long-range communications and V2I communications.

The general architecture of a TMS consisting of vehicles capable of collecting traffic-related data via its OBU and of forwarding such data to nearby cars using V2V communication, or using V2I communications to send those data via an access network to an RSU or central entity (e.g. cloud-based TMC). As for vehicles, RSUs can gather traffic-related data and send it to the cloud for use, as well as on-road and roadside sensors. This connects the core network to the cloud, providing several critical features, including aggregation, authentication, switching and routing. Moreover, many other sources can supply cloud data via the core network to improve TMS services.

TMSs can deliver services that can increase traffic efficiency and safety and reduce traffic incident response time by using traffic-related data. For the provision of such services, the TMSs are reliant on three main phases: (1) the collection of traffic-related information from heterogeneous sources; (2) the processing of the information that is based on the collection and processing of data received by the traffic system for further identification of traffic dangers potentially degrading the efficiency of traffic;

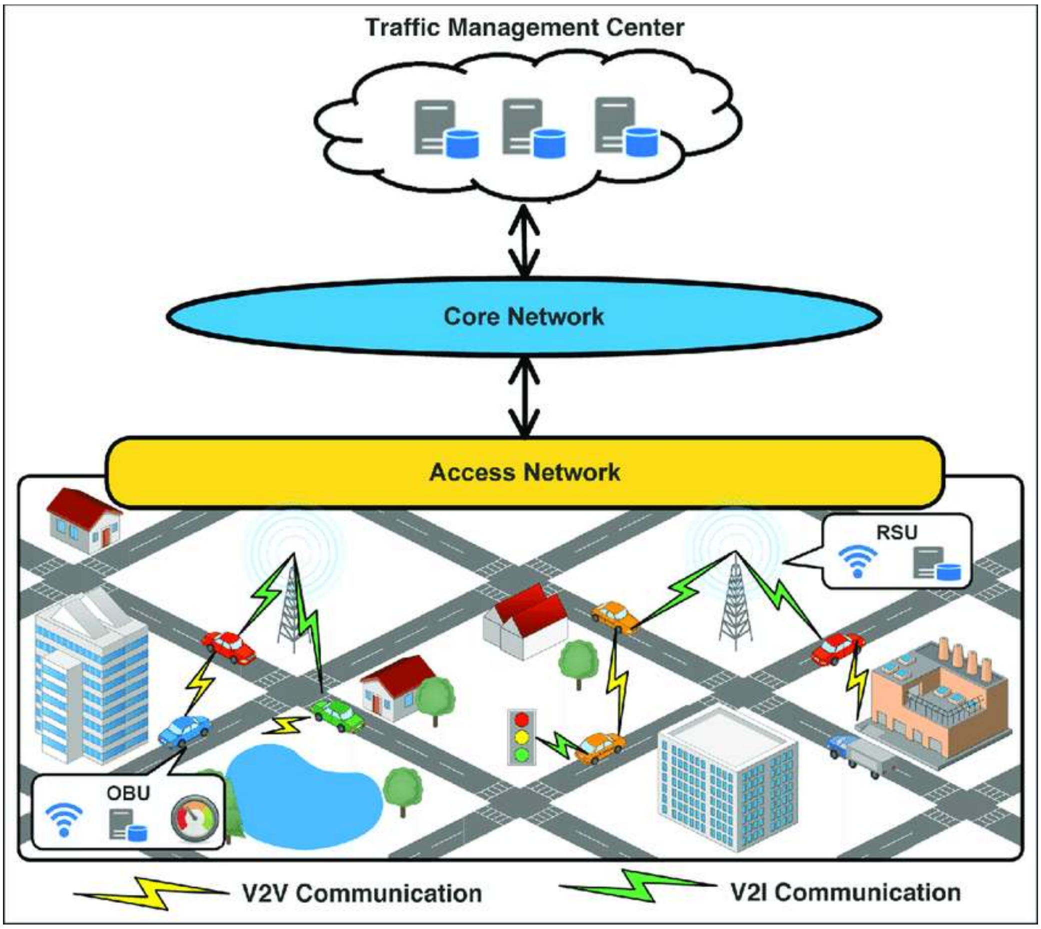

Figure 1: TMS architecture presents the most important composing entities.

Infrastructure-free TMS:

Bauza and Goza'lvez are proposing a new cooperative vehicle system based on V2V communications for detecting traffic congestions utilising fuzzy logic: Coopérative Traffic Congestion detECtion (CoTEC) [4]. To transmit the traffic condition regularly, CoTEC uses cooperative awareness messages (CAMs) or beacon messages. CoTEC also employs fluid logic to detect a potential congestion of traffic on each vehicle locally. Based on the level of service (LOS) in the highway capability manual, the fuzzy logic system was developed (HCM) [5]. The LOS represents an operating conditions measurement in a traffic flow. Thus, when a traffic jam is discovered, the vehicle first transmits their own estimates on the jam, and then cars collectively identify and characterise the traffic bottleneck.

Similar to CoTAC, Araujo et al. are proposing a solution for collaborative identification and reduction of congestion in transportation, Traffic Identification and Minimization Congestion (CARTIM). Same as CoTEC, CARTIM co-operatively measures traffic congestion levels through the use of V2V communications. CARTIM periodically collects information from cars (speed and density) transmitted by all vehicles beacons and can measure the congestion level using a fluid logic system [6]. However, despite the use of CARTIM and CoTEC, the rules are constructed using a variety of HCM metrics; hence CARTIM and CoTEC vary in the fugitive logic rules and the mechanism for spreading local traffic measurements over the network. In addition, CARTIM suggests a heuristic change in traffic congestion when a traffic congestion is observed to reduce the amount of traffic congestion detected. UCONDES, which is based upon V2V communication to identify and relieve congestion in urban sites, is introduced by Meneguette et coll. Meneguette et al. UCONDES is based on an artificial neural network (ANN) that detects and classifies congestions on the highways, different from CARTIM and CoTEC. UNCONDES uses average speed and current road density to identify and classify traffic congestion by periodic beacons spread by road vehicles. The current input road speed supports the ANN developed by UCONDES and density and the output is then the current road congestion level. UCONDES provides three levels of congestion: free (subject to the output of 0:3 or below), moderate (exit of 0:3 and below 0:7) (output is greater or equal to 0:7). The road rating is finally sent by beacon messages to the vehicles. In addition, when a vehicle receives a message about road classification, its classification is confirmed and the vehicle receiving a message in case of congestion checks if it will pass along the road, and a process applies if necessary to prevent such route [7]. However, UCONDES does not provide a removal process, and the network may be overloaded, therefore imposing unwanted overhead in high-density circumstances and reducing efficiency.

Infrastructure-based TMS:

Rakha and Kamalanathsharma present an ecodriving concept that relies on V2I connections incorporated into light intersections as a smart light application (ITLs). This report aims to improve fuel utilisation and decrease CO2 emissions by minimising the time spent on road traffic. In order to maintain optimum fuel usage and prevent delays in traffic lights, each vehicle changes its speed. Thus, the eco-driving model sends the vehicles entering the coverage and approaching the traffic light, where the actual traffic light condition, the time of the next phase, and the line's length at the crossing called the Signal Phasing and Timing are all these information (SPaT). When SPaT data is received, vehicles instantly use the VT-Micro model and calculate the ideal speed. For numerous possible speed profiles, the VT-Micro model estimates and determines the optimised fuel consumption.

Wei-Hsun Lee et al. is now offering the finest economic vehicle ideas for a Decision-Tree based Green Driving Suggestion System (DTGDSS), which aims to reduce carbon emissions based on a decision-making tree. DTGDSS assumes, thus, that every traffic lamps have a built-in RSU with the speed, location and direction of the vehicles. Furthermore, on receipt of this information, the waiting queue length at each intersection is calculated by the RSU, which may be compared in each direction with the last stopped vehicle. In addition, the current phase of the traffic, the time and length of the waiting lines, is transmitted by each RSU. Therefore, the RSU can calculate the suggested speed on the basis of a decision tree when a vehicle gets a broadcast. The recommended speed is utilised to reduce the queue duration and maximise the average cycle time. In order to define the recommendation, the decision tree is also arranged as a sectional tree, including free-flow speed, front car speed, speed maintenance, brake paddle free, front-wheel drive and front car drive speed and free gas pedal or front-wheel drive brake.

Pan et al. offer three traffic rerouting solutions designed to be implemented into a cost-effective car guide system to decrease traffic jams and related concerns. In reaction to newly obtained guidance, cars can thus collect data linked to traffic in real-time and adjust their routes. In addition, this system consists of a centralised traffic monitoring and routing service and vehicle software stack for periodic traffic-data reporting by means of a V2I communication (position, speed, and direction). The traffic guides system work in four-phase periods: (1) the collection and representation of data, (2) the detection of congestive traffic, (3) rerouting vehicle selection and (4) alternative route computation. The data collecting and display phase display the network by means of a graph in which the vertices match junctions, the edges match the roads sections, and weights correspond to the average journey period. The detection phase on traffic congestion regularly monitors the signs for congestion on all road sections. In the vehicle selection stage for rerouting, the system selects the adjacent vehicles for rerouting when a road section shows signs of congestion. The alternate route computation step calculates alternative routes for vehicles chosen previously. Three different procedures are remarkably proposed for the calculation of alternate paths. (1) Dynamic Shortest Path (DSP) is the traditional routing approach that calculates the lowest travel time route; however, it could lead in other places to congestion. This approach aims to reduce the possibilities for creating congestion within a different area, a deficit that is identified in the DSP. However, as the route selection is carried out randomly, the choice of longer routes for the vehicles is possible, the selection of long routes is reduced. (3) Entropy Balanced k Shortest pathways (EBkSP) is an upgrade to RkSP by taking into consideration the impact of each selection of the future density of the affected traffic segment and by making a smarter route selection [8].

Challenges and future perspectives:

The key open difficulties in TMS and the prospects are presented in this section.

- **Heterogeneous integration of data**

Although TMS can increase its overall performance by the data integration of different sources, this remains an open problem. This integration is the biggest challenge since we are equipped with many different systems and sources without integration, delivering tremendous data without uniformity. In addition, as new technologies such as the Internet of Things (IoT) will allow a large number of daily devices to trade their data and communicate, it is vital to leverage these devices to transform the paradigm of data collecting into a new paradigm. With this integration, however, there will be numerous more issues, including the tracking and management of the large number of devices involved [9]. Today's outstanding problems are: how to identify and generate new techniques for device identification; how to use these identification as forwarding addresses and route information, and how to use an IoT-based TMS Identifier. The information collected from these devices may finally provide the owner with private information and since this information could be attacked, a safe technique is necessary for the protection of this information.

- **Data management and big data issues**

A large amount of data must be handled by TMSs. Therefore, a standardised is needed in data representation once various problems develop if the data is measured and formatted independently by every source. In addition, numerous sources can report their data asynchronously; therefore, how to deal with such a matter is a major concern. Moreover, because of the non-integration between various systems and sources, in which data in multiple systems can be provided from the same source, the data correlation is another difficulty. In other words, data accounting can be wrong since separate systems are autonomous. The problem, however, is how much data can be linked to a single source. TMSs also need advanced systems for the fusion, aggregation and exploitation of data to deal with multiple types of data provided by heterogeneous sources. But, since present models and algorithms for large data are physically and conceptually dispersed but virtually centralised, the biggest obstacle is how to employ such large data problems in a vehicle setting.

- **Representation of traffic conditions and identifying dangers**

Following data use, the knowledge collected from the data must be correctly portrayed to represent the true traffic situation;otherwise false positive or misinformation can occur. Thus, the main issue is how much distinct information can be converted into a single representation of traffic conditions. In other words, what information is about the traffic and how it is going to affect the traffic? It's still a huge problem to provide such a representation. In addition, various TMSs were proposed in order to recognise traffic dangers to cope with such representations. Many are, however, ineffective or unable to spot such risks as soon as they happen. This enables it to recognise these dangers using predetermined intervals. However, how is this identification the best-predetermined interval to be tested; because TMS may not acquire sufficient information for identification at a little interval? Otherwise, the TMS can recognise the risk much later than its occurrence at a large interval. Another problem concerning the risk identification procedure is that which results better in a timely manner and which information is used in this process still constitute a major problem.

- **Alternative route guidance**

The best methods for enhancing the overall traffic performance are suggesting and computing alternative routes to avoid the dangers of transport. Nevertheless, the primary difficulty is how to ensure that the unwanted overhead is not brought into play and that the vehicles are not held in certain congestion in an appropriate time. While relying on central companies to calculate and suggest alternative pathways of all vehicles (Central approach) is more efficient because of their better management and scenario outline, the complexity of the algorithm used for the calculation of alternative roads could lead to significant overhead and degrade their performance, depending on the number of vehicles to be redirected. One option is to let each vehicle to calculate its own alternate path with this difficulty in mind. However, the main difficulty is how to provide a thorough perspective of the conditions of traffic for each vehicle so that it can calculate an effective route without overloading the network. Another issue is calculating an effective alternative route shortly and improving the balance and management of traffic in other locations without incurring congestions. This means a balance between efficiency and complexity is required if there is to be effective alternate path guidance.

- **Security and privacy**

In all concerned individuals, transportation agencies, government, and so forth, the privacy and security of information in the TMS is crucial. Given that the data may include personal information and potentially track persons and cars, a fundamental concern is for hostile groups to add or alter services-generated notifications, leading to problems like bogus alerts. VANET is one component of TMS. For the protection of safety and privacy of VANETs, certain needs must be achieved according to Parno and Perrig and Raya and Hubaux. Checks the lawfulness and consistency of the messages in order to avoid messages with malicious information. Availability ensures that the system operates continuously even under attacks (e.g. DoS by jamming). Even via the use of security technologies, real-time limitations focus on keeping communication and efficient computing. Authentically, messages are legitimised. The increasing trend of cloud computing employing TMS also increases the complexity of maintaining system security, as fundamental cloud computing security issues are also incorporated into TMS.

Conclusion:

The criticality of the transport infrastructure monitored by such systems still makes improving traffic efficiency a very active and demanding subject of research. In this article, comprehensive TMS research was conducted to highlight key issues and weaknesses in existing systems and provide guidelines for increasing the TMSs. First of all, we have provided an overview on the state-of-the-art at TMS, which outlined the three key phases of TMS: information collection, information process and service provision. We also suggested that TMS services should be thoroughly classified and examined according to the structure and purposes. A qualitative analysis on the basis of TMS mentioned was also performed. Finally, we presented our vision to increase efficiency and robustness of TMS in order to achieve the needed degree of accuracy and traffic control, which relies on open challenges. In addition, some potential approaches to fix it have been found and explored.

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