Advances in Nonlinear Variational Inequalities
ISSN: 1092-910X
Vol 26 No. 4 (2023)

Neutrosophic Set Based Traffic Mechanism Organization

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Article History:

Received: *14-08-2023*

Revised: *10-10-2023*

Accepted: *22-10-2023*

Abstract:

Managing traffic on roads has been a major issue for the transportation industry for a long time. As the number of automobiles continues to rise and new high-capacity road infrastructures in major cities are difficult to implement, reducing this risk has become a challenge for the scientific community. Increased pollution, financial losses, and a general decline in quality of life are all caused in part by traffic congestion. Thus, researchers are being challenged to deal with the difficulty of producing efficient and seamless traffic flow. Decision-making issues in the real world, like those in traffic management, are, nevertheless, constantly riddled with ambiguity and indeterminacy. Researchers have lately sought to employ different neutrosophic ways to handle the traffic congestion problem, and have found that the neutrosophic environment is a useful tool for dealing with these sorts of issues. This article presents a high-level summary of the most current neutrosophic strategies used to manage traffic congestion and other transportation issues. The study's goal is to provide a synopsis of the existing neutrosophic traffic flow difficulties and their development so that future researchers may better distinguish between the primary problems to be managed and identify circumstances to be optimized.

Keywords: Fuzzy set, Neutrosophic set, Map, Traffic, flow control, IVNSS, Interval set.

1. Introduction

Traffic management in metropolitan areas has been the focus of transportation studies for quite some time. Congestion is a major problem that has far-reaching, negative consequences for drivers and traffic managers. Although much effort and study have been put into reducing traffic congestion, the situation keeps getting worse. The sluggish expansion of transportation infrastructure and road capacity, along with the skyrocketing growth of urban and rural population rates, is directly responsible for the rise in the number of cars on the road. Because of this, providing a safe and healthy environment for people necessitates immediately addressing the issue of traffic congestion. The road traffic management system makes several instantaneous determinations in order to control the flow of traffic. The proposed models are unable to deal with the current real scenario as it involves ambiguity in traffic flow characteristics owing to various uncontrollable causes. One example is that, at any given moment, the exact number of cars in a certain lane cannot be determined. There is also no foolproof way to deal with the origins of occasional traffic jams, such as the abrupt occurrence of accidents or other events (see Figure 1). In light of this, the use of fuzzy logic controllers in traffic management is warranted. Since it simulates human perceptual and cognitive processes grounded on language information, the idea of fuzzy set has found widespread use in issues involving ambiguity and vagueness. The foundation for the neutrosophic approach was laid by the expansion of fuzzy logic and its offshoots. By allowing both the expression of erroneous membership information and the management of indeterminacy, it goes beyond both the fuzzy set and fuzzy logic. Consequently, it can deal with the ambiguity and imprecision associated with traffic movement on roads, which fuzzy logic may overlook. The following is the structure of the next section of the research. The core ideas discussed in this study are presented in Section 2. In Section 3, we show some of the approaches to road traffic issues that have been published in the scientific literature and are based on the Neutrosophic sets. Different approaches are discussed, and then compared and contrasted in Section 4. This short analysis is brought to a close in Section 5, where the primary difficulties and potential future developments are presented.

Congestion in urban road transportation networks is a concern in both developed and developing nations. See Figure 1 for a breakdown of the structure and organization of some of the sets. Congestion in urban areas causes delays in travel and increases pollution levels. The positive effects on the economy and the environment from reducing congestion are clear. Signal management at urban junctions is an efficient and crucial means of reducing traffic congestion. When there is a conflict between two or more directions of traffic, traffic lights are installed at intersections, pedestrian crossings, and other similar areas. Improved traffic safety, reduced congestion, increased flow capacity, and reduced delay are all goals of traffic light signal management, which aims to achieve these goals without resorting to the costly and impractical practice of constructing brand-new roads wherever they may be needed. Time sharing is a solution for resolving traffic problems caused by opposing traffic flows. A traffic signal's benefits include the smooth flow of traffic, the ability to accommodate more vehicles at the junction, and the minimal amount of geometry needed to implement them. However, significant waiting times are a drawback of the signalized crossing. To reduce congestion and delays at junctions, traffic signals are often utilized. Traditional traffic control techniques include both the use of hand signals by police officers and the use of signals and markings on the road. As studies have shown, conventional traffic control systems may add to junction congestion if not implemented correctly. Without considering the peak period or substantially variable traffic intensity over time, fixed time traffic light controllers have the lights change phases at a consistent cycle time. Congestion is exacerbated by pre-timed traffic lights, which are unable to gauge the volume of cars approaching a given intersection and hence fail to give priority to vehicles waiting in adjacent lanes. Uncertainty plagues current models of traffic signal controllers for a number of reasons, including a lack of understanding of the issue, faulty or missing data, poor forecasting, and undefined limitations. To address this, we created a model for controlling four-way isolated signalized junctions using a neutrosophic soft set with interval values.

2. Related Works

The term "computer simulation" refers to a digital model of a real-world system or event. This method includes translating the mathematical model of a system into code that a computer can execute. This part's primary job is to assess the system's efficiency in different contexts and propose improvements. The proposed IVNSS traffic signal management model may be compared to the standard pre-timed control on a variety of different MOEs (Measures of Effectiveness), such as delay, level of service (LoS), average queue length (AGL), maximum AGL, number of pauses (STOPs), and vehicle through put. The efficiency metric in this example is the time it takes vehicles to reach the intersection. The time it takes a vehicle to cross a signalized intersection is regarded as the single most essential metric by transportation experts. Delay is a challenging statistic to quantify because of the randomness of the arrival and departure processes at the junction. However, there have been several efforts to model delay in order to detect it. Given the inconsistency and unreliability of the data at hand, we discovered that the rough set theory could be effective in analyzing the traffic flow issue. Therefore, a combination of neutrosophic set and rough is one of the useful techniques to intelligent traffic control employing red, green, and yellow lights. The suggested study has the potential to aid academics studying traffic flow, traffic accident diagnostics, and the hybridization of these fields. In an attempt to cut down on travel times, the Saudi city of Dhahran uses intelligent traffic management based on meta-heuristic approaches at isolated signalized crossings. To enhance LOS at the intersection, a genetic algorithm (GA) and differential evolution (DE) were used to optimize the signal timings plan. Travel delays were proven to be decreased by 15%-35% when utilizing GA or DE, compared to the baseline situation, resulting in a methodical approach to signal timings. When compared to GA, DE takes less time to converge to the desired function, but GA provides better quality solutions (in terms of least vehicle delay). The optimization results from TRANSYT 7F, a cutting-edge traffic signal simulation, were compared with the GA and DE cycle length-delay curves, proving the validity of the suggested techniques. Pre-timed bidirectional signal coordination, as well as the methodology and data that supports it, are investigated. There will be less air and noise pollution as a consequence of this. To improve traffic flow, cut down on delays at signalized intersections, and increase productivity, the team devised a methodology and simulation tools to coordinate traffic lights. Using a phase difference technique for signal coordination may shorten the typical gap between nodes. Here, we model the combined impacts of TSP and arterial signal synchronization at a single, unconnected junction. Through simulation analysis, we see how TSP approaches change the optimal cycle for different flows, and we provide a feasible way for establishing the optimal gap and the optimal time for the priority phase to become green. Volume affects both the size of the TSP gap and the duration of the first phase of green. Last but not least, the red truncation method has a better chance of success than the green time extension plan. The agent-based transportation simulation MATSim has made available its decentralized, adaptive signal control, which may be used in large-scale, real-world settings. Several lanes at a single signal, brief periods of congestion, the concurrent flow of non-conflicting traffic phases, and shorter overall green durations are only some of the more complex use cases that may now be handled by this updated algorithm. In this context, the merits and drawbacks of adaptive signal control are evaluated and contrasted with those of fixed-time and traffic-actuated signal control. It was also shown that the adaptive signal control behaves as a fixed-time control to maintain system stability even in the face of overload conditions. A novel approach to creating a real-time traffic signal controller that takes into consideration all possible incoming traffic flows has been developed using the fuzzy logic method (FLM). The goal of the design of this four-legged, split-phasing, three-action FLM was to accommodate a single connection (through, right, and left). The created model's efficacy and accuracy were tested using calibration and validation studies. The created FLM delivers the best solution for every possible combination of traffic flows during simulation, calibration, and validation, indicating its potential use in efficient traffic signal control. built and implemented a step-by-step strategy to improve a process' efficiency. Following an initial assessment, it was determined to further investigate CG Road, which had been highlighted as a particularly hazardous stretch. We were able to produce a precise map of the area, replete with measurements of significant geometric features, with the aid of both the odometer and Google Earth. Peak and off-peak traffic volumes were captured by cameras with a resolution at least four times greater than 1080p. In addition, trained enumerators gathered information on signal cycle time, space mean speed, and discharge head direction concurrently at each of the three junctions. With VLC's most recent release, we were able to retrieve the data and show it on the projector screen with ease. Microsoft Excel was used to analyze the gathered geometric and traffic data. Using a Time Space Diagram, we compared three alternative Phase Optimization Techniques (POTs) with real-world traffic signal data from a two-way corridor. To determine the most efficient means of traffic management, we ran a MATLAB simulation in a neutrosophic setting. Fuzzy Numbers in the shapes of triangles and trapezoids were used here. Using the MATLAB tool, we have analyzed the unpredictability of traffic flow management in a neutrosophic environment. They looked at the benefits of using crisp, fuzzy, and neutrosophic sets for traffic control and compared them. The authors propose a connected vehicle signal control (CVSC) system, which uses real-time information including the locations and speeds of GPS-equipped cars arriving from different directions, to enhance traffic flow at a disconnected crossroads. The suggested solution attempts to lessen the likelihood of a bottleneck forming during the red phase by separating incoming traffic from outgoing traffic. The VISSIM 8 microscopic modelling program was used to evaluate many traffic situations, including ones with complete GPS market penetration. The suggested CVSC system was shown to outperform the EPICS adaptive control in minimizing travel time delays and the mean number of stops per vehicle. The type-2 Schweizer and Sklar weighted arithmetic (TIT2SSWA) operator and the type-2 Schweizer and Sklar weighted geometric (TIT2SSWG) operator for triangular intervals were investigated. Having analyzed the most congested intersection, they developed a novel scoring method for interval neutrosophic numbers (INNs) to regulate traffic flow. We used MATLAB to perform the Gauss-Jordan technique on traffic flow management data in a neutrosophic setting. Different academics have come up with different theories of traffic-light control that work in a neutrosophic setting, as we have shown. However, the outcomes of these models have not been compared or analyzed.

3. Proposed Model

Here, scheme was proposed the exact solution for analyzing the traffic signals. Some of the datasets are taken into test and they started well to perform. Firstly, initializing the scheme by choosing, crossing and variation to the datasets then performing the evolution operation for taking the decision whether it is yes or not. Figure 2, define the flow of the proposed scheme in step-by-step process.

3.1.Flow of Traffic

3.1.1. Count of Volume

Vehicles' directional movements (through, right, and left) are counted to determine the volume, frequency, and composition of traffic on a specific stretch of road. Data like this may be used to pinpoint peak flow times. During rush hour, for instance, it could be useful to tally the number of intersections. The amount of traffic might be estimated by manually counting vehicles every 15 minutes. Equation (1) – multiply the length, breadth and height for getting the volume.

$$CV = L + W + H \qquad \text{-----} \quad \text{Equation (1)}$$

3.1.2. Capability

Capacity is an adjustment to the saturation flow rate that takes into account the fact that most signals do not allow one phase to move continuously for an hour. If the approach is given permission to operate for half an hour every hour, then its true capacity is around half the saturation flow rate. Therefore, capacity is the maximum hourly flow of vehicles that may be discharged through the junction from the aforementioned lane group under the current traffic, roadway, and signalization conditions. How to figure out how much space something has, in Figure 3, linear equation diagram for traffic control was listed properly. C – Capacity, Q - Charge and V – Voltage in Equation (2) for calculating the capacity

$$Q = CV \qquad \text{-----} \quad \text{Equation (2)}$$

3.1.3. Signalized Intersection

The justifications for picking these particular values are as follows. Individual performance at intersections is mostly influenced by delay and LoS. Delay reveals the distinction between free-flowing and congested traffic circumstances, while Line of Sight may be utilized to get insight into the overall quality of traffic conditions at a certain crossroads. Common to urban transportation is the need to stop often owing to congestion. For one thing, there are traffic lights at all the major junctions. That's why metrics like wait times and stops must be included in as well. The maximum number of cars that may be discharged in a given time period can be calculated using the vehicle throughput. As an added bonus, data on travel time, delay, and stops may be used to conduct a more in-depth examination of the arterial segment of the urban traffic network under consideration. The amount of time it takes for a vehicle to cross a signalized junction is the most crucial metric utilized by transportation experts. Perhaps this is because of the obvious correlation to the delay incurred by a car at a crossroads. However, owing to the indeterminate nature of the arrival and departure processes at the junction, delay is a parameter that is difficult to define. However, a great deal of work has been done in this area to characterize delay via a variety of analytical delay models. However, the Webster delay model has gained widespread acceptance and is now in widespread usage. In Equation (3), CPV – Critical Phase Volume.

$$I = CPV_1 + CPV_2 \ldots\ldots CPV_n \quad ----- \quad \text{Equation (3)}$$

3.1.4. Component of Delay

Yields a delay known as the "uniform delay." Here, the signal cycle always completes successfully, thus no cars are stuck waiting for more than one green light. When the expected arrival times of vehicles are all the same, we speak of a "uniform delay." Due to the fact that traffic is dispersed at random rather than being concentrated at discrete junctions, an extra delay known as "random delay" occurs on top of the standard delay. In this instance, we have a scenario in which the time frame under consideration is stable. However, there have been isolated instances of cycle failure over this time. It's important to note that at certain times, the delay isn't uniform; there's an additional component. We call this particular lag time "Random delay." Algorithms are structured, well-defined, and well-organized sets of steps.

Algorithm:

Input: Parameter Setup

Initialize the Population

If condition is true **then**

Calculate the sets

Else

Select the sets

End if

Decode the sets

Repeat for getting the best sets

Output: Best traffic signal sets

In table 1, all set values are analyzed and compared as per the functions. Flexibilities are handled step by step. There are few sets has so many benefits and disadvantages. They are segregated as per their functionalities.

Table 1. Analysis of sets with explanations

SETS	ANALYSIS
Interval Valued	A capacity for change and alteration. copes with a higher degree of ambiguity and uncertainty. Incomplete criteria weight information cannot be processed. Mistakes in computations may be rounded up or down. Equipped to deal with issues involving a

	single number or a set of numbers in the real unit interval.
Graphs	If both the starting and finishing positions are unknown, an optimum result is still achievable. Not able to handle any more unpredictability.
Interval Valued Graphs	Account for new forms of ambiguity uncovered in routes and vertices (edges). Disabled due to missing criteria weight data.
Single Valued	Capable of working with incomplete or contradictory data. Not as adaptable and practical as sets with null values.
Cognitive Maps	Allow for a relationship between two nodes to be treated as ill-defined No research has been done to compare the effectiveness of different models with regard to the amount of time users must wait. The generalizability to other kinds of traffic intersections is unclear.

4. Experimental Analysis

4.1.Simulation Parameter

In order to simulate vehicle arrivals and saturation flows, a Poisson distribution model must be performed using the input parameters (average arrival rate and average saturation flow rate for each approach each day). Then, using flow rat, do a uniform distribution simulation of the associated interval valued neutrosophic soft sets. Using model values of the interval-valued neutrosophic data obtained under five separate situations, we determine the green duration and cycle length for each approach. The stated method of producing random numbers is modelled in MATLAB. You may use these figures as shown in figure 4 to get the Saturation Flow Rate (IVNSS 'B') and Vehicle Arrival Rate (IVNSS 'A').

4.2.Delay Simulation

Webster delay equations are used to make a comparison between the outcomes of the IVNSS traffic signal control model and those of a conventional, fixed-time traffic signal. In a simulation, the average amount of traffic (the arrival rate) and the saturation flow rate are often produced at random using a Poisson distribution (queue length). However, we count the number of vehicles moving through the area every 15 minutes, starting at 7:30 in the morning, throughout the duration of this study. can quickly get the mean number of daily visitors (arrival rate) and mean number of people waiting in line (saturation flow rate), both of which are used as input parameters in the simulation. to 7:30 p.m. For the duration of one complete week. This takes up a whole six hours every day, from 7:30 AM to 10:30 AM, noon to 2:00 PM, and 4:30 PM to 7:30 PM. The traffic count is broken down into weekday and weekend categories, with the former including rush hour and high saturation traffic and the latter encompassing off-peak hours and lesser saturations.

Table 2. Session based Analysis

Phases/SG	PH	Scenario1	Scenario 2	Scenario 3
1	Morning	122	74.5	105
1	Mid-Day	92.8	108	121.4
1	Evening	90.6	203.5	83.2
2	Morning	112	67	135
2	Mid-Day	23.2	63	72.8
2	Evening	23.8	166.5	44.8
3	Morning	61	7.5	75
3	Mid-Day	34.8	54	85
3	Evening	19	166.5	6.4
4	Morning	61	82	120
4	Mid-Day	34.8	45	60.7
4	Evening	47.7	148	51.2

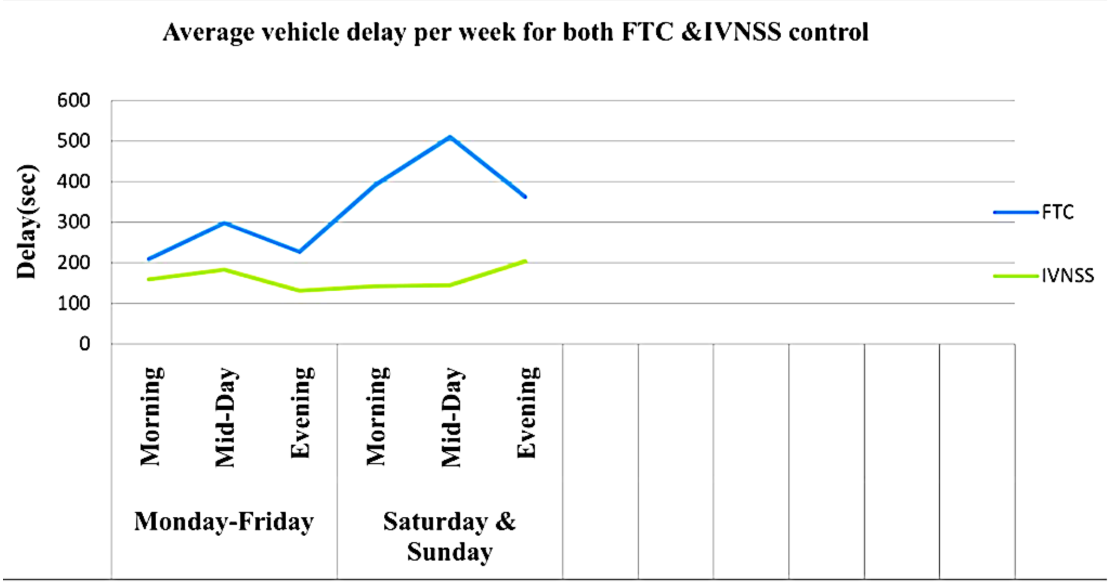

Figure 5. Comparison Graph

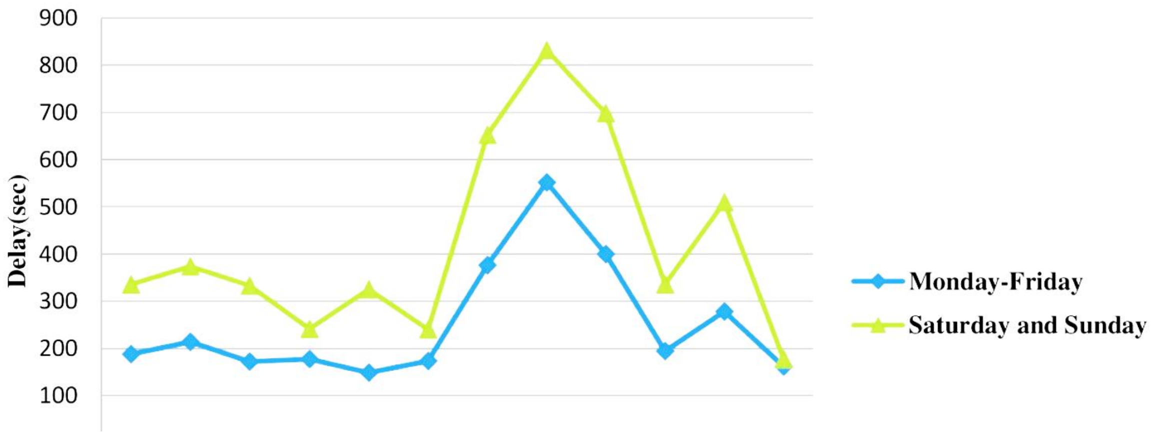

Figure 6. Day wise Analysis

In table 2, we have compared the scenario based values for day, week and month. Here some datasets have day wise and week wise entity. So values are segregated as per the elements. There are so many scenarios but due too comparison with existing system, we have defined so few for the solution. In figure 5, we can see the comparison of FTC with proposed model, has system have achieved the value with day wise datasets. In figure 6, day wise detailed comparison was listed. Finally proposed system was achieved the sets in organized manner.

5. Conclusion and Future Works

Road traffic management has been a pressing issue in the transportation sector for a long time. Poor air quality and longer commute times are two of the many negative outcomes of traffic congestion. Decision-making problems in the real world, like reducing traffic congestion, are constantly nebulous and uncertain. In light of this, the neutrosophic environment has been successfully used to deal with these issues, and recently, researchers have sought to deploy many neutrosophic strategies to deal with transportation issues. This study provides a quick overview of the literature on the application of neutrosophic logic to the problem of traffic management. The focus of the analysis was on different approaches to defining and bettering traffic patterns. The study surveyed numerous neutrosophic traffic control strategies and examined their strengths and weaknesses. Several studies have compared neutrosophic sets and logic to real-world datasets, proving their usefulness. The analysis of existing research indicates the existence of open questions that will have to be explored in further studies. The problems include I managing a large number of intersections concurrently to keep traffic moving smoothly, even during congestion, and (ii) evaluating the effectiveness of the developed model in comparison to existing models, specifically with regard to average vehicle delay, the primary metric for gauging the success of traffic flow at intersections. It's an exciting time to be a student of neutrosophic set theory (iii). However, measuring degrees of membership, falsehood, and indeterminacy in traffic flow metrics is difficult. Determining such levels is very subjective. It's possible that the insufficiency of the theory's parameterization tool is to blame for these problems. (v) At now, there does not exist a method for evaluating the robustness of neutrosophic controller systems. (vi) Most findings based on neutrosophic logic that improve performance rely on simulations.

Availability of materials and data

No datasets were generated or analysed during the current study.

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