ANALYSIS OF TRAFFIC ACCIDENTS USING GEOGRAPHIC INFORMATION SYSTEMS (GIS): A CASE STUDY OF THE CITY OF CONSTANTINE, ALGERIA

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ABSTRACT

Algeria has experienced both information and technological important revolution, in addition to the growing population in cities, and especially Constantine, the need to make appropriate decisions for solving many problems is necessary, including traffic accidents, which are one of the most worrying subjects causing anxiety to the inhabitants of Constantine and the Algerian society, these accidents have increased dramatically, causing the exhaustion of human and material resources. It has therefore become necessary to contain it by using systems that help support modern decisions, including Geographic Information Systems GIS, which are considered a tool with great potential in spatial analysis. In this article we will try to focus on the importance of spatial and statistical analysis of traffic accidents in Constantine, it is mainly to estimate their percentage, as we found through analysis models such as the neighborhood link and direction of propagation.....etc. a strong concentration of traffic accidents is located in the commune of Constantine, which has strong economic activities, and from there we find that there is a strong link between the movement of the population and traffic accidents.

Introduction.

Urban transportation has become an integral part of contemporary life, man has started to keep pace with his time in terms of speed and shortening of time and distances, and this requires means of transportation that allow him to spend his needs in different and multiple places, so transportation has

become an important part of the daily life of the individual, and this is due to the multiplicity of activities that he performs inside and outside his urban environment.

And through these trips that the individual makes to meet his needs, whether by car or using public transport such as buses or private cars, traffic accidents occur with disastrous consequences.

Traffic accidents are one of the most important problems facing countries around the world, as they have been increasing significantly in recent years, causing human and material losses, and many countries have worked to enact rules and laws to regulate road traffic for safety to reduce and mitigate dangerous phenomena. Traffic accidents can be linked to geographic locations where there is a concentration of population and economic activities, in addition to the concentration of road networks.

Algeria has experienced a tangible evolution in the density and volume of traffic on the roads. The progress recorded in the automotive industry and the road network in addition to the rapid development of traffic, despite its positive aspects, we found several other negative aspects, most of which were related to the problem of lack of road safety, and the lack of traffic education for drivers. With the existence of a direct relationship between the expansion of the transport network and traffic accidents, we contacted that the larger the road network, the greater the number of accidents.

Constantine, like other cities in Algeria, is experiencing an increase in traffic accidents, which has prompted the authorities to carry out numerous steps and research to reduce them, but these measures have not achieved the desired objective. This has led us to formulate the following questions: What is the contribution of GIS to reducing traffic accidents?

1. Method and tools.

To answer the main question and research problem, the study relied on the descriptive analytical approach to describe and analyze the state of the distribution of traffic accident points. the object of the study is constituted by: The National Directorate of Civil Protection of the city of Constantine, the National Gendarmerie Command of the city of Constantine, and the National police station for Road Safety), where statistics relating to traffic accidents were collected in addition to their locations in order to know the black spots, and we also found that the data obtained from official agencies did not agree, due to the different perimeters or regions of intervention of each agency, which led us to compare these data in order to arrive at a conclusion that helps understand the phenomenon.

After determining the location of the traffic accidents in our study, we used some statistical methods to analyze the data and draw conclusions.

2. Previous studies analysis.

the study conducted by Junaidi Helis and Hamza Sharif Ali (2019) through The use of geographic information systems to study the social variables of traffic accidents in Algeria (case of the cities of Setif, Djelfa, Tiaret), the study aims to investigate the existence of social or economic factors that can change the geographical shape of the map about traffic accidents, The results of the study showed that the distribution of traffic accidents on the ground of the cities of Djelfa, Tiaret, and Setif is irregular, and this is due to several factors, and the density of traffic accidents is located in the center of the cities because they are with a large population.

The study of Donia Shukr Al-Najjar (2019) spatially analyzed traffic accidents in the Middle Euphrates provinces, the occurrence of traffic accidents about the driver's age range, and the largest age group among drivers involved in traffic accidents is the group whose age ranges situated between (17-29 years), or at a rate of 47%.

The study of Haitham Ahmed Mahmoud Alwani (2018) concerned the spatial analysis of traffic accidents in Riyadh city using GIS. The study revealed that traffic accidents are concentrated in the southwestern part of Riyadh city.

Theoretical back and traffic accidents particularity.

Traffic accidents occur on the roads when a car collides with another car, person, or animal, or collides with a facility or other things. These accidents result in property loss, human injury, and death (Zanati & Benini, 2019, p .460).

It is also known that all collisions that occur cause accidents with one or more victims, including deaths or injuries, or material losses that are represented in personal or public property that belongs to the state (Boudarifa, 1991, p. 13).

A traffic accident can also be defined as an imbalance that occurs in the traffic system which includes humans, vehicles, and the environment. Any defect in these three elements will inevitably lead to a traffic accident, as traffic accidents are divided into physical and material accidents (Badi' ah, 2014, p 8).

Definition of GIS.

There are many definitions and concepts of GIS, but we can divide this definition as follows:

▪ Systems: a term that has recently become widespread to refer to the social, economic, and political system...etc. Like all systems, the word "System" represents the constituent parts of the system and the rules that govern these parts, how to deal with them, and their interaction with each other (Nawfal, 2021, page 9).

▪ Information: is the result of operations performed on data (statistics - texts and images in their raw form) such as selection, arrangement, and analysis according to a specific purpose, and therefore we can say that information is what can be extracted from the study and analysis of raw data (Daoud, 2014, p. 4).

▪ Geography: is a word with a Greek origin, which can be divided into two parts: Geo means land, and the spelling is deduced to describe the land in the form of an image, so from this point of view, geography is the description of the land or its image (Al-Shammari, 2008, p. 15).

GIS can be defined as "any sequence or arrangement of interdependent functions that perform the input, storage, processing and subsequent generation of spatial data".

The definition of GIS can be summarized in the following figure 1:
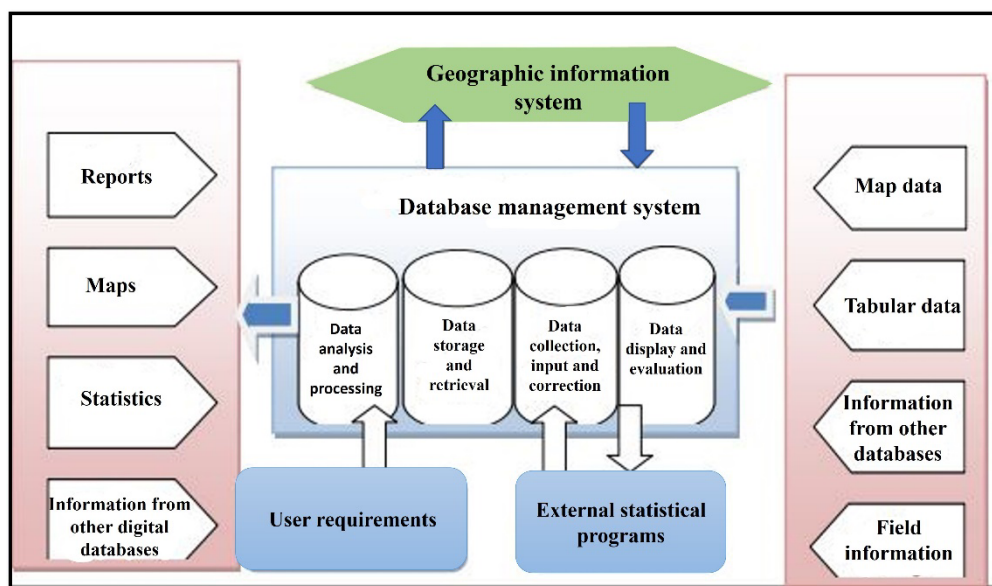
Figure 1. Inputs and outputs of GIS.

3. Presentation of the study area in Constantine.

Constantine is located in the northeast of Algeria, where it is considered the capital of the East, 245 km from the Algerian-Tunisian eastern border, about 431 km from Algiers, and 235 km from Biskra and 89 km from Skikda (Rahamniya, 2016). Its population is approximately 1.013 million in 2019. Constantine occupies an area of 2288 km².

It is located at 36.23 north latitude and 7.35 east longitude of the Greenwich line, composed of six districts and 12 municipalities. This is shown on Map 1:
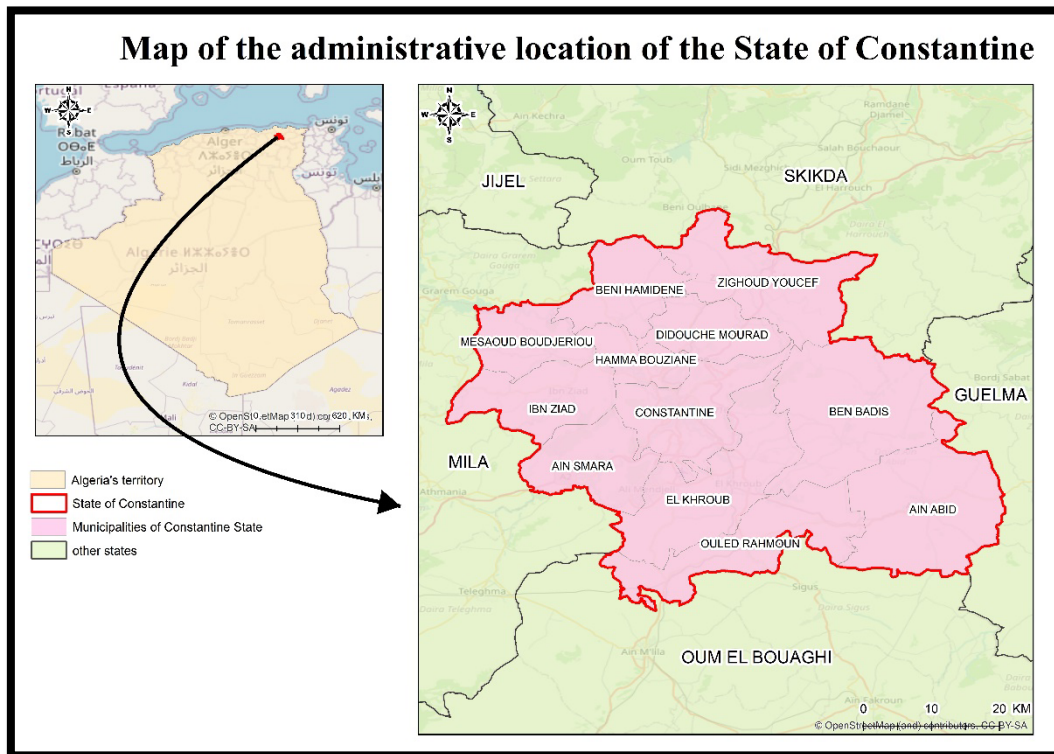
Map 1. Map of the administrative location of the city of Constantine.
Source: Author output based on ArcGIS 10.8.

4. Results and their discussion.
Spatial analysis of traffic accidents.

The geographical study of the phenomena concerns the knowledge of the geographical distribution model, in order to know the variables that overlap and influence this model.

The standard distance analysis.
The standard distance is an indicator of measuring the spatial distance or concentration of points of the phenomenon under study, the value of the standard distance is usually used to draw a circle called a standard circle, through which it is possible to know the extent of concentration or spread of the spatial dimension of the phenomenon under study, and the center of this phenomenon is the location (The coordinates of the spatial average, the larger the value of the standard distance and the larger the size of the standard circle, this indicates an increase in the spatial spread and dispersion of the distribution of the phenomenon and vice versa. (Juma Muhammad Daoud, 2012, p. 44).
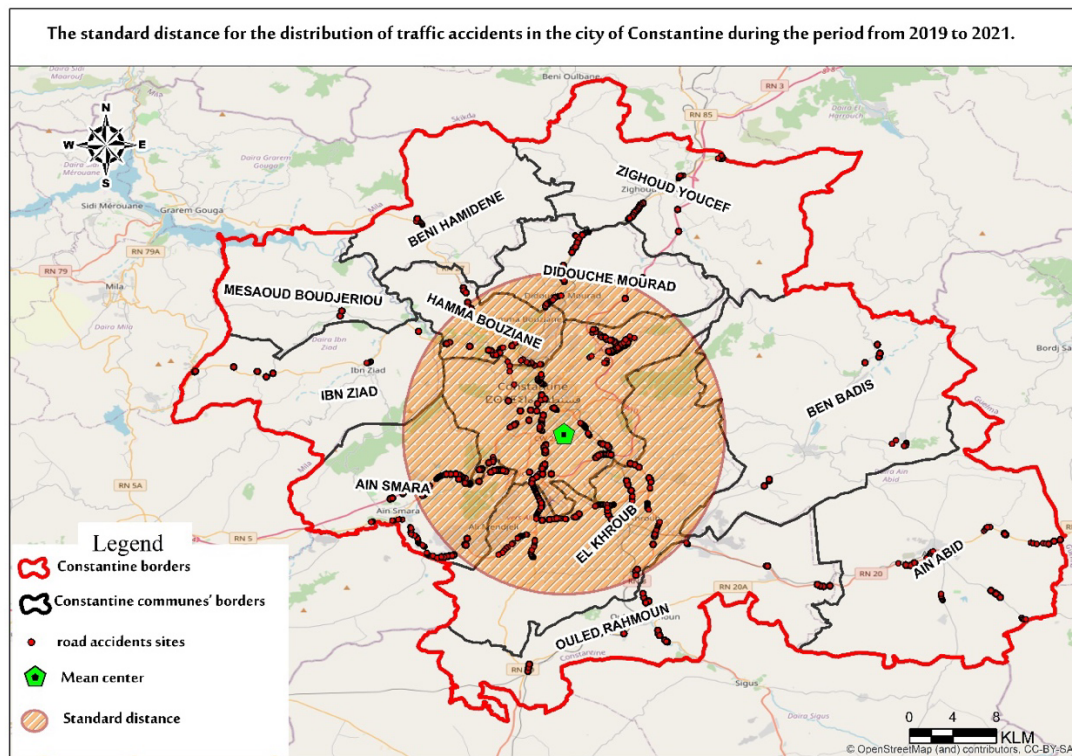
*Map 2. The standard distance for the distribution of traffic accidents in the city
of Constantine during the period from 2019 to 2021.
Source: Author's realization based on data from the national gendarmerie and the civil protection of
the city of Constantine with the ArcGIS 10.8 program.*

It is noted through the map 2 that the circular shape represents the standard distance for the distribution of the points of traffic accidents so that the center of this circle constitutes the average spatial center of the accidents, where we note the intensity of the accidents in the communes of Constantine, El Khroub and Ainsmara, and this at the level of each of the National Road n°03 and the East-West Highway, because it is likely that a large number of accidents is due to the important travel factor between these three municipalities mentioned above, in which are concentrated most of the public administrations, main markets, in addition to the daily travel of employees to workplaces and the density of existing roads within these municipalities with an urban character.

The radius of the standard circle was about 12 km, and the standard distance circle on a large number of traffic accident points was 74%, which indicates that the accidents are concentrated in the city center which witnesses a lot of movement.

The area of the circle of the standard distance was about 555 km², which is a fairly average area, or 25% of the total area of Constantine, where the area of the city was 2245 km² (this area is calculated by the program ARCGIS 10.8), and as a result of this analysis, which concluded that: Traffic accidents are collected in an average area of Constantine, this area represents the population density and the density of the road network in this standard circle.

This analysis helps the state security authorities to focus, especially in these areas that have an increased incidence of accidents, by intensifying surveillance operations through cameras - radar, and they can also develop modern technologies that help reduce these accidents.

Density Analysis.

Density analysis of phenomena points is one of the most important analyses in the study of traffic accidents, through which we obtain a surface map that contains categories showing the extent of change in the density of the distribution of traffic accident points across the city of Constantine, and through this analysis, it is also possible to know the number of injuries and the number of deaths in the city.

Through the ArcGIS 10.8 program, a layer of traffic accidents point is captured via the Density tool, and then the Density tool point, through which the density of traffic accidents is obtained in each municipality or each distribution point of traffic accidents.
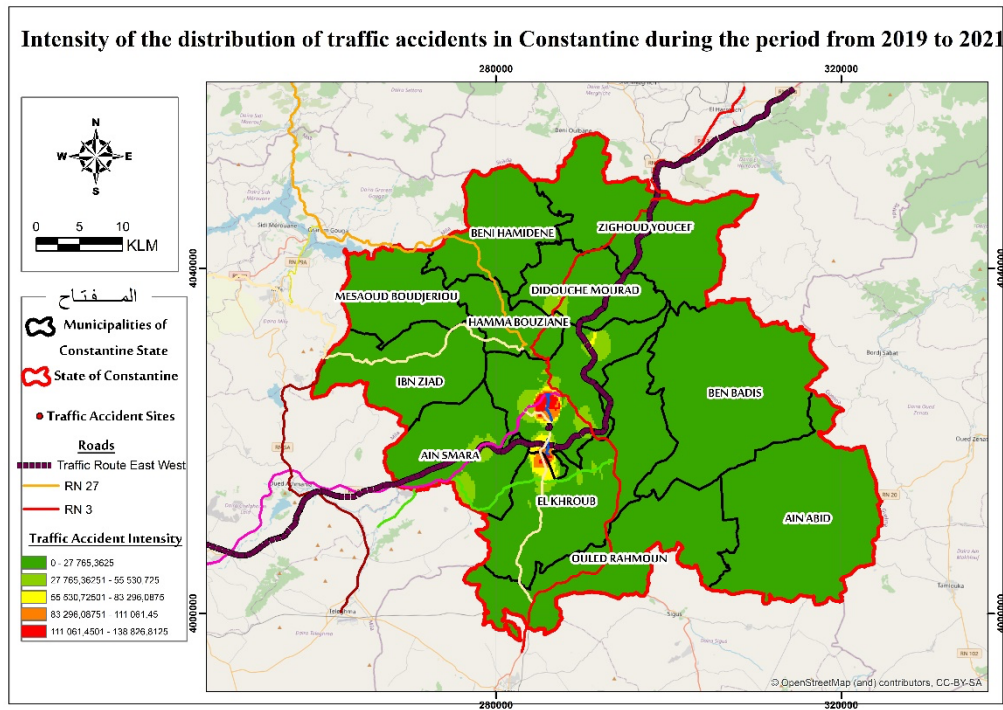
Map 3. Intensity of the distribution of traffic accidents in Constantine during the period from 2019 to 2021.
Source: Author's realization based on data from the national gendarmerie and the Civil Protection of Constantine city with the ArcGIS 10.8 program.

We note through the map 3, which represents the distribution of traffic accidents intensity in the city of Constantine, the red and orange colors represent the center of Constantine and part of the national road No. 03 adjacent to the airport Mohamed Boudiaf, in addition to the entrance of each of the new city Ali Mendjeli and El Kharroub town, the entrance to Didouche Mourad town, where these areas have experienced a high density of traffic accidents, this is due to the fact that the center of the commune of Constantine is overcrowded and that most public and governmental administrations and important services are concentrated there in addition to a large number of road junctions and the density of traffic in the road networks, it is expected that these traffic accidents will occur.

Also, most of the workers situated in the commune of Constantine, El Khroub, and Ainsmara, are obliged to go work in places far from their residence commune, which generates a daily displacement between the place of residence and the place of work, and this is what we have concluded from this analysis in the three large municipalities of Constantine in terms of population, it has an integration relationship, as a large number of these trips between these three municipalities creates a high density of roads and sometimes suffocating traffic jams, which leads to traffic accidents.

The yellow color is less intense than the red and orange colors because it is located at the level of the national road No. 101 connecting the new town of Ali Mendjeli and El Khroub, in addition to the section of the national road 3, which crosses the city of Constantine, the Hama Bouziane town, Didouche Mourad town and Ainsmara town.

The rest of the colors are represented by the green gradient, which is less intense for traffic accidents and distributed in the communes of Constantine.

The relationship of the intervention units of the civil protection with the points of traffic accidents.

We will apply the Buffer spatial analysis process to the traffic accident points distributed on the roads of the city of Constantine and their proximity to the intervention units of the civil protection, in order to facilitate the intervention process in case of traffic accidents, and therefore human losses can be reduced by accelerating the process of transporting the injured to the hospital, where we will create the most important sites for the locations of the intervention units of the civil protection of the city of Constantine, where the ranges will be as follows (2000, 4000, 6000, 8000, 10000, 12000 meters) and represented on the following map:
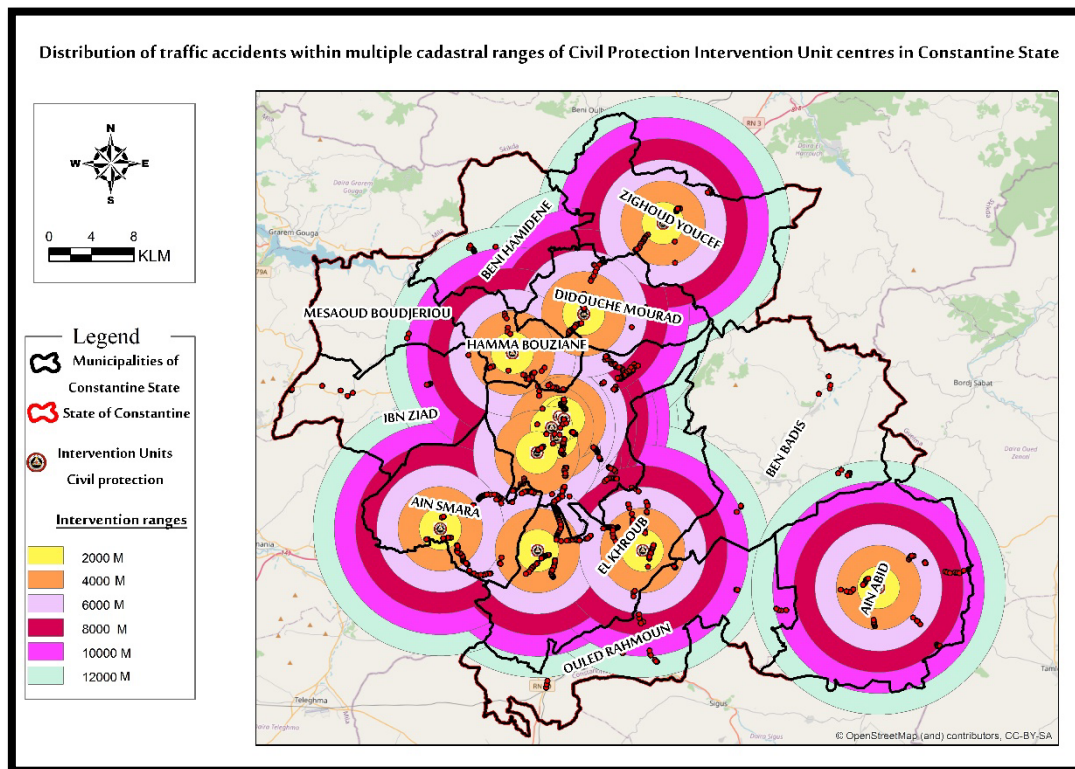
Map 4. Distribution of traffic accidents in the multiple spatial areas
of the intervention units centers of civil protection.
Source: Author's performance based on data from the civil protection + ArcGIS program.

Through the map 4 we see that the perimeter of the campus intervention units of civil protection, distant by 4 km, includes a large number of traffic accidents in the city of Constantine, where the percentage reaches 32%, While the two areas at a distance by 2 km and 6 km accounted for 28% of total traffic accidents, while there were some traffic accidents outside the areas that were specified at more than 12 km with a rate of 0.5%, and this is due to the fact that they are very distant from their intervention units. These accidents are found in the municipalities of Ibn Badis, Ibn Ziyad, and Ouled Rahmoun, and therefore it forces us to open intervention centers in these three municipalities mentioned above in order to cover traffic accidents at the level of the entire city.

Results:

- The occurrence of the highest percentage of traffic accidents in the commune of Constantine, is due to the fact that the commune has a large number of inhabitants and administrative facilities.

- The location of the spatial mean points and the central phenomenon of traffic accidents occurred in the commune of Constantine, and this is due to the concentration of accidents in this commune compared to the other communes.

- The intensity of traffic accidents distribution in Constantine is concentrated in the city center and part of the national road No. 03 adjacent to the airport Mohamed Boudiaf, in addition to the entrance to the new town of Ali Mendjeli, the commune of El Khroub, and the entrance to the commune of Didouche Mourad, as it is likely that the number of accidents is due to the factor of dense movement.

- The geographical distribution pattern of traffic accident points is a concentrated distribution in the center of Constantine.

Conclusion.

By conducting an applied study on some traffic accident points in Constantine in 2019, we have arrived at a set of results that show the possibility of using GIS in the process of analyzing traffic accidents and making the right decisions. technical authorities can verify the safety of road design at these locations.

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