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Original Article

Smart Mobility, Evaluation of Urban Congestion through the Frugal Multi-Level Governance

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Abstract *- Machine learning will be a technology that will greatly aid in the deployment of future smart cities in all these phases. Some complex problems can be difficult to understand or completely incomprehensible and can be difficult to solve using traditional machine learning approaches due to the lack of data on the problem. Therefore, there is a need for interactive machine learning (iML), an approach that uses humans as complements to machines. Smart mobility is one of the most popular areas of smart cities. This article is intended to distribute frugal diagnostics, which aims to investigate urban congestion based on input from users and people affected by machine learning technology. In addition, the presented assessments and perceived levels of congestion enable decision-makers to intelligently plan the transition to smart mobility, taking into account stakeholder views. This paper seeks to formulate a user-centric management process, as well as a frugal diagnostic system that enables agile and inexpensive decision-making.*

Keywords — *Natural Language Toolkit, Interactive Machine Learning, Smart Mobility, Open Data, Multi-Level-Governance, decision-making process.*

I. INTRODUCTION

Today, more than 53% live in urban areas, and this number is steadily increasing, with more than 73% of the world's population living in urban areas within 20 years. Moroccan cities [1] are rapidly urbanizing, and this change causes some problems for Moroccan cities (city administration, urban congestion, waste, etc.) [1].

Due to the severe changes in the Moroccan economy, the growth of Moroccan cities and the ongoing urban sprawl phenomenon reveal some problems at the forefront of urban congestion [2]. Urban congestion is a major challenge for developed and even developing countries [3] [4]. Socio-economic costs of traffic congestion, noise, and other phenomena can reach hundreds of millions of dollars over the next 15 years [5]. Some sectors face issues related to urban mobility planning, but quantifying and calculating these impacts may not be easy [6]. For example, it is difficult to quantify or understand the impact of urban planning on the tourism sector without a mechanism to get feedback from decision-makers from user experience [7].

Due to the rapid urbanization of the city of Casablanca, decision-makers must face many challenges in urban planning, especially in urban mobility.

The World Bank reports that the city of Casablanca is experiencing significant congestion rates facing a long and complex decision-making process regarding urban mobility. Qualitative and quantitative assessment of mobility systems is important to ensure continuous improvement and satisfaction of various stakeholders [1]. To achieve this goal, a large budget must be allocated by the local government [5] [3].

Investing in evaluation technology and control infrastructure (sensors, servers, etc.) has proven to be extremely difficult for developing countries. This difficulty is exacerbated in situations characterized by a pandemic investment ban on COVID 19.

Open data can be an important source of information for improving the mobility system of today's cities through the collection of quantitative and qualitative data. Today, open data represents an inexhaustible source of information for economically difficult countries to streamline their investments by providing data that can be used to provide diagnostic mechanisms continuously and quickly [9].

The involvement of city stakeholders in the day-to-day management of priorities is becoming a must [10]. Several kinds of citizen integration in local government are evolving, while the character of the stakeholders has an essential role in determining the form of integration[11].

This pandemic context associated with COVID-19 highlights the importance of improving or developing a new form of governance, which can take the form of intelligent governance, governance based on the collective intelligence of its stakeholders while also relying on technological progress and innovation [12].

Our case study will be the city of Casablanca, which showcases a low-cost smart city concept that attempts to engage citizens into municipal life via the use of technology and creativity [13].

This article focuses on algorithms for collecting and processing user experiences (tourists) through opinions and comments on special web platforms (TripAdvisor).

Ensuring that end-users are integrated into the diagnostic loop, not only facilitates economic assessment tools that decision-makers can use to streamline their approaches, both economically and from a governance perspective. [9]

II. URBAN MOBILITY AND USER EXPERIENCE

The concept of smart mobility was developed and presented as a whole, organic system[10]. Smart mobility is frequently regarded as encompassing measures that lead to more efficient transportation networks. Connectivity is a fundamental aspect of smart mobility, which, when combined with massive data, allows consumers to transmit all trip data in real-time, while members of local municipal administrations may undertake simultaneous strategic control [10]. Smart mobility refers to real-time traffic operations, consumer-means administration, applications and logistics monitoring, automotive parking maintenance, automobile allocation services, and a variety of other intelligent transportation services [7].

ICTs are critical for implementing smart city mobility successfully [13], as they are the primary tool for remote control and administration of the mobility system. They combine services, equipment, and applications to transmit, store, produce, share, or exchange information, providing a centralized framework of control and command for governance and assisting transportation operators and users in making choices [7].

User experience is rarely taken into account, and more precisely, the experience of tourists visiting Morocco is absolutely beyond the scope of ratings. This vector may be part of a mobility diagnosis in a given region [1,8,10].

For example, in Morocco, evaluation mechanisms are used around research that requires a significant investment of time and money, and the research performed is based mainly on outdated data without taking user feedback into account [7,9].

The digitization of the tourism sector has led to significant improvements across the value chain, especially in the customer and user experience components. Professional web platforms (Trip Advisor, Trivago, etc.) come to express and describe user experiences [11]; currently, regions, especially hotels, can fall victim to issues that occur outside the areas of intervention, such as urban congestion, racism, crime, and many other risks [12].

This paper presents the concept of smart mobility that interacts with several other concepts such as ICT "information and communication technologies" and ICT "information society technologies" or ICUT "information technology customers" [13].

A form of the algorithm used to mechanize movement. The purpose of this paper is to analyze road traffic using qualitative and quantitative approaches [14].

III. METHODOLOGY

Today, traffic sensors are not available to everyone, but the active use of smartphones has led to more frequent use of mobile applications [15]. Accessing user-generated and collected data is nearly impossible, especially in the absence of open data initiatives at the national level. To cope with this situation, the use of open data is crucial, Google traffic presents itself as a platform that provides instant information on the level of congestion in a territory [16][7].

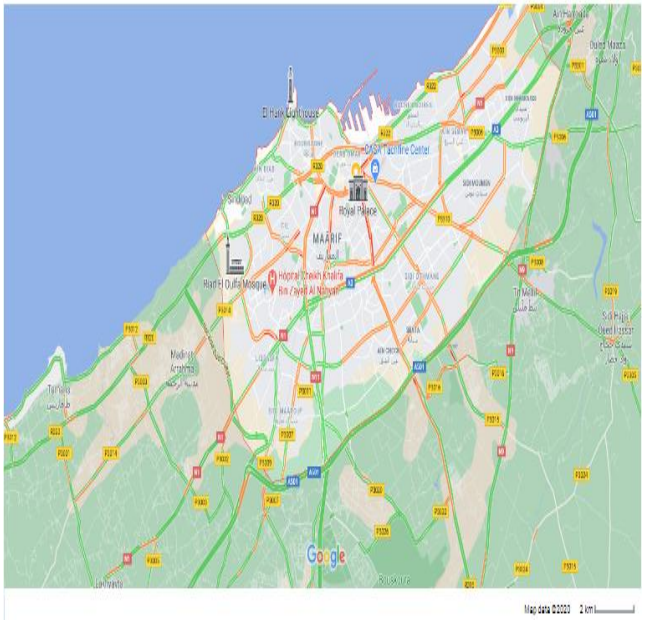


Fig. 1 Map of the city of Casablanca

The following is a map of Casablanca showing the hotels and their distribution. Based on this dispersion, it is clear that there are most hotels in the city center. For a more consistent experience, the location with the most hotels needed to be chosen. The second limitation identified in this task is the choice of hotel.
The international chain "Novotel" presents a good example for our study and this choice will make it easier for us to explore other areas in the future.

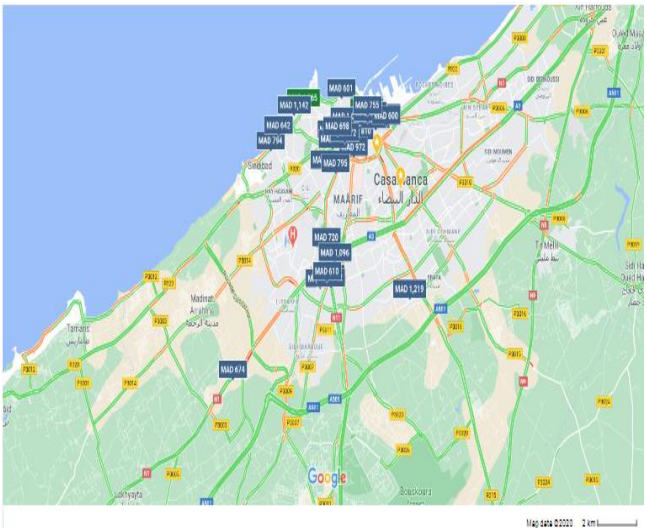


Fig. 2 Location of hotels on the map of the city of Casablanca

For data collection, we have developed a program used to collect customer opinions, primarily user opinions, on congestion and mobility issues in the city being studied. The concept of the open-source Python program is to automatically collect, analyze, and interpret all hotel reviews on Trip Advisor (Fig. 3).

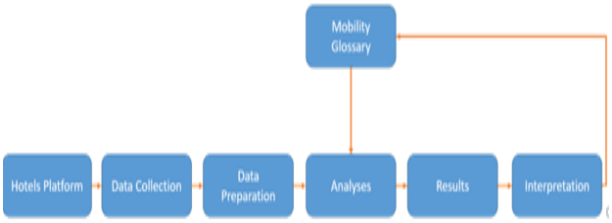


Fig. 3 General process of the proposed method

This program focuses on the Mobility Glossary and makes it easy to collect a vast database of hotel customer reviews by analyzing all the data using the Natural Language Toolkit (NTLK) and machine learning algorithms.

A. Collecting data

Our goal is to obtain data on the visitor experience. Therefore, we had to choose a platform that collects visitor data. In this paper, the data used are data from the Tripadvisor platform.

As a result of analyzing the structure of this website, since it is a web platform based on HTML and PHP languages, the open-source web removal software "Beautiful Soup", a Python library for importing data from HTML and XML, was used as its own proposed model focus on TAGS reviews.

Fig. 4 Web scrapping architecture

B. Data presentation

To prepare the collected data, the Natural Language Toolkit (NTLK), allows the creation of Python programs based on human language data, as well as sub-domains. Natural Language Processing (NLP) of artificial intelligence deals with understanding and processing human language.

C. Hardware and software architecture

Developed tourism mobility programs require software to perform the requested results. For this, an open-source tool (TripAdvisor) has been chosen to ensure that our solution is frugal.

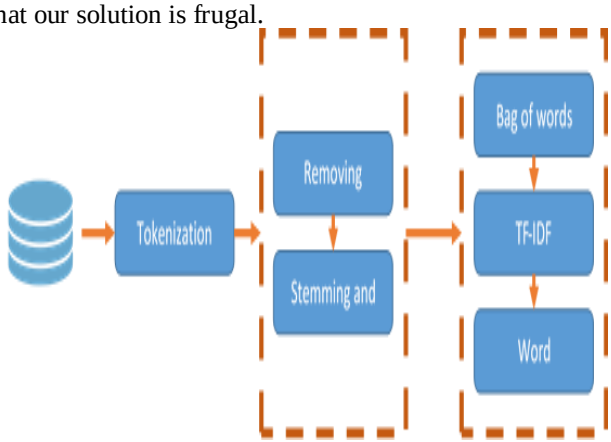


Fig. 5 Framework for creating Python programs

The mathematical equation chosen to calculate the frequency of words is the TF-IDF.

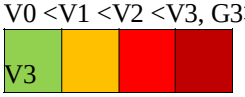
$$tf_{i,j}=n_{i,j} / \sum_k n_{i,j} \qquad (1)$$

The following code implements term frequency.

Code 2: Term frequency code

To validate the results of the qualitative evaluation, a comparison was made with the quantitative results, mainly based on the traffic recorded near this hotel via Google traffic. Use image processing based on the RGOB technique (red, green, orange, brown) to analyze the recorded results. In this diagram, speed and occupancy are inversely proportional:

V0 <V1 <V2 <V3, G3> G2> G1> G0



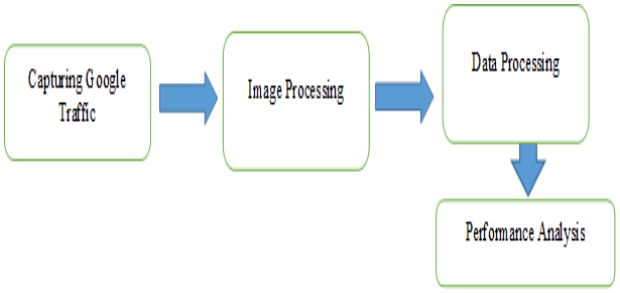


Fig. 6 Assessment process

IV. RESULTS AND DISCUSSION

The results of the textual analysis of customer reviews collected through the algorithm present an important picture of the chosen issue. When proofreading spelling and grammar.

After collecting, adjusting, and processing the data, you entered 30 mobility terms in the mobility glossary. A similarity algorithm was used to analyze the data stored in the database to expand the glossary for better results.

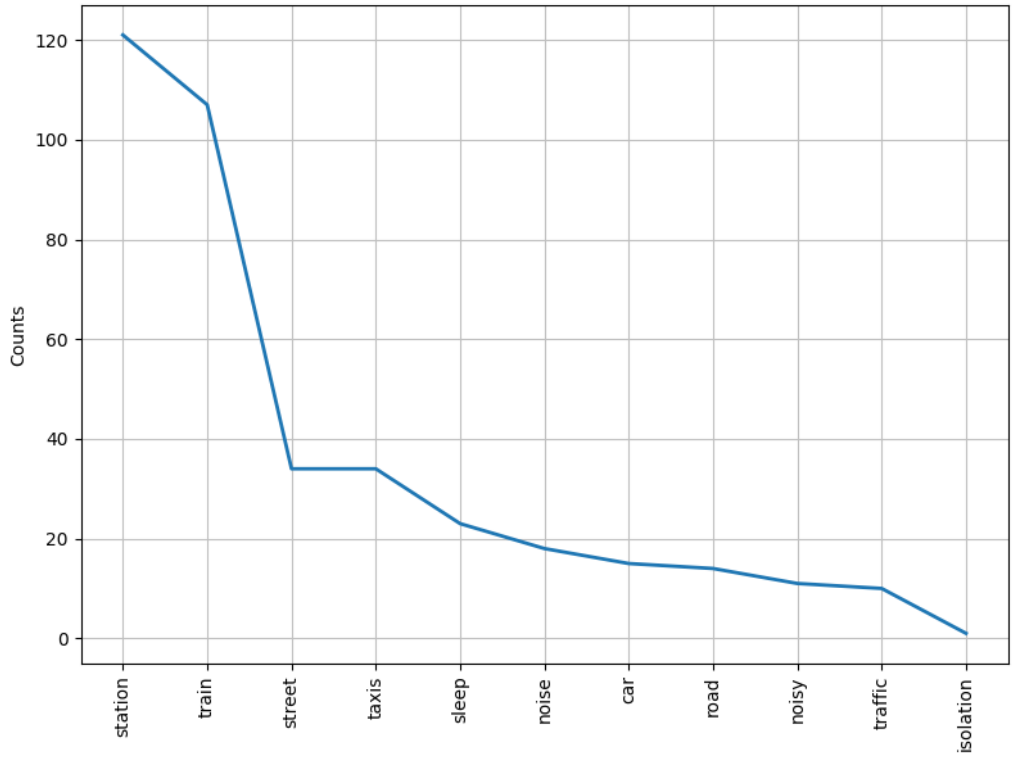


Fig. 7 The frequency of words used

Below are the results stored in a text document

The words "noise," "noisy place," "traffic," "insulation," and "road" are frequently used and provide important material for defining the problems associated with urban congestion. This group is already portraying customer dissatisfaction as a result of urban congestion.

Based on the similarity analysis of the words used by customers to express their opinion, it is clear that urban congestion is an important problem for tourists, this feedback also presents an important axis for decision-makers to identify urban problems, namely, the similarity results can already define the nature of the urgent problems found by tourists; in our case, the identified problems can be listed as follows: parking problem, noise pollution caused by urban congestion, accidents, etc.

To substantiate the following observation, we will present quantitative results of urban congestion at the level of the adjacent avenue to the hotel using Google traffic. The following is a list of the recorded traffic data:

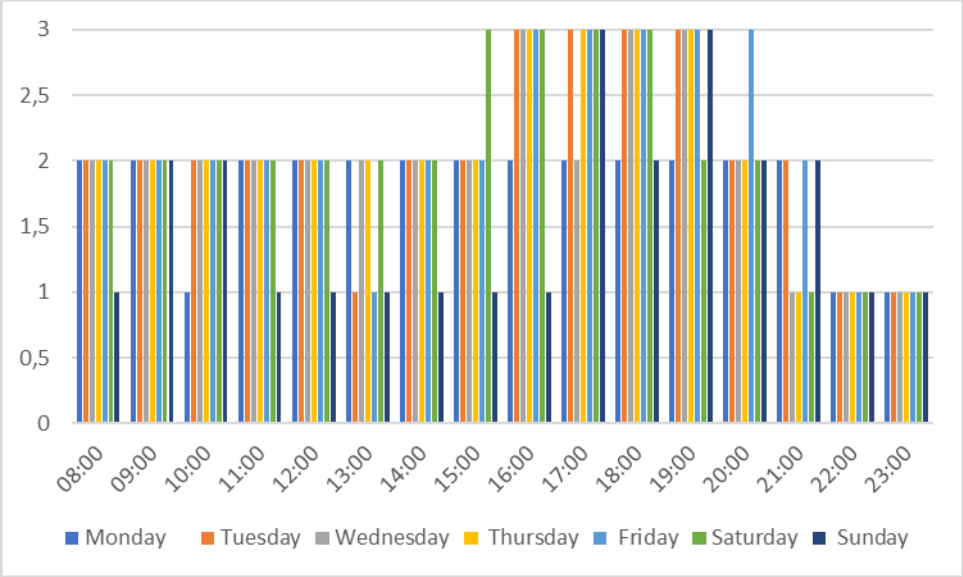


Fig. 8 The recorded traffic data

The recorded traffic data indicated in Fig 7 reveals an essential aspect of traffic congestions at the level of this avenue, namely that the congestion is broken down as follows:

Table 1. Level of congestion

Level of congestion	Percentage of congestion hours based on study hours.
Level 1	18,76%
Level 2	60,41%
Level 3	20,83

The typical level of congestion is frequently reported around 9:00 p.m. with an estimate of 18.76 percent, but level two of congestion is commonly documented at 8:00 a.m. with a rate of roughly 60.41
percent. Level 3 congestion can cause noise from cars' horns as well as accidents; level 3 has a rate of 20.83 percent.

This level of congestion signifies the presence of significant noise. A site visit was made to observe the potential reasons for the observed congestion to fully understand the source of the perceived congestion

-The avenue is connected to many other avenues
The ability to park, with an 80-second traffic light that turns green for 50 seconds.

-The presence of many administrations on the site. We can easily deduce and understand consumer dissatisfaction, which is related to urban congestion, after visiting the location and with a congestion rate of over 80%.

The following results demonstrate that the textual data collected by the algorithm provides important material for decision-makers to probe the opinion of visitors about the quality of mobility within the city, as well as a source of dissatisfaction with the services provided by the city for the benefit of these visitors. The technique utilized in this study may be applied in various sectors and locations to investigate tourists' perceptions of the city in connection to other services offered (Quality of public transport, Catering, etc.).

V. GOVERNANCE MODEL

Governance and decision-making are currently taking a new form, namely E-Governance and digital governance, these new approaches come to ensure the use of ICT in the governance process.

This new model of governance aims to improve the decision-making model through the reliability of the information collected as well as the time required to obtain it.

The current system of governance has some problems in the decision-making process. One of those problems is that there is only one decision-maker, the information is unreliable, and the decision process takes a lot of time. The citizen ends up being at the back of the process, which is what you would expect in a system that is designed to be a consumer of public policy.

The current decision-making process only intervenes after the problem is identified, making the decision-maker reactive rather than proactive.

Integrating stakeholders into the diagnostic process represents a significant opportunity for the city to improve the interaction between decision-makers and its stakeholders. This integration also allows the city to improve its economic performance by reducing the potential impact of stakeholder resistance to initiatives. The collection and intelligent use of data is also a key issue in improving the city's administration by responding to stakeholder demands and challenges.

This data-driven forecasting also allows for project prioritization and budget optimization, which has a direct influence on the cost of implementing post-crisis initiatives.

A. Frugal E-governance decision making process

The approach presented in this study aims to increase stakeholder engagement in the day-to-day management of the city.

The decision-making process at the level of this mode of governance must be proactive, inclusive, and above all frugal. [19]

Step 1, prediction of problems: consists of predicting problems using new technologies, the objective of this first step is to predict potential problems at the level of territory through accurate, reliable, and affordable information.

Step 2, focus group: comes to lay the foundations of a multi-level-governance approach which involves the creation of a focus group that includes different territorial actors.

Step 3, generation of alternatives: definition of the selection criteria while taking into account the sustainable development objectives as well as the listening approach to be taken into account to determine the solutions and potential alternatives. This step also consists of determining the environments and the test phases for each alternative.

Step 4, evaluation and choice of alternatives: this step aims at the evaluation and choice of the most suitable alternatives through the application of the criteria and modes of governance already established, at the end of this step it is appropriate to choose the alternative. or the alternatives to testing.

Step 5, simulation: This stage consists of providing a virtual simulation of the decided alternatives and determining the effectiveness and efficiency, the test environment can take a multitude of forms, the results of the simulation must have a direct impact on the potential issues identified in step 1.

Step 6, the implementation of alternatives and decided solutions: This step consists of moving from the simulation environment to the real environment.

Step 7 evaluation: this step consists of evaluating the impact of the alternatives put in place as well as the real impact.

The strategy that follows materializes an intelligent governance approach based on the demands of stakeholders while requiring the use of data as well as technology; we can claim that this sequence allows us to nourish the Human Technology-Driven approach. for municipal government.
By taking into consideration both collective intelligence and technical advancement, the notion of the thrifty smart city increases our perspective and sense of intelligence.

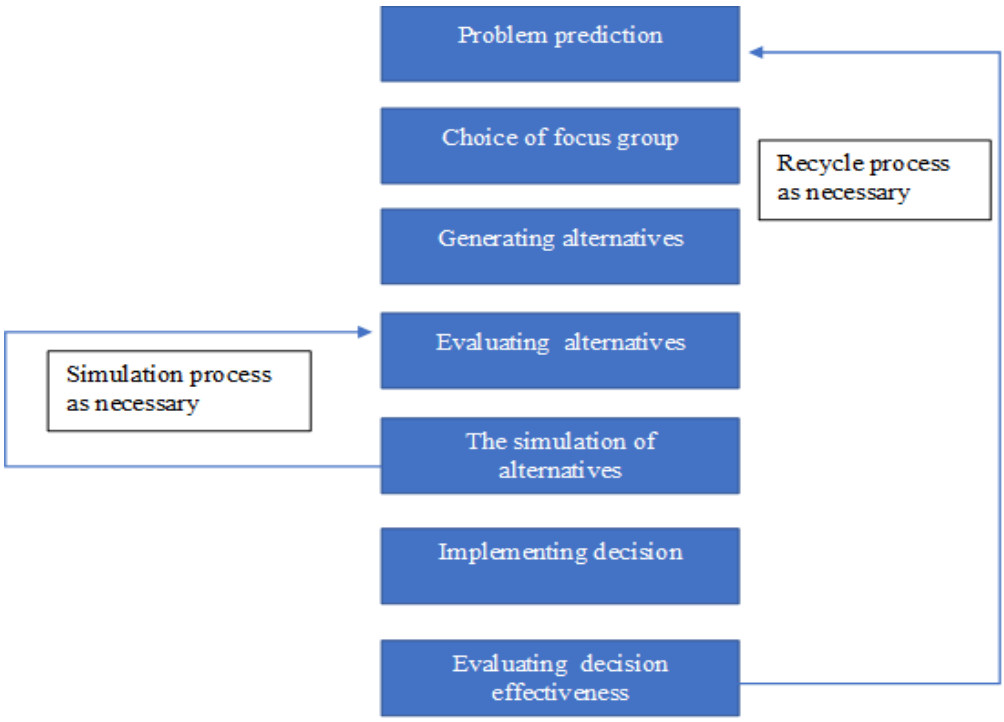


Fig. 9 Frugal E-governance decision-making process, the model proposed by the authors of the paper.

VI. CONCLUSION

The findings of this assessment indicate a full connection between the two techniques, clearly demonstrating the viability and relevance of selecting for collaborative and inexpensive evaluations based on open source and open data[17,18].

Because the cost of device assessments is relatively cheap, this strategy allows for the integration of a new idea at the level of diagnostics, allowing for a plurality of diagnostics as well as a quick decision cycle before decision-making, as well as rationalizing the diagnostics budgets.

This contribution also presented a general framework for participatory governance by integrating multiple interested parties, primarily citizens, through the Human Technology-Driven approach to the management of municipal problems through an integrative, participatory, and, above all, cost-effective solution. Our work begins with a serious reflection on the citizen's inclusion in public decision-making to further develop the concept of smart cities, as well as to make the citizen an active actor in the city management process and, most importantly, to empower the people. other actors to make city governance a common subject. This study also sets the basis for participatory democracy in smart cities by applying technology to bridge the gap between decision-makers and citizens as well as the role of this type of approach in promoting the concept of smart mobility and, in particular, intelligent frugal diagnostics.

The approach used is to address two fundamental questions:

- The first is how to use technology to put city stakeholders at the center of governance while employing technology.

- The second is how qualitative data are used in urban mobility diagnostics. The present technique also makes it simple to conduct similar research in other areas and, more importantly, to assess the impact of congestion across territories.

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