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MACHINE LEARNING TO SUPPORT SMART CITY INITIATIVES

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ABSTRACT

Machine learning is one of the technologies coming to help the deployment of smart cities in all phases. The diagnosis is a crucial phase that comes to ensure the implementation of a project adapted to the reality of the city diagnosed; this step requires a significant financial commitment.

This paper comes to deploy a frugal diagnostic approach of the smart environment component while using self-learning techniques. In addition, assessments are reported and regulatory maturity with respect to this new concept is explored through machine learning. In the near future machine, learning will play a crucial role in the implementation of this kind of concept.

Keywords: *Natural Language Toolkit; Machine Learning; High Performance Computing; Smart Governance ;Smart Cities, Oriented Topic Modeling.*

1. INTRODUCTION

In 2008, the urban population exceeded that of the rural area; today the city becomes more complex than before [1]. This growth of the urban environment has given rise to several problems of an environmental nature. Today's cities are faced with several environmental problems, for example climate change, urban sprawl, greenhouse gas emissions and several other phenomena. In this configuration, several countries are opting for solutions to face this reality, among the widespread solutions is the concept of smart cities [2] [3] . The smart city can be used to limit environmental impact through several levels (Strategic, Operational), for this, cities are required to analyze their environmental issues in an intelligent and efficient way while remaining in the environment centered philosophy [3]. This concept comes to further connect the citizen to the public administration through the proposal of adequate solutions to the daily concern of the city, among the concepts recently in place is the urban audit. [3] An understanding of the needs of the city clearly reflects the nature and level of intelligence of the operations carried out. [5] The current development of smart cities depends on several factors (Technical, Organizational, Human) This transition will mainly go through a clear strategy for deploying the concept of smart city, among the most important tools for deployment are regulations and standards [2]. In the current context, regulations play an important role in limiting environmental impacts through decrees, standards, laws and other provisions. [1][2][3]. The regulations and more precisely the environmental regulations present a mirror of the problems of the territory. In this configuration, which highlights the combination of territory and regulation, developing countries are faced with a dilemma, to invest to limit the impact on the environment or to suffer the impact of environmental issues. [2]. The current economic crisis due to COVID-19 puts the territories and governments of developing countries before the need to trace and reflect their investments in order to ensure efficiency in the level of investment. The development of the city requires significant resources, namely that the challenge lies in the

effective and efficient use of resources, the reason why the city must clearly identify the needs and resources in place in order to use them in a rational and especially frugal way. [1.2] Migration to the concept of smart cities mainly involves a sustainability-resilient-centric diagnosis, this kind of diagnosis is characterized by low cost, high repeatability, based on technology and especially open source and open data [2][3]. At the level of this paper, we will use a tool rarely used in diagnostics, it is the textual analysis of Moroccan environmental regulations in relation to the concept of smart environment, this concept which highlights three axes • Judicious land use planning • Attractiveness of natural conditions • Environmental protection and pollution control This assessment will allow us to see the maturity and adaptability of the current regulations in relation to the concept of the smart environment through a Natural Language Toolkit (NTLK) and machine learning algorithms [6]. The remainder of this paper is structured as follows. Papers addressing the machine learning applies to the smart city and specifically the smart environment. Secondly a proposal for a model developed based on Natural Language Toolkit (NTLK) and machine learning algorithms for textual analysis relating to the Moroccan environmental regulations, the last step lies in the analysis of the results of this assessment and the interest of frugal diagnostics.

2. SMART CITY AND ARTIFICIAL INTELLIGENCE

The overall framework of the Smart City incorporates two important parts, the first which ensures primary management operations through planning, organization, security and control. A second framework that ensures governance through city-specific indicators and objectives[60]. The nature of the operations and projects carried out and selected clearly affect the city and also demonstrates the importance of migration to the smart city concept[60]. The smart city concept is based on four structural elements: -Push-based technologies -Pull-based applications -Urban development -An economy based on knowledge and innovation. The use of technology comes to introduce itself further into the transformation of cities, namely that 3 this transformation can be summarized in three major phases

-Phase 1 : Technology Driven

-Phase 2 : Focused on city management, which uses technology platforms

-Phase 3: Centrist-oriented smart cities primarily focused on citizens [60].

The development of artificial intelligence is gaining in importance, especially the machine learning component, this development presents a favorable ground for further developing the concept of smart cities [5].

The term "intelligence or smart" which is in common between the smart city and artificial intelligence comes to question us on the way for the implementation of the project on site[5]. Artificial intelligence is a field that seeks to build mechanisms and develop devices that stimulate reasoning while allowing independent, fact-based decision making. The efficiency and effectiveness of the answers provided by artificial intelligence improves significantly and proportionally with the amount of data collected and processed. The improvement of collected data is also achieved through deep learning, a technique that improves the decision making process through classification, clustering and regression.

The deep learning allows to ensure a multitude of acts such as the recognition of objects, voice, texts and many other things. In this configuration, deep learning plays an essential role in solving different problems.

Similarly, the application of deep learning to solve problems in the fields of energy, railway system, air quality, traffic flow, wastewater, accidents, health and agriculture will certainly require a different set of data depending on the application domain. Data analysis in smart city will help decision makers to fully understand the effective and efficient ways for proper planning, resource sharing, regulatory framework formulation, critical decision making and monitoring in smart city.

Artificial intelligence comes to achieve specific objectives with determined constraints, the application of this intelligence comes through the following 6 categories: machine learning, robotics, computer vision, natural language processing, knowledge representation, and automated reasoning [5].

Similarly, the smart city is developing more to respond to various problems and objectives while considering the constraints of the city, namely that the city can be schematized under 6 main axes: Mobility, Environment People, Living, Governance and Economy [1].

Today, artificial intelligence comes as a major tool for the transformation of the city towards a smart

city, several research papers highlight projects in interaction between the Smart city concept and the tools of artificial intelligence, the table below presents a state of this interaction.

Tableau 1: Analysis of research papers in relation to the use of AI in smart city initiatives.

AI component / *Smart City component*	*Machine Learning*	*Robotics*	*Computer*	*Natural language processing*	*Knowledge representation*	*Automated reasoning*
Mobility	[7] [8] [9] [10] [11] [12]	[13] [14]	[15] [16]	[17[18[19[20]	[21] [22]	[23] [24]
Environment	[25] [26] [27] [28]	[29] [30]	[26] [29] [30]	[31]	[31] [32]	[33] [34] [36]
Society	[39] [40] [41]	[37] [38] [40] [41]	[38] [40] [41]	[39] [37]	[39] [32]	[37] [36]
Living	[39] [40] [41]	[40] [41]	[38] [40] [41]	[39] [46] [47] [48]	[39] [46] [47] [48]	[40] [41]
Governance	[42] [43] [44]	[44] [45] [46]	[43] [44] [45]	[46] [47] [48]	[46] [47] [48]	[49]
Economy	[51] [52] [53]	[50] [53] [54]	[53] [54]	[55] [56]	[55] [56]	[57]

Significant momentum and maturity mark the use of artificial intelligence in smart city initiatives, mainly at the level of the deployment and monitoring phases. Knowing that, some components of the smart city rarely use artificial intelligence, mainly the couple (Smart Environment, Natural language processing), after analysis of the study papers, we can also conclude that the diagnostic phase rarely calls on the artificial intelligence.

Clearly, artificial intelligence is introduced into the different components of the smart city and covers the entire value chain to support the operation and monitoring of the initiatives in place, albeit with different percentages[61].

The stake of artificial intelligence is twofold, first of all the choice of the technology adapted to the project and the associated investments[61].

The current literature shows at what level the smart city adopts the tools of artificial intelligence, today our definition of this combination is as follows "The intelligence of the city lies in its ability to use technology for the benefit of society, while respecting the objectives of sustainable development" On this paper we seek to see how Natural-language processing can intervene in the assessment of the concept of smart environment as well as the definition of gaps that can harm the deployment of the smart environment strategy while analyzing Moroccan environmental regulations.

Today, Moroccan cities are faced with an important challenge, which resides in the promotion of sustainability as well as the respect of the commitments made by the Moroccan state in terms of sustainable development.

3. METHODOLOGY

In this paper we use a bibliometric analysis based on two approaches, one relating to the collection of local Moroccan environmental regulations, namely the regulatory texts between 1933 and 2021, and a second that uses glossaries of the following themes, namely Green Economy, Judicious land Environmental protection, which are well defined in order to see the presence of certain themes in the regulations. The results obtained through data processing will highlight the presence of the themes determined at the level of the Moroccan regulation and will allow us to have a clear idea on the orientations traced by the state.

Several smart city initiatives have been initiated in Morocco for example Smart city Casablanca, Smart city Benguerir and many others, current initiatives ensure a migration to the concept of smart city through a project approach that is often initiated and managed by local authorities.

Namely that the projects in place come to meet a need expressed by the initiators of the initiative. If we take the smart city project Casablanca we find ourselves with smart mobility initiatives in order to find solutions for congestion, the city of Benguerir is highlighting an initiative in relation to the Smart Economy to overcome the concern for employability.

The smart environment presents a reliable framework to frame future initiatives of sustainable development This diagnosis will be based mainly on the textual analysis of the environmental regulations in relation to the following glossaries (Green Economy, Judicious land Environmental protection) this assessment will allow decision-makers to detect possible flaws and the limits of the current regulations.

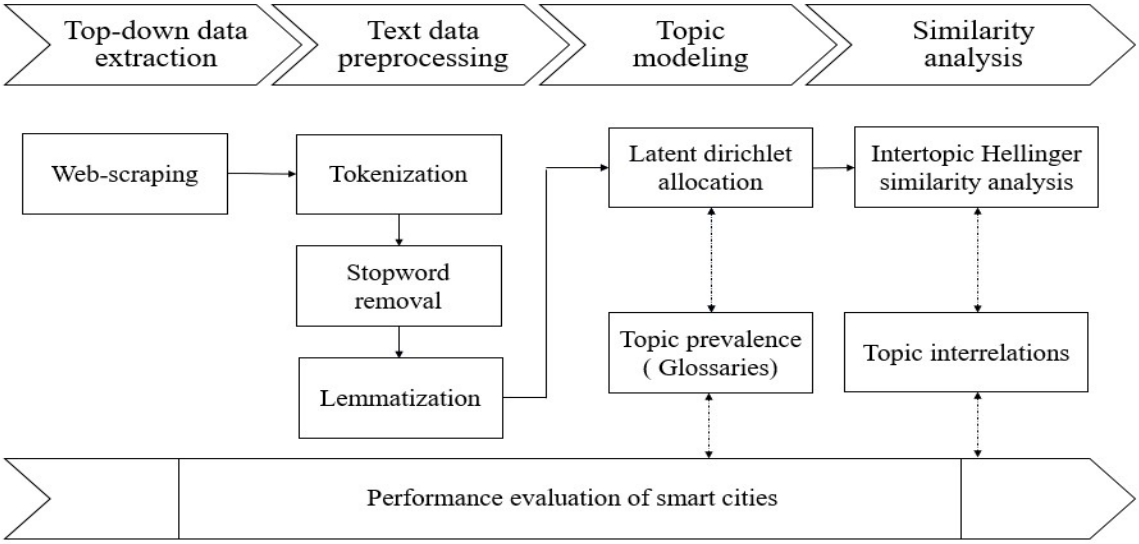

Figure1: Overview of the research framework

4. PROPOSED MODEL TO ANALYZE THE MOROCCAN REGULATION

4.1 Developed Automated Model

This paper was based on the collection of textual data related to environmental issues. Legal texts issued by government portals were discarded and selected to correctly reflect the environmental strategy, since regulations are presented as top-down information to inform and align stakeholders with a defined strategy.

In order to analyze the Moroccan regulations which contain more than 1000 pages divided by almost 40 PDFs , it has been necessary to develop an automated program allowing an access to the website, search and download all documents relating to the target domain. And then, analyzing and interpreting the requested results. Below the main architecture of our solution. characters of any form or language are allowed in the title.

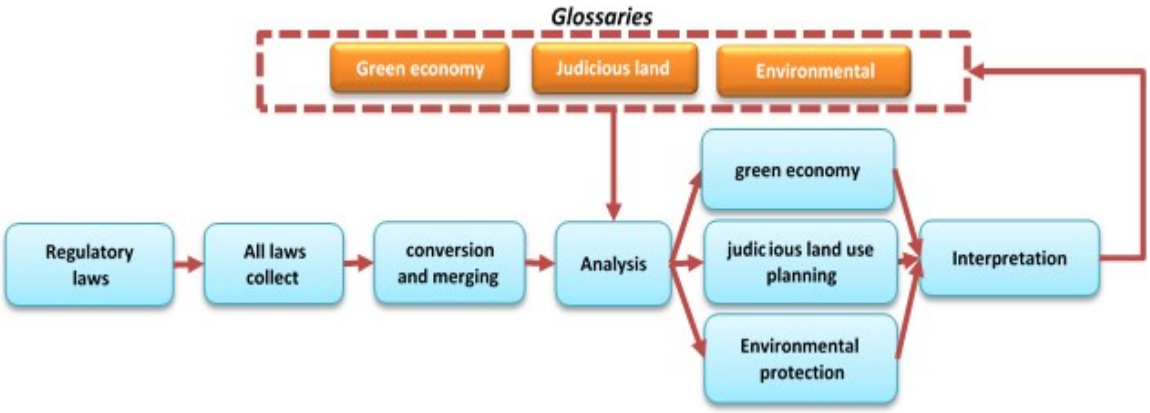

Figure 2: Analysis Process Of The Components Of The Smart Environment

With this program, we can easily collect a huge database of regulatory text and analyze all the data with the Natural Language Toolkit (NTLK) and machine learning algorithms.

4.2 Software architecture

4.2.1 Collecting laws

The proposed methodology, comes to ensure the collection of data through publicly accessible government portals. The extraction of textual data from regulatory texts is done through webscraping using the Python library "BeautifulSoup".

Webscraping of websites allows to collect and convert web data that is usually in HTML format, to structured data that can be stored in a central and local database for further use, the BeautifulSoup library provides simple methods to extract data from a web page and extract specific content from HTML code. Typically regulatory texts are encoded in individual pages by a common HTML code, the structure of these HTML documents (e.g. script tags) has been examined to implement a BeautifulSoup Python-based program that navigates through these templates and extracts textual information. [61]

4.2.2 Data preparation

Data formatting allows for efficiency in text processing. Text formatting involves the removal of unnecessary characters as well as inaccuracies that occur during web data extraction.

To prepare the data collected, we used the Natural Language Toolkit (NTLK), which is a framework for creating Python programs based on data from human languages, and also the Natural Language Processing (NLP) sub-field of artificial intelligence that deals with understanding and processing human language.

Data formatting refers to the normalization of text that includes tokenization as well as the removal of stop words through bigramming and lemmatization. In NLP, the unit of text analysis is the token, which is a string of coded bytes that represents the text. Tokenization is the process of segmenting individual text data into words and punctuation.

In this paper, a total of 239,045 tokens were extracted from the studied documents.

Text formatting was used to reduce words and punctuation. A lemmatization step was performed to reduce words to their corresponding root form. A Python-based pipeline was implemented to sequentially execute these tasks.

4.2.3 Oriented topic modeling “Naïve LDA Clustering Using Keyword”

The statistical model provides an important framework for determining the nature of the corpus as well as the general orientations of the text.
These models are built on the basis of standard latent semantic analysis (LSA) applied mainly to machine learning. In the LDA model, the topic parameter is built on the basis of the keywords designated in the glossaries. In other words, the glossaries reflect the statistical properties of the number of keywords used in the document as well as the general trend of the regulation by the environmental issue.
In addition, the LDA model also estimates that represents the distribution of keywords of a given topic, which in turn determines the topic proportion parameter.

5. DISCUSSION AND RESULTS

The results in relation to the use of glossaries in relation to the smart environment are as follow:

Tableau 2: Results In Relation To The Use Of Glossaries In Relation To The Smart Environment

Green economy Results	judicious land use planning Results	Environmental protection Results
(vert,5) (biomasse,0) (biomimetisme,0) (economie-bleue,0) (sous-produit,0) (cascade,0) (circulaire,0) (compatibilsateurs,0) (compostage,1) (decouplage,0) (dematerialisation,0) (depolymerisation,0) (durabilite,0) (recyclabilite,0) (reparabilite,0) (durabilite,0) (numerisation,0) (dissipatif,0) (downcycling,0) (durabilite,0) (eco-conception,0) (eco-efficacite,0) (dechets electroniques (dechets electroniques),0) (fin de vie,0) (empreinte,0) (hydrogenation,0) (location,1) (Iot,0) (Intelligence artificielle,0) (cycle de vie,0) (locaux,9) (obsolescence,0) (prefabrication,0) (reconditionnement,0) (reutilisation,0)	(contamination,2) (decouplage,0) (departement,0) (dmi,0) (dmc,0) (eco-industries,0) (ecolabel,0) (sme,0) (ew-mfa,0) (evapotranspiration,0) (alimentation,0) (aliments,2) (nourriture,0) (fongicide,0) (ogm,0) (gwp,0) (gaec,0) (ges,5) (habitats,0) (haie,0) (herbicide,0) (incineration,0) (dechets industriels,0) (insecticide,0) (kyoto,0) (decharge,0) (paysage,5) (Iot,0) (Intelligence artificielle,0) (mbt,0) (nox,0) (covnm,0) (ozone,0) (pesticide,0) (pefa,0) (recyclage,10) (dechets,2) (zoonose,0)	(dechets,2) (Eau,76) (amenite,0) (Energie,18) (charme,0) (zone de recherche,0) (biodiversite,0) (biomasse,0) (brulure,0) (batiment,0) (bund,0) (cabe,0) (eco-villages,0) (circulaire,0) (base de preuves,0) (centre d usine,0) (geodiversite,0) (sig,0) (Iot,0) (Intelligence artificielle,0) (geothermique,0) (autoroute,0) (incineration,0) (inclusive,3) (enfouissement,1) (paysage,5) (surdeveloppement,0) (autoritaire,0) (rurcharger,0) (surplombant,0) (eclipser,0) (pollution,53) (port,2) (recyclage,10) (logistique inversee,0)	(regeneration,0) (solidite,0) (viabilite,0) (quartier,0) (corridor ,0) (parc,4) (eolien,0)

```
(venv) C:\Users\Gateway1\PycharmProjects\Webscraping\venv\New>python reg.py
Environmental protection :8
green economy :4
judicious land use planning :8
```

Figure 3: Summary Of Results

The following results already give us an idea of the maturity of Moroccan regulations in relation to the sub-concepts of Smart environment, namely that environmental protection and judicious land use planning comes first with more than 8 terms used from the glossary; the terms most used are as follow with different frequencies: Water, Waste, Recycling, Landscape, and Energy. The frequency of use of the following terms already gives us an idea of the concerns of the legislator, who focuses on the standard issues of sustainable development (Water, Air, Soil, Energy).

We also note the total absence of terms related to new technologies for example (Artificial intelligence, Iot, etc.), which reflects that the legislator does not keep pace with the speed of development, as well as the absence of new mechanisms that can be used to develop sustainability.

The green economy is a concept rarely considered, namely that the regulatory texts studied at the level of the green economy do not present a ground for new issues such as the circular economy, the blue economy, etc.

This diagnosis clearly allows us to position Moroccan regulations in relation to the smart environment concept, knowing that the dynamics and maturity of Morocco remains too limited, especially since the new issues of sustainable development are not integrated, which makes it difficult to integrate smart environment initiatives and which reflects the absence of a strategy for deploying the concept in the national territory.

6. CONCLUSION

This paper comes as part of the promotion of frugal diagnostics, which can be used to promote smart city concepts using new technologies and more specifically artificial intelligence. Inclusion and efficiency in diagnostics is an important issue for all smart city initiatives. This paper comes to propose a framework of analysis which is based on an approach of text processing under NLP namely that the framework of this analysis comes to put in reading the environmental regulation in relation to well defined topics. [61]

The governance of frugal smart cities requires an inclusive approach that takes into account the benefits enabled by new technology while using a multidisciplinary approach.

The smart city and more precisely the concept of the frugal smart city augmented by digital, comes to establish governance mechanisms based on a mixed approach that uses human and technology respectively to improve the decision making process.

The governance process in this smart city concept aims at developing frugal decision maker oriented solutions in order to enable efficient and cost effective decision making, namely the integration of a continuous improvement mechanism that makes the process reliable through data collection and improvement of the existing model.

Firstly, the review and revision of regulations takes a long time and, at the same time, the convergence of public policies also presents an important obstacle, namely that regulatory trends are rarely evaluated. The aim of such a governance approach is to present a frugal and proactive evaluation tool and, above all, a rapid and effective tool.

The proactive, data-driven governance approach also allows for project prioritization and budget optimization, which has a direct impact on the cost of implementing post-crisis initiatives.

The current decision-making process occurs only after the problem has been identified, making the decision maker reactive rather than proactive.

The analysis of the regulation is important to determine the strategic orientations of the country in relation to the concept of smart environment and more generally the smart city, that is to say that the approach is initially a Top-Down approach that aims to establish the foundations of a smart city respectful and sensitive to environmental issues.

The tool developed clearly makes it possible to evaluate the maturity of the regulations in relation to the new challenges of the city, the application can be easily duplicated on the other sub-components of the smart city and on other territories, which makes the application of this kind an important one. [61]

The same method can be generalized in order to analyze the needs and opinions of the various stakeholders of the city all based on the quadruple helix approach (Citizen, Government, University, Industry).

The analysis of the regulation is important to determine the strategic orientations of the country in relation to the concept of smart environment and more generally the smart city, that is to say that the approach is initially a Top-Down approach that aims to establish the foundations of a smart city respectful and sensitive to environmental issues.

This model can be used to continuously study the maturity of the regulations in relation to the different smart city concepts. Certainly, the approach used contains limitations. Among the limits we can cite the great difference between the regulations and the reality on the ground, given that a lot of problems are present in the field without having a representation at the level of the regulations, this limit can be a source of bias to the diagnosis.

REFERENCES:

[1] Founoun A, Hayar A, Haqiq A. The Textual Data Analysis Approach to Assist the Diagnosis of Smart Cities Initiatives. In2019 IEEE International Smart Cities Conference (ISC2) 2019 Oct 14 (pp. 150-153). IEEE.

[2]Zezhou Wu , Mingyang Jiang , Heng Li & Xiaoling Zhang (2020): Mapping theKnowledge Domain of Smart City Development to Urban Sustainability: A Scientometric Study,Journal of Urban Technology, DOI: 10.1080/10630732.2020.1777045

[3]Ortega-Fernández, Anabel, Rodrigo Martín-Rojas, and Víctor Jesús García-Morales. "Artificial intelligence in the urban environment: Smart cities as models for developing innovation and sustainability." Sustainability 12.19 (2020): 7860.

[4]Luckey D, Fritz H, Legatiuk D, Dragos K, Smarsly K. Artificial intelligence techniques

for smart city applications. InInternational Conference on Computing in Civil and Building Engineering 2020 Aug 18 (pp. 3-15). Springer, Cham.

[5]Godin B. On the origins of bibliometrics. Scientometrics. 2006 Jul 26;68(1):109-33.

[6]Legg S, Hutter M. Universal intelligence: A definition of machine intelligence. Minds and machines. 2007 Dec 1;17(4):391-444.

[7]Karballaeezadeh N, Zaremotekhases F, Shamshirband S, Mosavi A, Nabipour N, Csiba P, Várkonyi-Kóczy AR. Intelligent road inspection with advanced machine learning; hybrid prediction models for smart mobility and transportation maintenance systems. Energies. 2020 Jan;13(7):1718.

[8]Ning Z, Xia F, Ullah N, Kong X, Hu X. Vehicular social networks: Enabling smart mobility. IEEE Communications Magazine. 2017 May 12;55(5):16-55.

[9]Overko R, Ordóñez-Hurtado R, Zhuk S, Ferraro P, Cullen A, Shorten R. Spatial positioning token (SPToken) for smart mobility. IEEE Transactions on Intelligent Transportation Systems. 2020 Oct 23.

[10]Ferreira S, Cardoso HL, Rossetti RJ. Workshop on Machine Learning in Smart Mobility. InInternational Conference on Intelligent Data Engineering and Automated Learning 2020 Nov 4 (pp. 573-574). Springer, Cham.

[11]Kronsell A, Mukhtar-Landgren D. Experimental Governance of Smart Mobility: Some Normative Implications. InShaping Smart Mobility Futures: Governance and Policy Instruments in times of Sustainability Transitions 2020 Aug 13. Emerald Publishing Limited.

[12]Athanasopoulou L, Papacharalampopoulos A, Stavropoulos P. Context awareness system in the use phase of a smart mobility platform: A vision system for a light-weight approach. Procedia CIRP. 2020 Jan 1;88:560-4.

[13]Jin X, Feng C, Ponnamma D, Yi Z, Parameswaranpillai J, Thomas S, Salim N. Review on exploration of graphene in the design and engineering of smart sensors, actuators and soft robotics. Chemical Engineering Journal Advances. 2020 Oct 15:100034.

[14]Mir UB, Sharma S, Kar AK, Gupta MP. Critical success factors for integrating artificial intelligence and robotics. Digital Policy, Regulation and Governance. 2020 Aug 12.

[15] Camargo MF, Gómez AR. Development of computer systems for urban mobility. InJournal of Physics: Conference Series 2020 (Vol. 1513, p. 012011).

[16] Mauri A, Khemmar R, Decoux B, Ragot N, Rossi R, Trabelsi R, Boutteau R, Ertaud JY, Savatier X. Deep Learning for Real-Time 3D Multi-Object Detection, Localisation, and Tracking: Application to Smart Mobility. Sensors. 2020 Jan;20(2):532.

[17] Sánchez-Ávila M, Mouriño-García MA, Fisteus JA, Sánchez-Fernández L. Detection of Barriers to Mobility in the Smart City Using Twitter. IEEE Access. 2020 Sep 9;8:168429-38.

[18] Di Martino B, Cante LC, Graziano M, Sard RE. Tweets Analysis with Big Data Technology and Machine Learning to Evaluate Smart and Sustainable Urban Mobility Actions in Barcelona. InConference on Complex, Intelligent, and Software Intensive Systems 2020 Jul 1 (pp. 510-519). Springer, Cham.

[19] Varghese C, Varde AS, Du X. An Ordinance-Tweet Mining App to Disseminate Urban Policy Knowledge for Smart Governance. InConference on e-Business, e-Services and e-Society 2020 Apr 6 (pp. 389-401). Springer, Cham.

[20] Wang Y. Data-driven smart mobility as an act to mitigate climate change, a case of Hangzhou.

[21] Schulz T, Böhm M, Gewald H, Krcmar H. Smart mobility–an analysis of potential customers' preference structures. Electronic Markets. 2020 Nov 16:1-20.

[22] Vrščaj D, Nyholm S, Verbong GP. Smart mobility innovation policy as boundary work: identifying the challenges of user involvement. Transport Reviews. 2020 Oct 9:1-20.

[23] Karballaeezadeh N, Zaremotekhases F, Shamshirband S, Mosavi A, Nabipour N, Csiba P, Várkonyi-Kóczy AR. Intelligent road inspection with advanced machine learning; hybrid prediction models for smart mobility and transportation maintenance systems. Energies. 2020 Jan;13(7):1718.

[24] Kodys M. Semantic Reasoning for Ubiquitous Smart Living Framework for Well-being and Digital Health (Doctoral dissertation, Université Grenoble Alpes [2020-....]).

[25] Ullo SL, Sinha GR. Advances in Smart Environment Monitoring Systems Using IoT and Sensors. Sensors. 2020 Jan;20(11):3113.

[26] Hameed A, Leivadeas A. IoT traffic multi-classification using network and statistical features in a smart environment. In2020 IEEE 25th International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (CAMAD) 2020 Sep 14 (pp. 1-7). IEEE.

[27] Chhabra GS, Singh VP, Singh M. Cyber forensics framework for big data analytics in IoT environment using machine learning. Multimedia Tools and Applications. 2020 Jun;79(23):15881-900.

[28] Anjomshoaa A, Curry E. Inter-space Machine Learning in Smart Environments. InInternational Cross-Domain Conference for Machine Learning and Knowledge Extraction 2020 Aug 25 (pp. 535-549). Springer, Cham.

[29] Winfield AF, Winkle K, Webb H, Lyngs U, Jirotka M, Macrae C. Robot Accident Investigation: a case study in Responsible Robotics. arXiv preprint arXiv:2005.07474. 2020 May 15

[30] Di Napoli C, Rossi S. A layered architecture for socially assistive robotics as a service. In2019 IEEE International Conference on Systems, Man and Cybernetics (SMC) 2019 Oct 6 (pp. 352-357). IEEE.

[31] Leelavathy S, Nithya M. Public opinion mining using natural language processing technique for improvisation towards smart city. International Journal of Speech Technology. 2020 Nov 11:1-9.

[32] Levonevskii D, Shumskaya O, Velichko A, Uzdiaev M, Malov D. Methods for Determination of Psychophysiological Condition of User Within Smart Environment Based on Complex Analysis of Heterogeneous Data. InProceedings of 14th International Conference on Electromechanics and Robotics "Zavalishin's Readings" 2020 (pp. 511-523). Springer, Singapore.

[33] Sioutis M, Alirezaie M, Renoux J, Loutfi A. Towards a synergy of qualitative spatio-temporal reasoning and smart environments for assisting the elderly at home. InIJCAI Workshop on Qualitative Reasoning 2017 (pp. 901-907).

[34] Mekuria DN, Sernani P, Falcionelli N, Dragoni AF. Smart home reasoning systems: a systematic literature review. Journal of Ambient Intelligence and Humanized Computing. 2019 Nov 15:1-8.

[35] Pohling M, Leichsenring C, Hermann T. Base Cube One: A location-addressable service-oriented smart environment framework. Journal of Ambient Intelligence and Smart Environments. 2019 Jan 1;11(5):373-401.

[36] ul Hassan U, Ojo A, Curry E. Catalog and Entity Management Service for Internet of Things-Based Smart Environments. InReal-time Linked Dataspaces 2020 (pp. 89-103). Springer, Cham.

[37] Cauteruccio F, Cinelli L, Fortino G, Savaglio C, Terracina G. Using Sentiment Analysis and Automated Reasoning to Boost Smart Lighting Systems. InInternational Conference on Internet and Distributed Computing Systems 2019 Oct 10 (pp. 69-78). Springer, Cham.

[38] Sharma R, Nah FF, Sharma K, Katta TS, Pang N, Yong A. Smart living for elderly: design and human-computer interaction considerations. InInternational Conference on Human Aspects of IT for the Aged Population 2016 Jul 17 (pp. 112-122). Springer, Cham.

[39] Bachate RP, Sharma A. Acquaintance with Natural Language Processing for Building Smart Society. InE3S Web of Conferences 2020 (Vol. 170, p. 02006). EDP Sciences.

[40] Neef C, Richert A. Promoting Autonomy in Care: Combining Sensor Technology and Social Robotics for Health Monitoring. InEngineering Proceedings 2020 (Vol. 2, No. 1, p. 42). Multidisciplinary Digital Publishing Institute

[41] Chen M, Jiang Y, Guizani N, Zhou J, Tao G, Yin J, Hwang K. Living with I-Fabric: Smart Living powered by Intelligent Fabric and Deep Analytics. IEEE Network. 2020 Apr 30.

[42] Kang J, Wang X. The Organizational Structure and Operational Logic of an Urban Smart Governance Information Platform: Discussion on the Background of Urban Governance Transformation in China. Complexity. 2020 Dec 12;2020.

[43] Kulkarni P, Akhilesh KB. Big Data Analytics as an Enabler in Smart

[44] Rainey S, Astobiza AM. Smart Technologies and Fundamental Rights: Global Governance of AI: Pressure on Political Legitimacy. InSmart Technologies and Fundamental Rights 2020 Nov 18 (pp. 198-218). Brill Rodopi.

[45] Tan SY, Taeihagh A. Governing the adoption of robotics and autonomous systems in long-term care in Singapore. Policy and Society. 2020 Jun 18:1-21.

[46] Varghese C, Varde AS, Du X. An Ordinance-Tweet Mining App to Disseminate Urban Policy Knowledge for Smart Governance.

InConference on e-Business, e-Services and e-Society 2020 Apr 6 (pp. 389-401). Springer, Cham.

[47] Dey P, Roy S. Governance in Smart City: An Approach Based on Social Network. InSmart Cities: A Data Analytics Perspective (pp. 63-87). Springer, Cham.

[48] Goyal M, Gupta N, Jain A, Kumari D. Smart Government E-Services for Indian Railways Using Twitter. InMicro-Electronics and Telecommunication Engineering 2020 (pp. 721-731). Springer, Singapore.

[49] Nagowah SD, Ben Sta H, Gobin-Rahimbux B. A systematic literature review on semantic models for IoT-enabled smart campus. Applied Ontology. 2020(Preprint):1-27.

[51] Liu L. STEAM Platform: Transforming Youth Leadership for a Smart Circular Economy. InAnticipating and Preparing for Emerging Skills and Jobs 2020 (pp. 297-304). Springer, Singapore.

[52] Eswaran K, Kumar MS, Thangavelusamy D, Murugadoss V. Smart Servomotor for Robotics and its Cyber security. In2020 Advanced Computing and Communication Technologies for High Performance Applications (ACCTHPA) 2020 Jul 2 (pp. 231-236). IEEE.

[53] Mohamed N, Al-Jaroodi J, Jawhar I, Idries A, Mohammed F. Unmanned aerial vehicles applications in future smart cities. Technological Forecasting and Social Change. 2020 Apr 1;153:119293.

[54] Peters E, Kliestik T, Musa H, Durana P. Product Decision-Making Information Systems, Real-Time Big Data Analytics, and Deep Learning-enabled Smart Process Planning in Sustainable Industry 4.0. Journal of Self-Governance and Management Economics. 2020;8(3):16-22.

[55] García A, González MV, López-Orozco F, Zamora L. Pronominal Anaphora Resolution on Spanish Text. InHandbook of Research on Natural Language Processing and Smart Service Systems 2020 Oct 2 (pp. 309-326). IGI Global

[56] Yin Q, Liu G. Resource Scheduling and Strategic Management of Smart Cities under the Background of Digital Economy. Complexity. 2020;2020.

[57] Gallone G. Public Administration and the Challenge of Contractual Automation. Notes on Smart Contracts. European Review of Digital Administration & Law. 2020;1:179.

[58] Kummitha RK, Crutzen N. Smart cities and the citizen-driven internet of things: A qualitative inquiry into an emerging smart city. Technological Forecasting and Social Change. 2019 Mar 1;140:44-53.

[59] A Omojolaibi J, P Nathaniel S. Assessing the potency of environmental regulation in maintaining environmental sustainability in MENA countries: An advanced panel data estimation. Journal of Public Affairs. 2020:e2526.

[60] Governance for the Future Smart Cities. InSmart Technologies 2020 (pp. 53-65). Springer, Singapore.

[61] Nicolas, Clément, Jinwoo Kim, and Seokho Chi. "Natural language processing-based characterization of top-down communication in smart cities for enhancing citizen alignment." Sustainable Cities and Society 66 (2021): 102674.