Digital and Smart Cities

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Mobility is notoriously a key aspect of our modern economy and humans' way of life. In an edge situation such as the current coronavirus pandemic, transportation is one of the first affected mechanisms of a city. In our paper, we highlight the potential of operations research and computational intelligence tools for cities' services. The contributions involves aspects of optimization, internet-of-thing and internet-of-value (brought with concepts of Blockchain). When we sum up all these tools, it becomes possible to envision the potential that emerging software and systems can bring to society, associated with the wave of innovation surroundings the smart cities.

Keywords: Mobility ; IoT ; Internet-of-Value ; Blockchain ; ICT ; Optimization ; Operations Research

1. Introduction

Aligned with machines' advancement and the new generation of personal devices, cities are evolving into a new paradigm called Smart Cities (SC) [1]. This evolution, closely related to equipment embedded with techniques from the field of Computational Intelligence (CI), is occurring in urban and rural areas. In addition to promoting decentralization of the current system, these new cities' paradigms open doors for different autonomous agents, devices with CI capabilities, to optimize and manage their own interests. A complex decision-making scenario has been emerging based on historical data and an increasing potential of solving mathematical problems. While each of these software-based systems optimizes specific goals, simulations with multi-agent scenarios [2][3] should focus on improving overall performance. While this combination of technologies emerges, there is a huge trend moving to decentralized solutions, such as those based on Distributed Ledger Technologies (DLTs). The hidden layer behind the intelligence of these selfish agents and decentralized entities is the core of the future Smart and Digital Cities [4], which is presented along this paper.

The expected outcomes of current transformations encompass systems that should reach favorable agreements, considering citizen opinions and participation of all involved entities. However, coordinating these agents handling a big volume of historical and real-time information [5] usually leads to the resolution of combinatorial optimization problems [6] [7], which are undoubtedly a challenge for modern societies and technological development. In this sense, a multi-criteria view of this transition [8], aligned with the management of these emerging decentralized cities [9], should be carefully considered to address different stakeholders' perspectives.

2. Development

It is noteworthy that connecting the dots between what the academy and industry have been doing, and how to take profit from this previous knowledge, may save time and create pillars for future implementations. Since investments and the boom of novel devices are usually sponsored by the private sector, which is usually profit-driven, we emphasize the importance of taking into account all involved partners wishes, which would contribute to a progressive and holistic development [10][11][12].
Blockchain based technologies are used not only for enhancing trust between parties, but also because it has the potential to reduce costs [13]. Blockchain has different streams and a promising set of techniques encompass the connection of private and public chains. As an example, NEO Blockchain can be used as a framework for creating this network.

In particular, cities' mobility [14] and the future of the transportation systems are often one of the main concerns when talking about SC [15]. Zhuadar et al. [16] emphasized a next wave of SC intelligent systems, in which humans' ability to connect with machines is advocated. This ability mentions the possibilities of implementing operational systems that connect citizens to smart equipment, mostly embedded with Internet of Things (IoT) capabilities [17]. Nowadays, we can

add this IoT design with the concepts of Internet of Value (IoV) [18][19], which combines the potential of IoT with value transfer, mostly assisted by smart contracts designed with decentralized and semi-decentralized technologies such as blockchain [20].

In summary, the main points that will be highlighted along this paper are:
(i) technological solutions that will be used in the digital cities transportation environment, both for the public and private interest;
(ii) blockchain based technologies for promoting distributed trust on transportation systems;
(iii) consider social aspects, highlighting how citizens are now interacting with the transportation services offered within the cities, such as carpooling, smart parking, and alternative transports;
(iv) discussions about the possibilities that CI inspired tools have been offering for the future of our cities, pondering a trade-off between technology and quality of life.

Ultimately, this entry expects to contribute with readers to:
(i) understanding some of the current transportation systems that are reality in some parts of the globe, as well as envisioning possibilities and technologies that might come to;
(ii) creating awareness among citizens, researchers, teachers and students about the importance of the transformations that are occurring in urban environments, aligned with the SC paradigms;
(iii) introducing state-of-the-art concepts about decentralized solutions, such as those using blockchain;
(iv) highlighting the importance of considering multi-objective optimization problems and multi-criteria analysis;
(v) motivating the academy and the industry to develop and work towards "fully" distributed and "transparent" approaches, in order to balance the goals of different autonomous agents;
(vi) understanding the potential that DLT technologies have in removing the trust barriers in Peer-to-Peer (P2P) Transportation systems.

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