Information support of the flow processes in the smart city transport and logistics system: methodology basis

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Abstract. The transport and logistics system is a high-tech intelligent system that focuses on the development of the relevant world-class industry, innovations, software and people's skills. Besides, it is aimed to exchange routine interaction between economic operators with the use of distributed data registry technology and intelligent management systems, develop a trust center of competence, and form an open architecture with dynamic infrastructure development. At the same time, with the general trend for digitalization, today there are two main ways of their development distinguished: machine learning of the vehicle for its interaction with pedestrians and stationary objects, and filling the infrastructure with accounting and information systems when combined with intelligent transport systems. These days the development of the second way lags behind due to the high cost of both bringing its current state into a normative form, and creating a new digital and intelligent world-class infrastructure. In this situation the development of smart contracts is a necessary element for coordinating and organising transportation, which also provides effective transformation of the transport and logistics system, savings for economic operators and the city's environment improvement.

1 Introduction

Today, considering the evening-out of environmental risks, the development of the transport and logistics system (TLS) of a smart city is becoming a new way of solving complex issues of socio-economic growth. Besides, combined with technical maintenance, it can also become a high-tech sector of advanced development.

If we speak of the integrated management system development in the smart city TLS, which depends on the model and conditions of implementation [1-3], it is necessary to focus on the digital logistics in coordinating the flow processes [4]. Its role is growing in the development and implementation of socio-technological drivers of the digital economy [5-7] in the smart city transport and logistics system, as well as in the field of standardization, the integration of intelligent transport systems [3, 8, 9] and coordination between economic agents. To reach this state, it is necessary to invent rules (norms) that

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could help to achieve the inter-organizational interaction, and which are expressed with the use the elements of the information space of the smart city transport and logistics system formed with "end-to-end" digital technologies.

2 Materials and methods

In the field of the smart city TLS functioning, there is a need to make maximum use of the existing transport infrastructure [10], and the author's approach to the development of urban transport and communication corridors and the formation of controlled traffic along them allows to create a system for booking time intervals of movement, which, with the development of modern technologies, will increase the carrying capacity with both cargo and passengers, as well as to come to a market-redistributive management system that will increase the efficiency of using passenger transport, optimize traffic, achieve adaptive coordination of flow processes, and reduce transaction costs for supply chain enterprises, as well as other economic agents.

In supply chains, signing a smart contract [8, 11, 12] may help to track the goods origin and to allocate the time and place of loading and delivery, while the transportation itself will be carried out according to a given algorithm taking into account its movement rationalization (while minimizing downtime and stops), as well as with guaranteed financial security.

In the field of passenger transport each trip is obviously financially secured, and programmed for the consumer's needs and plans. At the same time, in the dynamic pricing system the level of traffic in logistics service varies..

The smart contract for the use of individual passenger transport regulates the use of the route at a given time.

Besides, real-time information management [2] requires the consolidated use of the vehicle technical state databases, compliance with environmental standards, assessment of offenses, health status, and other indicators. In this situation, the smart contract acts as a supporting element for introducing modern technologies and services, infrastructure forming, personnel training and the collected information processing, which are all aimed for improvements on behalf of economic agents and other flow processes participants, and it also provides a rational choice for optimization of limited resources.

To sum up, the use of smart contracts in the smart city TLS ensures a systematic and efficient use of the existing transport and logistics infrastructure and vehicles, which provides flow processes adaptive coordination. Besides, it can act as a mechanism for raising capital from anonymous investors for their development and renewal.

3 Results and discussion

Today in the context of smart city cooperative intelligent transport system development [3, 12, 13, 14, 15], in which the vehicle and the stationary infrastructure work together to ensure the safety and efficiency of traffic, the transportation process is strongly influenced by the human factor. As a result, the rational choice is taken at the time of participation between the driver, the carrier and traffic participant.

The smart contract secures the transaction, which requires "oracles" (decision-making mechanisms, system aggregators), as well as data collection equipment and access to them. In this situation, the structure of the smart city TLS will be a multi-level structure, in which Smart contracts are formed for the participants of the flow processes, which may provide a more efficient adaptive interaction of economic agents while distributing data registers.

The model of routes booking in the urban transport and communication corridors ensures a free issue of CITY tokens in the amount necessary to cover the maximum load of the smart city's TLS for a certain cycle (Figure 1).

Fig. 1. A model for booking traffic routes on the city transport and communication corridors within the smart city transport and logistics system with the use of CITY token

After the request and evaluation by the system integrator the request and evaluation by , as well as the proposed solutions for moving and choosing, a smart contract is formed, which takes into account the requests of other similar economic agents.

Thus, it becomes possible for firms to implement combined modes of cargo movement, it forms flexible routes of movement for public transport and a system of travelling companion for private transport.

The QR code provides identification of the economic agent for access to the urban transport and communication corridors, as well as for paid services (Wi-Fi, parking, changing the vehicle, etc.).

This approach will make it possible to use the city space most effectively, while alternatives for the development of technologies and the use of various transportation schemes can include drones, bicycles, taxis, car sharing, as well as a combination of them.

Traffic management can be implemented by the following:

First, driving a vehicle could be assigned to a person, while the main processes of collecting information and predictive analytics would be carried out by automated algorithms and data processing centers.

Second, the automation of flow processes could be implemented only in the urban transport and communication corridor branch and include highly automated vehicles usage.

Third, including all-around automation of the entire smart city transport and logistics system.

In addition to the route booking process, the terms of a smart contract or a mechanism for identifying the economic operator and the vehicle, as well as access to the transport and communication corridor. When forming CITY tokens, it is necessary to assess various factors providing access to the ecosystem.

The field of operating and developing the smart city TLS also includes smart contracts for the coordination of the route with the town council and with a service company, for capability improvements for users, as well as for forming world-class transport and logistics, digital, and intellectual infrastructure, as well as ICO (Figure 2).

Fig. 2. A model for the smart city transport and logistics system development by means of the CITY token

In the ecosystem economic operators form requests for improving flow processes in traffic management, These requests are focused on changes in current schemes, adjustments to interactions, as well as the formation of new infrastructure, equipment, software, training of specialists, etc. Then follows a rational choice of the best solution combined with analyzing the aggregate pool of improvements, on these design and investment smart contracts are formed. After their completion goes the next step - to draw a smart contract for construction with subsequent expertise.

Thus, the system aggregator as the main "oracle" of the smart city TLS when using the CITY token works with the smart contracts listed in Table 1.

Table 1. System aggregator smart-contracts

Smart-contracts	Description
UC	Accepts requests and forms a traffic pool for the flow processes participant along the specified corridors, and consists of route smart contracts for the flow processes participants.
IOT	Makes a request for collecting information, as well as analyzing information, and decisions made without human participation and based on out-of-chain resources.
Big Data	Forms a request for information analytics to the type that allows to make decisions, and also forms traffic options that ensure that with dynamic pricing economic operators get some savings.
ITS	Requests real-time traffic status information from of-chain resources.

SCRP	Ensures consistency of recommendations for flow processes improvement.
Traffic	Provides automation of the flow from the departure point to the destination and operates UC
Education	Provides necessary skills training for future specialists.
Service	Controls the admission and repair of a vehicle, software, and equipment, as well as provides scheduled maintenance services.
Finance	Ensures collecting financial resources from economic operators, and paying interest on investments, as well as monitors transactions.
Improvement	Initiates improvement and design process.
Research	Initiates selection and comparative genetic analysis of technologies and technological solutions.
Implementation	Controls all procurement processes, the quality of materials, construction work, commissioning and expertise.
Contesting	Promotes risk insurance, as well as ensures the contestation of financial transactions
Oracular	Acts as an referee when automated algorithms make decisions, and also runs the system audit processes.

When transforming the smart city TLS implementing Blockchain technology allows to replace routine operations in cross-functional and inter-organizational interaction between economic operators and ensure their reduction and the reliability of the transmitted digital information, and also accelerates the system transformation to Web 2.0 (3.0) architecture.

This article suggests to use the CITY token as:

- as a digital key for accessing the smart city's TLS ecosystem and initiating recommendations for its improvement;
- for booking routes on the urban transport and communication corridor;
- as an ICO mechanism for updating assets.

Thus, the use of a smart contract lies in the legal field, but the process of recognizing smart contracts has already been launched and there are many platforms on which they are being developed. Their formation is realized in developing consensus algorithms, architecture, and integration of various applications. It is important to mention that a public network is one of the important factors in their development, others being a competence trust center and the amount of contributors involved in the development and improvement of the system..

As a result, in distributing the data register, the need to implement "regulatory sandboxes" is a common trend for testing ready-made solutions for the development of smart contracts for the smart city transport and logistics system.

4 Conclusion

Significant investments put in the intelligent transport systems development in the context of increasing traffic and congestion of the cities' TLC give the assumption that the existing approaches do not fully meet the needs of modern cities. At the same time, the formation of controlled traffic along the urban transport and communication corridor can act as a new testing approach and an alternative for the traffic organization of a smart city's TLS.

The use of a smart contract in this situation minimizes transaction costs in the field of adaptive coordination of flow processes, and also allows to:

- move from a command-and-control system to a market-based redistribution system in the area of traffic management;
- create a unified ecosystem meeting the consumers requests;
- ensure permanent system improvement and development, and boost social innovation;

- optimize the last mile;
- ensure the information authenticity;
- ensure the assets update according to the demands of socio-economic development.

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