Organization of data gathering and preparing on the basis of blockchain for the supporting system of making decisions in the sphere of developing human capital of region

Sergey Novikov 1*, Oleg Kazakov 1, Natalia Kulagina 1, Maxim Ivanov 2
1 Bryansk State Engineering Technological University, Stanke Dimitrova av., 3, Bryansk, 241037, Russia
2 Peter the Great St. Petersburg Polytechnic University, Politechnicheskaya st., 29, St. Petersburg, 195251, Russia

* E-mail: spnovikov@gmail.com

Abstract. In the context of establishing the digital economy there appears the necessity to apply innovative methods of processing increasing volumes of data on digital platforms with the use of intellectual computer systems. The necessity of creating a subsystem for gathering digital data is substantiated in this work; this subsystem should meet modern requirements for the quality of these data in terms of reliability, targeting and security. The authors have suggested a model of digital accounting of data on labor activity of individuals with the use of the blockchain technology and smart-contracts with the aim of providing the required quality of the data. In this case, the blockchain technology provides reliable preservation and authenticity of data and the system of smart-contracts presents the data in a convenient form for any consumers of this information. It has been demonstrated in this work that the subsystem of digital accounting in labor sphere will allow for creating a unified information environment for cooperation of all subjects. The collected data can be successfully used in support systems for making decisions in the field of development of the human capital of the region. In this case the system of smart-contracts plays a key role and acts as an integration bus which provides cooperation of the blockchain subsystem with the automated subsystem of intelligent data processing.

1. Introduction
Currently, innovative technologies of the digital economy are being used for automation of activity of socio-economic systems more and more often [1]. Gradually, traditional procedures of analyzing activity of such systems are being replaced by machine learning algorithms. It allows for creating efficient models of economic and production systems [2]. However, it is impossible to create an efficient system of supporting and making decisions without a digital base for data which fulfills the quality requirements for further processing by intellectual systems. At that, there is much concern about the issues of storing personal data, providing free access to them, protection of information. Therefore, creating a subsystem of gathering digital data which fulfills the specified requirements to the quality of this data is a primary task while developing a system model of socio-economic development of the region [3].
In order to solve the problem, it is reasonable to pay attention to cross-cutting technologies of the digital economy [4]. In our opinion, the most suitable technology is the blockchain-technology [5]. This technology allows creating reliable and secure digital information storage in the global Internet network, automatizing the process of supplying information in the desired format for further intellectual processing by means of machine learning methods with the use of smart-contract technology [6]. Thus, the blockchain technology allows for creating an efficient subsystem of collecting and accounting digital information related to the activity of any socio-economic systems. At that, blockchain can provide convenient access to the digital registry for all users and automated systems by means of cryptographic technologies.

We can distinguish the following significant advantages of the blockchain technology.

- decentralization which minimizes the risks of fails in case of a certain system failure;
- the impossibility of changing data of an approved block as the hash identificator of each block is calculated on the basis of the cumulative hash of data of the entire block and the hash identificator of the previous block;
- transparency as all actions are documented and available for studying to all the system participants.

The advantages of the blockchain technology specified above will allow for providing necessary characteristics of collected data for their further processing.

2. Blockchain technology as a reliable source of high quality digital data

2.1. Blockchain technology

Blockchain is a type of a distributed data base where records are grouped into blocks. Each block is connected with the previous one with the help of a hash-key [7]. It makes it impossible to change information inside the block without changing the information stored in the following blocks. The entire chain of blocks is stored on the node computer (Node), each participant of the system has it; the chain makes a distributed registry of data. When a new block is being added copies of the whole system of blocks of every participant are being upgraded. Consensus regarding what types of blocks and transactions can be a part of a blockchain is automatically obtained in accordance with the fact whether the most part of block-chain holders agree with the suggested blocks.

2.2. The spheres of applying the blockchain technology in modern conditions

The blockchain technology was developed in 2008 [8] and it has come a long way of transformational development from making certain transactions with crypto-currency to the base of creating blockchain-platforms for further implementation in a wide variety of fields.

Obvious advantages of the blockchain technology (openness, transparency, high level of security and safety of executed transactions) induced specialists of the IT-sphere to search opportunities for its implementation in different fields of socio-economic relations of the modern society [9].

The blockchain technology is extensively used outside the financial sphere in the international practice:

- the Dubai department of land resources (DLD) has created a system of registering contracts for realty on the basis of the blockchain technology [10];
- a special work group in the European Parliament is searching for methods of applying the Ethereum blockchain for solving the problem of refugee migrants identification [11];
- the Ministry of Planning, Budget and Management of Brazil, together with the international technological giant, Microsoft, is testing an application on the basis of the blockchain technology designed for identification of users [12].

Implementation of the blockchain technology in educational environment was approved in 2017 which is demonstrated by the European Commission report, “Blockchain in Education” [13].

Developments of applying the blockchain technology in the systems for personal identity authentication are actively carried out [14].
Reasonability of applying the blockchain technology has been elaborated also by designers of different complex information systems, in particular, those who develop the methodology of creating solutions within the framework of “SmartCity” conception.

3. The method of implementing the digital data accounting subsystem

From the point of view of the data gathering subsystem the blockchain technology can be considered as a shared use registry, protected from unauthorized access and distributed between all system nodes; the registry keeps records of transactions in the peer-to-peer network. Thus, a blockchain is a unified source of valid data and the blockchain participants see only those transactions which are related directly to them.

Components of the blockchain system, in accordance with the above-mentioned principles of functioning, are presented in figure 1.

![Figure 1. The blockchain system components.](image)

The basic elements of the blockchain system are:
1. The Infrastructure of Public Keys (PKI – Public Key Infrastructure) – is used for signing transactions and controlling data access.
2. The Data Transfer Protocol (System Protocol) – a set of agreements of the logic level interface which define exchange of data between the system participants.
3. Storage (Storage) – any data base may be a storage of information.
4. Consensus (Consensus) – the basis for protecting transactions from changes which defines the basic properties and restrictions of the system [16].
5. A Smart-contract (Smart Contract) – represents a digital protocol which automatically executes transaction processes predefined in advance.

The method of cooperation with the system is based on transactions which include a public key or a system participant certificate, a transaction body, a signature and meta information [17].

4. Basic results and their discussion

4.1. A model of a subsystem of gathering and preparing data in the sphere of labor

Within the framework of the present study, the authors have developed a model of a subsystem of digital accounting of individuals in the sphere of labor on the basis of the blockchain and smart-contracts technology. Such subsystem is the main source of valid and protected data for the system of supporting making decisions in the field of developing the human capital in the region [18].

Open solutions are the basis of developing the subsystem model, in particular, the public Ethereum has been selected as the blockchain-platform [19] and this blockchain project ranks second in popularity after Bitcoin [20]. In our opinion, this project is most convenient as it allows for solving a
wide range of problems providing conditions for executing transactions on the basis of the smart-contracts technology.

A transaction in such a system is: the fact of job assignment, receiving a certificate, skills upgrading or another professional achievement. This transaction can be initiated by any employer or a training center, registered in the system. Government institutions which maintain control in the labor sphere can act as validators of such transactions.

Thanks to the blockchain technology any system participant can easily check his or her professional achievements by building a complete chronological chain. The problem of authentication can be solved by using cryptography with an open key. Each user of the system receives a pair from the secret and open key. The open key can be published without any problems for determining the digital personality of a user because the secret key cannot be obtained from the open key. Thus, it is possible to form a digital registry of professional assets if the principle of inalterability and validity of all data, included into it, is observed. With the help of the smart-contracts system, this registry can supply data in the required format into the automated analytical system which allows modeling and forecasting the labor potential of the region. Thus, the Ethereum-platform gives the possibility both for creating a secure and transparent registry with professional data and for making efficient exchange available (figure 2).

Figure 2. Organizational scheme of information exchange with the blockchain system.

The participants forming the digital registry of professional competencies are shown in the scheme presented above, on the left, and the users of this registry are on the right. Cooperation with the registry is executed by means of smart-contracts which allow forming digital data streams with the given contents and formatting.

4.2. A model of a point-rating system of accounting professional competencies of individuals
In order to improve the format of the stored information and make its perception convenient, the authors have developed a model of a point-rating system for accounting competencies. Basic indices of professional activity have been suggested with the aim of their subsequent processing by machine learning algorithms and developing a system model of development of the human potential of the region. The basic indices include: a professional activity code number, indices which reflect experience and the level of professionalism of every registered participant and also all of his or her professional achievements (skills upgrading, probation, certificates, etc.). The list of these indices may be expanded with the approval of the labor market participants.

Thus, it has been suggested to create a digital professional portfolio for any participant of the system. Such portfolio will allow obtaining a comprehensive picture of distributing specialists in
regions, building imitation models on developing labor resources and estimating the labor potential of the region.

In order to improve business processes of the labor market, it has been suggested in the study to use an integrated index which represents an individual index of the professionalism level (Professional Index – PI) for each sphere of activity which takes into account work experience and professional achievements.

It is reasonable to form such indices in the form of a group of figures divided by a point. In this case, the first figure, which precedes the demarcation point, represents total rating points (professional level rating – PLR), which reflect the fact of documented professional mastery. The second figure reflects work experience (WE) in the given professional field. The remaining figures correspond to the professional activity field code (field of professional activity – FPA) codified by law in professional standards according to the list of fields and types of activity.

Thus, the PLR index reflects all total accumulated professional competencies of individuals. The authors have suggested to accrue a certain number of points for each granted certificate on vocational preparation; this number should correspond to the level of significance of this document (level of the professional document – LPD), multiplied by the weighing coefficient (rating of the vocational training center – RVTC), which reflects the rating of the professional training center which has issued the corresponding document. Then, the PLR index can be calculated by the equation 1.

\[
PLR = \sum_{i=0}^{n} LPD_i \cdot RVTC_i
\]  

(1)

Here, \( n \) is the total number of issued documents.

Thus, the resulting index of the professionalism level can be presented in the following form:

\[
PI : PI_{PLRWE.FRA}
\]

For example, the PI record 13.5.06.001 will mean that the level of professionalism of its possessor is equal to 13 points, the work experience is equal to 5 complete years, the area of activity: 06.001 – Software programming.

The presented scheme of calculating the PI index can be implemented by a smart-contract which is activated each time after registering the fact of undertaking vocational training.

5. Conclusion
Within the context of this study, the necessity of using the blockchain technology for organizing a subsystem of gathering and preparing data in the sphere of labor is substantiated. One of the main advantages of the blockchain, in comparison with other models of distributed data bases, is integration of data processing, providing correctness and security in the unified protocol implemented algorithmically and minimizing the human factor. The efficiency of the elaborated system for providing digital data for the system of supporting making decisions in the sphere of developing the human capital in the region has been demonstrated. The algorithm of calculating key indices for professional activity has been developed. Also, a model of a point-rating system of forming these indices has been suggested.

It is especially important to provide integration of the subsystem of accounting professional competencies, which is being developed, with all the labor sphere participants. It is reasonable to use smart-contracts for these purposes. They are used for convenient presentation of the stored data with the aim of their subsequent processing by any artificial intelligent computer systems. Preliminary preparation of data will allow for increasing the general efficiency of computing processes of analytical systems. The main difficulty of using the blockchain technology in the labor sphere is in achieving balance between protecting interests of the system participants and satisfying wider interests and requirement of the society.

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