

The concept of implementing distributed registry technology in the activities of wholesale distribution centers

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Abstract. The paper considers the conceptual aspects of the application of distributed ledger technology elements (blockchain) and their derivative smart contract for the construction of automated transactions on the example of individual business tasks of large wholesale distribution centers. In the course of the study, the elements and properties of the smart contract characteristic of the subject area under study were determined, as well as the conditions, types of business operations and the corresponding data allowing them to consider the business object state with its subsequent implementation in the smart contract transaction.

1 Introduction

The Decree on the National Development Goals of Russia until 2030, the National Project "International Cooperation and Export" identified priority measures for the entry of Russian agricultural enterprises into the foreign market. The real growth of exports of non-raw non-energy goods by 2030 should be at least 70 percent compared to 2020 [1, 2].

International trading platforms set a high level of quality of work with consumers, suppliers, and manufacturers in various trading segments – B2C, B2B, B2G. An important factor in the implementation of foreign economic activity is to ensure equal opportunities for the unhindered opening, expansion, and conduct of business by trading entities of any size (small, medium, large), regardless of the trade format chosen by the economic entity, under stable business conditions, comprehensive guarantees of rights and minimization of administrative impact [3].

The trade development strategy in the Russian Federation provides for the solution of a number of global tasks in terms of expanding multi-format trade (creation of retail networks, organization of small-format trade, Internet trade, etc.), as well as the development of the wholesale food link while providing the industry with the appropriate infrastructure [3].

The key indicators of the Strategy implementation effectiveness are the criteria of a comfortable consumer environment, convenient and cheap trade infrastructure, as well as the level of entrepreneurial activity, which include:

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- the number (availability) of retail facilities of all trade formats, including retail outlets at markets and fairs;
- availability of financial, payment, accounting, information, logistics, insurance, clearing, and other tools for carrying out trading activities.

The ways (mechanisms) of achieving the goals set out in the doctrinal documents, in our opinion, lie not so much in the plane of deregulation of the trade industry, the elimination of existing administrative barriers that hinder the development of all forms of entrepreneurial activity, but are mainly concentrated in the field of trade infrastructure.

The development of trade infrastructure through the mechanism of competition allows, on the one hand, to restrain the growth of consumer prices, thereby stimulating consumer demand (including, for example, increasing the consumption of perishable and fresh food); on the other hand, to have a positive impact on the efficiency of all participants in the trade chain from the manufacturer to the retailer reducing indirect costs [4].

As world experience shows, an effective mechanism for ensuring transparent interaction and convergence of the needs of all participants in the trading process is the transformation of the business model of omnichannel interaction with the buyer based on the consolidation of a large volume of heterogeneous data (in digital form) into a single array at all stages of the product lifecycle (BigData), thereby enhancing the generation of customer traffic (online and offline), control over supply chains, development of own production, activation of imports, etc.

The priority direction is the creation of a set of favorable regulatory, organizational, and technical conditions to stimulate the business activity of participants in terms of electronic commerce development in the Russian Federation [5,6]. This is due to the fact that currently e-commerce mainly covers the retail segment (B2C). Most of the purchase and sale operations are carried out on such domestic marketplaces as Ozon, Yandex, Sbermarket, and others.

The wholesale segment (B2B, B2G), due to the specifics of its activities, is practically not represented on the above-mentioned platforms. Representatives of the wholesale segment work with a different set of conditions, processes, and relationships between participants: large wholesale production, storage of large volumes of products in special places - wholesale distribution centers, multi-basis scheme of delivery and sale, customs support, various payment schemes, etc. These conditions impose their own requirements for conducting transactions in electronic form and can be implemented, for example, using distributed ledger technology (blockchain) and their smart contract derivative.

The peculiarity of a distributed registry is that it is stored in a distributed, decentralized manner on a number of hosts, and not centrally in one specific place. The blockchain architecture is based on the decentralized placement of information on a huge number of nodes connected to each other in a chain that is resistant to unauthorized interference and allows only addition, while the implemented information processing functions and their basic logic cannot be changed from the outside [5].

Based on this, it can be assumed that the blockchain is conceptually applicable for maintaining various registries (documents, operations, transactions, cadastres, registers, etc.) that are consistently filled in over time. This concept is applicable in many sectors of the economy, trade, law, production, logistics, as well as in state and organizational management.

The main smart contract elements are the following [4]:

- participants in the transaction who use digital signatures to agree or refuse to comply with the conditions presented in relation to the goods or services;
- object (subject) of the contract, which can be a product or service sent in exchange for money;

- conditions that must be met for automatic exchange, such as compliance with the rules of sale or product quality standards, etc. They must be mathematically described in full;
- decentralized platform where the program code (algorithm) for smart contract is written.

Smart contract characteristics [5]:

- ensuring the integrity of data due to their "hashing", which makes it impossible to change data after confirmation by consensus, in addition, every attempt to change data can be tracked;
- ensuring high reliability of data storage and procedures, which makes it relatively easy to resist external threats and perform data recovery without loss;
- ensuring high speed of operations and exchange of large amounts of information (almost in real time) is achieved through the use of elements of microservice architecture and distributed computing;
- ensuring broad opportunities for analysis and transparency – the immutability of information, its transparency at all stages of operations allows to make transactions and their impact on various project participants visible and easily amenable to analysis by the regulator or any participant (for example, a bank, an insurer, a surveyor, etc.), which significantly increases the "trust" of participants in each other. In other words, blockchain technology can act as a trusted environment between participants and in general does not require the use of services of trusted third parties, for example, certification centers, time stamp authorities, etc.

The Russian Federation has adopted a corresponding regulatory act that defines a smart contract as an agreement in electronic form, the fulfillment of rights and obligations under which is carried out by automatically performing digital transactions in a distributed register of digital transactions in a sequence strictly defined by such an agreement and upon the occurrence of circumstances determined by it [6].

In addition, since April 1, 2023, the Central Bank of the Russian Federation launches real settlements with the digital ruble in a test mode. This platform, built on a combination of technologies of distributed registries and special centralized components, will also be used for processing special types of settlement / payment transactions in digital form (smart contracts) [6,7].

2 Materials and Methods

Methods of scientific cognition are methods of system analysis and synthesis, indirect measurement, comparison, and information modeling. To model the objects, architecture, and behavior of the system, the object-oriented modeling language UML, patterns of construction of microservice architecture (MSA) were used.

3 Results

The wholesale trade format is accompanied by a continuous process of formation, accumulation, and updating of a large amount of data on market participants, supply and demand, contract transactions, payment transactions, operations of goods movement, production, etc.

In relation to the agro-industrial complex, the processes of wholesale turnover of products are concentrated in wholesale distribution centers. Currently, a network of wholesale distribution centers has been deployed in the country, which has at its disposal about 50 large sites throughout the country, which allows aggregating up to 30% of the turnover of agricultural products on its premises, which will affect the market in terms of increasing the

volume of domestic products, reducing prices, and establishing modern standards for storage, processing, and quality control of agricultural products [8].

The purpose of creating wholesale distribution centers is to expand sales channels for agricultural products based on the organization of complete production distribution chains. The wholesale distribution center is a complex of buildings and structures designed for storage, underworking and primary processing, acceptance, packaging, and sale of agricultural products, raw materials, and food, including retail, using automated electronic information and settlement systems.

For large manufacturers, such a platform is convenient from the point of view of centralization of logistics and distribution of large batches of goods for their contract deliveries, with the possibility of small wholesale trade. For small producers, the wholesale distribution center can become the main channel for the sale of products. In addition, the integration of logistics infrastructure facilities into a network will create a unified decision-making system and management of commodity flows in the agro-industrial complex, including within the framework of the Eurasian Economic Union.

Nationwide, the network of wholesale distribution centers is designed to serve four aggregated food flows (Figure 1):

- west stream – vegetables, milk, and meat, the main suppliers are Belgorod, Bryansk, and Voronezh regions;
- northern and eastern streams – fish and seafood from the Murmansk and Sakhalin regions, Primorsky and Khabarovsk Territories;
- south stream – vegetables, fruits, dairy products from Krasnodar Territory, Stavropol, Dagestan, Astrakhan, and Volgograd regions [3].

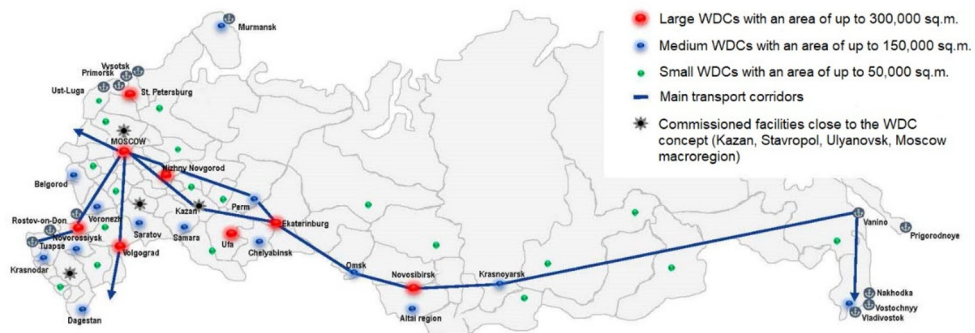


Fig. 1. Arrangement of wholesale distribution centers [3, 9].

Such an arrangement of wholesale distribution centers in conjunction with a complex of multimodal transport and logistics services within the framework of the common customs space of the Eurasian Economic Union and certain BRICS countries objectively increases the demand for the creation of customer-oriented services for users of wholesale distribution centers based on modern digital technologies.

Simply, the business model of a wholesale distribution center can be represented as a certain set of functions performed in the course of the main activity (Table 1).

Table 1. Functions performed by the wholesale distribution center.

Function name	Function feature	Digital maturity
Trading	Sales of products on various bases (CPT, FCA, CFR, CPT): WDC sale; WDC sale and delivery; sale from seller's warehouse, delivery to the WDC; sale and delivery from seller's warehouse; WDC sale, delivery from seller's warehouse	High
Warehouse, service	Storage and distribution of agricultural products, raw materials, and food. Provision of equipped retail outlets, warehouses with various temperature conditions, office premises, commercial and warehouse equipment to wholesalers, organization of auctions, exchange and electronic trade in agricultural products, raw materials, and food [3]	Low
Processing	Pre-sale preparation of agricultural products, raw materials, and food, manufacture of certain types of finished products, pre-packing, and packing	Low
Transport	Transportation, in-warehouse cargo handling, including acceptance, unloading, loading, and dispatch of goods by transport, provision of transport and cargo processing infrastructure (railway and automobile access roads, unloading platforms, parking lots), provision of transport and loading facilities	Low
Logistics	Complex logistics services, including acceptance of applications, registration of transport and financial documents, delivery of complex cargoes, cargo support, control of cargo movement, including operations of foreign economic activity	Medium
Financial, legal	Cash and settlement and other banking services, financial services, including lending services, insurance, assistance in creating one-stop shop services for small businesses (consultations, paperwork for subsidies, loans), notary and legal services [3]	High

For further use, it is advisable to decompose the selected functions to the level of individual business processes or business operations. To elect such processes that meet the following requirements:

- strictly regulated and relatively simple from an organizational point of view (do not contain logical operations related to obtaining agreement and/or approval);
- have a complete character within the framework of one business function (processed within one workplace);
- have high digital maturity (application software is used to perform operations, manual data entry is practically absent).

Based on the preliminary survey data, the following processes meet the above criteria (see table 1):

- sales of products on various bases;
- settlement and cash services.

The application of the distributed registry technological features, when organizing the interaction of participants in the B2B, B2G segments, will manifest in the sequential implementation of individual operations (transactions) according to a predetermined scenario (set of transactions) agreed upon by its participants and implemented on the platform.

Figure 2 schematically shows the events of the transfer of asset ownership, which will be jointly executed by the participants in the process of implementing a smart contract, transforming a business object (cargo, documents) from one (initial) to another (final) state [10].

The various states of the smart contract business object are regulated by operations and data that participants automatically or manually enter during the execution of smart contract transactions. When executing a transaction, the received transaction data is verified and stored on all nodes of the network in a decentralized way (Figure 2).

The buyer irrevocably initiates an event for the purchase of an asset indicating the value of the contract, the specification of the supplied products (quantitative and qualitative characteristics), the delivery period (on time, for the future harvest, etc.), the payment method and type (own funds, borrowed funds, digital assets, etc.), as well as a set of additional conditions - the delivery basis (for example, in the manufacturer's warehouse or in the warehouse of a wholesale distribution center, etc.), phyto-, veterinary-sanitary requirements, customs clearance requirements, storage, packaging, etc., cryptographically signs and sends this requirement to the seller (supplier) through the platform. The seller (supplier) expresses his consent by signing this requirement and assumes obligations for the manufacture (delivery) of products (see the color selection of item 1 in Figure 3 A).

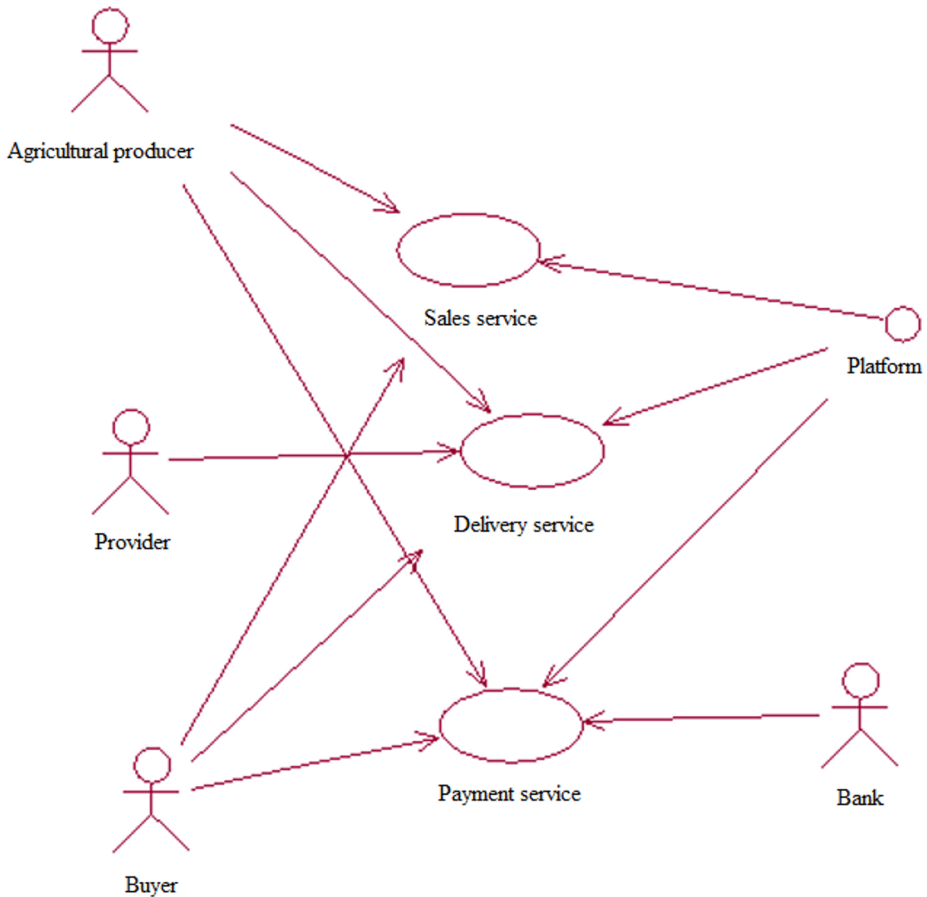


Fig. 2. Use cases and roles of smart contract participants.

After registration of the transaction and approval of the delivery terms from both sides, this approval (by the platform methods) is transferred to the credit institution that services the contract. Depending on the financing scheme, the buyer can provide a contractual

guarantee (letter of credit), or he can ask his bank to use digital assets to make a payment instead of a traditional letter of credit.

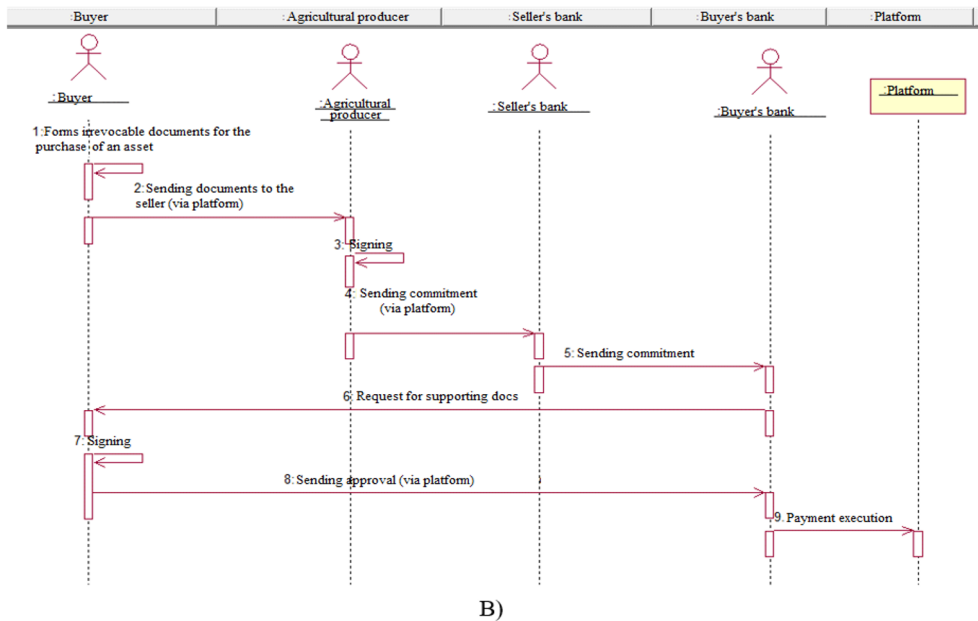
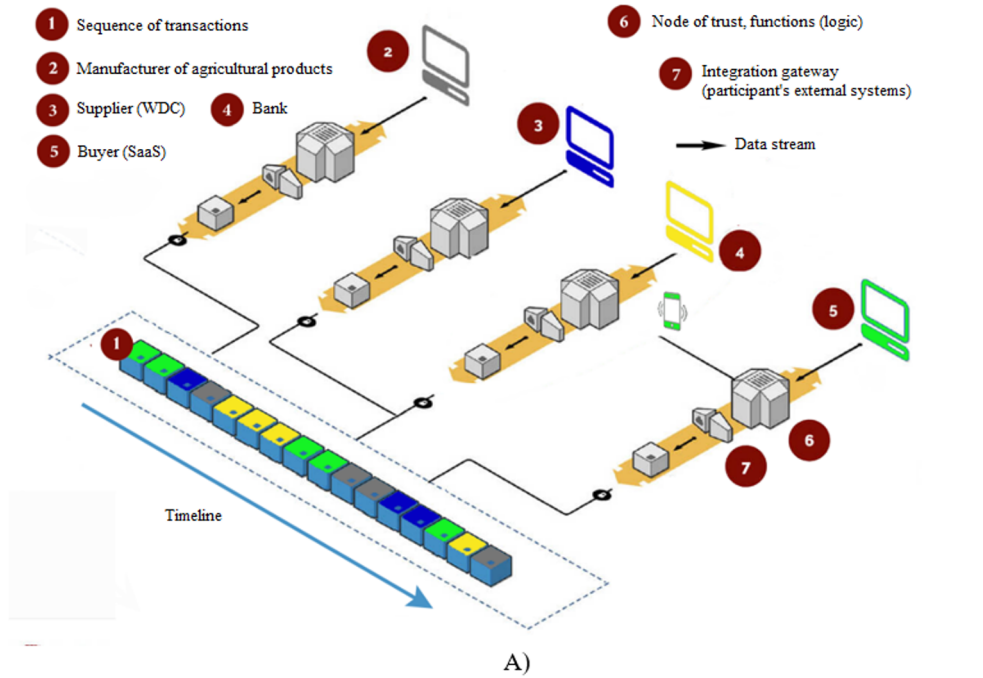


Fig. 3. Layout diagram (A), diagram of conditions (B) of the smart contract operation.

Upon the occurrence of payment terms and the transfer of asset ownership from the seller to the buyer, the bank, depending on the payment model defined in the smart contract, reduces the amount of the asset from the seller and increases it on the receiving account of the buyer. At the same time, it should be noted that during the execution of all transactions, network nodes will check transactions and, if they are valid, include them in the blockchain to confirm their validity (see Figure 3 B).

During the execution of transactions, a stable and previously known set of data is generated. For example, information about buyers, types of products, suppliers (sellers), type, terms, and status of the contract, completed orders, payment methods and statuses, contract status, etc. All this data in the context of a separate transaction can later be collected into a common pool for the formation of BigData sets. The information obtained in this way is structured, numerous and complete, which makes it an attractive source for further analysis (Figure 4).

At the application level, the implementation of smart contract execution with pre-configured automated methods for verifying and establishing trust, securely executing transactions and protecting user data is based on a microservice architecture. The choice of this type of architecture is due to the fact that in it all functions are defined as independent services with called interfaces.

Accessing these services in a certain sequence allows to implement a particular business process, flexibly describing the necessary behavior of smart contract elements and at the same time adapting to the existing limitations of the subject area. This makes smart contracts independent of specific development tools (programming languages) and physical conditions of implementation (hardware) (Figure 5).

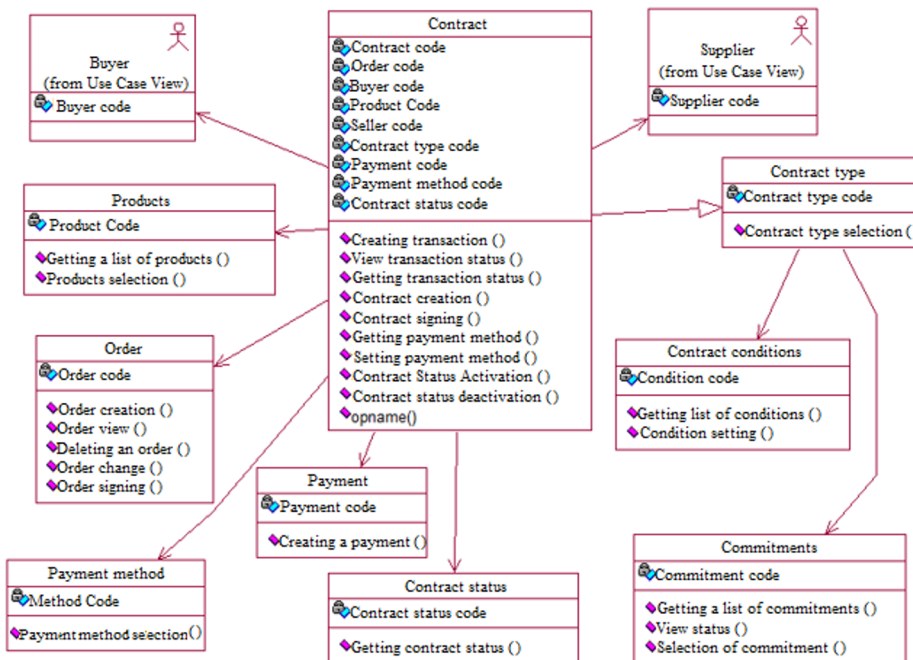


Fig. 4. A set of data used in smart contract (fragment of the class diagram).

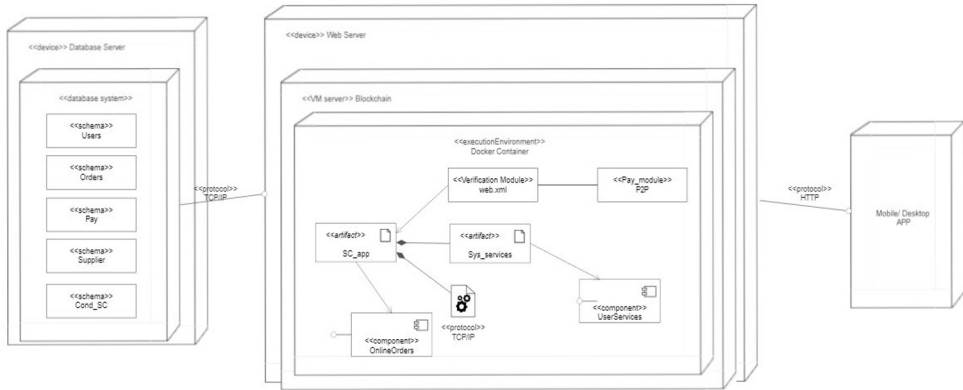


Fig. 5. Smart contract deployment diagram (fragment).

4 Discussion

In accordance with the purpose of creating a wholesale distribution center, it is focused on expanding sales channels and increasing the turnover of agricultural business, thereby excluding small wholesale dealers from the supply chain, working under a gray scheme and increasing the cost of products for end customers [11]. A large number of participants in various activities are involved in the turnover of agro-industrial complex products - agricultural producers, processors, transport organizations, banks, investors, insurance agencies, government agencies, etc., each of which has its own interests [12].

The largest material, financial, labor, and other flows are concentrated in wholesale distribution centers, which, if there is an appropriate infrastructure, can be used to expand multi-format trade and develop the wholesale food link in terms of creating an ecosystem of decentralized data processing based on distributed registry technology [13].

On the one hand, it will simplify the interaction of buyers and suppliers, will enable a more rhythmic organization of production and sales activities for large producers and processors of agricultural products, the banking sector, legal and insurance organizations will provide an opportunity to offer new products considering a new level of transparency and trust between ecosystem participants. On the other hand, such a solution will allow government agencies to reduce the number of control and supervisory actions, since such projects are available for verification in real time, allow accumulating a large data array, and thereby minimize risks in terms of ensuring the safety and traceability of products.

5 Conclusion

The study conceptually substantiates the expansion of the format of interaction between participants of the wholesale link of wholesale distribution centers based on the use of distributed registry technology and the construction of smart contracting ecosystem. This approach was implemented through the formation of functional and non-functional requirements for business procedures and information used in smart contracts. Based on the OOD and MSA methodology, information modeling of individual components of a smart contract was performed - use cases, classes, states, objects for deployment.

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