Product Traceability as a Mechanism for Ensuring Quality and Safety in Digital Economy

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Abstract. The presence of counterfeit and pirate goods in circulation, along with original products, has become a worldwide social problem. The task of goods quality and safety assurance is relevant worldwide. The example of products made from wool mixtures of various animals shows the complexity of identifying counterfeit products and the prospects of combating the above negative phenomena by ensuring product traceability throughout the supply chain from manufacturer to consumer using information technology. The quantitative determination of the fibrous composition of precious wool products in mixtures with sheep wool was estimated by optical microscopy, its complexity was shown. Inclusion of products from precious types of wool, including those made in mixtures with sheep wool, in the list of goods subject to mandatory labeling with control and identification tags was proposed.

1. Introduction
Cases of detection of counterfeit products, products with unauthorized use of other people's intellectual property, gray imports are found around the world. Articles covering individual cases are increasingly common in the press, that is illustrative of public concern. The presence of such products in the market poses a serious threat and is very difficult to prevent.

At the same time, in the markets of most developed countries, consumer demand for confidence in the quality and safety of purchased goods, provoked by scandals surrounding the detection of dangerous products, is increasing [1-3]. One of such notable scandals with catastrophic consequences was, for example, the case in China, when melamine was found in milk powder for baby food in 2008 [3].

The solution to these complex and pressing problems of modern times is proposed through the implementation of goods traceability systems, including those created on the basis of Blockchain technologies. [4] and RFID (Radio Frequency IDentification) [5].

A general definition of traceability is given by Olsen and Borit [6] - “The ability to access any or all of the information related to what is under consideration throughout the life cycle using registered identifiers”.

Product traceability elements have long been used in world practice [7], including in product quality management systems within a single enterprise (so-called internal traceability), however, at present, this mechanism has gained wider application and significance in the form of tracking global supply chains.

In a number of countries, traceability systems are used to ensure the quality and safety of national livestock products [7], wine sector [8], other agricultural products, food for restaurants [9].

As the authors of [10] note, consumers prefer suppliers with a high degree of food product traceability, even if this increases the cost of a commodity unit.
The authors of [11] investigated consumer preferences for traceable foods in China. The results show that consumers are willing to pay for traceable products, but their ratings may vary depending on their degree of state food safety and labeling supervision. Consumers prefer traceability together with convincing control that ensures the reliability of information.

The authors of [12] also suggest using QR coding to provide consumers with more complete information about the product, such as access to scientific publications about the beneficial properties of product components, which will help consumers get information about healthy eating and encourage the purchase of healthy food.

To ensure the operation of the single traceability system, technological independence and a high level of information security are required. This is proposed to be solved on the basis of Blockchain technologies.

Blockchain technology enables the decentralization of distributed software architectures, where components can reach agreement on common system status without trusting a central point of integration. Since Blockchain is a new technology that is still at an early development stage, there is limited experience in applying Blockchain to real software applications. In this regard, a number of authors, for example, authors of the work [13] emphasize the importance of testing their software products on real projects.

In some cases, problems arise in practice and the use of Blockchain does not go beyond the scope of pilot projects. This mainly occurs in systems with a low level of trust of partners to each other and unwillingness to exchange information. In this regard, the authors [14] note the importance of organizing a well-thought-out and standardized supply chain between all (internal and external) participants. This should be determined first of all before starting the process automation.

RFID technology is now widely used for tracking, logistics and access control. It has become ubiquitous in industry and everyday life (ticket sales, payment, passports, car keys, etc.). RFID is currently a standardized technology; Its inherent advantages, such as unitarity, identification capability, wireless connectivity and low cost of RFID tags, provide it with practical advantages that drive new developments. This trend is largely confirmed by the market forecast, as well as its implementation in the field of healthcare (“smart hospital”), helping people, combating counterfeiting, as well as from the point of view of new paradigms of distributed surrounding intelligence (Internet of things). [15]

The purpose of this study was to elucidate the prospects for introducing traceability systems for goods and their capabilities to ensure the quality and safety of goods in the market, and to exclude counterfeit and pirated products from circulation in the digital economy.

The objects of research, on the example of which the questions will be considered, are selected products from precious types of wool.

Object selection is due to the prestige and popularity of products from precious wool, a significant difference in the cost of raw materials and products made from wool different species of animals, reaching tens and hundreds of times, and also proven cases of adulterating the precious type of wool: cashmere, Angora, mohair, camel wool, etc. found all over the world. [16]

In accordance with ISO 17751:2007 [17], the cattle hair of these animals is intended to describe the general term “special wool”, while “wool” is called sheep wool.

2. Methods
To achieve the goals of the study, a standard method for determining the mass fraction of special wool in mixtures with sheep wool was tested. The veracity of the results obtained by optical microscopy by various researchers, as well as the complexity of the method, were estimated.

To this end, five researchers with special knowledge and skills were given two samples of the fiber mixture without labeling the fiber composition for determination. These samples were preliminarily composed of known fibers of thin merino sheep wool, cashmere and angora in predetermined proportions.
The fibrous sample was a sample prepared for the study, consisting of carefully mixed, crushed fibers of two types.

Microscopic preparations were prepared using glycerol; water was not used to avoid swelling of the fibers and a change in their thickness.

The quantitative content of the most precious fiber mixture component (angora, cashmere) was carried out in accordance with AATCC Test Method 20A-2011 Fiber Analysis: Quantitative [18] using a microscopic complex consisting of a light microscope Mikmed-4, equipped with video eyepiece, computer with Scope Photo software product, which allows to conduct a digital micro-capture of the fibers that make up the objects under study, and measure the size of their cross-section.

Elaboration was carried out using generally accepted methods. [19]

The results of a pilot project on the implementation of labeling systems for fur products with control identification tags (CIT) based on RFID technology are considered. Estimation of the project efficiency was carried out by reviewing the official press and analyzing the statistics of foreign trade of the Russian Federation for heading 4303 “Articles of apparel, clothing accessories and other products, of natural fur”, Unified Commodity Nomenclature for External Economic Activities of EAEU for the period 2015-2018.

3. Results and discussion

The traditional tool for identifying low-quality, dangerous, counterfeit or pirated products in the market is commodity examination.

Standard methods for the quantitative determination of special animal fibers in mixtures with sheep wool are based on microscopy methods: optical and electronic.

The mixture of fibers of known fiber composition was identified by optical microscopy. The results are presented in Table 1.

In the first case, the sample consisted of fibers that are easily distinguishable by the features of the morphological structure. In this case, the mass fractions of the fibrous mixture components, determined experimentally, differed from the actual ones by an average of 4% in weight. In the second case, the test sample was also two-component, but its fibers were similar in thickness and structural features of the scaly layer. In this case, the mass fractions of the components determined experimentally differed from the actual values by more than 12%, which may lead to incorrect conclusions regarding the fibrous composition of the samples in practice.

Table 1 – The results of determining the mass fraction of fibers in the mixture by various researchers, mass fraction.

| Sample number | The actual composition of the fibrous mixture, special fiber / sheep wool | The result of determining the composition of the fibers by the researcher |
|---------------|------------------------------------------------------------------------|-----------------------------------------------------------------------|
|               |                                                                        | 1   | 2   | 3   | 4   | 5   |
| 1             | 50/50                                                                  | 47/53| 52/48| 50/50| 54/46| 49/51|
| 2             | 67/33                                                                  | 58/42| 60/40| 75/25| 70/30| 71/29|

Note: type of special fibers in samples: sample 1 – angora; sample 2 – kachemir

The experimental data show that standard research methods, in this case, do not always allow reliable results on the quantitative composition of the fibrous mixture containing special fibers of animal origin.

In addition, it should be noted that research by this technique is quite time-consuming. Table 2 shows the approximate results of the time spent on the determination of the fibrous composition of one sample, consisting of a two-component mixture of wool and special fibers. For quantitative
determination of the mass fraction of fibers in one sample, a researcher of an average level of experience will need 50 hours, which is more than 6 working days.

Table 2 – Assessment of time spent on the study of one sample

| Number in order | The name of the stage                                      | Time required for one stage, min. | The number of repetitions of the stage in the study of one sample | Total time spent, min. |
|-----------------|----------------------------------------------------------|----------------------------------|-------------------------------------------------------------------|-----------------------|
| 1               | Sampling for research                                     | 15                               | 1                                                                 | 15                    |
| 2               | Preparation of the sample for the study                  | 15                               | 1                                                                 | 15                    |
| 3               | Preparation of the preparation for viewing under a microscope | 1                                | 10                                                                | 10                    |
| 4               | Fiber measurement and identification                      | 15 (for one field of view)       | 150 (study of at least 1000 fibers of each species)               | 2250                  |
| 5               | Data entry into the computer, calculations, processing of results | 60                               | 1                                                                 | 60                    |
| 6               | Regulatory breaks when working on the computer           | 10                               | 66 (10 minutes rest every 35 minutes work; 140 minutes per 8-hour working day) | 660                   |
| 7               | All                                                       | x                                | x                                                                 | 3010                  |

Review of publications on the research topic, analysis of practice, and the experimental data cited above allow to conclude that the prevention of violations associated with the illicit trafficking of pirated, counterfeit, as well as dangerous goods is more effective than the identification of individual cases of fraud by regulatory authorities and the adoption of measures thereon. Increasing legislative pressure does not lead to a noticeable reduction in the number of violations.

According to the authors, the most effective measure to exclude pirated and/or counterfeit goods from legal turnover is to ensure the traceability of goods, covering all stages of their life cycle and supply chain in international trade. In a digital economy, this can only be achieved with the joint participation of individual states. At present, this does not seem so impossible, unlike the statement in 2004. Golan et al. state that full traceability is never possible because of the amount of detailed information and the degree of accuracy that would be required. [20]

An example of cooperation in the field of ensuring traceability of goods in the market is the Agreement on the Labeling of Goods by Means of Identification in the Eurasian Economic Union (EAEU), signed by the heads of government of the Union countries in Almaty on February 2, 2018 and entered into force on March 29, 2019. Digital labeling of goods is the application of identification facilities on goods and entering information on both the product itself and the identification facilities into the information labeling system. In general, the introduction of a labeling system can contribute to the digitization of commodity flows and the formation of a traceability system in the EAEU.

In recent years, specific steps have been taken to legalize goods in free circulation in the market of the Eurasian Economic Union (EAEU). These steps include the implementation of the labeling and traceability systems, the introduction of mandatory labeling of goods of certain groups with control identification tags (CIT).

By the time of its introduction in 2015. Agreements on the implementation of a pilot project on the introduction of labeling of goods with control (identification) tags for the heading “Garments, clothing
accessories and other products made of natural fur” in the field of industrial product turnover has
developed a situation characterized by a high proportion of illegal traffic. According to the Ministry of
Industry and Trade, the illicit turnover of the light industry market in Russia amounted to 1.4 trillion
rubles – this is about 35% of the total market. Of these, more than half (50-60%) were gray supplies
from non-CIS countries, about a third (25-30%) were imported from the EAEU countries and about
15% were unaccounted for domestic production.

The named pilot project showed its positive results. Minister of Industry and Trade of the
Russian Federation D. Manturov In his report on November 19, 2018, at the Anti-Counterfeit-2018
forum, he noted that over the three years of operation, the share of counterfeit products in the light
industry decreased by 10% - this is 400 billion rubles.

Table 3 presents the dynamics of imports into Russia of goods by commodity subheading
4303 10 “Articles of apparel and clothing accessories from natural fur” for 2015-2018. From 2015 to
2018, inclusive, imports of goods from fur, for which compulsory labeling is introduced with control
identification tags, increased by 75% in quantitative terms and by 48% in value terms.

In total, in Russia and Belarus, after the labeling system launch, the legal market for fur
products increased by more than 10 times according to official data from the Eurasian Economic
Commission.

Figure 1 – The Dynamics of imports of goods classified by code of UCN EEA EAEU

The main approaches to the formation of the goods traceability mechanism in Russia are
determined by the Concept of the creation and functioning in the Russian Federation of the goods
labeling systems with identification facilities and traceability of the movement of goods, approved by
order of the Government of the Russian Federation dated December 28, 2018 No. 2963-r.

In accordance with the Concept, the main goal of introducing the labeling and traceability systems
is to ensure the receipt of timely and reliable information on the movement of goods within the
framework of the economic activities of organizations.

The concept stipulates that a group of actions ensuring the registration of the movement of goods
through the distribution network can be implemented in two ways:

• physical traceability (type of traceability provided by labeling);
• documentary traceability, which is ensured by transmitting data on the movement of goods in
accompanying documents (waybills, delivery notes, tax and other documents).

One of the main elements of the introduced labeling and traceability system is the state information
system (SIS), which ensures traceability of the movement of goods and monitoring of their turnover.

It is assumed that the state information system will be built on the basis of the use of identification
tools to ensure physical traceability. At the same time, the system will, if necessary, be integrated with
tools of documentary traceability to ensure the consistency of data on the movement of goods.
In accordance with the instructions of the Government, an end-to-end system for marking goods should be created in the Russian Federation by 2024. The coordinator of the system is the Ministry of Industry and Trade of Russia.

The existing version of the Concept does not provide for the introduction of control identification tags and traceability of all products on the market, but only for selectively products with the highest degree of risk. In this regard, we propose to supplement the list of light industry products that are already on the list of mandatory marking of CIT with knitted wool products, which are not on this list. Among these products, a certain share is occupied by products made of special fibers and their mixtures with wool and the adulteration of the fibrous composition for them is confirmed by data from different countries and studies conducted by the authors earlier on the Russian market [15].

In our opinion, the traceability system can largely help the market not only in solving the problems of counterfeit and counterfeit products, in removing goods from illegal circulation, but also become a mechanism for ensuring the quality and safety of goods. This is possible when information on the confirmation of goods compliance with mandatory and/or voluntary requirements and information with the results of quality control by departments of technical control of production enterprises or other expert organizations and testing laboratories are included in the general traceability system.

In these cases, the procedure for confirming the conformity of products will become more transparent, because it is no secret that a significant proportion of certificates issued without proper product testing and forged documents are being circulated in the market.

According to the Russian Accreditation Committee and the Russian newspaper, as of the first quarter of 2019, the number of testing laboratories decreased to 6,157, certification bodies – to 912. The head of Rosaccreditation, Alexey Khersontsev, connects this with the departure of unscrupulous players, as certain measures are already being taken. So in 2018, the activity of 1,201 persons involved in the issuance of certificates was terminated.

The authors of the work [10] also propose the inclusion of certification in the traceability chain of goods and show the advantages of this step in order to ensure the quality and safety of goods in the market.

4. Conclusions
The introduction of the goods traceability system alone will not guarantee the quality, safety, and originality of products, but it will, if necessary, clearly determine by whom the product is manufactured and which supply chain the product passed to the consumer.

Transparency of the system should become an obstacle for unscrupulous market players, since when detecting cases of counterfeiting and piracy, regulatory authorities will be able to find the guilty persons faster, and all research practice shows that with falsification, the true manufacturer of fakes does not identify itself in the label, most of these products have an unknown origin. In the case of the introduction of the traceability system of goods with unknown origin, it will not and all manufacturers will be responsible for their products.

Traceability also increases customer confidence and satisfaction, which is an important factor in demand.

However, the effectiveness of the traceability system will largely depend on its organization, on the completeness of the inclusion of separate market players in the system. The system should provide the ability to receive information by both regulatory authorities and consumers. Include a stage of product testing for quality and safety and confirmation of its compliance with established requirements.

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