a smarter, more innovative and efficient customs system. These measures include improving the use of data through the Collaborative Analytics Capabilities initiative and redefining the roles of e-commerce participants (EU Customs Action Plan). These efforts are aimed at addressing structural changes and ensuring that Customs administrations are flexible and technologically advanced.

The foresight study, launched in 2018, aims to create a vision for EU Customs by 2040, which includes full digitalization, use of data and integration into the wider trade ecosystem (Future Customs EU 2040). Comparative examples show the global reach and context-specific adaptations of customs. In the US, CBP facilitates legitimate trade while enforcing trade remedies under laws such as Section 232 of the Trade Expansion Act of 1962 (CBP Trade Remedies). In Indonesia, the Directorate General of Customs and Excise (DJBC) focuses on trade facilitation, border protection, and revenue optimization, including smuggling prevention (DJBC Mission)[1].

Customs administrations are not just border agents, but key players in shaping global trade, performing functions ranging from revenue collection to crisis management. Their roles ensure their indispensability in the economic fabric of nations. Effective Customs services enhance economic stability, facilitate international trade and support global security. In a rapidly changing world, Customs administrations continue to adapt to new challenges by innovating and strengthening international cooperation.

Ulanov Artem Andreevich, Savko Darya Denisovna
Belarusian National Technical University, PhD, Associate Professor Veremeychik O.V.

SECURITY ENGINEERING OF TRANSPORT DOCUMENTATION

Research field:
Modern technical means as a basis for effective customs control at the border.

The consignment note (CN) is one of the key primary accounting documents used in the transportation and transfer of material assets. In the context of digitalization and increasing requirements for the reliability of accounting, the importance of ensuring the authenticity and protection of CN forms from forgery and unauthorized use is growing. This issue is particularly relevant in the Republic of Belarus, where the CN serves not only as an accounting document but also as a legal instrument, confirming the conclusion and execution of the transportation contract.

[1] DJBC Mission (Directorate General of Customs and Excise, Indonesia) [Электронный ресурс]. – Режим доступа: https://hisconsulting.co.id/en/customs-and-excise/. – Дата доступа: 01.05.2025

Therefore, the study of the security features of the CN form is a significant scientific and practical task.

In the course of studying the consignment note form used in the Republic of Belarus, various security features aimed at preventing forgery and ensuring the authenticity of the document were identified. The combination of these features creates a multi-level protection system that integrates visual, optical, and physico-chemical control methods.

One of the visually identifiable authenticity indicators is the presence of a unigram with the inscription «ТТН ТН ». This element appears when the angle of the document is changed and confirms the originality of the form. It is detected using an authenticity detector, indicating the use of optically variable graphics (Fig. 1).

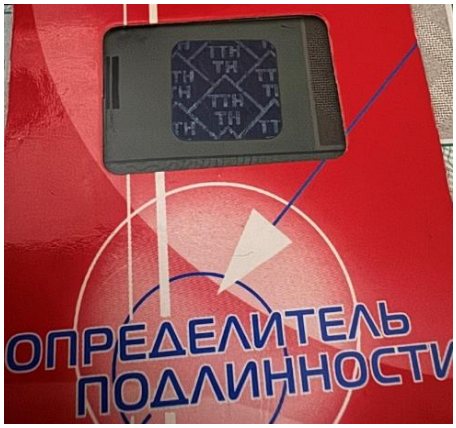

Figure 1. – Unigram

The form also contains microtext with the inscription in Russian «ГОЗНАК РЕСПУБЛИКИ БЕЛАРУСЬ», printed in extremely small font (Fig. 2). Microprinting complicates the exact copying or reproduction of the document, as it becomes illegible or distorted when scanned and reprinted.

Figure 2. – Microtext

An important security element is the guilloche grid, which uniformly covers the surface of the form and forms a complex pattern with color transitions (Fig. 3). Guilloche patterns are created using specialized software and cannot be accurately reproduced without the appropriate technological means.

Figure 3 – Guilloche grid and pattern

The paper structure contains invisible fibers that fluoresce under ultraviolet light in green, violet, and yellow colors. These fibers are evenly distributed across the form's surface and are not visible under normal lighting, making them a reliable means of covert authenticity control.

Particularly interesting is the presence of an invisible protective image in the form of a stylized floral element. This image becomes visible only under ultraviolet light and glows with an intense bright green color. The use of fluorescent dyes combined with artistic design increases the document’s resistance to forgery and makes it difficult to reproduce accurately with standard copying tools (Fig. 4).

Figure 4 – Invisible protective image, fluorescent fibers under ultraviolet light

An additional means of identification is the barcode, which contains unique data about the form, such as the series and number (Fig. 5). The use of barcodes allows for the automation of accounting and control processes, ensuring transparency and traceability of the document's movement within the document flow system.

Figure 5 – Barcode

One of the promising ways to enhance the protection of transport documentation, particularly consignment notes (CN), is the integration of blockchain technology for digital verification. Despite the existing set of visual and covert security features modern forgery techniques and the growing use of digital workflows call for an additional layer of protection. Blockchain technology provides a decentralized, tamper-resistant platform that can be used to register and verify the authenticity of each CN. In this approach, when a CN is issued, a digital record is created containing essential data such as the document number and series, date of issue, names of the consignor and consignee, goods description, and transport details. This information is cryptographically indicated. At any stage of transportation or customs control, this QR code can be scanned to instantly verify the authenticity of the document by comparing the physical CN data with the immutable record stored in the blockchain. This ensures that the document has not been altered or substituted and allows for transparent tracking of its lifecycle. Additionally, updates or status changes—such as confirmation of delivery, changes in the route, or transfer of responsibility—can also be recorded as successive entries in the blockchain, maintaining a transparent audit trail. The use of blockchain not only increases resistance to forgery and tampering but also facilitates more efficient control procedures for logistics companies, customs authorities, and inspection services. Importantly, this technological enhancement does not replace traditional physical protections, but rather complements them by adding a robust digital verification layer.

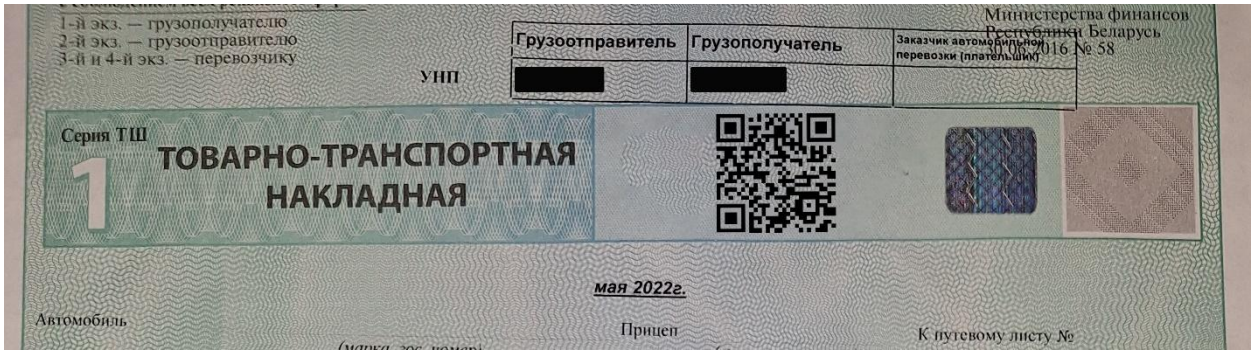

Figure 6 – QR blockchain based code

An effective enhancement to the security and functionality of consignment notes (CN) is the replacement of a traditional linear barcode with a QR code that is integrated with a blockchain-based verification system. While standard barcodes typically store only basic information such as

the document number or a serial identifier, they are limited in both data capacity and security. Barcodes can be easily duplicated or manipulated, and they do not offer any mechanism for real-time verification or tracking.

By contrast, a QR code can store more complex data and act as a dynamic gateway to external systems. In this proposed solution, each consignment note would include a QR code that links to a secure blockchain record corresponding to that specific document.

Modern transport documentation requires both physical and digital protection. While current visual and covert features provide solid security, integrating blockchain and replacing barcodes with QR codes linked to immutable records offers stronger verification, traceability, and fraud resistance. This combined approach ensures the consignment note remains secure and reliable in a digital age.

Остапенко Софья Дмитриевна
Государственное учреждение образования
"Гимназия №10 г.Минска имени дважды Героя Советского Союза П.Я.Головачёва"
Новикова Людмила Михайловна, учитель русского языка и литературы

SMART ГРАНИЦЫ ДЛЯ ТОРГОВЛИ, ПУТЕШЕСТВИЙ И ТРАНСПОРТА БЕЗ БАРЬЕРОВ

Область исследований:
Цифровые технологии для создания SMART-границ.

В условиях современной глобализации и активного развития технологий концепция умных границ становится особенно актуальной для международной системы торговли, путешествий и транспорта.

Современные таможенные процедуры сталкиваются с рядом серьезных проблем, создающих существенные препятствия для международной торговли. Одной из ключевых трудностей является чрезмерно усложненный документооборот. Участники внешнеэкономической деятельности вынуждены осуществлять подготовку и согласование обширного пакета документов: коммерческие, транспортные, разрешительные и сертификационные. Каждый из указанных документов требует значительных временных затрат на оформление, последующую верификацию и согласование с уполномоченными контролирующими органами. Особую сложность представляет осуществление внешнеторговых операций с пересечением нескольких таможенных границ, где фиксируются значительные расхождения в требованиях к представляемым документам.

Значительные сложности создают задержки при таможенном оформлении. Они возникают как из-за бюрократических процедур, так и по причине несовершенства