Completeness, correctness and reliability of customs control

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Abstract

This paper considers the possibility of applying indicators used in technical diagnosis and reliability theory in order to evaluate the effective functioning of customs control, taking into account the error factor. Such notions as completeness, correctness and reliability of customs control are introduced. The purpose of customs control, as we understand it, is to identify customs law violations, and the choice of the object for that control process is made with the help of risk assessment.

1. Introduction

In accordance with the Revised Kyoto Convention (WCO 1999), customs control means 'the measures applied by Customs to ensure compliance with customs law'.[1] Similar definitions of customs control can be found in the customs legislation of many countries. Following these definitions, we can assume that the main objective of customs control is to identify customs law violations.

Customs control is, in fact, the main function of customs administrations and much attention is paid to evaluation of its effectiveness. Nowadays, that effectiveness is evaluated by such indicators as the amount of fines, the number of administrative and criminal lawsuits started, the quantity of seized drugs, etc. Though these indicators are important, they are not systematic and indirectly characterise the main objective of customs control. A decrease in fines and the quantity of seized drugs does not mean that the capability of the customs control system to identify customs law violations has deteriorated. It is quite possible that business people abide by the law more and violate the law less.

There are scientific directions in the technical systems area (such as reliability or technical diagnosis) in which the effectiveness of the control is assessed by some formal indicators characterising the precise detection and localisation of violation[2] in the object under control as well as the reliability of the customs control system (CCS) (Malyshenko, Sharshunov & Chipulis 1986). Within these theories, it was proved that the more reliable the control system and the more precise the detection and localisation, the greater benefits the control system provides.

As far as the formulation is concerned, the objectives of technical object control and customs control are alike, therefore it is logical to try and use the elements of technical diagnosis and reliability theory to evaluate effectiveness of the CCS.

In this article, the author attempts to show the possibility of applying certain ideas and concepts used in technical diagnosis and reliability theory in order to evaluate the effective functioning of customs control, as well as to consider the impact of various errors on customs control results.

Though the objectives of customs control and technical object control are alike, they are absolutely different from the organisational point of view. The customs control system is a set of regulations, techniques, technologies and control equipment. Conducting customs control involves, among other activities, applying risk management, checking documentation, and carrying out examinations, as well as using various hardware and software. All this makes it difficult to apply the methods and quality assessment indicators used in technical diagnosis and reliability theory. It is necessary to adapt them to the purposes and peculiarities of customs control.

When the technical objects control system is created, the most important indicators of effectiveness are considered to be the completeness and correctness as well as the reliability of its functioning.

Let's define the notions of completeness, correctness and reliability of the CCS.

2. Completeness of customs control

Customs control completeness is indicated by the percentage of possible customs law violations detected when applying a particular CCS.

As a simple but illustrative method of the CCS numerical assessment, we can propose to assess the percentage of probable customs violations detected by the system.

Completeness of customs control can be determined by the formula:

$$C = (G_1/G) \times 100\%.$$

G is the number of violations which are possible in the object under control; G_1 is the number of violations which may be detected by this particular CCS.

Suppose 100 various cases of false declarations are possible, and the applied CCS detects only 70 of them. Then the completeness of control is:

$$C = (70/100) \times 100\% = 70\%.$$

How can we calculate the factual indicator? There are two possible mathematical/methodological approaches: computer or physical modelling. In the first case, we should create computer models of violations and the CCS, and then implement CCS modelling whenever a violation occurs. The data received are used to determine the violations which the given CCS detects and the completeness of customs control is assessed.

In physical modelling, violations are committed in real objects, and the factual control is carried out to see if those violations are detected. For instance, false information is entered into documents or some foreign objects are placed into goods, and they are supposed to be detected during goods examinations or documentation checks.

One can assert that the number of possible violations is great and some of them are difficult to foresee. However, we can refer to the practice of creating the technical diagnostics system. Firstly, it proved possible to formulate some rules to identify a limited number of probable violations that are more frequent.

Secondly, new techniques designed to detect types of violations were developed. For example, discrepancy between the actual weight and that stated in the declaration or between goods codes might be a sign of unauthentic declaration of numerous goods bearing different codes of the Harmonized Commodity Description and Coding System (the HS) (WCO 1999).

It is obvious that control completeness can serve as an objective criterion for comparing various CCSs and technologies, and for choosing the best available. The low value of C may lead to additional refinement of a CCS and its constituents (for example, risk profiles).

There are four possible scenarios of CCS solutions during customs control.

1. There are violations of legislation and the system detects them.
2. There are no violations of legislation and the system confirms it.

3. There are violations of legislation but the system does not detect them.
4. There are no violations of legislation but the system shows a possible violation.

The above variants form a complete group of events, that is,

$$P_1 + P_2 + P_3 + P_4 = 1,$$

where P_i is the possibility of i variant (event).

The first two scenarios correspond to the error-free CCS work. However, in reality, customs control does not detect all violations; in many cases, assigned customs control does not find any violations whatsoever. There may be cases when goods are prohibited from release but upon the declarant's appeal, they are released. That is why scenarios 3 and 4 may be considered as errors in CCS functioning, which should be taken into account in evaluating customs control effectiveness.

Generally, these errors are probable, that is why we will try to consider them by applying relativity theory.

We will use the following variations in our discussion:

- The code, the country of origin and other characteristics of goods under control are random.
- The arrival of goods with customs law violations is random.
- The customs control consists of the following:
  - the information is submitted to a Risk Management System (RMS) which assigns a certain type of customs control if the risk is detected
  - this control is carried out and violations may or may not be detected
  - if risks are not detected, the goods are released.

It is also important to specify what we mean by 'CCS error' (error model). The error is regarded as either an incorrect decision after carrying out the customs control assigned by the RMS or undetected risks when customs violations are present.

It is assumed in scenario 3 that legislation violations are committed. There are then two variations:

- RMS does not detect the risk and the goods are released
- RMS detects the risk and sends the goods for further customs control, but violations are not detected and the goods are released.

The probability of the error in scenario 3 may then be shown by the formula:

$$P_3 = p_b\,(p_1 + p_2\,p_3)$$

Where p_b stands for the probability of legislation violations in declaring goods; p_1 is the probability that when this violation occurs, the RMS does not detect it and the cargo is released; p_2 is the probability that when the violation occurs, the RMS sends the cargo for further control; p_3 is the probability that the follow-up customs control does not detect any violations and the cargo is released. Taking into account that $p_2 = 1 - p_1$, we may write:

$$P_3 = p_b\,(p_1 + (1 + p_1)\,p_3).$$

We can consider the constituents of p_3 probability in greater detail. If the control is conducted using X-ray systems, there might be several reasons for the error such as low qualification and tiredness/incompetence of an image operator, sophisticated concealment of undeclared goods, bribery of customs inspectors, and so on.

The probability of error in scenario 4 can be expressed as:

$$P_4 = (1 - p_b)\,p_4\,p_5,$$

where $(1 - p_b)$ stands for the probability of the absence of violation of legislation; p_4 means the probability of the RMS sending the cargo for further control by mistake; p_5 shows the probability that further control results in the decision to delay releasing the cargo.

It is easy to notice that formula P_3 contains a certain constant constituent p_1. But formula P_4 lacks such a constituent. It reflects the fact that in scenario 4 (formula P_4) the erroneous RMS solution (further control even though there is no violation) does not mean that an error was in the CCS. The customs control will result in a decision made only after conducting the actual (physical) control assigned by the RMS. However, scenario 3 type errors always lead to errors in the CCS as a whole.

The probability of violation detection is an important indicator of the quality of the customs control.

When an *i*-shipment undergoes customs control, $d_i = p_{bi}\ p_{2i}\ p_{6i}$ shows the probability of violation detection, where p_{bi} is the probability of violation in declaring the *i*-shipment; p_{2i} is the probability of this shipment being sent by the RMS for customs control when the violation is detected; p_{6i} is the probability of a decision to detain the *i*-shipment if subsequent customs control revealed violations.

The d_i probability is a localised estimation. However, based on this estimation, more general estimations can be made. For instance, it is possible to calculate the average number of shipments containing violations in declarations which are detected during customs control within a certain period of time: $M_x = \Sigma\, d_i$, *where* $i = 1, 2, \ldots, n$; n is the number of shipments within a certain period. M_x may have various values from 0 (no violations) to n (all shipments contain violations).

To check the effectiveness of customs control some customs administrations examine all shipments arriving at customs on a particular day. As a result of such an exercise, the data concerning RMS decisions and shipments containing violations in declarations may be used to calculate factual probabilities p_b, p_1, p_2, p_3, M_x.

As errors are possible during customs control, CCS solutions are not always credible. The level of credibility can be determined with the help of such characteristics as ‘correctness’.

3. Correctness of customs control

Correctness of customs control is the objective ratio of customs control results to the real state of the object under control.

The correctness of decisions made during customs control can be calculated by the formula:

$$D = 1 - P_{er},$$

where $P_{er} = (P_3 + P_4)$.

Actually, D shows the probability that customs control will result in making the right decision on an object under control (whether there are violations or not). In other words, D shows how much you can trust the results of customs control.

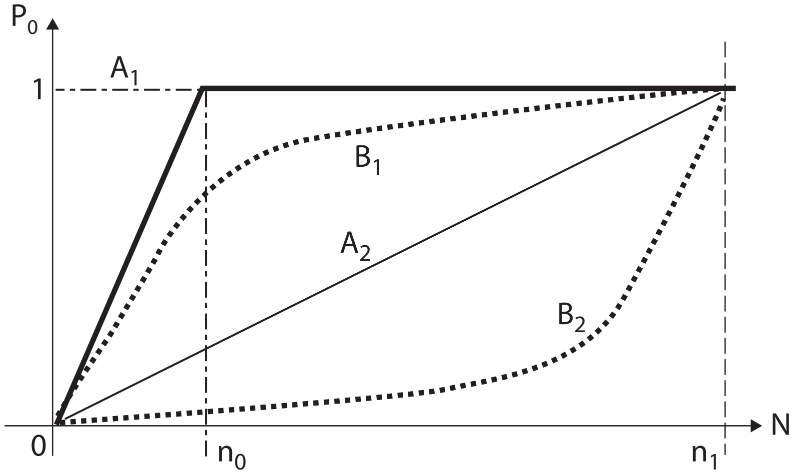
An RMS is a very important part of CCS. The purpose of an RMS is to choose goods for further customs control. Figure 1 shows graphs illustrating the change of probability in detecting violations (P_0) when the number of shipments (N)[3] sent for further customs control increases.

Suppose the RMS exactly defines the state of the object (that is, determines precisely if there is violation or not), and the number of shipments containing violations is n_o. This case corresponds to A_1 in Figure 1. When more than n_o shipments are chosen for control then $P_0 = 1$. In Figure 1, A_2 reflects the case when the goods for control are selected by the RMS at random according to the principle of uniformity. The probability P_0 grows linearly with the increase in the number of shipments, directed by the RMS to the control and reaches 1, when all shipments are subject to the control (n_1 is the total number of shipments).

In Figure 1, B_1 and B_2 illustrate the situation when the RMS chooses shipments for further control more 'correctly' (B_1) or 'not as correctly' (B_2) as with a random choice.

Figure 1 shows how important it is to improve and perfect the RMS and how the quality of RMS work influences the validity of customs control. In order to reduce the time of goods release it is necessary to reduce the number of shipments directed to physical examination which is, in fact, the purpose of the RMS. To avoid lowering the value of P_0, it is vital that the percentage of the 'correct' choice of shipments directed for further control be increased, that is, to achieve P_0 which indicates an effective CCS, B_1 type selections are preferable.

Figure 1: Probability of violation detection depending on the number of shipments being examined and CCS effectiveness



4. Reliability of customs control

One of the most important requirements for any system is reliability. Let's define the concept of reliability for a CCS.

The reliability of the system of customs control is a feature of the system that enables it to keep within specified values and all the parameters which characterise its ability to perform the required functions within the preset modes, conditions of use and service.

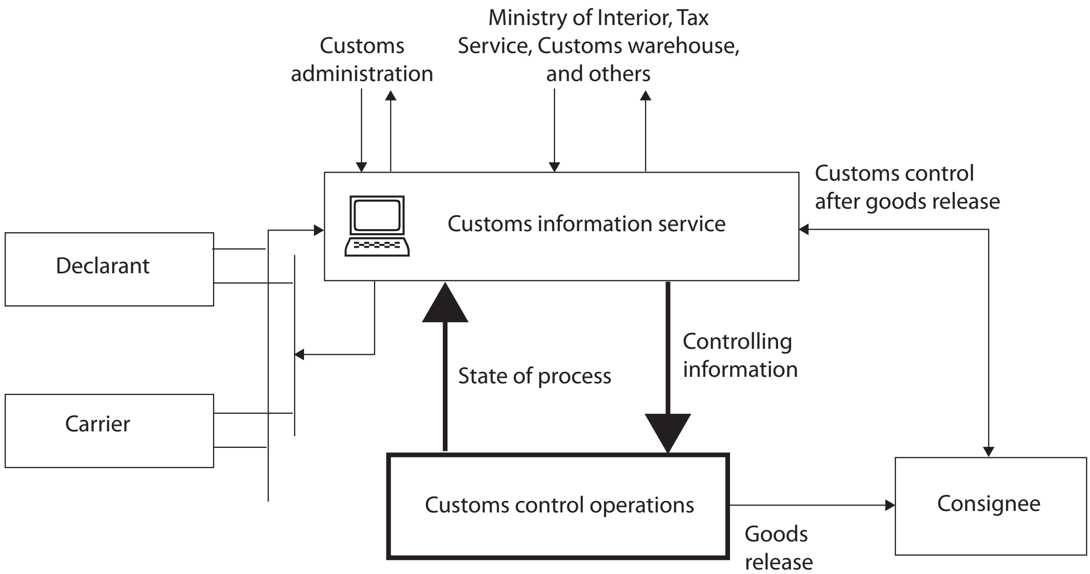
It follows from the definition that, for example, the more frequently the customs control software or hardware fails, the lower the CCS reliability; and if the effectiveness of the RMS lowers over time, that leads to a decrease in CCS reliability.

Reliability is determined not only by the properties of the separate components of the system but also by the structure of the system, which also applies to the CCS. Figure 2 shows (with some simplifications) the information flows in the process of conducting customs control.

In Figure 2, you can see some of the contours of the feedback. The declarant and the carrier submit certain information into the customs information system and, in turn, the customs authority may ask them for additional information. A customs inspector may send an inquiry to the temporary storage warehouse (TSW) and the TSW supplies Customs with the information about the goods movement at that warehouse. After release of the goods, the customs authority may validate the correct use of the released goods, which is also shown in Figure 2.

The presence of feedback contours in the information exchange increases reliability. If, for example, goods with 'violation' are released, there is still the possibility of discovering that violation by means of customs control after the release of the goods. Thus, the implementation of the basic function of customs control which, as we said earlier, is to detect violations of customs legislation even if there are 'failures' in the work of the CCS at the previous stages of control, is ensured. Such a system is properly called 'failover'[4] or 'survivability' and is one of the properties of reliability.

Figure 2: Information flows during customs control



The reliability of the CCS is estimated by some 'indicators of reliability' (RI).[5] The standards allow the use of names, indicators and definitions, taking into account the specifics of the object and/or the specifics of its application.

Consider some of the RI which can be used to assess the reliability of the CCS.

Readiness coefficient is determined by the formula:

$$K_r = T / (T + T_1),$$

where T is mean operating time prior to failure (the average working time of the system prior to failure), T_1 is the average time to restore the system.

In fact, K_r determines the portion of working time, when the control system is operational. This indicator is often used in the evaluation and selection of technical means. It is considered that a good computer network server must have K_r not less than 0.9999. During round-the-clock work, this means that the server will not be operational for a total of about 1.5 hours a year.

K_r may well be used to assess the reliability of an individual CCS component such as x-ray systems for inspection, data processing servers, software tools used to perform customs operations in the electronic declaration, etc. Moreover, the exploitation system that exists in customs administrations involves fixing a point of failure and recovery of such components. It is obvious that this RI would be useful in comprehensive evaluation of the CCS, both at the customs office and at customs posts. However, it is necessary to study this concept in relation to such cases.

It follows from the definition of reliability, that the RI assess the work of the system in terms of time, while many events CCS deals with are of a random character. In such cases they usually calculate the average probability of events.

The following characteristics can be regarded as valid:

- **Probability of failure-free operation** is the probability that no failure of the control system occurs within the operating time[6] *t*
- **Probability of failure** is the probability of CCS failure at least once within operating time, though it was in good operating condition at the start of operating time
- **Mean error-free operating time** is the ratio of the total running time of the CCS to the mathematical expectation of the number of failures within operating time (statistical estimation of mean error-free operating time is determined by the formula $T = t / r(t)$, where $r(t)$ is the number of failures which occurred within the total running time t).

A CCS is a set of legal principles, methods, technologies and means of control. If we define the notion of 'failure' for this set, it is possible to apply the above-mentioned indicators as RI, not only for the individual components of the CCS but also for the CCS at the customs posts or within the customs administration itself. Thus it is necessary to take into account that the failure of one of the elements of a CCS, for example, an x-ray inspection system, does not lead to terminating the work of the CCS in general. It usually increases the control time, and probably reduces the likelihood of detecting violations and the reliability of the controls. Indirectly, such a situation can be characterised by traditionally used evaluation of the customs administration's operation such as the average declaration check time and the average number of declarations checked within a certain timeframe: an hour, a shift, a day, a month, etc.

5. Conclusions

This paper considers the possibility of using, in the customs environment, concepts of completeness and correctness of control, as well as some other indicators, characterising the a CCS's ability to detect violations of customs legislation and to function reliably. Much of the detail remains outside the scope of this paper and will no doubt require further analysis.

To assess the efficiency of the customs service, a set of parameters describing the different spheres of its activity is used. However, despite a large number of indicators, it is difficult to identify the actual effectiveness. Therefore, it is important to have integrated indicators which should not be numerous but should make the overall assessment of effective performance.

The proposed definitions of completeness, correctness and reliability of customs control are integral indicators for evaluating CCS effectiveness. Obviously, the higher these indicators are, the higher other indicators will be which are traditionally used for the evaluation of customs administrations performance.

The proposed ratings are fundamental in the sense that they fully reflect the nature and purpose of a CCS. The majority of criteria used today to evaluate CCS effectiveness are specific and do not possess such qualities. For example, in many countries the most important indicators of evaluation of customs administration performance are the number of administrative hearings or criminal prosecutions or penalties resulting from customs control. However, the decrease in these indicators does not mean that the CCS lowered its effectiveness. Perhaps the private sector in this region violates the law less frequently. At the same time, the values of the completeness and reliability in this case do not change. The correctness may change, which is quite understandable and is interrelated with the variation in the probability of customs law violations.

References

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Notes

1 World Customs Organization 2011, p. 8, citing the Revised Kyoto Convention, General Annex, Chapters 2 and 6.

2 ‘Violations’ are called failures in these theories.

3 It is assumed that the control guarantees violation detection if there is any, and that violations occur occasionally according to the principle of uniformity.

4 ‘Failover is a backup operational mode … Used to make systems more fault-tolerant, failover is typically an integral part of mission-critical systems that must be constantly available’ (http://searchstorage.techtarget.com/definition/failover).

5 Indicators of reliability are quantitative characteristics of one or a few properties that constitute the reliability of an object (GOST 1990).

6 ‘Operating time’ is the period or volume of CCS operation. ‘Error-free operating time’ is CCS operating time from the start to the first failure.

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