



## Development of the effective information and analytical support of the OSH management system

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### ABSTRACT

**Purpose:** Studying urgent problems in the OSH management field in the in European countries to create effective information and analytical support for the OSH management system.

**Design/methodology/approach:** An analytical review of open sources, a comparative analysis of the legislative framework of different countries and logical conclusions based on existing opportunities at the current stage of development of the country were used to study current problems in the field of labour protection management and find ways to create effective information and analytical support. Improved IS "Vizit" was tested for 2018-2019: to identify undeclared labour, the dynamics of various types of labour violations has been studied; to predict the load of inspectors, the quarterly dynamics of inspection actions was studied; the accumulated statistics were processed using multiple regressions; for 22 enterprises, employees of all levels were remotely trained in labour protection issues.

**Findings:** Information and analytical support for the OSH management system has been developed. On the basis of indirect signs it allows to identify undeclared work cases, to predict the labour inspectors' inspection activities by quarters, to provide effective distance learning of enterprise employees and labour inspectors. The distance learning system for labour protection was tested at 22 enterprises: the head of the enterprise, the heads of departments and employees of the enterprise passed the training. Since 2018 (start to use of this information and analytical support), the dynamics of inspection actions and various types of labour violations have been monitored.

**Research limitations/implications:** Information and analytical support was tested on the example of Ukrainian labour legislation. However, it can be adapted to the legislation of another country.

**Practical implications:** The proposed information and analytical support using indirect evidences provides an opportunity to identify undeclared work and that significantly reduces the inspection visits number in order to monitor and detect violations of the law; makes it possible to predict the inspection activities and the workload of labour inspectors; contributes to the organizations managers and employees' effective training, and the inspectors training remotely (and therefore is less costly).

**Originality/value:** A non-standard approach to the identification of undeclared work on indirect grounds using information and analytical support for the OSH management system is proposed.

**Keywords:** Occupational Safety and Health, Undeclared work, Control, Information and analytical support

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## INDUSTRIAL MANAGEMENT AND ORGANISATION

### 1. Introduction

To help the European Commission (EC) monitor compliance with EU legislation at the national level, in 1982, the Senior Labour Inspectors' Committee (SLIC) began to hold informal meetings. SLIC is authorized to express its opinion on all matters relating to the enforcement of EU labour and safety legislation [1]. Some of the main activities of SLIC are [1]:

- To contribute to the improvement of knowledge and mutual understanding of various national systems and practices of labour inspection, methods and legal framework for action;
- To develop the exchange of information between national labour inspection services about their experience in monitoring compliance with the Community secondary law on health and safety at work;
- To promote a program of exchange of labour inspectors between national administrations and the organization of training programs for inspectors;
- To develop a reliable and efficient system for the rapid exchange of information between labour inspectorates on health and safety;
- To establish active cooperation with labour inspectorates in third countries in order to promote a better understanding and help in solving any cross-border problems.

Ukraine, as a member of the Eastern Partnership program of the European Union (since 2009), in recent years has begun active implementation of common European approaches, including on all issues related to ensuring and complying with labour protection and safety regulations.

One of the directions for the successful implementation of European approaches to the implementation of the control and supervision and managerial functions of the State Service of Ukraine on Labour (SSUL) is the introduction of a unified information and analytical system to address regulatory, methodological, organizational, technical, scientific issues in the field of labour relations, hygiene and labour protection. It is this task at the present stage that is relevant.

In this regard, the study purpose is studying urgent problems in the OSH management field in the in European countries to create effective informational and analytical support for the OSH management system.

### 2. Materials and methods

An analytical review of open sources using keywords related to the OSH management system was used to study current issues in the field of OSH management in the in European countries. A comparative analysis of the legislative and legal framework for OSH management in Ukraine and other European countries, as well as logical conclusions based on existing opportunities at the current stage of the country's development, were used to find ways to create effective information and analytical support.

The additional functions development that increase the efficiency of the IS "Vizit" OSH management system (which is currently used by SSUL inspectors) was carried out on the basis of the MySQL database management system.

Brief characteristic of the IS "Vizit":

- Intended for keeping records of inspectors' visits and of violations of applicable labour protection legislation and labour legislation;

- Used by SSUL inspectors, structural territorial departments and the SSUL central office;
  - The IS Visit database includes 13 information tables, 7 classifiers and 6 reference books;
  - Hosted locally on the SSUL web resource, which must have access to the Internet.
- Functionality of IS Visit:
- Entering data on the enterprise visit by the inspector and on the results;
  - Entering data about employer, whom inspector visits;
  - Formation of the database on the web server SSUL;
  - Export results.
- Improved IS "Vizit" was tested for two years 2018-2019:
- To identify undeclared work, the dynamics of various types of labour violations has been studied and an analysis of regular data about of the levels of wages and working time volumes at enterprises was carried out (according to Article 265 of the Labour Code of Ukraine);
  - To predict the load of inspectors, the quarterly dynamics of inspection actions was studied;
  - The accumulated statistics were processed using multiple regressions;
  - For 22 enterprises, employees of all levels were remotely trained in labour protection issues.

### 3. Results and discussion

#### 3.1. Analytical review of international trends in systems for checking violations of labour legislation

Investigation of occupational safety and population safety problems are the subject of much scientific works [2-7]. The article 427 of ILO standards calls on countries to establish a labour inspection system. If you look at the international picture, then, at least in all developed countries, as well as in many developing countries, there are organizations that check and monitor violations of labour laws.

As practice shows in many countries (for example, the Czech Republic [8], Spain [9], Poland [10], Turkey [11], Ukraine [12], etc.), one of the urgent tasks of the inspection is to identify cases of illegal employment of citizens of the country and foreigners. Undeclared work is often accompanied by inappropriate working conditions, which can be hazardous to the health and life of workers. According to labour law in most European countries undeclared work is work without an employment contract

between the employee and the employer, or in violation of its conditions. Consequently, undeclared work is a paid activity that is either not recorded or its results are hidden from state institutions in order to avoid taxes or take advantage of tax advantages, while violating the laws governing labour relations. It should be noted that cases of undeclared work include only those cases when state institutions do not have any information (or such information is insufficient in comparison with official employment data) on the avoidance of taxes and social insurance contributions. If state institutions do not have information about a specific case of labour relations, since such a case is considered prohibited by law and is concealed (for example, the goods production and distribution that are prohibited by law), it is the criminal activity and not undeclared work [13], as defined EC.

Undeclared work has been part of the socio-economic and political priorities of the European Union for over twenty years and the importance of this problem is constantly growing. Several other official texts have been published on this subject, revealing its importance to the EU [14]. In particular, Council Resolution 2003/C260/01, which recommends to Member States special preventive and deterrent measures to reduce undeclared work, to which national governments have responded by developing various strategies to improve the identification, prevention and strengthening of sanctions [15]. Undeclared work has become a priority for many labour inspectorates, and this is reflected in their annual planning (in Belgium, France, Italy, Lithuania, Portugal, Spain, Romania) [16].

In this regard, one of the tasks of labour inspectorates, among others, should be the clarification of such information as:

- Whether a citizen performs work for a legal entity or an individual on the basis of an employment relationship, or does a foreigner perform work on the basis of a work permit, a green or blue card, or on the basis of another contract;
- Whether the alien has a work permit (if the law requires its issuance), does he have a residence permit, or has a green or blue card (as required by law);
- Is there a formalization of labour relations and conditions for labour relations (working hours and days off, employee benefits, safety, conditions for maintaining health at work, the possibility of risk prevention, providing employees with personal protective clothing and auxiliary equipment, training and preparation for work, as well as the technical condition of the machines and equipment used at work).

Counteracting the use of undeclared work is included in the curriculum in many inspections for both primary and

continuing education. For example, in France and Portugal, during initial training, an average of two weeks is devoted to training new designated inspectors on how to identify and use various methods to investigate fraud cases, with particular attention to atypical forms of labour that violate labour laws, such as fictitious self-employment and informal employment. Technical tools developed in some EU countries to identify undeclared work include plan maps, company selection criteria, guidelines, operational guidelines, checklists and interview scripts, visit protocols and control procedures. In Ireland, for example, NERA inspectors conduct inspections based on agreed procedures (checklists and questionnaires) that describe in detail the inspection visit methodology and measures to be taken in case of violations [16].

It should be emphasized that occupational safety education is also an effective tool:

- Prevention of diseases and injuries, as employee training contributes to a better work culture;
- Reducing the burden on inspectors, since they should only explain some features or innovations in safe working methods or in legislative and regulatory documents;
- Training inspectors and sharing experiences on best practices for collecting evidence and interviewing, identifying and using various methods to investigate cases of fraud, violation of labour laws, etc.

However, due to the economic crisis, some countries are not able to train their inspectors. For example, in Romania over the past four years, labour inspectors have not received any actual training on how to counter undeclared work, which significantly weakens their ability. Previously, the curriculum included the study of a complete set of information on the types and causes of undeclared work,

legislation and inspection procedures [16]. A similar situation with the training of inspectors and workers has developed in Ukraine.

To reduce the level of diseases and injuries, regular training of managers and employees of enterprises (organizations) in safe procedures (basic training) on labour protection is necessary. As a work on the prevention of diseases and injuries, consultations and explanatory work by inspectors for organizations employees is being done. However, the amount of information that the inspector has to tell is huge, since a large enterprise can have hundreds of specialties, each of which has its own characteristics. At the same time, quality training should be organized for employees of all levels and specialties. That is why, the emergence and active spread of distance learning forms is an adequate response of the educational systems of many countries to the integration processes taking place in the world, the movement towards the information society. Training using a single information and analytical system is an affordable and effective tool, since it provides access to the latest and most useful, from a practical point of view, information.

To identify cases of undeclared work in Ukraine, the Resolution of the Board of the Pension Fund of Ukraine dated May 29, 2017 No. 11-1 “On the Procedure for the Exchange of Information on Information Containing Signs of the Use of Unformed Workers Labour and Violations of Labour Laws” was adopted. It defines the information exchange mechanism, which contains signs of the use of informal workers and labour law violations. The entities of such information exchange are shown in Figure 1. The information used by these entities is provided at the central level in the electronic version and at the regional level in the print version.

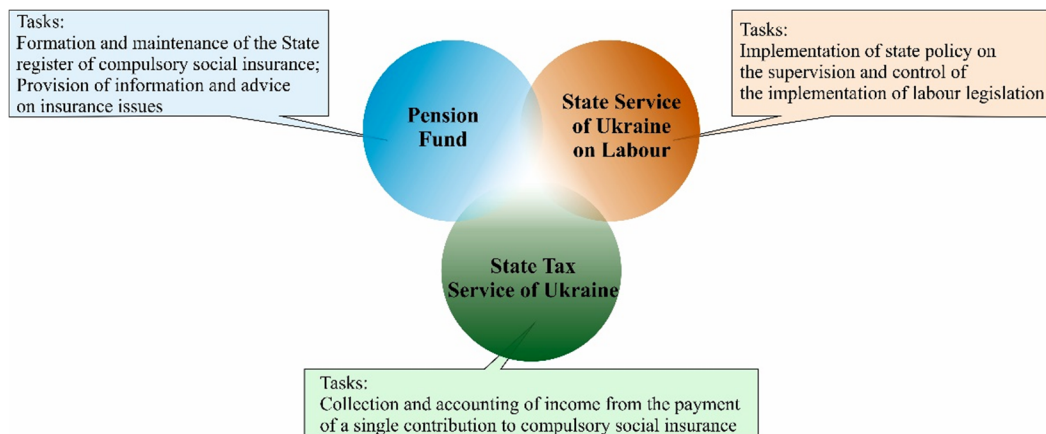


Fig. 1. The interactions between the entities of information exchange for identify signs of the use of informal workers and labour law violations

Figure 1 shows that close cooperation should be ensured between such state institutions as SSUL, Pension Fund and State Tax Service of Ukraine. These state institutions, as entities of information exchange, are responsible for the timely provision of reliable information in full in a given form. Moreover, more than 25 information items should be submitted and more than 20 types of registers should be used to fill out the form, as well as appropriate electronic forms of reporting and access to information necessary to fill out these forms, including legislative documents.

Based on the foregoing, it can be seen that the information and analytical support of OSH management system should combine and be able to use a very large database that contains legislative documents (laws, orders, decrees, standards, etc.), registers (of insured persons, insurance organizations, etc.), classifiers (professions, geographical locations codes of territorial labour protection departments, etc.) and other information (about inspectors and inspections, organizations that use wage labour, individuals positions, electronic forms of reporting on the results of inspections, etc.). Otherwise, the work of inspectors will be significantly more difficult, which will contribute to:

- 1) A longer inspection (although the time of the inspection is strictly limited by legislative acts);
- 2) Overload of the inspector, since he must complete the work within the specified time;
- 3) Errors or corruption, since control and accounting is not transparent for all entities of the information object.

There is an obvious need to free specialists in this field from routine work so that they can focus on the most important issues. According to statistics, professional security professionals spend more than 70% of their time on paperwork [17,18]. Obviously, this is unacceptable in a highly competitive production environment.

Attempts to store all the information about the inspector's visit to the verification object (organization) in one database table leads:

- To a sharp increase in the size of the database due to significant duplication of existing information;
- To inability implement verification of the uniqueness and integrity of information.

Such a system operation is unproductive. In addition, an information system that implements data collection procedures should be designed in such a way as to facilitate close cooperation between the entities of information exchange and the identification of causal relationships of identified violations, diseases and injuries.

An interesting fact is that at present some information systems have already been proposed aimed at:

- Assisting human resources specialists for human resources accounting [19];

- developing an indicator system of the influencing factor and analysis of the indicator weight using the Analytical Network Process (ANP) [20];
- developing of the fuzzy decision support system (FDSS), to find the precedence of jeopardy in occupations [21];
- developing of the determination algorithm of the interval of workplace environmental physical factors values control [22].

However, there is no informational and analytical support to identify undeclared work and analyse the professional activities severity of labour inspectors. It is accepted that labour inspectors identify hazards, carry out explanatory work, etc., but there is no analysis regarding the professional hazards of labour inspectors as workers. Although the labour inspectors, like workers in other professions, are exposed to occupational hazards.

### 3.2. The effective informational and analytical support creation for the OSH management system

An analytical review made it possible to identify promising areas for improving the system of control and accounting for compliance with applicable labour protection legislation, namely, to create information and analytical support that is capable of:

- 1) Provide operational access to the necessary databases (legislative documents, registers, classifiers and other information) and operational work with them;
- 2) Identify undeclared work;
- 3) Provide effective and inexpensive training in the latest achievements in the field of labour protection.

#### Work with large databases

In order to ensure the efficiency (speed of action) of query execution when creating information systems, Database index should be used. Since it is supposed to work with large databases, the information and analytical support of the OSH management system should have indexation of database objects. Acceleration of work using indexes is achieved primarily due to the fact that the index has a structure that is optimized for search – for example, a balanced tree.

In particular, in the first version of the IS "Vizit", indexing with a primary or secondary key was not used in one of the information tables of the existing database. This contributed to a significant increase in time (up to several tens of minutes) in search operations (when performing queries and generating reports). With further expansion and updating of the database, the time delay will be unacceptable. Due to the lack of indexing, it is now

impossible to implement a check on the uniqueness of table records or its integrity.

Also, serious attention should be paid to storing scanned copies of all necessary types of documents. This is justified by the fact that if the scanned copies of documents are will recorded in the fields of the database table, and then there will be a sharp increase in the amount of data and, consequently, an increase in the size of the table itself. This, in turn, leads to both an unproductive growth in the volume of the database itself and an increase in the time it takes to execute queries to the database. Currently, the most acceptable solution to this problem is to store scanned copies of documents in separate files and provide access to them with additional system functionality.

The software should be able to be used for risk analysis of violations of the law, the choice of the purpose of the audit and should help in the investigation of cases of companies or legal entities. Unfortunately, in fact, there are very few countries in which labour inspectorates (unlike tax authorities) make full use of these tools. For example, in Portugal, the Main Directorate for Support of Inspection Activities under the National Authority for the Supervision of Working Conditions was created, which maintains a database of legislation, jurisprudence and collective agreements on the Internet, where all methodological tools are also uploaded [16].

#### Identification of undeclared work

Of course, any information-analytical system is not capable of revealing undeclared work, since such work is deliberately hidden by employers and workers who work without labour agreements.

Identification of undeclared work can only be done by direct inspection. However, the information-analytical system can evaluate undeclared work by indirect methods based on the interpretation of regular data about of the levels of wages and working time volumes at enterprises. In particular, such a function is implemented in the improved IS “Visit” in Ukraine (according to Article 265 of the Labour Code of Ukraine). For this, the IS “Visit” registers the following data:

- Violation of the deadlines for the wages payment to employees, other payments provided for by labour legislation for more than one month, failure to pay them in full;
  - Failure to comply with minimum state guarantees of remuneration;
  - Failure to comply with statutory guarantees and benefits for employees involved in the performance of duties stipulated by the Ukraine laws “On military duty and military service”, “On alternative (non-military) service”, “On mobilization training and mobilization”.
- This is due to the fact that, according to article 265 of the Labour Code of Ukraine, legal entities and individuals – entrepreneurs using hired labour, are liable in the form of a fine in case of:
- the factual admission of the employee to work without an employment contract (contract), registration of the employee for part-time work in the case of the actual performance of the work full time established at the enterprise, and the payment of wages (remuneration) without accruing and paying a single contribution to the compulsory state social insurance and taxes – in the amount of thirty times the minimum wage established by law at the time of detection of a violation, for each employee for whom the violation was committed (Paragraph 2 of Article 265 of the Labour Code of Ukraine);
  - violation of the established deadlines for the wages payment to employees, other payments stipulated by labour legislation for more than one month, failure to pay them in full - in the amount of three times the minimum wage established by law at the time of detection of a violation (Paragraph 3 of Article 265 of the Code of Ukraine about work);
  - non-compliance with the minimum state guarantees of remuneration – in the amount of ten times the minimum wage established by law at the time of detection of the violation, for each employee in respect of whom the violation has been committed (Paragraph 4 of Article 265 of the Labour Code of Ukraine);
  - non-compliance with statutory guarantees and benefits for employees involved in the performance of duties stipulated by the laws of Ukraine "On military duty and military service", "On alternative (non-military) service", "On mobilization training and mobilization", – in the amount of ten times the minimum wage established by law at the time the violation was discovered, for each employee in respect of whom the violation was committed (Paragraph 5 of Article 265 of the Labour Code of Ukraine);
  - prohibitions to conduct an audit on compliance with labour laws, the creation of obstacles to its implementation – in the amount of three times the minimum wage established by law at the time of detection of a violation (Paragraph 6 of Article 265 of the Labour Code of Ukraine);
  - the actions performance provided for in paragraph six of this part, when conducting an audit on the identification of violations specified in the second paragraph of this

part - in the amount of hundred times the minimum wage established by law at the time of the violation (Paragraph 7 of Article 265 of the Labour Code of Ukraine);

- violation of other requirements of labour legislation, except as provided for in paragraphs two to seven of this part - in the amount of the minimum wage (Paragraph 8 of Article 265 of the Labour Code of Ukraine).

Thus, on the basis of fines in accordance with article 265 of the Labour Code of Ukraine, the inspector concludes that

it is necessary to visit the enterprise with a detailed check. This approach significantly narrows the list of enterprises requiring detailed verification and reduces the burden on inspectors. In turn, the number of visits by inspectors to monitor and identify violations is decreasing, and the number of visits to advise and conduct outreach activities is increasing. The scheme of the improved information-analytical system IS "Vizit" structure is presented in Figure 2.

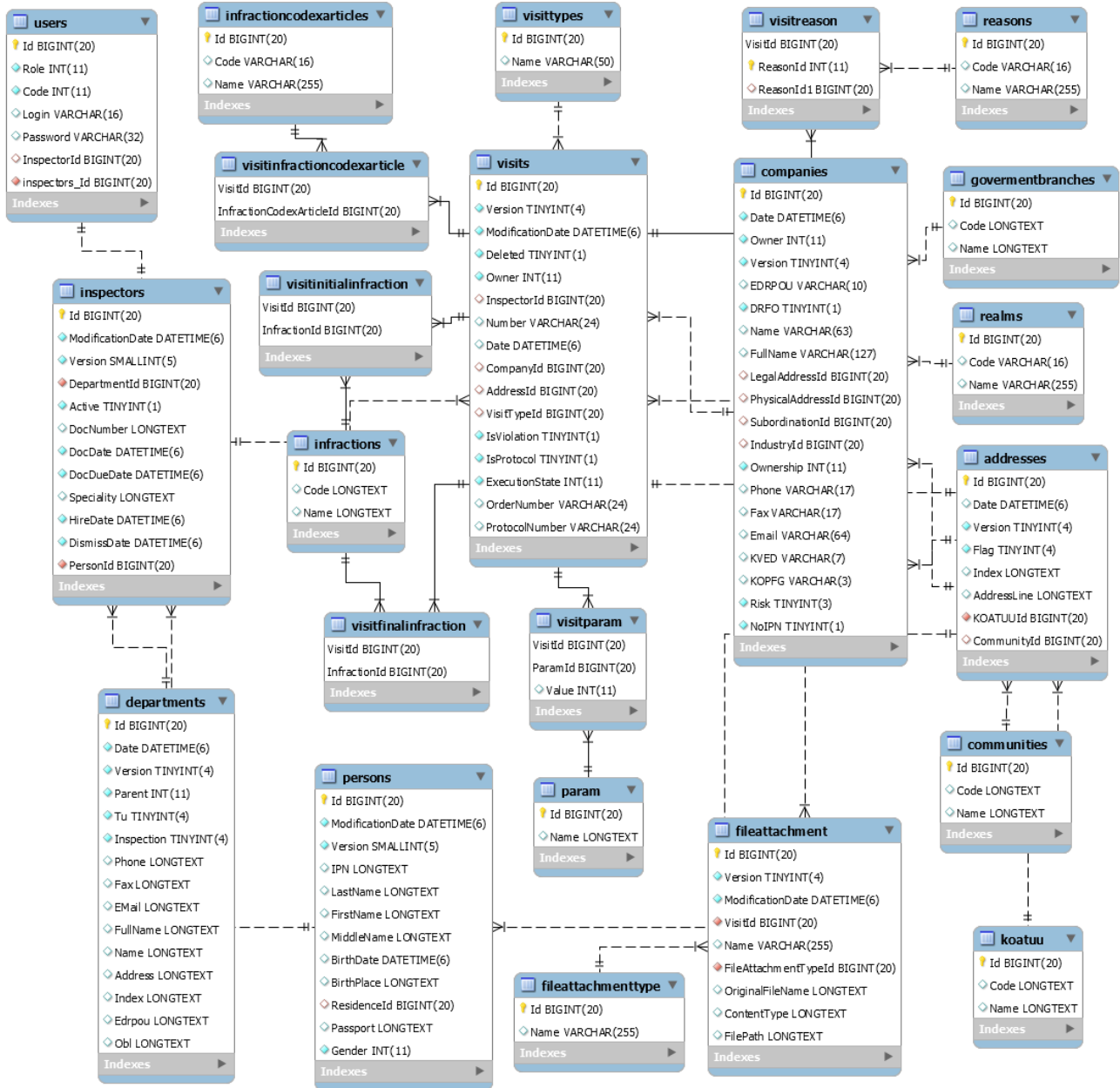


Fig. 2. The scheme of the improved information-analytical support structure

The learning function of the managers and employees on labour protection issues and the inspectors training.

In order to create the “learning” function in information and analytical support, a comparative analysis of distance learning systems was carried out. The information technologies modern market offers a wide selection of software systems that meet the general requirements for electronic distance learning systems, the most popular of which are presented in Table 1 [23].

Of the presented distance learning systems, the most appropriate is the software based on Moodle.

Moodle (Modular Object-Oriented Dynamic Learning Environment, pronounced “Mudla”) is a modular object-oriented dynamic learning environment, also called Learning Management System (LMS), Course Management System (CMS), Virtual Learning Environment (VLE) or a training platform, which provides teachers, students and

administrators very developed tools set for computerized learning, including distance learning.

Moodle has about 130 million users worldwide and continues to develop further, significantly faster than other distance learning systems. This is a significant indicator of the merits of the system. In addition, Moodle is a free, open system (Open Source), does not need paid software for its functioning, which is very important for developing countries in the context of the economic crisis.

Materials for training can be presented in the form of text, graphs, presentations, videos, instructions, etc. Since the developed information system has access to a database of standard materials related to labour protection, there is no need to develop separate trainings for each specialty. This is especially important for new specialties appearing at the enterprise.

Table 1.  
The distance learning systems comparison

Comparison parameter	Electronic distance learning systems								
	MOODLE	LAMS	Sakai	ATutor	Claroline	Dokeos	OLAT	OpenACS	ILIAS
SCORM	+	-	+	+	+	+	+	-	+
IMS	+	-	+	+	+	+	+	-	-
Language	PHP	Java	Java	PHP	PHP	PHP	Java		PHP
Database management system	MySQL	MySQL	MySQL Oracle hsqldb	MySQL	MySQL	MySQL	MySQL Postgre SQL	Oracle Postgre SQL	MySQL
Licenses	GNU/GPL	GNU/GPL	GNU/GPL	GNU/GPL	GNU/GPL	GNU/GPL	GNU/GPL	GNU/GPL	GNU/GPL
Languages of use, pcs	>54	20	28	>50	36	38	34	35	43
Knowledge testing system	tests task seminars activity on forums	tests	tests task seminars activity on forums	tests	tests exercises	tests	tests task	tests	tests
Demo server	+	+	-	+	+	+	+	-	-

Table 2.  
The distance learning systems comparison

Parameter	2018		2019		Difference	
	Absolute values	%	Absolute values	%	Absolute values	%
Total number of inspection activities per year, including:	33358	100	42988	100	9630	28.87
• Visits to monitor and identify labour law violations	16311	48.90	13569	31.56	-2742	-16.81
• Acts drawn up indicating violations of labour law	2206	85.34	1152	73.75	-1054	-47.78
• Decisions to impose a fine for violations identified	2585	15.85	1562	11.51	-1023	-39.57
• Court decisions imposing financial sanctions for violations of labour law	34	1.54	24	2.08	-10	-29.41



### 3.3. Testing of information and analytical support of the OSH management system and analysis of the dynamics of identified cases of undeclared work

Inspectors enter inspection results in the IS "Vizit". Using the information stored in the improved IS "Vizit" the following statistics were obtained (Tab. 2).

Table 1 shows that, compared to 2018 in 2019, the number of inspection activities (with the number of inspectors unchanged) increased by 28.87%. However, it should be emphasized that the number of inspection visits in order to monitor and identify violations of labour legislation decreased by 16.81% (by 2742 the visits number). At the same time, the number of inspection for consultation and explanatory work by inspectors increased and amounted to 68.4% of the total number of inspection activities (Fig. 3).

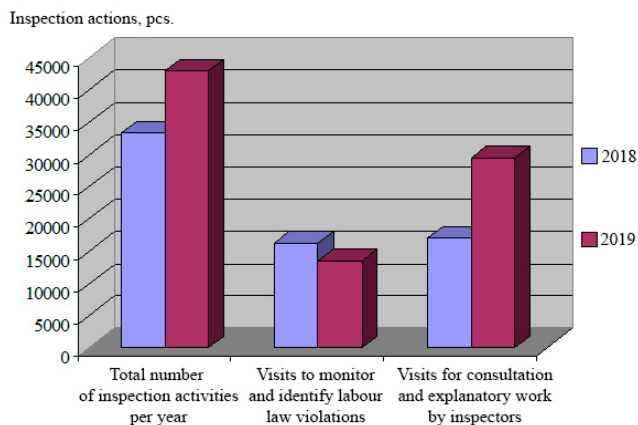


Fig. 3. Dynamics of inspection actions in 2018-2019

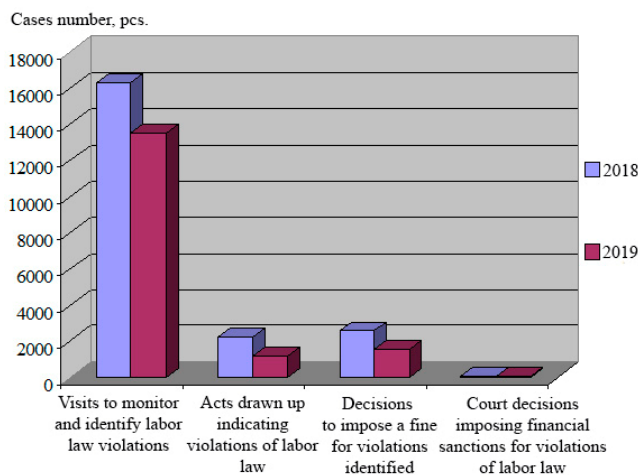


Fig. 4. Dynamics of the identification and imposition of financial sanctions for labour law violations in 2018-2019

It is also important that there is a decrease in the violations number of labour legislation, namely:

- The inspections acts number in which reported labour law violations decreased by 47.78%;
- The decisions number to impose a fine for identified violations – by 39.57%;
- The number of court decisions imposing financial sanctions for violations of labour law – by 29.41%.

This may also indicate an increase in the effectiveness of inspection visits for the consultations and explanatory work by inspectors for organizations employees (Fig. 4).

Table 3 presents the statistics of detected cases of undeclared work in 2018-2019.

Table 3.

The statistics of detected cases of undeclared work in 2018-2019

Article 265 of the Labour Code of Ukraine*	2018	2019	Difference
Paragraph 2	465	289	-176
Paragraph 3	250	164	-86
Paragraph 4	57	24	-33
Paragraph 5	16	3	-13
Paragraph 6	17	22	5
Paragraph 7	20	13	-7
Paragraph 8	1254	641	-613

\*A detailed description of the paragraphs of Article 265 is presented above in paragraph "Identification of undeclared work" of this article

Table 3 shows a decrease in the number of cases of actual admission of an employee to work without an employment contract (contract), registration of an employee for part-time work in the event of actual performance of the work, the full working time established at the enterprise, and the payment of wages (remuneration) without accrual and payment a single contribution to compulsory state social insurance and taxes. This decrease is 176 cases in one year (Fig. 5).

The improved IS "Vizit" was tested based on Ukrainian legislation. At the same time, it can be adapted to the legislation of another country by providing access to the legislative norms of the respective country and ensuring close interaction between government departments that control labour relations (that is, it is necessary to take into account the specifics of the legislation of a particular country).

A multiple regression method was used to obtain a mathematical model for predicting the number of inspection visits.

$$Y = 12580.25 - 5352.08 \cdot X_1 + 926.5 \cdot X_2 + 153475 \cdot X_1^2 - 101.67 \cdot X_1^3,$$

where  $X_1$  – the ordinal number of the quarter, that is, it can take the values 1, 2, 3 or 4;  $X_2$  – the ordinal number of the year, that is, it can take the value 1 for 2018 or the value 2 for 2019.

As the initial data for obtain the mathematical model, we used the quarterly data of the IS "Vizit" for 2018-2019 (Tab. 4).

The results of forecasting inspection activity by quarters are presented in Figure 6.

Figure 6 shows that in the second quarter of each year (2018 and 2019) there is a sharp decline in inspection activity and its sharp increase in the fourth quarter. This means that the load of inspectors (with their number unchanged) is not uniform throughout the year.

There are several reasons for this fact, for example:

- organizational reasons: the audit plan was drawn up without taking into account the possible burden on inspectors; the fourth quarter is final, so there is a need to prepare annual reports and collect the missing information (in addition to the planned inspection activities).

- psychological reason: due to checks and high-quality explanatory work that were carried out in the first quarter, the number of violations and the need for additional explanatory work are reduced, however, in the third quarter, managers and employees gradually lose their vigilance and the need for additional explanatory work increases.

However, it is difficult to explain the true reason for such an uneven load distribution without additional research. Therefore, it is necessary to adjust the plan of inspection visits based on the obtained statistics.

Similarly, predictive models were obtained for various types of inspection activities (not presented in this study). All models demonstrate the existence of certain patterns, and therefore, the results can be used to predict the inspection activities of labour inspectors, determine trends in the inspection load during the year, and adjust plans for inspection visits.

Table 4.

Initial data for the mathematical model construction for the inspection actions prediction [24]

Number of inspection activities per quarter, pcs.	Quarter ( $X_1$ )	Year ( $X_2$ )	$X_1^2$	$X_1^3$	The inspection actions prediction
9691	1	1	1	1	9587.75
8158	2	1	4	8	8128.25
9041	3	1	9	27	8518.25
9492	4	1	16	64	10147.75
10411	1	2	1	1	10514.25
9025	2	2	4	8	9054.75
8922	3	2	9	27	9444.75
11730	4	2	16	64	11074.25
	1	3	1	1	11440.75

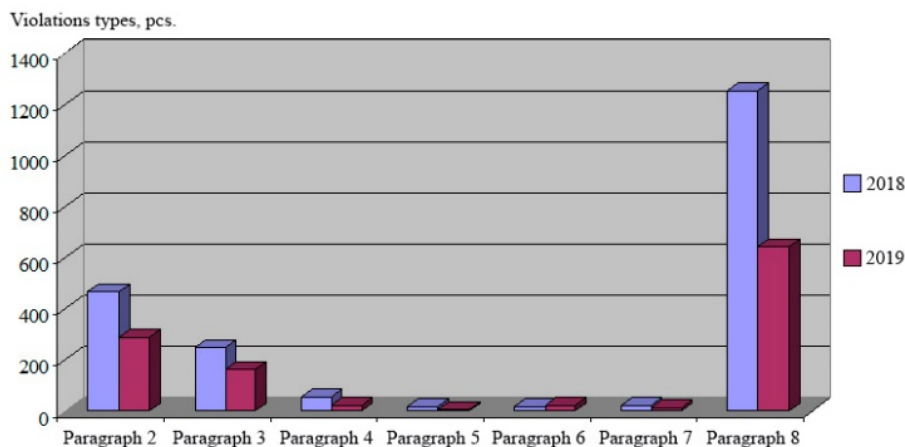


Fig. 5. The cases of undeclared work in 2018-2019 (A detailed description of the paragraphs of Article 265 is presented above in paragraph "Identification of undeclared work" of this article)

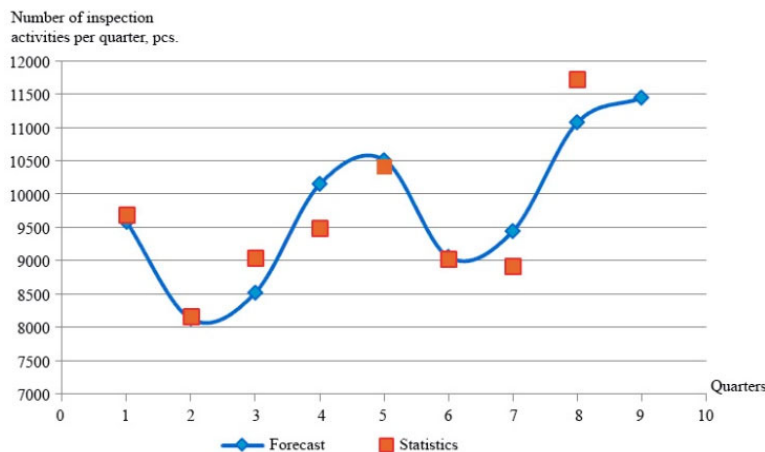


Fig. 6. Forecasting Results of quarterly inspection activities

Same the distance learning system for labour protection issues, which is based on IS "Vizit", has been tested at enterprises OOO «DTEK ENERGO», PAO «DTEK Pavlogradugol'», «Shakhtoupravleniye im. Geroyev Kosmosa», «Shakhtoupravleniye Dneprovskoye», «Shakhtoupravleniye Pavlogradskoye», «Shakhtoupravleniye Pervomayskoye», «Shakhtoupravleniye Ternovskoye», ect. (total at 22 enterprises). At the same time, officials were trained from the workshop (site) head to the enterprise head, as well as various professions and specialties employees.

Listeners are provided with lectures in the form of text, presentation or video, which allows you to choose the most convenient of the options yourself. After reading the lecture materials, the system gives access to a test on a current topic, which can be done an infinite number of times for self-monitoring and preparation for the exam. At the end of each attempt, the listener is provided with full information about his or her success in the test, and the questions that have been answered incorrectly are indicated correctly.

When creating a test, the curator may add the following restrictions to the availability or process of the test:

- Time limitation of assembly;
- Date restrictions;
- Need to enter a password issued by the curator;
- Limit on the number of attempts;
- IP addresses restriction;
- Group restrictions.

Due to these limitations, tests are fine-tuned to the needs of the listener. The question databases used to create the test are filled with a flexible interface. This interface has many settings for question type, feedback/comment on questions or answers, limitations on viewing tips, scoring points for answers, and other mechanisms that allow you to get the desired result.

## 4. Conclusions

Based on the results of the study, the following conclusions can be formulated:

1. One of the main problems in the OSH management system in European countries, which is the most relevant today, is the use of undeclared work, and as a result, a labour safety legislation violation. To identify cases of undeclared work, labour inspectors undergo special long-term training. In addition, there is an obvious need to free inspectors from routine work so that they can focus on the most important issues. For this reason, information and analytical support of the OSH management system was developed and chosen for the tests.
2. Information and analytical support for the OSH management system should ensure the speed of action; close cooperation between entities of information exchange (in accordance with labour legislation of the respective country); the possibility of using legislative documents, a register, a classifier and other information (including electronic forms of reporting on the results of inspections); identification of causal relationships of identified violations (diseases, injuries) and undeclared work; the training function (with all informational and methodological materials) of labour inspectors, organizations managers and employees.
3. The developed informational and analytical support of the OSH management system allows, on the basis of indirect signs, to identify cases of undeclared work, to forecast the inspection activities of labour inspectors by quarters and to conduct effective distance learning of enterprise employees and inspectors. This is evidenced by the results of the implementation of the information-analytical support. The distance learning system for

labour protection was tested at 22 enterprises: the head of the enterprise, the department's heads and enterprise employees passed the training. Since the introduction of the developed support (since 2018), the dynamics of inspection actions and various types of labour violations have been monitored.

4. A multiple regression method was used to obtain a mathematical model for predicting the number of inspection visits.

Analysis of the forecast model showed that in the second quarter of each year there is a sharp decline in inspection activity and its sharp increase in the fourth quarter. That is the inspectors load (with their number unchanged) is not uniform throughout the year. Therefore, it is necessary to adjust the plan of inspection visits. Similarly, forecast models were obtained for various types of inspection activities and were identified existence of certain patterns. Therefore, the results can be used to forecasting the inspection activities of inspectors, determine trends in the inspection load during the year, and adjust plans for inspection visits.

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## Additional information

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