Intelligent Information Technology for Verifying the Correctness of the Mortgage Agreement Structure

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Abstract. An analysis of known models, methods, tools for mortgage support showed that they do not solve the problem of verifying the correctness of the mortgage agreement structure. Therefore, the design and implementation of intelligent information technology for verifying the correctness of the mortgage agreement structure is currently an urgent task for Ukraine, because it's an example of risk-informed development (it represents a risk-based decision process that enables development to become more sustainable and resilient). In this paper, intelligent information technology for verifying the correctness of the mortgage agreement structure is first time developed. It provides: verifying the correctness of the mortgage agreement structure from a legal point of view, which provides an opportunity to enter into legally correct mortgage agreements without paying lawyers for their inspection; opinion on the correctness of the mortgage agreement structure with a visualized list of missing essential conditions (if the agreement structure is incorrect); pushes development decision-makers to understand and acknowledge that all development choices involve the creation of uncertain risks, as well as opportunities. Developed intelligent information technology for verifying the correctness of the mortgage agreement structure helps to avoid signing the mortgage agreement with incorrect structure, the signing of which can lead to negative consequences for one or both parties of the agreement. According to the results of the study, the use of developed intelligent information technology for verifying the correctness of the mortgage agreement structure makes it possible to increase the level of correctness of the mortgage agreement structure by an average of 17.5% (from 165 to 200 correct agreements).

Keywords: Intelligent Information Technology, Risk-Informed Development, Mortgage Agreement, Correctness of the Agreement Structure, Ontology.

1 Introduction

Mortgage is a pledge of land, real estate, in which the land and/or real estate that is the subject of the pledge, remain with the mortgagor or a third party (property guarantor), and the mortgagee acquires the right to satisfy the mortgage obligation, which is not

fulfilled, by the subject of the mortgage [1]. In most European countries, mortgages belong to property rights and are classified as part of property rights.

The mortgage market occupies one of the most important places among the financial mechanisms of economic stimulation and stable development of the country's economy, i.e. is a direct consequence of the fact that mortgages have recently become the most widely used in the economic circulation of the state. In this regard, the legislator has decided to more fully regulate the legal relationship regarding the use of mortgages as a type of security for the fulfilment of obligations. This decision was reproduced in the Law of Ukraine "On Mortgage", which filled a significant gap in Ukrainian legislation [2].

According to the above Law [2], a mortgage is a type of security for the fulfilment of obligations by the real estate, which remains in the possession and use of the mortgagor, according to which the mortgagee has the right in case of default by the debtor of the mortgage obligation to obtain satisfaction of their claims at the expense of the subject of the mortgage mainly before other creditors of this debtor.

Mortgages, as a way of securing an obligation, are a complex legal and social phenomenon. Mortgages are widely used to ensure the proper execution of various types of agreements, namely: credit, supply, sale, etc.

According to current legislation, a mortgage arises on the basis of an agreement, law or court decision. The rules on a mortgage arising on the basis of an agreement shall apply to a mortgage arising on the basis of a law or a court decision unless otherwise provided by law.

In essence, a mortgage is an additional means of the proper performance of obligations and a derivative agreement from the main agreement, so it is sufficient to refer in the mortgage agreement to the relevant terms of the loan agreement. There is no need to duplicate these conditions in the mortgage agreement (interest and fine on the loan, as well as the terms of their payment).

A mortgage is one of the most effective ways to ensure that the debtor's obligations to the creditor are met, as it reliably protects the creditor's rights and sets a high priority for the mortgagee's claims.

Thus, the mortgage today is almost the only civil-law way to ensure the fulfilment of obligations, which has real property coverage and is rightly considered the most reliable tool among those used by banking and financial institutions in lending.

Given the above, the issue of concluding a mortgage agreement, in particular, verifying the correctness of its structure, needs more and more attention today. The lack of essential conditions in the mortgage agreement, the obvious limitations of its content, and the insufficient training from a legal point of view can lead to unfavourable legal consequences for both the mortgagor and the mortgagee. Of course, not every mortgagor can afford to hire a lawyer to prepare a mortgage agreement. As a rule, the mortgagor relies on the mortgagee and his lawyers when concluding such an agreement. However, the mortgagee and his lawyers also do not always treat the preparation of the agreement in good faith, intentionally or unintentionally missing the essential conditions of the agreement. Under such conditions, intelligent information technology for verifying the correctness of the mortgage agreement structure from the legal point of view can significantly increase the legal correctness of the mortgage agreement, as well as protect the mortgagor (and the mortgagee) from undesirable consequences (and free).

In general, accelerating the development and implementation of the latest competitive information technologies in all areas of human activity in order to reduce the share of physical labour and minimize the impact of the human factor through process automation is the main strategic goal of the information society in Ukraine [3, 4].

The design and implementation of intelligent information technology for verifying the correctness of the mortgage agreement structure is currently *an urgent task* for Ukraine.

2 Related Works

Let's analyze the literature to find known models, methods, tools for mortgage support.

The commercial platform Sentinel [5] is a flexible loan and lease management platform. Sentinel was developed to meet the varied needs of the instalment credit industry. The platform boasts a modular design that allows customers to create the right solution for their particular business requirements. The platform manages loan origination process from initial enquiry through underwriting to payout of the loan aiding.

The commercial platform Comarch Loan Origination [6] software provides solutions for all segments: retail, SME or corporate. The platform incorporates a full portfolio of credit products.

The commercial platform Outsource Mortgage Loan Underwriting Support Services [7] leverages various automated underwriting systems and software to deliver real-time underwriting. This platform specializes in both Fannie Mae's Automated Underwriting System (Desktop Underwriter) and Freddie Mac's Automated Underwriting System (Loan Prospector).

Scarlett Network broker management software [8] is a commercial technology solution for mortgage brokers & lenders, that provides features such as mortgage broker customer relationship management tools, digital document management, point of sale, and payroll and commissions processing.

In the [9] there is a review of the best mortgage and loans software for business.

Given the growing demand for more realistic and informed credit risk assessment mechanisms, the study [10] sought to create a multiple criteria credit risk assessment system for mortgage loans using cognitive maps and the Measuring Attractiveness by a Categorical Based Evaluation Technique.

The research [11] proposed a hybrid decision support system in which neural networks was used to build learning and adaptive capabilities into a fuzzy inference module for mortgage loan risk assessment.

A concept of a decision support system based on the fuzzy logic for loan granting based on the use of a continuous loan price function of the borrower's creditworthiness rating is proposed in [12].

The paper [13] presents a data mining decision support system called DMDSS based on a methodology, which is introduced to integrate the decision support system with data mining for loans to the Real Estate developments fund Customers.

The paper [14] presents an explainable artificial intelligence decision-support-system to automate the loan underwriting process by belief-rule-base. The system can

explain the chain of events leading to a decision for a loan application by the importance of an activated rule and the contribution of antecedent attributes in the rule.

Thus, the analysis of known models, methods, tools for mortgage support showed that known commercial software tools are aimed at supporting underwriting or loan calculation. At the same time, well-known decision support systems make it possible for the bank employee to make an informed decision in a timely manner that considers all the different internal and external data sources. However, the known models, methods, tools for mortgage support do not solve the problem of verifying the correctness of the mortgage agreement structure.

Given the above urgency, importance and relevance of the task of designing and implementing the information technology for verifying the correctness of the mortgage agreement structure, *the aim of this research* is to develop the information technology for verifying the correctness of the mortgage agreement structure, as well as developing a method of verifying the correctness of the mortgage agreement structure.

3 Civil Law Aspects of the Mortgage Agreement

Let's analyze the subject area – let's consider the civil law aspects of the mortgage agreement.

A mortgage agreement is an agreement between two or more parties aimed at securing the fulfilment of an obligation by real estate remaining in the possession and use of the mortgagor, according to which the mortgagee has the right to obtain satisfaction of his claims at the expense of the mortgage's subject mainly to other creditors of this debtor in the manner prescribed by law.

The parties to a mortgage agreement are always the mortgagee and the mortgagor. A mortgagee is a person to whom real estate, property complexes, etc. are transferred as a means of securing a principal obligation. The mortgagor is a legal entity or a natural person, the owner or a person authorized to transfer real estate to ensure the fulfilment of the obligation.

A mortgage presupposes that the land and real estate that are the subject of the mortgage remain with the mortgagor or a third party. In this case, the mortgagor retains the right to own or use the subject of the mortgage in accordance with its purpose. He independently disposes of the income received from the use of the mortgage subject, receives income. In this case, it is much easier for the mortgagor, who is the debtor of the main claim secured by the mortgage, to repay the loan or fulfil another obligation within the prescribed period.

The mortgage agreement, the subject of the mortgage under which are the property rights to the object of unfinished construction, is certified by a notary on the basis of documents confirming the property rights to this object. A mortgage agreement is concluded between one or more mortgagors and the mortgagee in writing and is subject to notarization. This agreement is consensual, bilateral and repayable.

It should be noted that the mortgage agreement must contain the following *essential conditions*:

1. for the mortgagor and mortgagee - legal entities, information on:

– for residents – name, location and identification code in the Unified State Register of Legal Entities and Individual Entrepreneurs;
– for non-residents – the name, location and country where the person is registered;

2. for the mortgagor and mortgagee - individuals, information about:

– for citizens of Ukraine – surname, name, patronymic, place of residence with the address and individual identification number in the State Register of Individuals-Taxpayers and Other Obligatory Payments;
– for foreigners, stateless persons - surname, name, patronymic (if any), address of permanent residence outside Ukraine;

3. the content and amount of the principal obligation, the term and procedure for its implementation, reference to the transaction in which the principal obligation is established;
4. description of the subject of the mortgage, its registration data, cadastral number;
5. link to the issuance of a mortgage.

The mortgage agreement may contain other provisions, in particular, determination of the amount for which the subject of the mortgage should be insured, reference to the document confirming the mortgagor's ownership of the mortgage, information on restrictions and encumbrances of the mortgagor's rights to the mortgage, determination of foreclosure mortgage.

4 Intelligent Information Technology for Verifying the Correctness of the Mortgage Agreement Structure

The main source of information is the mortgage agreement. In the absence of one of the above essential conditions in the mortgage agreement, it may be declared invalid on the basis of a court decision. Therefore, it is necessary to check the structure of the mortgage agreement for the presence of all the above essential conditions. For such verification, the developed intelligent information technology for verifying the correctness of the mortgage agreement structure will be used. When choosing a method of identifying the missing essential conditions in the mortgage agreement, two effective approaches were analyzed. The paper [15] describes a new effective missing data imputation method through SGTM neural-like structure, which can be used in various areas such as medicine, materials science, economics, science services, but this method cannot be used for mortgage law. The paper [16] represents effective ontology-based approach for evaluating the sufficiency of information in the surrogate motherhood contract. This approach, which is effective for medical law domain, will be used for mortgage law domain.

Intelligent information technology for verifying the correctness of the mortgage agreement structure is represented on Fig. 1.

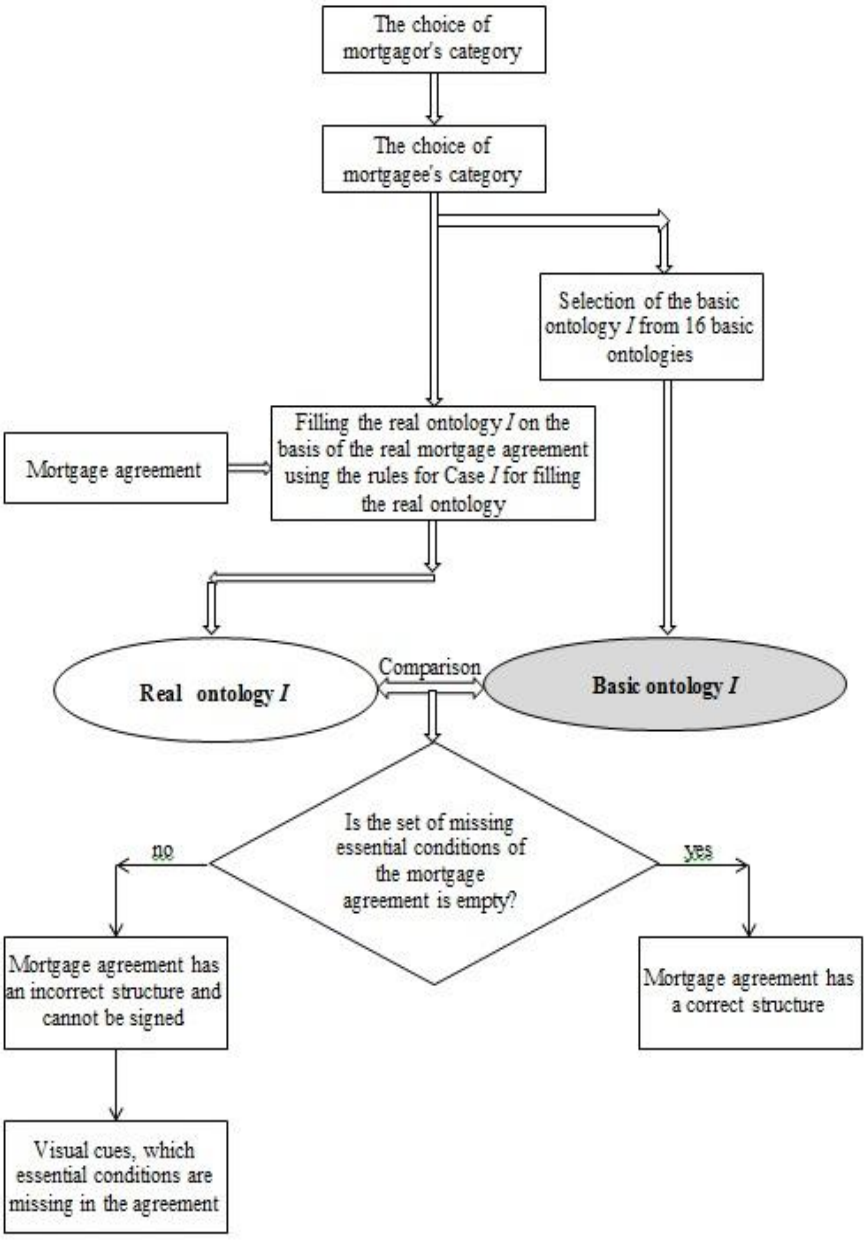

Fig. 1. Intelligent information technology for verifying the correctness of the mortgage agreement structure

Given the fact that both the mortgagor and the mortgagee may be an individual or legal entity, as well as a citizen (resident) of Ukraine or a foreigner (non-resident), and for different categories of mortgagor and mortgagee the essential conditions of the

mortgage agreement are different, we have 16 different cases (variants of essential conditions of the agreement):

1. the mortgagor is an individual and a citizen of Ukraine, the mortgagee is a legal entity and a resident of Ukraine;
2. the mortgagor is an individual and a citizen of Ukraine, the mortgagee is a legal entity and a non-resident of Ukraine;
3. the mortgagor is an individual and a citizen of Ukraine, the mortgagee is an individual and a citizen of Ukraine;
4. the mortgagor is an individual and a citizen of Ukraine, the mortgagee is an individual and is not a citizen of Ukraine;
5. the mortgagor is an individual and is not a citizen of Ukraine, the mortgagee is a legal entity and a resident of Ukraine;
6. the mortgagor is an individual and is not a citizen of Ukraine, the mortgagee is a legal entity and a non-resident of Ukraine;
7. the mortgagor is an individual and is not a citizen of Ukraine, the mortgagee is an individual and a citizen of Ukraine;
8. the mortgagor is an individual and is not a citizen of Ukraine, the mortgagee is an individual and is not a citizen of Ukraine;
9. the mortgagor is a legal entity and a resident of Ukraine, the mortgagee is an individual and a citizen of Ukraine;
10. the mortgagor is a legal entity and a resident of Ukraine, the mortgagee is an individual and is not a citizen of Ukraine;
11. the mortgagor is a legal entity and a resident of Ukraine, the mortgagee is a legal entity and a resident of Ukraine;
12. the mortgagor is a legal entity and a resident of Ukraine, the mortgagee is a legal entity and a non-resident of Ukraine;
13. the mortgagor is a legal entity and a non-resident of Ukraine, the mortgagee is an individual and a citizen of Ukraine;
14. the mortgagor is a legal entity and a non-resident of Ukraine, the mortgagee is an individual and is not a citizen of Ukraine;
15. the mortgagor is a legal entity and a non-resident of Ukraine, the mortgagee is a legal entity and a resident of Ukraine;
16. the mortgagor is a legal entity and a non-resident of Ukraine, the mortgagee is a legal entity and a non-resident of Ukraine.

The user of intelligent information technology for verifying the correctness of the mortgage agreement structure must first make a choice of the category of mortgagor and mortgagee. Based on the selected categories of the mortgagor and the mortgagee, a basic ontology is selected from 16 basic ontologies (one basic ontology for each of the 16 described above cases), which contains all the necessary essential conditions that must be a presence in the relevant mortgage agreement. Each basic ontology contains general conditions that do not depend on the categories of the mortgagor and the mortgagee, as well as conditions that depend on the categories of the mortgagor and the mortgagee, which are described in section 3 of this paper. On the basis of the mortgage agreement, the formation of a real ontology is conducted, which contains the conditions available in the real mortgage agreement. This is followed by a comparison of the real ontology with the selected basic ontology, the result of which is a set of missing

conditions for a particular version of the mortgage agreement. If such a set is empty, it means that all the essential conditions are present in the mortgage agreement, then it has the correct structure. If such a set is not empty, therefore, not all the essential conditions are written in the mortgage agreement, then it has an incorrect structure and cannot be signed. The result of the comparison of ontologies visually reflects the list of essential conditions, which were missing in the agreement.

Intelligent information technology for verifying the correctness of the mortgage agreement structure provides: verifying the correctness of the mortgage agreement structure from a legal point of view, which provides an opportunity to enter into legally correct mortgage agreements without paying lawyers for their verification; provides an opinion on the correctness of the mortgage agreement structure with a visualized list of missing essential conditions (if the agreement structure is incorrect).

5 Method for Verifying the Correctness of the Mortgage Agreement Structure

We will develop a method for verifying the correctness of the mortgage agreement structure, which is the basis of intelligent information technology for verifying the correctness of the mortgage agreement structure. But first we develop *the rules for filling the real ontology based on the real mortgage agreement*:

– Case 1:

1. if there is a surname, name, patronymic of the mortgagor in the mortgage agreement, then the concept "surname, name, patronymic of the mortgagor" is included in the real ontology;
2. if in the mortgage agreement there is a place of residence with the address of the mortgagor, then the concept "place of residence with the address of the mortgagor" is included in the real ontology;
3. if the mortgage agreement has an individual identification number of the mortgagor, then the concept "individual identification number of the mortgagor" is included in the real ontology;
4. if the mortgage agreement contains the name of the mortgagee, then the concept "name of the mortgagee" is included in the real ontology;
5. if the mortgage agreement has the location of the mortgagee, then the concept "location of the mortgagee" is included in the real ontology;
6. if the mortgage agreement contains the mortgagee's identification code from the Unified State Register of Legal Entities and Individual Entrepreneurs, then the concept “identification code of the mortgagee” is included in the real ontology;
7. if the mortgage agreement contains the content and amount of the principal obligation, then the concept "content and amount of the principal obligation" is included in the real ontology;
8. if the mortgage agreement has a term and procedure for its implementation, then the concept "term and procedure for implementation of the agreement" is included in the real ontology;

9. if the mortgage agreement contains a reference to the transaction in which the principal obligation is established, then the concept "reference to the transaction in which the principal obligation is established" is included in the real ontology;
10. if the mortgage agreement contains a description of the subject of the mortgage, then the concept "description of the subject of the mortgage" is included in the real ontology;
11. if the mortgage agreement contains the registration data of the subject of the mortgage, then the concept "registration data of the subject of the mortgage" is included in the real ontology;
12. if the mortgage agreement has a cadastral number of the subject of the mortgage, then the concept "cadastral number of the subject of the mortgage" is included in the real ontology;
13. if the mortgage agreement contains a link to the issuance of a mortgage, then the concept "link to the issuance of a mortgage" is included in the real ontology;

– Case 2 – Case 16: the rules for ontologies are analogous - rules 1-6 are a combination of essential conditions for different categories of mortgagor and mortgagee, and rules 7-13 are common for filling all real ontologies, as they are formed on the basis of general essential conditions.

Method for verifying the correctness of the mortgage agreement structure consists of the next steps:

1. analysis of the mortgage agreement for the availability of the essential conditions;
2. filling the real ontology *I* on the basis of the real mortgage agreement using the rules for Case *I* for filling the real ontology;
3. comparison of the real ontology *I* with the basic ontology *I*, the result of which is a set of missing essential conditions of the mortgage agreement;
4. if the set of missing essential conditions of the mortgage agreement is empty, the mortgage agreement has a correct structure, otherwise, if the set of missing essential conditions of the mortgage agreement is not empty, the mortgage agreement has an incorrect structure and cannot be signed (maybe, the agreement needs reprocessing);
5. providing the information technology's user with visual cues, which essential conditions are missing in the agreement.

6 Results and Discussions

We consider the operation of the developed intelligent information technology for verifying the correctness of the mortgage agreement structure in the following example. An individual, who is a citizen of Ukraine, wants to take a loan and must enter into a mortgage agreement with a bank that is a legal entity and a resident of Ukraine. The bank offered its version of the mortgage agreement. The developed information technology conducted an analysis of the mortgage agreement for the availability of the essential conditions, on the basis of which the real ontology 1 was filled using the rules for filling the real ontology for Case 1. After this, the comparison of the real ontology 1 with the basic ontology 1 was conducted. The result of this comparison was a set of missing essential conditions of the mortgage agreement, which consists of the following

elements: “cadastral number of the subject of the mortgage”, “link to the issuance of a mortgage”. Because the set of missing essential conditions of the mortgage agreement is not empty, then the mortgage agreement has an incorrect structure and cannot be signed (perhaps, the agreement needs reprocessing). Therefore, after verifying the proposed mortgage agreement using the developed information technology, the mortgagor received a conclusion about the incorrect structure of the mortgage agreement offered by the bank and also received a hint, what the essential conditions are not specified in this agreement. In the case of signing such a mortgage agreement, without the necessary essential conditions, the agreement could be declared invalid on the basis of a court decision, which could have negative consequences for both the mortgagor and the mortgagee.

Thus, the intelligent information technology developed for verifying the correctness of the mortgage agreement structure helps to avoid signing the mortgage agreement with incorrect structure, the signing of which may lead to negative consequences for one or both parties and provides the opportunity to conclude legally correct mortgage agreements without paying lawyers for their inspection. In addition, it pushes development decision-makers to understand and acknowledge that all development choices involve the creation of uncertain risks, as well as opportunities.

The authors verified the correctness of the structure of 120 mortgage agreements concluded by various Ukrainian banks with mortgagee - individuals and 80 mortgage agreements concluded by various Ukrainian banks with mortgagees - legal entities. The developed intelligent information technology for verifying the correctness of the mortgage agreement structure showed that, from the point of view of civil law, only 97 mortgage agreements of the first type and 68 mortgage agreements of the second type had a correct structure (81% and 85% respectively). Thus, from 200 analyzed mortgage agreements, only 165 agreements (82.5%) had the correct structure - Fig. 2.

If, before signing, mortgagors and mortgagees used the developed intelligent information technology for verifying the correctness of the mortgage agreement structure, then 35 agreements with incorrect structure would either not be signed or would be signed after their reprocessing (after providing all the essential conditions).

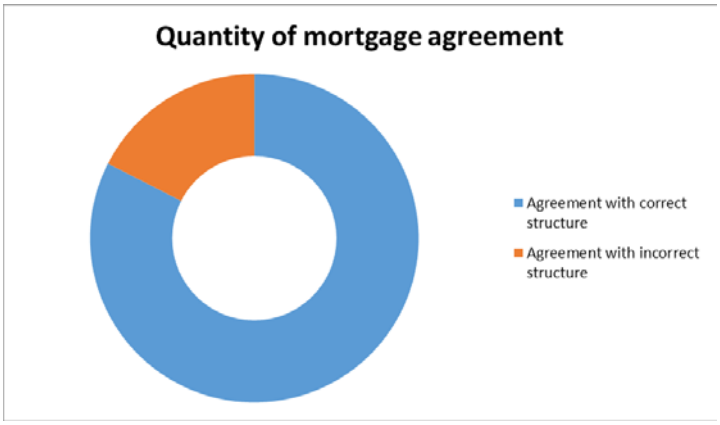

Fig. 2. The correctness of the structure of mortgage agreements, which were concluded by various Ukrainian banks

7 Conclusions

The conducted analysis of known models, methods, tools for mortgage support showed that known commercial software tools are aimed at supporting underwriting or loan calculation. At the same time, well-known decision support systems make it possible for the bank employee to make an informed decision in a timely manner that considers all the different internal and external data sources. However, known models, methods, tools for mortgage support do not solve the problem of verifying the correctness of the mortgage agreement structure. Therefore, the design and implementation of intelligent information technology for verifying the correctness of the mortgage agreement structure is currently an urgent task for Ukraine.

In this paper, intelligent information technology for verifying the correctness of the mortgage agreement structure and method for verifying the correctness of the mortgage agreement structure are first time developed. They provide: verifying the correctness of the mortgage agreement structure from a legal point of view, which provides an opportunity to enter into legally correct mortgage agreements without paying lawyers for their inspection; opinion on the correctness of the mortgage agreement structure with a visualized list of missing essential conditions (if the agreement structure is incorrect); pushes development decision-makers to understand and acknowledge that all development choices involve the creation of uncertain risks, as well as opportunities. The developed intelligent information technology for verifying the correctness of the mortgage agreement structure helps to avoid signing the mortgage agreement with incorrect structure, the signing of which can lead to negative consequences for one or both parties of the agreement.

According to the results of the conducted study, the use of developed intelligent information technology for verifying the correctness of the mortgage agreement structure makes it possible to increase the level of correctness of the mortgage agreement structure by an average of 17.5% (from 165 to 200 correct agreements).

The future research of authors will devote to: 1) development of the method of automatic semantic parsing the natural language mortgage agreement; 2) implementation of the intelligent information technology for verifying the correctness of the mortgage agreement structure – in the form of free web-service with online access.

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