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CONTENTS

A Review and evaluation of Machine Translation methods for Lumasaaba

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Abstract. Natural Language Processing for under-resourced languages is now a mainstream research area. However, there are limited studies on Natural Language Processing applications for many indigenous East African languages. As a contribution to covering the current gap of knowledge, this paper focuses on evaluating the application of well-established machine translation methods for one heavily under-resourced indigenous East African language called Lumasaaba. Specifically, we review the most common machine translation methods in the context of Lumasaaba including both rule-based and data-driven methods. Then we apply a state of the art data-driven machine translation method to learn models for automating translation between Lumasaaba and English using a very limited data set of parallel sentences. Automatic evaluation results show that a transformer-based Neural Machine Translation model architecture leads to consistently better BLEU scores than the recurrent neural network-based models. Moreover, the automatically generated translations can be comprehended to a reasonable extent and are usually associated with the source language input.

Keywords: machine translation, Lumasaaba, data-driven machine translation, phrase-based statistical machine translation, Neural machine translation.

1. Introduction

There is a growing need to provide Natural Language Processing (NLP) resources and applications for under-resourced languages. Machine Translation (MT) is one NLP application that has been of greater use and impact in the exchange of information across languages. For example, different forms of MT have been incorporated in various types of Web-based applications to enable access to information in more than one natural language. The access to MT not only benefits the consumer but also the provider of the service, even when in some cases it is free. Machine translation comprises several methods under two major approaches: rule-based MT and data-driven MT. Rule-based MT approaches require sufficient linguistic input while data-driven approaches require lots of parallel sentences. Despite the general progress in MT using methods from the different approaches, many under-resourced languages are yet to be involved and hence lack any knowledge concerning the development of MT and resulting benefits. Since natural languages usually have distinct inherent properties, there is always a need to study them separately in the context of NLP so as to guide the development of effective solutions. In this regard, we focus on one heavily under-resourced East African language called Lumasaaba which has not yet been involved in any forms of MT. The first contribution of the paper is a review of the main MT methods in the context of automating translation between Lumasaaba and English. The second contribution of the paper is an application and evaluation of state-of-the-art approach to MT called Neural Machine translation using a limited corpus of parallel sentences from the Bible. The rest of the paper is organized as follows: In section 2, we present an overview of the Lumasaaba language; in

section 3, we present a review of the different MT methods in the context of Lumasaaba; in section 4, we present the data and methodology for evaluating a state of the art approach in Neural Machine Translation in an experimental Lumasaaba-to-English MT task; in section 5, we present the Neural Machine Translation evaluation results; section 6 concludes the paper with pointers to future work.

2. The Lumasaaba Language

Lumasaaba is regarded as a Bantu language under the Niger Congo language family. The language is mostly spoken in the Eastern part of Uganda around the western side of Mt. Elgon. The language has a number of dialects under two main categories [1]: the 'southern' dialects (for example: Lubuya, Lusoba, Lukiende, etc.) and the 'northern' dialects (for example Ludadiri, Luwalasi, Lufumbo, etc.). There are clear differences in both pronunciations and vocabularies between the two categories of dialects. The differences warrant a separate treatment of the two main categories of dialects with regard to MT. In this paper, we focus on a representation that is mostly associated with the 'southern' dialects. A reasonable amount of monolingual text and bilingual text (with English) has been generated can be used for MT study.

The representation of the 'southern' dialects just like a number of African Bantu languages uses the modern Latin alphabet except two characters (Xx and Qq) but with another character ŋ 'ng'. The language recognizes the usual common parts of speech although some of them are very limited. These are some example words [2]: nouns (umulimi 'farmer', Wele 'God') , adjectives (buli 'each', nanu 'who'), pronouns (ise 'I', iwe 'you', ifwe 'we'), verbs (bona 'see', soma 'read') , adverbs (hano 'here', kindi 'in another way') prepositions (ku 'on', ni 'with'), conjunctions (ne 'but', oba 'or', and interjections (aso! 'now you see!').

3. Review of MT methods in the context of Lumasaaba

This section reviews the two main MT approaches (Rule-based MT and Data-driven MT (Example-based, PBSMT and NMT) while illustrating their application to translation between Lumasaaba and English. We identify opportunities and requirements of implementing MT involving Lumasaaba for some of the methods in each approach.

3.1 Rule-based Machine Translation

The Rule-based MT approach is regarded as the first approach in the field of machine translation. As the name suggests, the Rule-based MT approach mainly involves the use of linguistic rules of various kinds including rules for syntax, lexical, lexical transfer, syntactic generation, morphological and semantic analysis [3]. The main principle of Rule-based MT is based on linking the structure of a 'source language' sentence with the structure of a 'target language' sentence. The following example illustrates the general application of the approach to English-to-Lumasaaba translation as we point out what is required to achieve each of the steps. Consider this sentence in English (source): *The Minister said that "this project will increase food"*. At a basic level, we need the following resources to get a Lumasaaba translation: a dictionary for mapping each English word to a suitable Lumasaaba word; rules for representing regular English structure; rules for representing regular Lumasaaba structure; and rules for relating the English and Lumasaaba structures together. Based on these requirements, the following steps follow:

Step 1: identify English part of speech information for each English word. In this step, English part of speech taggers can be used and different approaches are possible including rule-based tagging, stochastic tagging, and transformation-based tagging ([4][5]). Using the Penn Treebank tag set [6], we get the following annotation for the English sentence:

The=DT Minister=NN said=VBD that=IN this=DT project=NN will=MD.VB increase=VB food=NN.

Translation in the direction of Lumasaaba-to-English will also require part of speech information for a Lumasaaba 'source' sentence. This implies the need for a Lumasaaba part of speech tagger.

Step 2: Get syntactic information for the source sentence and parse it. Different grammatical formalisms and parsing methods can be used to get syntactic information. Using the Link parser [7] and the Penn Treebank tag set leads to the following syntactic information for the example:

(S (NP The Minister) (VP said (SBAR that (S (NP this project) (VP will (VP increase (NP food)))))).

Step 3: Translate English words into Lumasaaba. Assuming the same part of speech for English, we will get the following:

The (category = DT) → (), Minister (category = NN) → Minista (category = NN), said (category = VBD) → alomele (category = VBD), that (category = SBAR) → ari (category = SBAR), this (category = DT) → yino (category = DT), project (category = NN) → i polojekiti (category = NN), will (category = MD.VB) → (), increase (category = VB) → ongela (category = VB), food (category = NN) → bilyo (category = NN).

Step 4: Map dictionary entries into appropriate inflected forms to have the following final generation:

'target language sentence': Minista alomele ari "I polojekiti yino inongela bilyo."

There are currently very limited resources for the Lumasaaba language to facilitate the steps above. Rule-based MT is still very necessary either as a standalone approach or in combination with other state-of-the-art MT methods for achieving high quality translations in various applications. So the development of linguistically motivated resources (such as part of speech taggers, parsers, and bilingual dictionaries) for low-resourced languages should also be prioritized. If resources were available, it would be interesting to explore currently active Rule-based frameworks such as Apertium [8] and Grammatical Framework [9].

3.2 Data-driven machine translation

The field of machine translation is currently dominated by data-driven (or corpus-based approaches) [10] which can be categorized into three: Example-based machine translation (EBMT), statistical machine translation (SMT), and Neural Machine Translation (NMT). Data-driven approaches require a parallel corpus (which is at least sentence aligned) between two languages which is used to either build a knowledge base or translation models for automating translation.

3.2.1 Example-based Machine Translation

Example-based MT was proposed as an alternative to Rule-based MT and its origins are attributed to a paper presented by Makoto Nagao at a 1981 conference and which was later published in 1984. The idea behind the EBMT approach is captured in Nagao's much quoted statement [11]:

> *Man does not translate a simple sentence by doing deep linguistic analysis, rather, Man does translation first, by properly decomposing an input sentence into certain fragmental phrases …, then by translating these phrases into other language phrases, and finally by properly composing these fragmental translations into one long sentence*. *The translation of each fragmental phrase will be done by the analogy translation principle with proper examples as its reference*.

EBMT is generally composed of three stages: search for examples and matching, extraction and retrieval of examples, and recombination [10]. The first stage takes a source language sentence and tries to find examples in the knowledge base which closely match it. For effective results, the search process is usually linguistically motivated. For matching, the input sentence is parsed into segments of a certain granularity; then each segment is matched with example segments from the source language section of the knowledge base at the same level of granularity; the example translations from the target language side of the knowledge base are also retrieved for each source language example segment. The third stage involves determining an alignment of the retrieved segments so as to produce a grammatical output in the target language.

Although EBMT is considered to be data-driven, the techniques that have been used at different stages of the process come in several flavors ranging from those that rely on less to those that rely on more linguistic information. The effort in developing the knowledge base for EBMT depends on the features that the examples should have. Of course, manual construction of the knowledge base is possible and can guarantee high quality results in specific cases but will take a lot of time. Automatic induction of examples from a parallel corpus for the knowledge base can be used to overcome the limitation of manual construction, but at the expense of quality. There are also other issues to address when using EBMT [12] including: determining the optimal level of granularity, determining the limit at which more examples may not improve the quality of translations; determining suitable examples; how to store examples for efficient searching especially when lexical, syntactic and other information is included; generalization of examples. Where linguistic information is required, the resources that facilitate Rule-based MT should suffice for EBMT as well. In this case, we lack the same resources for Lumasaaba as mentioned in the previous section. Alternatively, statistical information about the examples can be used; in this case, the knowledge base stores precomputed statistical parameters associated with bilingual word pairings and the "translation model" [10]. A target language model which gives the probabilities of target language sentences is also precomputed. Here, the EBMT approach becomes an SMT approach. There are a number of open source tools that can facilitate the development of an EBMT system as long as we have a sentence aligned Lumasaaba-English parallel corpus with additional linguistic information. We have established that the parallel corpus in its basic form (with just parallel sentences) is not enough for EBMT and the resources required for specifying additional linguistic information are currently non-existent for Lumasaaba.

3.2.2 Statistical Machine Translation

Statistical Machine Translation constitutes a considerable amount of the near past in the field of MT. This is mainly attributed to the relative ease with which SMT tools can be configured to work with available parallel corpora. The SMT approach has its beginnings in IBM's candid project in the late 1980s and early 1990s and the methods and principles defined by Brown et al. [13] underpin other SMT approaches. The most popular of these approaches is Phrase-based Statistical Machine Translation (PBSMT) which considers a sequence of words (or phrases) as well as single words as the fundamental units of translation. Just before 2016, the best performing MT systems for language pairs with adequate data were based on the PBSMT approach and some Web-based MT systems were using this approach. In the following paragraphs, we describe the PBSMT approach in the context of Lumasaaba-to-English translation. Consider the following Lumasaaba sentence:

n'unengekhareengekhele shiseenge she khukonamo shitweela.

Figure 1 illustrates Lumasaaba-to-English translation using the PBSMT approach. In the figure, the Lumasaaba sentence is first broken up into phrases which are then translated using a phrase translation model; the phrase translations are then reordered according to a reordering model to generate the final target sentence. The best English translation (e_{best}) given the Lumasaaba input sentence *l* is defined as [14]:

$$e_{best} = \underset{e}{\operatorname{argmax}} p(l|e) \times p_{LM}(e) \tag{1}$$

where $p_{LM}(e)$ is obtained from an English language model. The language model measures the likelihood or fluency of a sequence of words in the English language and is also used to choose the most likely sequence from a set of propositions. Several natural language modeling methods and techniques can be used including n-gram methods, neural network-based methods, dynamic Bayesian networks, and other statistical and probabilistic techniques. Most of these methods and techniques are language independent. The other component of equation 1, $p(l|e)$ is mainly associated with the actual translation, and for PBSMT, it is decomposed further into translation and reordering components as follows [14]:

$$p(l_1|e_1^n) = \prod_{i=1}^{n} \phi(l_i|e_i) \times d(start_i - end_{i-1} - 1) \tag{2}$$

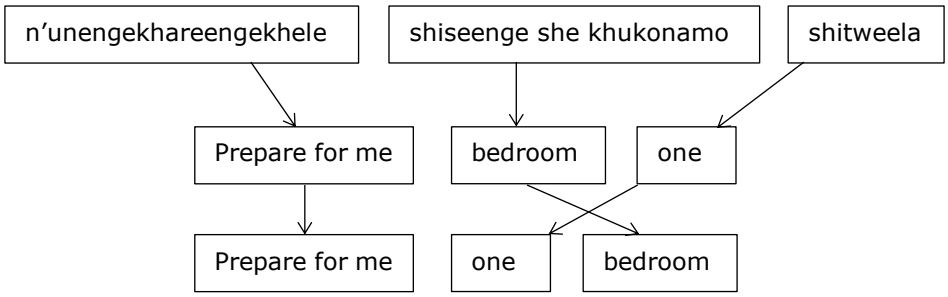

Fig. 1. Illustration of Phrase-based translation of a Lumasaaba sentence to an English sentence.

Equation 2 is representative of the breakup of the Lumasaaba sentence into *n* phrases and the translation of each i^{th} Lumasaaba phrase (l_i) to an English phrase (e_i) according to a phrase translation probability $\phi(l_i|e_i)$ which in terms of the noisy

channel model is modeled as a translation from English-to-Lumasaaba. $\phi(l_i|\mathrm{e}_i)$ is obtained from a phrase translation model which requires a number of steps to achieve [14]: the creation of a word alignment between each sentence pair of the parallel corpus; the extraction of phrase pairs that are consistent with the word alignment; and the estimation of phrase translation probabilities. Since the methods that automate each of these steps are language independent, all that is required is an appropriate parallel corpus between Lumasaaba and English. Equation 2 also involves a reordering component $\mathrm{d}(\mathrm{start}_i - \mathrm{end}_{i-1} - 1)$ which is obtained from a distance re-ordering model [14]. In this model, reordering is considered relative to the previous phrase. start_i denotes the position of the first word of a Lumasaaba input phrase that translates to the *i*th English phrase and end_i is the position of the last word of the Lumasaaba phrase. As a result, the re-ordering distance is the number of words skipped (either forward or backward) when taking Lumasaaba words out of sequence. Although the probability of d can be learned from data, a data-independent exponentially decaying cost function is usually used in the case of phrase-based modeling.

The PBSMT approach has already been evaluated in translating between English and Lumasaaba [15] and for two other under-resourced Ugandan languages; Luganda [16] and Acholi [17] and others (for example in (de Pauw et al., [18]; Pa et al., [19]). The Lumasaaba-to-English translation results in [15] showed the PBSMT approach outperform other state-of-the-art methods using a limited Bible-based parallel corpus in an experimental Lumasaaba-to-English translation task. Although the PBSMT approach is relatively automated, a lot of effort is involved in combining different components to improve translation quality.

3.2.3 Neural Machine Translation

Neural Machine translation is the current state-of-the-art MT approach. Recent automatic evaluations (using the popular BLEU metric), for example from the MT shared tasks since 2016 ([20],[21],[22],[23]) shows that Neural MT significantly outperforms other MT approaches on many language pairs. Initially Artificial Neural Network approaches were hindered by limitations in computational resources. Advances in processing power in terms of Graphical Processing Units (GPUs) and increased computer storage capacity have made the ANN-based methods feasible for several applications including MT. Neural MT is now preferred and is implemented in commercial and publicly accessible Web-based MT systems. Just like other data-driven MT approaches, Neural MT requires sufficient amounts of parallel text to learn effective translation models.

At first, the most popular NMT architecture used a Recurrent Neural Network (RNN) – based encoder decoder model with attention. The basic details of this model are well described by Neubig [24]. For Lumasaaba-to-English translation, a source encoder maps each Lumasaaba word to a word vector and the word vectors can be processed to a sequence of hidden vectors. Then a decoder (for the target language) combines an RNN hidden representation of previously generated English words with the source hidden vectors to predict scores for each possible next English word. A softmax layer can then be used to produce the next English word distribution. Figure 2 illustrates this architecture in translating a Lumasaaba sentence "*renghekha shiseenge*" to an English sentence "*prepare a room*". The mathematical formulation for this process is as follows [24]:

$$m_t^{(l)} = M_{\cdot,l_t}^{(l)} \rightarrow \quad h_t^{(l)} = \begin{cases} RNN^{(l)}\left(m_t^{(l)}, h_{t-1}^{(l)}\right) & t \geq 1 \\ 0 & \text{otherwise} \end{cases} \rightarrow m_t^{(e)} = M_{\cdot,e_{t-1}}^{(e)} \rightarrow$$

$$h_t^{(e)} = \begin{cases} RNN^{(e)}\left(m_t^{(e)}, h_{t-1}^{(e)}\right) & t \geq 1 \\ h_{|L|}^{(l)} & \text{otherwise} \end{cases} \quad \rightarrow \quad p_t^{(e)} = \text{softmax}(W_{h_s} h_t^{(e)} + b_s) \qquad (3)$$

The first step in Equation (3) corresponds to the mapping of Lumasaaba words to word vectors and the second step refers to the calculation of the hidden state $h_t^{(l)}$ for the *i*th Lumasaaba word in the Lumasaaba sentence L. At the end of L, we have $h_{|L|}^{(l)}$ which is used to initialize the target RNN. The first and second step refer to the encoder phase which can be implemented in different ways including: linearly from left to right (which is the case in Equation (3); in reverse from right to left; and bidirectionally, where we use two encoders (one traveling forward and one backward) [24]. The decoder phase starts from the third step where we look up the mapping for the target English word $m_t^{(e)}$ by also using information about the previous target English word e_{t-1}. In the fourth step, the decoder is run to calculate $h_t^{(e)}$. In the fifth step, we calculate the probability $p_t^{(e)}$ using a softmax function. Attention can be incorporated via a context vector c_t which is concatenated with $h_t^{(e)}$ to calculate the softmax distribution over the next target English words.

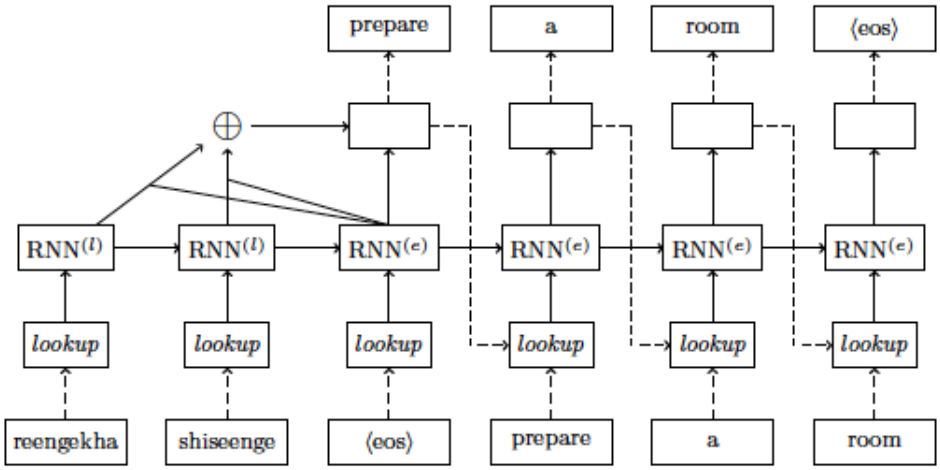

Fig. 2. An illustration of a RNN encoder-decoder architecture for translation from Lumasaaba-to-English.

The words in the Lumasaaba sentence are mapped to a word vector which is passed to a RNN. The final time step (at <eos> on the encoder side) initializes the RNN on the target side. Attention is used over the RNN at the encoder side at each time step and is combined with the current hidden state to produce the prediction of the next English word $p(e_t|e_{1:t-1}, l)$*. The prediction is then fed back into the target RNN. Adapted from [25].*

The RNN-based encoder-decoder model in Figure 2 has now been outperformed by the transformer model [26] in various sequence-to-sequence tasks including machine translation ([22],[23]). The transformer model which still uses an encoder-decoder approach emphasizes more attention instead of the RNN layers. Figure 3. Illustrates a transformer architecture with one encoder and decoder. The original model by Vaswani et al. [26] constitutes six encoders and six decoders. As shown in Figure 3, each layer has a multihead attention component and a simple position wise fully connected feed-forward network. The feed-forward network composes two linear transformations with either a sigmoid or ReLU activation function. The decoder side additionally has another multihead attention component that performs attention over

the output from the encoder side. Embeddings in the transformer architecture are used to convert tokens (words) in the input sentence to vectors. Positional encodings (that are calculated from sine and cosine functions) are added to the input embeddings to incorporate information about relative and absolute positions of the words in an input sentence. The "Add and normalize" layer facilitates the addition of the input to a sublayer and the normalized output from the sublayer for the final output from each sublayer. Lastly the "Linear + softmax" layer facilitates the conversion of the decoder's output to predicted next target language words.

The transformer approach has not yet been evaluated for translation involving Lumasaaba or any other Ugandan indigenous languages. In this paper, we evaluate its performance against the RNN-based encoder decoder models that use Long Short Term Memory (LSTM) and Gated Recurrent Units (GRU) gating mechanisms.

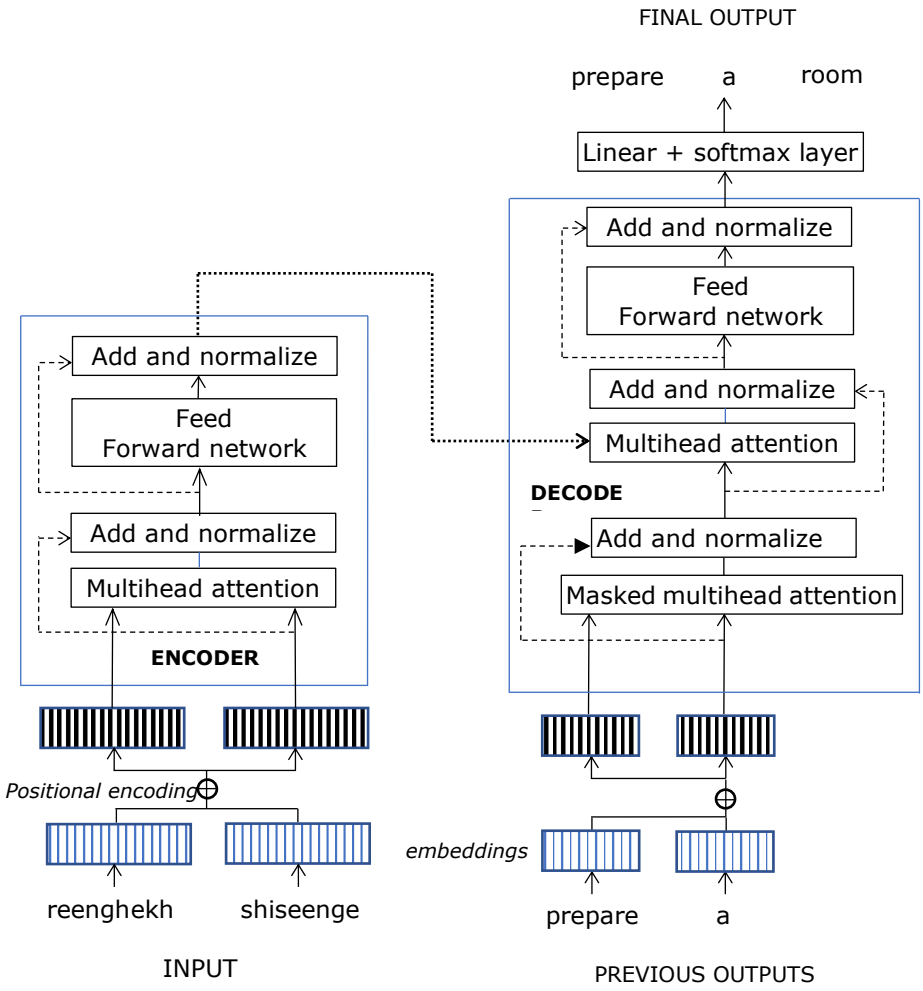

Fig. 3. An illustration of the transformer model with one encoder and decoder.

4. Data and Methodology for evaluating Neural MT methods

4.1. Data

We use an electronically accessible New Testament version of the Lumasaaba Bible to process parallel sentences for evaluating the Neural MT methods described in the previous section. Initially, we mapped verses in the Lumasaaba version of the Bible to those in the English New International Version (NIV) from which we tried to extract parallel sentences using the full stop character (.) as a sentence separator. However, there a number of issues to consider when using Bible versions as a source for parallel sentences including the occurrence of imperfect translations. After running a simple algorithm for extracting parallel sentences from the corresponding verses in the Lumasaaba and English NIV versions of the Bible, manual verification was done on a sample of six hundred sentences. At the start of the verification process, we observed that some pairs were not perfect translations. To deal with the imperfect cases, we sought representations from other versions of the English Bible in the hope of finding better translations. At this stage, we found that the English Good News Bible version contained more satisfactory translations for the Lumasaaba sentences than the other English Bible versions. In the end, we decided to add translations from other Bible versions, and if there was more agreement across the different versions, we decided to modify an imperfect translation to only one suitable translation. The following is an example of one such initial translation pair from the extraction script that we decided to modify:

> Lumasaaba: *baryo be mu lukhabo ni baamala khuriisariisa barume musaambo tsitsindi, babalekhuula baatsya, nga sibabona isaambo ikiindi iye khubawa shitaambiso ta, lwekhuba baarya babandu*
> English mapping from an extraction algorithm: *after further threats, they let them go*

As seen in the example above, the English representation from the extraction algorithm does not contain translations for other parts of the Lumasaaba sentence. In other words, it is an incomplete representation. For such a case, a consultation with other English versions of the Bible resulted in the following as an appropriate English translation for the Lumasaaba sentence:

> Appropriate English translation from other versions: *so when the council had further threatened them, they let them go, as they could not find any other basis on which to punish them, because they feared the people*

On average, it took around five minutes for one person to verify and modify each translation pair or add more translations. In total it took eight days to verify and edit the sample of 600 translations (using approximately seven hours per day).

There were other cases where the differences in representations across a pair were because of other symbols. For example, there were several cases where use of braces on the source side was not the same as on the target side, or where a semi colon (;) was replaced by a comma (,) on the other side. For these cases, searches for symbols other than alphabetical characters were made and the sentences containing those symbols were checked and edited so that they are consistent across the source and target language sides.

In total, 7290 Lumasaaba-English parallel sentences resulted from the data processing described above. The small size of this data set makes it unrealistic for developing a full scale data-driven MT system. However, it is acceptable to use it in an experimental setting to evaluate MT methods. This data set (or corpus) can also be used for creating other important Natural Language Processing resources including [27]: as a source for extracting word and phrase pairs for creating Lumasaaba-English bilingual dictionaries; Named Entity Recognition between Lumasaaba and English; discourse analysis; word alignment; multi-document classification; bilingual

lexical and semantic resources such as ontologies, sentiment analysis, bilingual document classification, typological or comparative language analysis; etc.

4.2. Experimental setup

The 7290 sentence pairs data set described in the previous subsection was used for evaluating the different Neural MT models described in section 3.2.3. The data set was preprocessed further and divided into three sets: a training set of 5448 parallel sentences (~75%); a validation set of 1200 parallel sentences (~16%), and a testing set of 642 parallel sentences (~9%). Further preprocessing involved tokenization (where spaces were inserted between words and other symbols), truecasing (where the sentences where all converted into the most probable casing to reduce on sparsity. Since the number of parallel sentences is small, all sentences were converted to lowercase on both sides. All NMT methods were evaluated on the same training, testing, and validation datasets. Usually, a validation phase involves further tuning of trained models to improve model performance on the validation data set; in this study, the validation dataset was used to only determine the performance of the trained models without tuning the trained models for improvement in performance.

The freely available OpenNMT-Py implementation [25] of the NMT methods was used for specifying the different architectures, and for using the trained models to generate translations. The first set of models was based on a default configuration of a unidirectional RNN encoder decoder architecture that uses two layers of 500 units each on the encoder and decoder with LSTMs as the gating mechanism. The second set of models was still based on a unidirectional RNN encoder decoder architecture but with a change in the gating mechanism from LSTMs to GRUs. In the third set of models, we used a bi-directional RNN encoder decoder architecture with LSTM units. The configurations described so far had been tested in [15] but for only models that had been generated after thirteen epochs. In this paper, we evaluate models generated from as far as 15000 training steps which is 1000 times further. Table 1 shows the standard settings for the RNN-based architecture (Figure 2). The final set of models are based on the transformer architecture (Figure 3) where we varied the number of encoder layers from one to six and the number of heads for multi-head attention between 8 and 16. Table 2 shows the standard settings for the transformer-based architecture.

All models were trained using freely accessible Google Colab GPUs. We used the adam optimization technique with residual drop out and label smoothing for all models except the default configuration from OpenNMT-Py's Quick Start demonstration which uses stochastic gradient descent (SGD). Vaswani et al. [26] observed that label smoothing makes the models more unsure as the training proceeds but at the same time improve accuracy and BLEU scores. This is indeed the case in the experiments that were conducted in this study.

Table 1. Hyper parameter settings for the RNN-based encoder decoder architectures

Parameter	Value
Word embedding size	512
Encoder type	RNN/Bidirectional RNN
Decoder type	RNN
RNN type	LSTM/GRU
Number of layers	2/4
Decoder attention	Global
Batch size	4096
Optimization techniques	adam/SGD
Learning rate	2
Learning rate decay method	noam
Dropout	0.1

Label smoothing	0.1
Maximum number of training steps (epochs)	15000

Table 2. Hyperparameter settings for the Transformer architecture

Parameter	Value
Encoder type	transformer
Decoder type	transformer
Number of encoder/decoder units	2/3/4/6
Positional encoding (using sine function)	TRUE
Adam beta 2	0.998
Number of heads for multihead attention	8/16
Size of hidden feed forward network	2042

The settings for word embedding size, optimization technique, learning rate, learning rate decay method, drop out, label smoothing, and maximum number of training steps are as indicated in Table 1.

For decoding or translation, a beam search algorithm was used without any changes to the default settings. We considered only the best translation estimated by the algorithm per input sentence.

5. Lumasaaba-to-English Neural Machine Translation Results

5.1. Training results

Figure 4 shows the progression of accuracy on training data taken at each 1000 training steps until 15000 steps. The training process for most of the models proceeds gradually with the RNN_LSTM_2L_SGD model having a smoother progression and the RNN_GRU_4L_adam model having the most relatively rougher progression. Also, the RNN_LSTM_2L_SGD model seems to peak at a considerably lower accuracy than the other models that use the adam optimization method. The transformer-based models all reach high accuracies faster than the RNN-based methods. The same can be said of Perplexity (Figure 5) where the transformer-based models have lower perplexity values than the RNN-based models in the early stages of the training process. The RNN_LSTM_2L_SGD in this case has the highest perplexity values at the start. Generally, the transformer-based models have lower perplexity values than the RNN-based methods. All models seem to converge to the same lowest perplexity value at higher training steps (10000 to 15000).

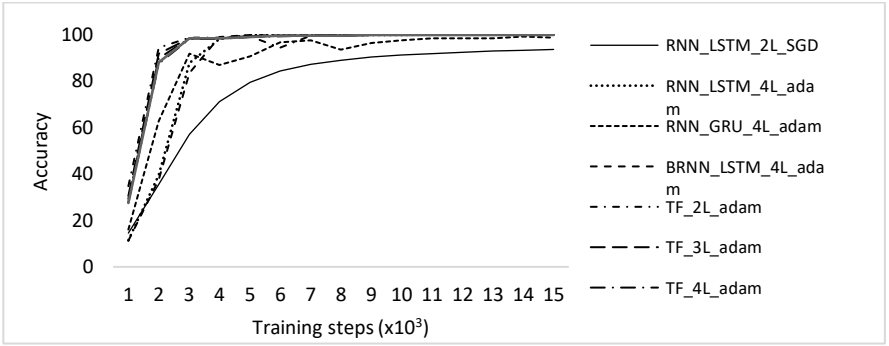

Figure 4. Progression of accuracy on training data after N training steps.
RNN_LSTM_2L_SGD refers to the default model that uses two layers of 500 units each with LSTM units and SGD for optimization. RNN_LSTM_4L_adam uses four layers of 512 units each with LSTM units and adam optimization method. RNN_GRU_4L_adam uses four layers of 512 units each with GRU units and adam optimization method. BRNN_LSTM_4L_adam uses a four layer

bidirectional RNN on the encoder each with 500 units, LSTM units and adam optimization. TF_2L_adam refers to the transformer model with two encoders, two decoders, eight heads and uses adam optimization. The next transformer models TF_3L_adam to TF_6L_adam have more encoders and decoders (so that we have three encoders and three decoders for TF_3L_adam and so on). The last model TF_6L_16H_adam has 16 heads with six encoders and six decoders and uses adam optimization.

5.2. Validation set results

Table 3 shows the perplexity and accuracy measures of the trained models on the validation data set after every 5000 steps of the training process. The transformer models generally have lower perplexities than the RNN-based models. As has already been mentioned, the perplexities of the models on the validation data set are bound to increase for better accuracies. Apart from the RNN_LSTM_2L_SGD model, we see just slight improvements in the validation accuracies which is in line with the observations of the accuracies in Figure 4 where most models have almost peaked by the 5000th training step. Although the RNN_LSTM_2L_SGD model has the lowest accuracies on the training data set, it achieves the highest accuracy on the validation data set.

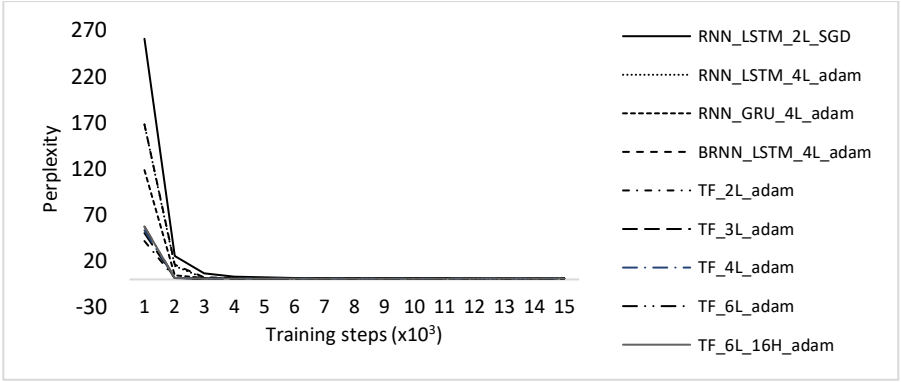

Fig. 5. Progression of perplexity on training data after N training steps.
The description for the models in this Figure (RNN_LSTM_2L_SGD, RNN_LSTM_4L_adam, RNN_GRU_4L_adam, BRNN_LSTM_4L_adam, TF_2L_adam, TF_3L_adam, TF_4L_adam, TF_6L_adam, TF_6L_16H_adam) is the same as in figure 4.

Table 3. Validation (Perplexity/Accuracy) results from the validation data set

Models	Perplexity/Accuracy on validation set after n training steps		
	5000	10000	15000
RNN_LSTM_2L_SGD	137.88/36.76	263.46/38.24	379.19/**38.58**
RNN_LSTM_2L_adam	387.26/26.01	425.39/27.54	466.75/27.61
BRNN_LSTM_4L_adam	345.22/27.27	354.56/28.75	382.39/28.70
RNN_GRU_4L_adam	230.14/29.90	256.56/30.73	234.61/31.07
TF_2L_adam	166.91/36.65	196.78/37.10	230.76/35.86
TF_3L_adam		201.60/36.48	218.34/36.98
TF_4L_adam	189.70/34.54	198.56/35.73	217.03/35.91
TF_6L_adam	183.29/35.03	222.57/35.21	232.73/35.54
TF_6L_16H_adam	188.89/34.37	224.82/34.74	258.33/34.87

The notations for the models are as specified in the description of Figure 4. Perplexity and Accuracy measures were computed after every 5000 steps of the training process. The blank cell in the Table simply means that no perplexity/accuracy was displayed for that model and hence nothing to capture at that time.

5.3. Test set results

The BLEU metric [28] which considers n-gram matches between automatically generated translations and reference translations was used for evaluating the NMT models. The BLEU metric is defined as:

$$\text{BLEU} = \text{brevity-penalty} \times \exp\left(\sum_{i=1}^{r} \lambda_i \times \log(\text{precision}_i)\right)$$

where brevity-penalty = $\begin{cases} 1 & \text{if } c > r \\ \exp\left(1 - \frac{r}{c}\right) & \text{if } c \leq r \end{cases}$

precision_i refers to the ratio of correct n-grams of a certain order n in relation to the total number of n-grams. λ_i is a weight of a specific precision, c is the length (or number of words) of an automatically generated translation, and r is the length of the reference translation. In our evaluation, λ_i is 1 for all precisions while the maximum order of n-grams to be matched is 4.

Table 4 shows the BLEU score evaluation results for the different NMT models. We again see that there are minimal variations in BLEU scores for each model after 5000 training steps. The transformer models lead to significantly higher BLEU scores than the RNN-based models that were trained using the same optimization method (adam). The highest score of 13.53 points is from a relatively simpler transformer model that uses only two encoders and two decoders. The results show that there are no performance gains from using more layers of encoders and decoders beyond the simple architecture of two encoders and decoders. The TF_6L_16H_adam model which uses more heads for attention has the lowest BLEU score among the transformer-based models; this seems to suggest that there are no MT performance gains from using more heads for attention beyond the eight heads used in the other transformer-based models. The RNN_LSTM_2L_SGD leads to comparable BLEU scores as the other transformer-based models. However, the results suggest that the transformer-based models guarantee stably better MT BLEU scores than the RNN-based models. We then evaluated the RNN_LSTM_2L_SGD and TF_2L_adam models at much higher training steps up to 100000 steps. The TF_2L_adam model posted better BLEU scores than the RNN_LSTM_2L_SGD model at lower training steps up to the 35000th training step; afterwards, the RNN_LSTM_2L_SGD model continued to improve and perform better than TF_2L_adam model at much higher training steps albeit with the highest BLEU score of 14.08 at the 80000th training step.

Table 4. Lumasaaba-to-English NMT BLEU scores using the test data set

Models	**BLEU score on test set after *n* training steps**		
	5000	10000	15000
RNN_LSTM_2L_SGD	10.30	11.75	12.74
RNN_LSTM_4L_adam	6.20	6.45	6.69
BRNN_LTSM_4L_adam	6.78	7.53	7.35
RNN_GRU_4L_adam	8.41	8.75	9.03
TF_2L_adam	**13.53**	**13.36**	**13.16**
TF_3L_adam	11.94	11.98	12.12
TF_4L_adam	11.19	11.70	11.56
TF_6L_adam	11.56	11.75	11.58
TF_6L_16H_adam	10.60	10.59	10.44

The notations for the models are as specified in the description of Fig. 4.

6. Conclusion and future work

This paper set out to evaluate MT methods for automatic translation involving Lumasaaba, a heavily under-resourced East African language. Rule-based and data-

driven MT methods were reviewed and opportunities and requirements for using the methods for automatic translation with Lumasaaba were identified. Neural Machine Translation (which is a state of the art machine translation method) was then used to learn two sets of models (Recurrent Neural Network based models and Transformer based models) using a small set of parallel sentences from the Bible. Automatic evaluation of the NMT models on an experimental Lumasaaba-to-English translation task show that the transformer encoder decoder architecture leads to NMT models that guarantee stably better BLEU scores than the other NMT models at lower numbers of training steps. The work presented in this paper is the first attempt at applying currently powerful MT methods to automate translation involving Lumasaaba. The main limitation of this work is the scarcity of linguistic resources and the considerably small size of available parallel corpora for Lumasaaba which are all needed for improving MT quality. The other limitation is associated with the lack of access to more powerful GPUs for experimentation with more complicated architectures that may incorporate more helpful features. There are a number of possibilities for improving NMT that we did not explore in this paper. In future, we shall first of all continue to develop and increase the parallel sentence data set to a size that can guarantee the generation of desirable translations from data-driven MT methods. We shall also investigate the use of post-processing techniques such as the use of language models and the use of feedback for improving the quality of the automatically generated translations.

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Neural Network Model for Assessing the Physical and Mechanical Properties of a Metal Material Based on Deep Learning

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Abstract. The paper investigates the algorithmic stability of learning a deep neural network in problems of recognition of the materials microstructure. It is shown that at 8% of quantitative deviation in the basic test set the algorithm trained network loses stability. This means that with such a quantitative or qualitative deviation in the training or test sets, the results obtained with such trained network can hardly be trusted.
Although the results of this study are applicable to the particular case, i.e. problems of recognition of the microstructure using ResNet-152, the authors propose a cheaper method for studying stability based on the analysis of the test, rather than the training set.

Keywords: Deep neural networks, material microstructure, image recognition, deep learning, algorithmic stability.

1. Introduction

A well-known problem is the creation of the training and testing sets in machine learning problems, which also include deep learning tasks in order to predict the physic mechanical properties of functional materials [1, 2]. Many researchers in the field of applied calculations use the rule of dividing the entire available set into a learning and testing ratio of 80/20 or 70/30. Usually the reasons of such a division is not given. As for the recommendations on the size of the training set, they are completely absent, except for the statements that the power of the set must be 3-10 times the number of parameters of the neural network. Such a wide range of opinions says only that this task, for all its relevance, is poorly investigated.

In addition, there is the problem of assessing the quality of the training set. There is no clear answer to the question: how erroneously annotated images can affect the learning outcome? For example, quite often the work of the classifying neural network is compared with the human work process. Is such an assessment fair? After all, the training set contains annotated data that was prepared by people and which, in turn, contain the same errors. How can these errors distort the result?

It is known that the fundamental theory of uniform convergence of V.N. Vapnik - A.Y. Chervonenkis [3] treats the fatal errors of the learning algorithm as a fail of algorithmic stability. Stable learning algorithms are understood as those that form only those hypotheses, the result of which changes only slightly with a small change in the training set [4, 5]. Within this theory, sets of such algorithms have been found, for example, regression, support vector machine, etc.

Learning deep neural networks can hardly be analyzed within the theory of uniform convergence, but numerical research on the stability of specific networks can be quite accessible. For example, in [6], the influence of the size of the training and

testing sets on the accuracy and generalizing ability of the three-layer MLP neural network in the binary classification problem was studied. In [7], the accuracy and scatter of the GoogLeNet network in the problem of the classification of body parts by computed tomography images is investigated. The size of the training set is selected on the basis of the analysis of the accuracy of the training results. The disadvantages of this work include the fact that the dependence of the accuracy of training on the size of the training sample was calculated on the basis of 6 computational experiments (for each of the classes), and the testing set itself was obtained as a result of the separation of the training set in 75/25 proportion. However, if there is no sustainability of training, then these results can hardly be trusted.

2. Literature Review

There are successes in the recognition and spatial localization of objects by machine learning methods based on convolutional networks, first proposed by Jan LeCun [8]. With millions of pre-classified images collected in bulky databases of annotated images, such as ImageNet or COCO, and the back propagation method the results were really impressive [9,10,11].

Modern methods are also used in metallurgy. The problems of classification of microstructures are solved mainly. For example, in [12] the problem of classification of high-carbon steels by their microstructure using the VGG-16 network is studied. For training, testing and validation the base of sections' images of the CMU-UHCS (Carnegie Mellon University Ultrahigh Carbon Steel) taken by an electron microscope (the base contains 961 marked images divided into 7 categories) is used. In [13] an attempt to classify low-carbon steels is made. The training set of Material Engineering Center Saarland (MECS) was used. In [14] recognition of dendritic microstructures on the digital images of the microsections is performed. The training set was formed on the basis of micro images of the DoITPoMS project (Dissemination of it for the promotion of Materials Science) of the University of Cambridge.

Convolutional networks are successfully used in similar problems in the sense of determining surface defects. In the work [15] with the help of MPCNN (CNN with max-polling of subsampling layers) the problem of classification of surface defects of steel pipes is set and solved. Later, the authors [16] solved a similar problem of classification of surface defects of steel sheets. In [17,18] the method of detection of defects on the surface of rails is investigated.

The purpose of the work consists in the construction and training of a convolutional neural network able to predict the physicomechanical properties of the material at the images of the microstructure. Within the framework of the developed approach the problem of constructing a generative-adversarial network (GAN) [19,20] able to represent the structure of the material with predetermined physicomechanical characteristics is posed. In [21] is shown that with the help of trained on textures convolutional network it is possible to calculate quite accurate characteristic of texture recorded in the form of Gram's matrix. Components of the matrix are obtained from the cores of convolutions belonging to different levels of the network. In the work a well-known pre-trained VGG-19 is used. The author argues that his approach is much more accurate and flexible than the description of the texture by a two-point correlation function. By applying noise and other transformations, it is able to generate textures similar to the original using a convolutional network. The author [22] used this technique to analyze and generate the microstructure of metals and alloys (Fig.1). Noise, scaling and rotation were used during generation. There is a paper more focused on sustainability research only [23]. This paper should provide more details on experimental part of research.

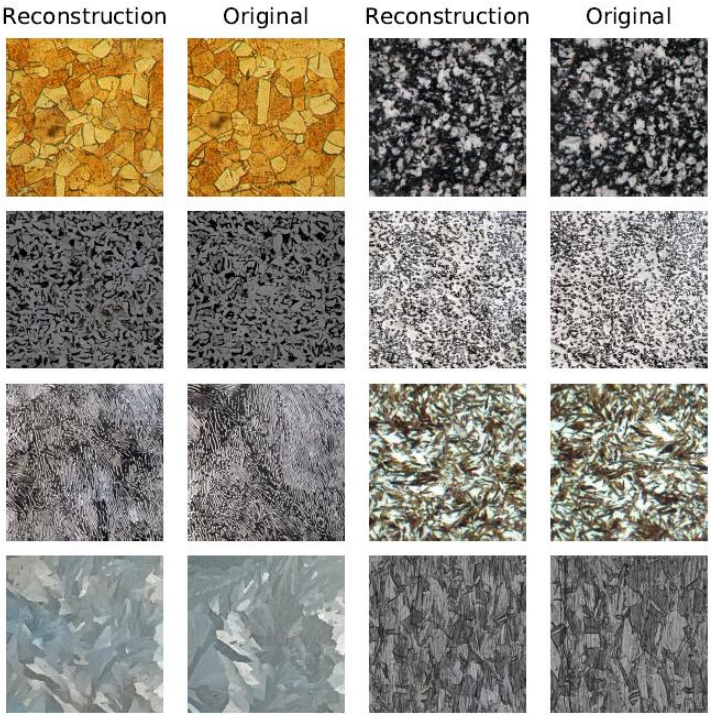


Fig. 1. The original structures and their reconstruction analogues [15].

The network constructed and trained in the work will be the basis for the construction of generative and discriminant parts of GAN.

3. Data and Methodology

To solve the problem the VGG-16 architecture was chosen as the most proven convolutional neural network in this area. A pre-trained version of the network with an input image of size 256x256 was selected. The process of preparation the training set and the learning process of the network are described below.

Training dataset

The primary data for the training set was prepared by the staff of the Institute of Nanosteels of Magnitogorsk State Technical University in the frame of international project Horizon 2020. The data was represented by 758 digital annotated images of metal alloy sections based on iron of different chemical composition and grain-phase structure. The images were made using an electron microscope with different powers from x1000 to x20000. Examples of images are shown in Fig.2. The images were annotated with physicomechanical characteristics measured during the tests.

The samples were tested for hardness and strength to determine the physicomechanical properties and the following characteristics were established: microhardness, conditional yield strength, time resistance, elongation, relative contraction. Tests were carried out at room temperature. The manufacture of the sections was performed before the test for the unloaded sample.

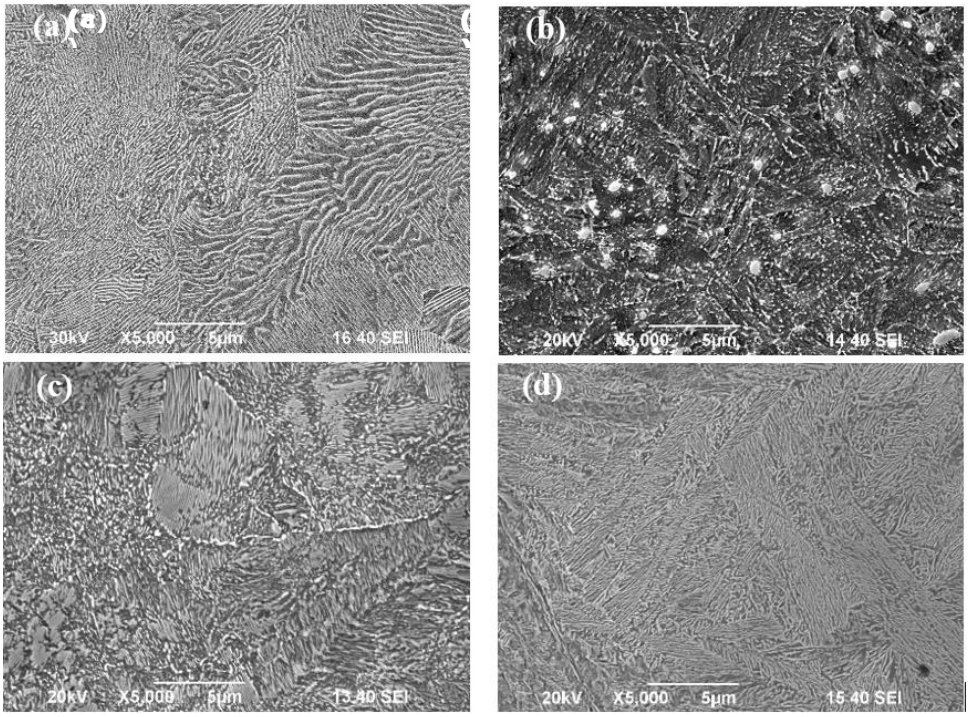


Fig. 2. Images of microsections from the training sample: (a) ferritic-carbide mixture, (b) secondary troostite-sorbite+chromium carbides, (c) lamellar pearlite +granular pearlite, (d) lower bainite.

During the process of preparing the training set of available images with the help of various transformations, learn and verification sets of 8200 and 2000 images were formed, respectively. This was done in order to increase the learning set and the accuracy of recognition. The learning set was divided into classes on microhardness. Classes of microhardness and distribution of the learning set on them are presented in Table.1.

Table 1. Distribution of the training set by microhardness classes

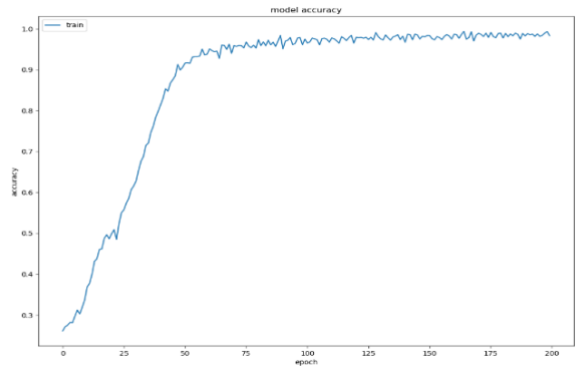
Microhardness classes	Number of images in the learning set	Number of images in the verification set
I class, (0-2600 MPa)	940	240
II class, (2600-2900 MPa)	1420	260
III class, (2900-3200 MPa)	2620	640
IV class, (3200-3500 MPa)	1480	360

Learning process

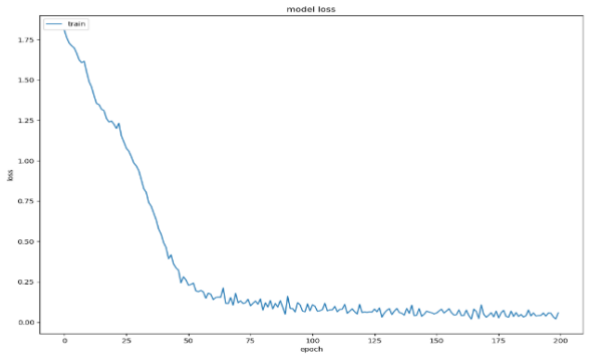
The Keras framework in conjunction with the TensorFlow machine learning library was chosen as a software platform for the implementation of the network.

The learning was conducted on a hardware platform with the following characteristics: VGG16 pretrained network with imagenet weights on 200 epochs. One computational experiment took 9 hours. Network learning lasted no more than 525 iterations. The calculation of accuracy was performed every epoch and is equal to the

percentage of correctly recognized images from the testing set formed from the learning set using random selection. Fig.3 shows a graph of the accuracy changes in the learning process. At the end of learning, the network recognition accuracy reached 62.5%. Figure 3, b shows the dependence of the change of the error function on the epoch number.



(a)



(b)

Fig. 3. Learning process: a) accuracy changes, 6) changes of the error function.

From Fig. 3 it can be seen that the learning process is typical for this kind of problems and does not have any features.

Improvement

Second part of experimental calculations is done with training dataset divided to 14 classes in terms of microhardness and tensile strength. The new class ranges and counts are shown in Table 2.

Table 2. Training dataset class distribution

Class #	Microhardness range, MPa	Tensile strength range, MPa	Image count
0	2100-2444	660-830	66
1	2100-2444	831-1001	36
2	2445-2789	831-1001	160
3	2445-2789	1002-1171	47
4	2445-2789	1172-1342	32
5	2790-3134	831-1001	158
6	2790-3134	1002-1171	166

7	2790-3134	1172-1342	30
8	3135-3479	1002-1171	55
9	3135-3479	1172-1342	188
10	3480-3824	1002-1171	28
11	3480-3824	1172-1342	89
12	3825-4169	1343-1513	19
13	4170-4514	1343-1513	22

This data set was used for training VGG-16[1], VGG-16[2] and ResNet-152. Learning process shown on Figure 4. It can be noticed that non pretrained VGG-16[2] acting unstable while training. Several times calculation experiment was restarted due to significant accuracy drops. Sometimes training process lead to memory crashes.

The process of studying stability was to find such a neighborhood of a stable solution, in which there is a violation of the uniform nature of convergence to the mean. A stable solution was understood as the trained deep network ResNet-152. The network was trained to solve the problem of classifying microstructure images by the hardness of a metal iron-based alloy. Annotated images of the microstructure of the alloys were used as a training set, examples of which are shown in Fig.1. In this case, the microstructure shown in Fig. 4 on the left corresponds to an alloy with a microhardness of 1900 MPa, and on the right – 7000 MPa.

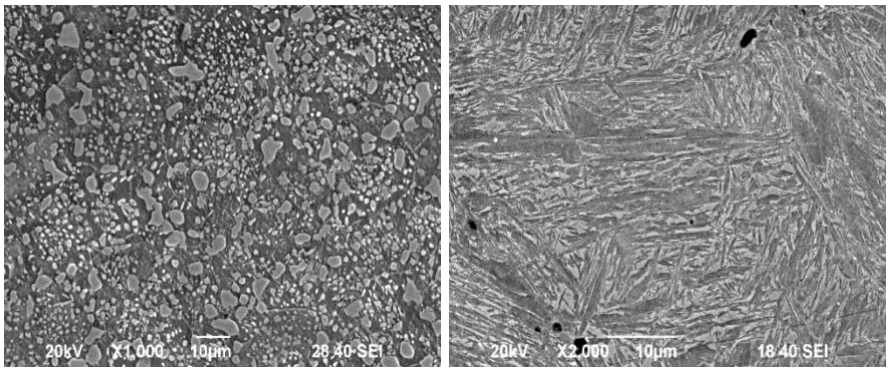


Fig. 4. Examples of images of microsection of material included in the training set

In the process of training the network, at the 200th epoch, an accuracy of 83.9% was achieved according to Top-3, after which the weights of the network were frozen. Accuracy assessment was made on a set consisting of 1097 elements not presented to the network during its training. The process of convergence in accuracy calculated on the training set is depicted in Figure 2.

ResNet-152 network shows a high rate of convergence. For almost a few epochs, an accuracy of 80% on Top-3 was achieved (Figure 5). The learning process is stable.

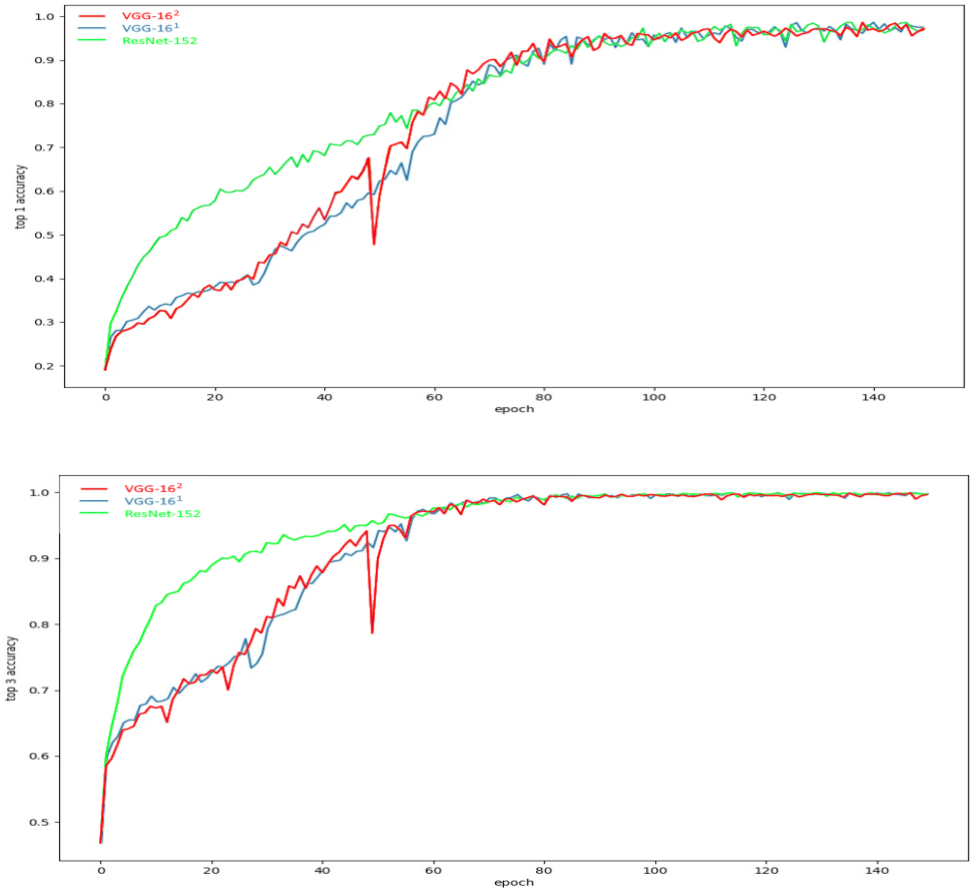


Fig. 5. Accuracy on the training set on the evaluation of Top-1 and Top-3

Table 3 shows the learning outcomes performed by different estimates on the training and validation sets.

Table 3. Network Learning Outcomes

Network	Training accuracy		Validation accuracy	
	Top-1	Top-3	Top-1	Top-3
VGG-16[1]	0.9751	0.9975	0.4704	0.8117
VGG-16[2]	0.9712	0.9970	0.5203	0.8142
ResNet-152	0.9593	0.9978	0.6243	**0.8933**

A definite surprise was that, despite the instability of learning, the unexperienced VGG-162 network showed a much better Top-1 result compared to the pre-trained version of the same network. This can be explained by the fact that the first layers of the convolutional untreated network were able to better adapt to specific images of microstructure. The pre-trained network has previously been trained on a very large and diverse set of photos. This improved the universal properties of the VGG-161 network (in particular, its first layers), but worsened the degree of recognition of structures of a special type.

As expected, the ResNet-152 network showed the best result of 83.9% in the Top-3 rating. The shown accuracy allows the use of a trained network as the core of an intelligent system for the integrated assessment of the strength properties of functional and structural materials. For the above computational experiments, the training set was divided into 14 classes of metals and alloys microstructures. Each of the 14 classes corresponds to the range of values of microhardness and tensile strength. Thus, the classification problem within the framework of these parameters was solved [21, 22], but the accuracy indicated in Table 1 can be improved by changing the training set.

A significant improvement in ResNet-152 results was achieved while improving the quality of the training set. Samples of images with magnification of x40 were excluded from it. Firstly, their number was small, and secondly, images with such multiplicity were not present in all categories. It was suggested that these images impair learning outcomes. Table 4 presents the recognition accuracy by material class.

Table 4. Recognition Accuracy by Material Class

Class number	**Validation accuracy**	
	Top-1	Top-3
0	0.718	1.000
1	0.812	1.000
2	0.593	0.843
3	0.562	0.812
4	0.375	0.937
5	0.937	1.000
6	0.687	0.937
7	0.500	0.933
8	0.562	0.875
9	0.906	0.906
10	**0.937**	**1.000**
11	**0.375**	**0.843**
12	0.894	1.000
13	0.590	1.000

The best accuracy according to both estimates was achieved in class 10. The worst accuracy was estimated at Top-1 in classes 11 and 4. At the same time, according to Top-3, acceptable accuracy was reached at the same classes, which was 84.3%.

Sustainability research

Determining the accuracy of the network on the test set showed that the density of the error distribution can be approximated by the lognormal distribution (Fig.6), which once again confirms the correctness of the network. The optimization criterion in the learning process was cross-entropy, which is known to be proportional to the logarithm of the network error probability distribution.

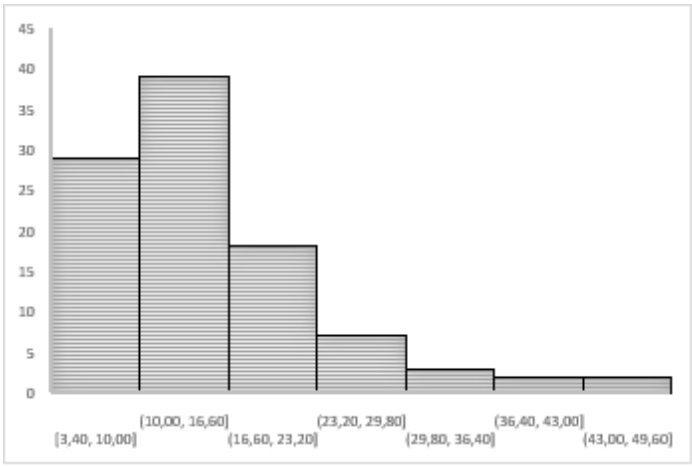


Fig. 6. The histogram of the distribution of accuracy in the test set

To study the stability of a trained network, the test set was subjected to variations. The neighborhood of a stable solution was formed by excluding a certain number of elements from the test set. Elements were randomly selected on 100 implementations. Such a neighborhood is called Leave-one-out (LOO) [4]. Usually its depth is 1 element. In this work, several neighborhoods were built: with a 2, 4, 6, 8, 10 and 12 percent deviation from the base number of elements in the test set, which was used to assess the accuracy of a stable solution. After running and determining the accuracy for all implementations in the neighborhood, the resulting accuracy was obtained by averaging. The results of the computational experiment are shown in Figure 7.

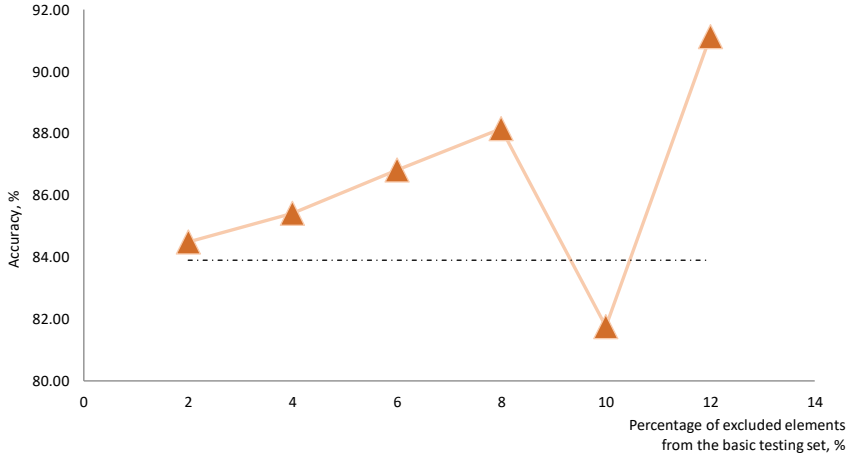


Fig. 7. Dependence of the accuracy of the trained neural network in the LOO neighborhood of the basic testing set

4. Results

From Figure 7 it follows that the process of validation the trained network evenly converges to the accuracy obtained on the base sample (indicated by the dotted line). When the number of elements in the test set decreases by more than 8%, there is a sharp oscillation of the accuracy estimate, which, in our opinion, is the loss of the algorithmic stability of the neural network in the classification problem

under consideration, which it solves.

This statement may be applied to the learning process, since the test set is an independent random homogeneous sample. If the algorithm lost stability on the test sample during the control test of the accuracy of the network, then the network learning process will lose stability when the number of elements in the training sample decreases by more than 8%. Deviations of 8% cannot be considered random, since the accuracy obtained by averaging over 100 computational experiments for each percent distribution where on each iteration random elements were removed from full elements set in according to that percent count.

It should be noted that the search for the loss of stability of the learning process in deep networks by the direct method is a difficult task. If the network learning process on a training set with a size of decades of thousands of elements can take several days, then the study of learning sustainability is difficult from a practical point of view. The authors of this paper propose a simplified approach — investigate uniform convergence on a test set, and then extend the findings to the entire training set.

The result obtained in this paper may impose not only quantitative but also qualitative limitations on the training set. The resulting limit may indicate that in the training set there cannot be more than 8% of erroneously annotated images. Otherwise, the learning process will lose its stability and the learning outcomes cannot be trusted.

5. Conclusion

The paper studies the problem of uniform convergence of the learning process and the accuracy assessment of the deep ResNet-152 network in the problem of analysis of microsections of iron-based alloys. It is shown that with 8% quantitative deviation in the base set, the algorithm of the trained network loses stability. This means that with so many elements in the test set an adequate assessment of the accuracy of the network is impossible.

The methodology for assessing the stability of the deep network, applied in this work, can be extended to other networks and tasks. It does not require volumetric computations, since it allows one to estimate the sufficiency of the number of elements in the training set without performing network training on training sets having various capacities.

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Multifactorial model of adverse events and medical safety management

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Abstract. The article describes a multifactorial model of adverse events related to the provision of medical care. It is shown that their origin is caused by the transformation of systemic causes (latent failures) acting at the level of medical organization, external microenvironment and macro-factors. Four types of global latent failures are described at the level of a medical organization related to: medical technology, work of medical personnel, work environment, and patient behavior. At the external microenvironment level, major latent threats are concentrated at the level of partners, suppliers and outsourcers. Among macro-factors influencing medical care safety especially important are the legal factors defining the status of medical errors and their consequences; economic model of state health care; financial provision of state guarantees and rationing of these volumes in regions and municipalities; availability of state medical care safety management programs; state regulation of medical activity; system of pre- and post-graduate medical education; system of labor regulation and remuneration of medical workers; society's attitude towards medical errors and its participation in the process of medical care safety management. The authors present an algorithm for implementation of a safety management system in a medical organization, including the construction of a new safety culture, an accounting system for recording of threats and incidents, a model for managing medical care safety built into the operational system of the organization.

Keywords: medical care safety, adverse events, incident, medical care safety management system.

1. Introduction

Safety, along with the effectiveness, efficacy and accessibility is an important attribute of the medical care quality. The term safety is directly linked to the risk of harm in medical care provision or development of an adverse event. We defined adverse events as unintentional physical or psychological trauma resulting in temporary or permanent disability, death, extended hospital stays which is most likely

related to medical care rather than the course of the main disease or concomitant diseases [1].

2. Data and Methodology

The work presents a clinical review and its own analytical study. Information was searched independently by three researchers over the period 1990-2019 using medical databases MEDLINE, Cochrane Collaboration, EMBASE, SCOPUS, ISI Web of Science. Prospective and retrospective observation studies of high methodological quality were used for the analysis.

3. Literature review

In Table 1, data on incidence of adverse events in inpatient care in high-income countries over the past 30 years is shown.

Table 1. Incidence of adverse events in inpatient care

Author, year of publication	Country	Number of hospitals	Number of observations	Incidence % (95%CI)
Retrospective studies				
Brennan T. et al., 1991[2]	USA (Harvard)	51	30 195	3,7 (3,5-3,9)
Wilson R. et al., 1995 [3]	Australia	28	14 210	16,6 (15,9-17,2)
Thomas E. et al., 2000 [4]	USA (Utah, Colorado)	28	14 565	5,4 (5,0-5,8)
Vincent C. et al., 2001 [5]	United Kingdom	2	1 014	10,8 (8,9-12,8)
Schioler T. et al., 2001 [6]	Denmark	17	1 097	10,4 (8,6-12,2)
Davis P. et al., 2002 [7]	New Zealand	13	6 579	12,9 (12,1-13,7)
Baker G. et al., 2004 [8]	Canada	20	3 745	6,8 (6,0-7,6)
Michel Ph., 2007 [9]	France	71	8 754	6,6 (6,1-7,1)
Zegers M. et al., 2009 [1]	Netherlands	21	7 926	8,4 (7,8-9,0)
Aranaz-Andres J. et al.,2009 [10]	Spain	24	5 624	9,3 (8,6-10,1)
Shoop M. et al., 2009 [11]	Sweden	28	1 967	12,3(10,8-13,8)
Landrigan C. et al., 2010 [12]	USA (North Carolina)	10	2 341	18,1 (16,5-19,6)
Aranaz-Andres J. et al., 2011 [13]	Argentina,Mexico, Colombia, Peru, Costa Rica	58	11 379	10,5 (9,9-11,0)
D'Amour D. et al., 2014 [14]	Canada	11	2 699	15,3 (13,9-16,7)
Somaella L. et al., 2014 [15]	Italy	1	1 380	3,3 (2,5-4,4)
Deilkas E. et al., 2015 [16]	Norway	20	40 581	14,6 (14,3-15,0)
Nilson L. et al., 2016 [17]	Sweden	7	3 301	15,4 (14,1-16,6)
Halfon P. et al., 2017 [18]	Switzerland	1	1 007	12,6 (10,6-14,8)
Rafter N. et al., 2017 [19]	Ireland	8	1 574	12,2 (10,6-13,9)
Prospective studies				
Andrews L. et al., 1997 [20]	Spain	3	1 047	17,7 (15,4-20,0)
Wanzel K. et al., 2000 [21]	Canada	1	192	39,1 (32,2-46,0)
Rebasa P. et al., 2011 [22]	Spain	1	13 950	37,8 (37,0-38,7)
Forster A. et al., 2019 [23]	Canada	5	1 159	22,2 (19,8-24,7)
Atkinson M. et al., 2019 [24]	USA (California)	1	1 423	4,1 (3,1-5,2)
Meta-analysis	-	430	177 709	12,7 (12,6-12,9)

More than 15% of adverse events are severe or fatal (Table 2).

Table 2. Severity of harm in case of an adverse event

Source	Number of adverse events	Severity of harm			
		Severe harm and disability		Death	
		Number	Percentage % (95% CI*)	Number	Percentage % (95% CI)
Wilson R.et al., 1995 [3]	2 324	315	13,7 (12,3-15,1)	112	4,9 (4,0-5,8)
Thomas E. et al., 2000[4]	787	130	16,6 (13,9-19,1)	52	6,6 (4,9-8,3)
Wanzel K.et al., 2000 [21]	144	10	6,9 (2,8-11,1)	2	1,4 (0,5-3,3)
Vincent C.et al, 2001[5]	110	7	6,4 (1,8-10,9)	9	8,2 (3,1-13,3)
Davis P. et al., 2003 [7]	850	87	10,2 (8,2-12,3)	38	4,5 (3,1-5,9)
Baker G. et al., 2004 [8]	289	15	5,2 (2,9-8,4)	46	15,9 (11,7-20,1)
Andrews J. et al., 2006 [22]	655	90	13,7 (11,1-16,4)	15	2,3 (1,1-3,4)
Zegers M. et al., 2009 [1]	663	33	5,0 (3,3-6,6)	52	7,8 (5,8-9,9)
Landrigan C. et al., 2010[25]	588	67	11,4 (8,8-14,0)	14	2,4 (1,1-3,6)
Meta-analysis	6 388	754	11,8 (11,0-12,6)	340	5, 3 (4,8-5,9)

The scientists at the Johns Hopkins Clinic [26] showed that adverse events related to medical care provision account for every tenth death in population, ranking at third place for causes of mortality amongst the causes of death in the U.S. population, after cardiovascular disease and neoplasms.

Additional direct and indirect costs associated with the diagnosis and treatment of one patient with an adverse event are on average USD 13,019 [27,28]. Thus, adverse events in medicine are not casuistic and represent one of the main problems in health care systems today. When comparing the probability of death in air travel (1 death per 5 million passengers transported) and the probability of death from medical complications (1 death per 140 hospitalized), it is easy to see that civil aviation safety is more than 30,000 times greater than that of health care. All of the above confirms the fact that modern health care should be classified as an unsafe area of services, and the management of health care safety should be integrated into the management systems of the entire medical industry, as well as into the management systems of each medical organization [29].

Understanding of the medical care safety concept and how the global causes of adverse events develop should form the basis for building health care safety management systems. From our point of view, most definitions of health care safety are not specific and sometimes even based on the assumption that it is possible to completely exclude the possibility of adverse events. In our opinion, this is wrong, because even in the best clinics in the world, including those with sufficiently effective safety management systems, adverse events continue to occur, even in the form of the most incredible accidents. In 2015 scientists from Mayo Clinic [30] showed that of the 1.5 million operations and interventions performed between 2009 and 2014, there were 69 incidents that were attributed to unlikely events (no events), of which 24 (34,8%) - wrong procedure, 21 (30,4%) - wrong side/site surgery, 19 (27,5%) - forgotten instruments and materials (foreign object post procedure), 5 (7,2%) - wrong implant/prosthesis.

In addition harm may be caused not only to the patient but also to the personnel of the medical organization itself (e.g. a biological accident), to the work environment (e.g. chemical contamination, delocalization of medical waste), and to the environment (e.g. chemical and biological contamination) during provision medical care provision. Finally, medical care safety assessment makes sense only in terms of obtained benefits or favourable targeted clinical outcome.

Interaction of the medical organization with the external microenvironment (suppliers, partners, outsourcers) and macro-factors (political, legal, economic, social, technological, environmental) is another important issue to ensure medical

care safety. Political factors (volume of state guarantees), legal factors (quality of state regulation of the industry and legal consequences of medical errors), economic factors (economic model of health care), technological factors (system of pre- and post-graduate medical education, quality of research and development, total technological infrastructure, including information technologies) have the greatest influence on medical care safety. Based on the above, in our opinion, the most correct way to define "medical care safety" is the ratio of benefit and harm to the patient, taking into account the risk of adverse events in the personnel and the risk of unfavourable changes in production and environment. This balance is created by optimal interaction of the safety management systems of the medical organization, the external microenvironment and macro factors.

Construction of a safety management system in a medical organization, apart from precise definition, requires adherence to a model that describes the mechanism of adverse event development, which is called a safety model. The modern safety model is based on two assumptions [31]:

existence of multiple non-linear relationships between probability of incident and severity of harm in the organization;

high proportion of uncertainty in prediction of adverse events development and the consequences of the interventions to prevent these events.

The basic or systematic causes (main causes) are the so-called latent (hidden) failures or latent conditions. These failures are not directly related to an adverse event, are characterized by relative constancy and do not carry any danger if they are dormant [31,32,33]. Under certain conditions, latent failures become an vulnerability. As an example, let's consider such latent failure as coincidence of two patients with the same personal data (first and last names). It will only become a vulnerability if these patients are hospitalized in the same ward, or if they are together in front of the same outpatient doctor's office. Vulnerability further develops into active threat (by interacting with medical personnel, patients, and defense systems): personnel errors and violation (e.g. choice of the wrong patient for intervention), unsafe patient behaviour (e.g. tripping and slipping) or unsafe processes in the environment where medical care is provided (e.g. non-sealed container with aggressive acids). The outcome of the active threat is a dangerous event or incident (e.g. a medical intervention performed on the wrong patient; crash, fall). The incident that does not end with harm is called an incident without sequelae – near miss (e.g. a fall without injury). The incident that caused harm is referred to as an accident or an adverse event (e.g. a threatening rhythm disturbance following amiodarone injection to the wrong patient). The incident that ended in death is called a critical incident. The multiple non-linear safety model assumes that the vast majority of the incidents are the result of a transformation of many latent failures, among which two groups should be distinguished: root and contextual. Root latent failures transformation ends in an incident, and context latent failures transformation removes barriers to root failures transformation. The model's non-linearity also implies that the magnitude (strength) of the active threats not proportional to the severity of the resulting incident (e.g. a high degree of patient's walking impairment at risk of falling may be accompanied by minor injury, and vice versa) [34,35,36].

All latent failures are divided into two large groups: global (that are present regardless of the site of medical care provision and its profile) and specific (caused by the specific site of medical care provision and its profile). There are four levels of latent failures within each of these groups; each of them could be a source of an incident: level of medical technology, level of personnel, level of environment in which medical care is provided and the level of the patient. [33,36, 38,39,40,41,42].

The safety medical care management system in a medical organization should include a new safety culture, an accounting system for recording failures, threats and

incidents, a model of medical care safety management embedded in the main operational function and a mandatory part of the technological process.

A new safety culture, as part of the corporate culture, implies a change in the key paradigm and is based on the main assumption that harm caused in the process of medical care provision is not related to the final care providers, but to a multitude of systematic threats, without management of which it is impossible to significantly influence the frequency and severity of adverse events [31,35,36,37,38]. Several questionnaires with certain limitations and disadvantages have been proposed to assess the safety culture in a medical organization [43,44].

The accounting system of recording failures, threats and incidents includes 5 directions: continuous data and information collection; processing and verification of failures, threats and incidents (based on a higher probability of connection with medical care processes); registration of failures, threats and incidents (on a material carrier); measurement of failures, threats and incidents (analysis of frequency and severity of 100% of incidents during a certain period) monitoring of failures, threats and incidents (repeated measurements at specified intervals). In the process of health care system registration in many countries the letter coding of threats and incidents is used, as proposed by the U.S. National Coordinating Council for Registration and Prevention of Medical Errors - NCC MERP, 1998-2001 [34,36,45,46]. Qualitative and objective reporting and accounting of failures, vulnerabilities, threats and incidents is one of the main elements of the health care safety management system, without which all follow-up activities are meaningless. The most frequent problems in failures, threats and incidents report and account are reception of poor-quality data and the information, masking of incidents (ignoring their connection with process of rendering of medical care provision), concealment of incidents (absence of registration of verified incidents), false optimization of measurement (analysis and estimation with exception of critical and severe incidents). We want to underline that in countries with practice of prosecution for medical errors, and also in the organizations where there is no transparent climate in relation to incidents originator, overcoming the described problems is impossible; therefore, construction of a control system of safety will have exclusively declarative character. Reliable sources should be used to obtain quality data and information in other cases. From this point of view, we would like to distinguish two groups of sources: with high and low dependence on care provider (Table 3).

It is quite obvious that at the first stage the main role in obtaining reliable data and reliable information will belong to sources with low dependence on the performer. When a high level of safety culture is achieved, sources with high dependency on the performer begin to prevail. Rather important direction to improve quality of received information is the use of encouragement procedure of personnel for verification and registration of threats and incidents at first stages [33,34,36,38,41].

Table 3. Sources of Data and Information

With high dependency on care provider		**With low dependency on care providers**	
Source	Method of obtaining data and information	Source	Method of obtaining data and information
Personnel	Voluntary communication Voluntary reporting	Auditor	Direct control of staff actions and medical records Analysis of ratio incidents of various severity
Medical records	Retrospective analysis Prospective analysis	Patient	Interview with family Complaints from patients and their families
Colleague	Cross-Control	Automated control systems	Automation of error accounting Automation of complaint recording
Official (mandatory) reporting	Analysis of integral indicators (lethality, complications, etc.)	Official (mandatory) reporting	Cross-analysis of integral indicators dynamics (mortality and complications dynamics)

		Global Trigger Tool	Atypical event analysis Atypical death analysis Atypical complications analysis Atypical patient behavior analysis

In recent years, an increasing number of medical organizations have begun using the methodology for evaluating Global Trigger Tool include atypical treatment abnormalities, atypical deaths, atypical complications given the nature of the disease and used medical technology, and atypical behaviors. For example, unplanned return of a patient to the operating room within 30 days of surgery is usually associated with development of a postoperative complication; prolonged antibiotic treatment after a planned abdominal surgery is usually associated with medication-associated infections; neurological deficits in a patient after a planned cholecystectomy followed by transportation home in a wheelchair are usually associated with medication-associated complications [1,47,48,49].

The health care safety management model provides for management of latent failures transformation in order to reduce the probability of an incident and severity of harm. The tool of this model is risk management in medicine. By risk we will mean multiplying the probability of an incident by the severity of its consequences [50,51,52]. Risk management includes incident analysis; incident risk assessment; developing a risk response plan; plan execution, performance and efficiency assessment; standardization of plan's activities; monitoring residual and emerging risks.

Incident analysis involves identifying latent failures and constructing a root latent failures transformation route. For this purpose, it is most convenient to use the Ishikawa chart at all levels (technology, personnel, environment, and patient) described above, which easily identifies root and contextual latent threats.

Confidence that the final failure latent rather than active threat is usually given by the 5-6 level of fork (Figure 1).

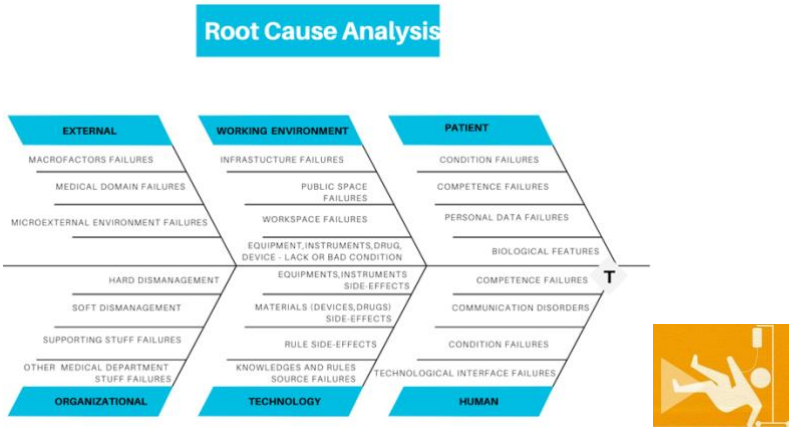

Fig. 1. Incidence analysis (World Health Organization (WHO) patient safety curriculum guide: WHO multi-professional edition. 2011)

In order to assess magnitude of incident risk, we need to bring the severity and likelihood of the incident to the expert grade scale. For this purpose, scales proposed by experts from the UK National Health System (NHS Commissioning Board Authority) are usually used. To estimate severity and probability, 5-point scales are used [50]. It should be noted that all incidents listed on the NQF list (No events) should be

classified as large incidents, regardless of the severity of caused harm [53]. Thermal risk scale is used to assess the amount of risk. Risks entering the red zone are classified as extremely dangerous (Score 15-25), those entering the orange zone as dangerous (Score 8-12), those entering the yellow zone as moderately dangerous (Score 4-6) and those entering the green zone as non-dangerous (Score 1-3). The risk response plan includes 5 key sections (Table 4).

Table 4. Risk response plan (based on [50])

Medical care provided by the riskowner	Response method	Risk management area	Resources for risk management	Residual risk level
-continues -ends	-risk accepted -risk minimized -risk eliminated -risk is avoided	-risk owner -other departments -medical organization -health care authority	-people -finance -material -inventories -info	Risk value determined by the risk management committee in a medical organization

Features of response plan depending on the risk value are given in Table 5.

Table 5. Risk Response Plan for different sizes (based on [50])

Risk value	Medical care	Risk management area	Monitoring	Risk response
Low	continues	Risk owner	every six months	accepted
Moderate	continues	Risk owner	quarterly	minimize, eliminated
Significant	continues	risk owner other departments organisation management	monthly (if they score 10 or more); bi-monthly (if they score below 10)	minimized, eliminated
Extreme	continues	-risk owner -other departments -organizational management -health care authority	monthly	avoided, minimized

Risk minimization or elimination is determined by the possibility to influence the root latent failures. If the root latent failures are completely eliminated, the residual risk value is 0. The majority of latent failures cannot be completely eliminated, therefore, in this case, it is possible to speak only about minimization of risk influence by formation of procedural and physical barriers to transformation of root and all contextual latent failures. The Risk Management Committee of a medical organization determines a target indicator - an acceptable residual risk level that in most cases corresponds to green or yellow risk level areas [54,55,56]. Residual risk will never be acceptable in the case of a law violation, or if there is a probability of death or disability more than 80%, in case of damages resulting in a critical decrease of the medical organization assets.

Implementation of the plan envisages practical application of influence methods on transformation of latent failures. The sequence of actions used in the plan is standardized and becomes the procedural norm for the risk owner and other units after efficiency and effectiveness evaluation.

Reaching the residual risk level takes risk management to the next stage - monitoring residual and new risks. New risks always appear when new medical technologies are introduced, new medical devices (including equipment) and new pharmaceuticals appear, new employees are hired, large changes in the work environment where medical care is provided (repair, reconstruction, redevelopment), changes in legislation, organizational changes are made.

4. Results

The changes described above can be considered organizational changes that involve a deep transformation of strategy, corporate culture, and operating model. It is a movement to safety from the inside. Unfortunately, outside movement is also needed, transformation of the microenvironment and macro factors that allow for the successful implementation of internal changes. As for the microenvironment (suppliers, partners, and outsourcers), an alliance of the right relationships can and should be built by the medical organization itself. Above all, it is a choice of partners who could ensure continuous quality and safe medical cycle for the patient. It is better if these partners make a similar transformation in their organization. Secondly, they are suppliers of equipment, consumable medical devices, pharmaceuticals, and disinfectants. An uninterrupted supply chain of inventories and services should be created and automated to ensure uninterrupted supply, as well as a system of transparent control by the medical organization of legality, goods quality and transportation conditions. The second group of suppliers is suppliers of network resources (water, heat, electricity, sewerage, water supply, low-power resources) with whom contractual relations and any other interaction should have a long-term nature and provide for minimization of risks of network failures (maximum protection, duplication of networks, etc.). Outsourcing activities (cleaning, laundry washing, catering, waste disposal, security, etc.) should be built into the operating system of the medical organization, comply with established safety requirements. Outsourcing process itself, its intermediate and final results should be controlled by responsible persons from the medical organization.

It is much more complicated in terms of macro factors. The main condition for success is state and society obsession with quality and safe health care [57,58,59,61,62]. Relationship between patient, his or her family members and health care workers must be transformed from antagonism into a cooperative relationship at the society level. Society must be aware of high risk of complications associated with medical care, understand the root cause and negative consequences of sanctions by the patient's relatives against medical professionals. By gaining access to their medical history, the patient and their family members should become partners in medical care safety management system, taking part in the control of processes involving the patient, in discussions on the development of effective solutions concerning the identification of errors, incidents, and management of latent failures, especially in terms of failures related to patient behavior [63,64,65,66].

5. Conclusion

The concept of medical care safety is much broader than the absence or minimization of unintentional harm to the patient. Medical care safety should be considered as a dynamic property of a medical organization in the process of interaction of its internal environment with external microenvironment and macro-factors. One the one hand, a medical organization can be a source of adverse events for both patient and staff, as well as for the environment. On the other hand, safety within a medical organization is affected to an equal extent by the state and changes of external environment. This explains the fact that medical care safety management solely at the hospital level (even an expert hospital - a referral center) often fails to deliver the expected success that would have seemed to be guaranteed by a new culture, new solutions and practices, impeccable infrastructure and state-of-the-art technological approaches. Unfortunately, the organic dependence such of a complex system as a medical organization on external and internal disturbances necessitates a vertically

integrated approach to managing the risks of adverse events at the level of the state, society and entire health care system.

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The influence of FDI on sustainable economic development of Ukraine in terms of global digitization

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Abstract. This article is a research study of the role and necessity of digital transformation of Ukrainian economy in the context of digitization of the world economy, which will promote economic growth and increase the international competitiveness of national economy, which in its turn will contribute to the further formation of an attractive investment environment. The modern tendencies of information economy development are disclosed. Changes of the determinants of FDI in the Ukrainian economy in terms of its digital transformation are revealed. It is proved that foreign trade and the globalization index of the country influence on the process of attracting FDI. Much attention in the article is paid to the role of information, development of information sphere, digitization, formation of a new information economy, foreign direct investments, which are necessary for the economic development of the country and affect economic growth in the context of global digitization. The necessity of this study is due to the modern trends of development in the world economy and the digital transformation of the national economy. The role and importance of foreign direct investments in the digital transformation of the national economy has been proved on the basis of a broad analysis of research works of foreign and national specialists, analysis of economic situation in Ukraine and the main macroeconomic indicators identified the role and necessity of transformation processes, macroeconomic indicators of economic development of the country were analyzed, the necessity and requirements for the formation of an attractive investment environment, favorable investment climate and business environment have been identified. Using the econometric model, based on E-Views software, the indicators of GDP, foreign trade, inflation, employment level and the globalization index have been analyzed in the context of their impact on the volume of FDI attraction and their forecasting have been made.

Keywords: digital transformation, globalization, information economy, information technology, foreign direct investments.

1. Introduction

The process of integration of Ukraine into the world community and the European integration vector of development of the national economy presupposes the formation of an attractive investment environment for attracting foreign direct investments (FDI). FDI stimulate economic growth, promote job creation (i.e. reduce unemployment), promote the development and implementation of innovative, digital technologies and provide further economic growth. Innovative and digital technologies will contribute to the formation of national advantages and enable to keep competitive positions on the global arena. The dynamic development of information and communication technologies, the scientific and technological revolution and the processes of globalization determine the role and the necessity of digital transformation of the Ukrainian economy.

The purpose of our research is to identify changes of the determinants of FDI in the national economy in the context of digital transformation as a general trend of further development of the world economy. Based on the goal, the objectives are to research the basic principles of the formation of digital economy and to identify its impact on the process of attracting of FDI into the national economy.

2. Literature Review

Theoretical and applied aspects of issues of digital transformation of economy and digitization were considered in the research works of famous Ukrainian scholars, such as, I.V. Dulska [1], A.O. Dzhusov [2], S.V. Kolyadenko [3], N.P. Meshko [4], et al. The analysis of research works prepared by these authors have shown that they have paid considerable attention to the formation of high-tech development in the context of globalization, to the role and importance of the digital economy at the current stage of development, to the necessity of the introduction of digital technologies, which will promote the realization of synergistic effect and economic growth.

Among foreign scholars, the foundations and development of the digital economy, digital society and global changes in the world are considered in the research works of M. Castells [5], A. Grimes [6], T. Niebel [7], F. Webster [8], et al.

The relationship between FDI and economic prosperity has been considered in many theoretical and empirical studies of different countries and regions of the world. In particular, we note in the research works of Chowdhury A. [9], Eswar S. Prasad, Raghuram G. Rajan [10], Pegkas R. [11], Sunde T [12], Hyungsun S. and Miguel R. [13] and in the author's a study that identified the role and importance of FDI in the digital transformation of Ukraine [14], et al.

Consequently, the digital world economy is of great importance, promoting the creation of new information and communication technologies, new products and shaping new market needs. Investment flows are mostly directed into new digital technologies. For Ukraine, this segment is not sufficiently developed, but it has huge potential and prospects for future development. In addition, FDI more positively influence also on the economic prosperity of the country.

Therefore, the authors of this article prove the actuality and necessity of digital transformation of the Ukrainian economy with the purpose to increase rates of economic growth and national competitiveness on the world level. The role of foreign direct investments in the digital economy and the determinants of attracting foreign direct investments into the national economy are determined. Based on econometric modeling using E-Views program, the impact of macroeconomic factors on FDI attraction is determined.

3. Data and Methodology

XXI century is characterized by new qualitative features of globalization as a new phenomenon in the development of humanity, its economic, civil and political structures. Globalization represents by itself the emergence of a single economic and informational space in a planetary scale. Just globalization today reflects the new reality of the growth of global interdependence, which is mostly due to the new communication technologies. Consequently, the current stage of development of the economies of the countries of the world is characterized by an increase of the role and importance of information and knowledge that has become the dominant factors in the process of formation and use of intellectual capital, which in turn contributes to the creation of new high-tech and scientific products that will ensure the appropriate

level of countries competitiveness on the world markets. The modern era is associated with an era of constant transformation and the transition of society from the outdated entropy-market system to a new highly organized economic system [15]. Such system will require the attraction of additional financing and foreign direct investments, which will inflow to the country's economy in case of creation of attractive and competitive environment.

In order to achieve the setted goal it is necessary to research the current stage of digitization; to reveal the modern trends of information economy development; identify and disclose factors of formation of a new information economy; to prove the role and necessity of FDI in terms of formation of information economy, in particular in Ukraine; using the econometric model and forecasting methods to show the influence of the most significant factors on the attraction of FDI into the economy of Ukraine, and to prove their influence on the formation of digitization of the Ukrainian economy.

Transformation of national economy assumes the transition to an information society, which means that the level of socio-economic development is directly related to access to information resources. Thus, information becomes a means by which corporations prove that consumption is an essential and inevitable element of life [16]. This means that the growth of the role of information and the development of the information sphere has become an important condition for the spread of consumerism (the mass consumption of material goods and the influence of consumers on the producers of products). The modern process of production, distribution and use of knowledge forms is the basis of a new information economy, and the global information network is its infrastructure. The development of communications, the commercialization of knowledge, electronization, and the transformation of knowledge into the product is the basis of the modern stage of digital transformation. So, the digital economy is a new paradigm of world economic development, and in particular in the context of the digital transformation of the national economy.

It should be noted that in developed countries, digitization takes a leading position in the policy of the governments. Just such an active policy of countries helps to stimulate business and their engagement in the processes of digitization; business expansion will require the attraction of private investors, as well as their involvement in the creation of digital platforms. Thus, the digital economy promotes the development of world trade that displays through the speed of turnover and increase of efficiency.

The term «knowledge-based economy» by itself is used to refer to two concepts: first, the information economy is a modern stage in the development of civilization characterized by the primary role of creative labor force and information products; and secondly, the information economy is an economic theory of the information society [17]. The information economy focuses on the following aspects: the study of information asymmetry; economics of information products; economics of information technologies.

The development of information products and information technologies, while ensuring the rights and freedoms of citizens to use these technologies and access to information, are key factors in the effective transition to a new information economy. It should be noted that some countries can turn information technology into an engine of their development, move from an agrarian or industrial base to a new information economy, others may be far behind. Such a process of transition to a new economy is objective and requires the consciousness of society.

Bases for the formation of a new information economy are the following factors, which explain the rapid distribution of information, namely:

- factors directly related with the scale of multinational company's activity: by placing their brunches around the world, these companies cannot operate without communication and information infrastructure which provide their activities. In addition, information networks are vital not only for a particular company, they link to a single whole all the market agents, without which the global market cannot function. Therefore, the international financial networks in the information environment take a leading place;
- the results of information revolution, which were first used by transnational corporations (all the more so, because long-term judgments about the need of information networks contributed to this).

The formation of the information economy takes place against the backdrop of the main challenges of a rapidly changing world. The unique international challenges faced recently by the economies of the world, including the national economy, are significantly different from the problems that were inherent two or three decades ago. The scale and innovation of changes have led to widespread use of the terms «globalization» and «informatization» of society and the economy. Crisis phenomena at the turn of the XX-XXI century indicate on the need to revise the principles of consumption and production from the point of view of sustainable development of society and certain spheres of economy. Thus, the current crisis is a crisis of industrial-market paradigm, ideology, concept, model of development of the world economy, which should be replaced by a new innovation-synergistic information paradigm, on the model of socio-economic development and formation of knowledge-based economy [15]. In such a model of development, the main role is played by highly skilled professionals who are the bearers of intellectual capital, creative and innovative abilities, and are the main drivers in ensuring business competitiveness.

Economic theory has revised its own preconditions and tasks of theoretical knowledge, which is due to the achievements of humanity in the creation and implementation of information and telecommunication technologies. The question about the entrance of world civilization in the post-industrial era was the subject of discussion just in the early 1960's. This was due to the achievements of humanity in the creation and implementation of information and telecommunication technologies. D. Bell [18], U. Beck [19], Castells M. and Himanen P. [20], G. Schiller [21], A. Toffler [22], I. Wallerstein [23] and others stood at the roots of the theory of information and communication technologies. They describe in different ways in their research works the information economy and society, its economic principles, which are based on information and telecommunication technologies. In particular, American Daniel Bell, believed that just now the process of formation of information society is going on [24]. American Herbert Schiller recognizes the fact that today information technologies have a significant impact on economic development, but does not see a fundamentally new phenomenon. It is the phenomenon that reveals a new paradigm of the information economy, which is based on knowledge and information. British Peter Golding and Graham Murdoch have recognized the influence of information on society development and growth in the XXth century, and agree with its axial purpose for events in the world, but argue that information and communication are only the main components of the long-established and well-known capitalism formation [25]. So, such issues in the global information economy are also relevant today.

Consequently, today information is the driving force in the development of society, economy and business. Information affects human activity, the economy of the countries of the world, the surrounding world, becomes a giant, technical, socio-economic, political and cultural power. At the current stage of business development, the most competitive is that business entity which can produce more information of the best quality, introducing it into all spheres of life, using modern information technologies. In its turn, for Ukraine, the use of up-to-date information, modern technologies will mean attraction of foreign direct investments.

Undoubtedly the leading places in the modern information economy take big companies - transnational corporations. Just these corporations offer innovative products and services that are characterized by global innovation; and are the major source of FDI. The rapid development of such corporations and their expansion today has a significant impact on the economic development of other countries of the world, including Ukraine.

From the second half of the XXth century the movement of capital is taking place at a high rate. During the last fifty years, capital inflows have increased in 133 times (to $ 1.42 trillion in 2017), outflows of foreign direct investment have increased in 104 times (to $ 1.4 trillion in 2017) [26]. The FDI in stock, possible potential, namely the cost of capital share and reserves (including retained earnings) related to the parent company, as well as the net indebtedness of branches of parent companies, also significantly increased over the past thirty-five years: stock inflows have increased almost in 29 times and the stock outflows increased almost in 45 times.

However, it should be noted that from the middle of XXth century, the main volumes of inflow-outflows of foreign capital have just developed countries: they account for about 55% of capital imports, and 72% of capital exports. On the one hand, this is due to the development of the scientific and technological revolution, later with the formation of Western European integration, the liberalization of foreign economic relations, the activities of transnational corporations, the development of international financial markets; on the other hand, the main donors of capital are precisely economically developed countries, exactly in these countries there is the largest number of parent companies, which in its turn are owners of capital.

For Ukraine, the driving forces in ensuring the international competitiveness of the national economy are investments and technologies. The dynamics of FDI attraction is the basis of long-term development of the economy, the basis of the reproduction process, which will contribute to the expansion of high-tech forms of reproduction of fixed capital and the accumulation of highly intellectual capital. One of the driving forces of such fundamental changes in the Ukrainian economy are foreign direct investments. Table 1 shows the total volume of attracted FDI in the economy and the GDP of the country. Statistics shows that the growth in 2008 was due to the deployment of privatization processes; since 2014 there has been a slowdown in economic development and the decrease in volumes of FDI, due to the political and economic situation in the eastern part of the country.

Table 1. FDI and GDP of Ukraine for the years 1999-2018, mln USD

Period	**1999**	**2001**	**2003**	**2005**	**2007**	**2009**	**2011**	**2013**	**2015**	**2017**	**2018**
FDI	2810,7	3875	5471,8	9047	21607,3	35723,4	45370	51705,3	38356,8	31606,4	35809,6
GDP	31580,9	39309,6	513315	89239,4	148734	122993	69333	190499	91031	112190	113691

Table 1 presents the statistical data about the FDI inflows and GDP of Ukraine for the period from 1999 to 2018.

Overall, Ukrainian economy is characterized by a low level of attraction of foreign direct investments, which is primarily due to the underdeveloped financial and credit system, unfavorable investment environment, constant changes in the tax code, and in the context of the crisis, due to the low level of savings of population in the investments. According to the data of European Business Association, the investment attractiveness index of Ukraine at the beginning of 2019 fell to the level of 2016 and amounted 2.85 (out of 5), and is in the negative plane (i.e. below 3.0 points).

At the same time, positive factors should include the stability of the national currency, the liberalization of currency legislation, the reduction of inflation since 2015, and other political factors. The main macroeconomic indicators, foreign trade, inflation and employed population which have the greatest impact on FDI attraction, are given in Table 2 [27].

Table 2. Some indicators of economic development of Ukraine

Period	FT (export and import) million USD	I (inflation), %	Employed population, million people
1997	37516.6	106.4	22.6
1998	32563.7	110.0	21.8
1999	28154.8	122.1	21.0
2000	33334.6	127.8	20.2
2001	36919.3	112.3	19.9
2002	40432.6	101.0	20.1
2003	52077.1	105.0	20.2
2004	69338.5	108.9	20.3
2005	79749.7	113.6	20.7
2006	94929.0	108.2	20.7
2007	124344.7	110.3	20.9
2008	17124.2	121.4	20.9
2009	100444.9	114.9	20.2
2010	129505.3	109.1	19.2
2011	169926.7	104.6	19.2
2012	174378.4	99.8	19.3
2013	161926.7	100.5	19.3
2014	128936.7	124.9	18.1
2015	92687.3	143.3	16.4
2016	90674.6	112.4	16.3
2017	108216.0	113.7	16.2
2018	120713	109.0	16.4

Table 2 presents the statistical data about basic macroeconomic indicators of economic development of Ukraine, which have the greatest influence on attracting FDI.

Presented economic indicators from 2014 due to the political and economic situation in Ukraine deteriorated.

4. Results

Ukraine in the period of the digital transformation of the national economy needs to attract significant volumes of foreign direct investments. At the same time, it is necessary to create the most attractive environment for their attraction and effective use. While making this research study, the statistical database from 1999 to

2018 was used. The results of the authors study made it possible to explain the relationship between the selected variables using the E-Views package. To explain the relationship between the selected variables, a correlation matrix was constructed (see Table 3).

The statistical data for the analysis in the model include 20 observations (1999-2018). A general view of the FDI model from the main variables chosen by us can be described by the following equation:

FDI= f (GDP, FT, I, LM, GI),

GDP - GDP of Ukraine, millions USD; FT - foreign trade (the sum of exports and imports of goods and services), millions USD; I - inflation, %; LM - employed population of Ukraine, millions of people; GI - index of globalization of the country.

To explain the relationship between selected variables we construct the correlation matrix (see Table 3).

Table 3. The Matrix of Correlation Coefficients

	FDI	**GDP**	**FT**	**I**	**LM**	**GI**
FDI	1	0.1447	0.8395	0.03355	-0.5928	0.9326
GDP	0.1447	1	0.2662	-0.1894	0.05206	0.1483
FT	0.8395	0.2662	1	-0.1301	-0.2014	0.8084
I	0.03355	-0.1894	-0.1301	1	-0.2261	0.1336
LM	-0.5928	0.0520	-0.2014	-0.2261	1	-0.5868

Source: authors development

Table 3 presents a correlation matrix that explains the relationship between selected variables and shows their impact on foreign direct investments. Matrix constructed by us confirms the success of the model.

The indicated correlation coefficient matrix shows a strong correlation between FDI and globalization index of 93%; a strong 84% link between foreign trade and FDI; a significant negative relationship (meaning decreasing the value of a variable leads to an increase in another variable) between FDI and the employed labor force (59%). The result of the correlation between the variables is acceptable, which confirms the success of this model. Results of multivariable regression are presented in Table 4.

Table 4. The Results of Multi-Factor Regression of Foreign Direct Investment

Dependent Variable: FDI
Method: Least Squares
Sample (adjusted): 1999 2018
Included observations: 20 after adjustments

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
GDP	-0.005274	0.014081	-0.374550	0.7136
FT	0.169276	0.065607	2.580136	0.0218
I	-5481.578	14765.23	-0.371249	0.7160
LM	-2750.597	1237.961	-2.221878	0.0433
GI	1360.559	615.5854	2.210187	0.0442
C	-23976.27	54982.43	-0.436071	0.6694
R-squared	0.921305	Mean dependent var		26680.71
Adjusted R-squared	0.893199	S.D. dependent var		18403.89
S.E. of regression	6014.468	Akaike info criterion		20.48505
Sum squared resid	5.06E+08	Schwarz criterion		20.78377
Log likelihood	-198.8505	Hannan-Quinn criter.		20.54336
F-statistic	32.78019	Durbin-Watson stat		1.303515
Prob(F-statistic)	0.000000			

Source: authors' development

Table 4 shows the results of multi-factor regression using the least squares method and different coefficients, which as a whole prove the significance of the equation.

R^2 shows on how much selected variables explain the extent of attracting foreign direct investments in Ukraine (which in turn reflects the attractiveness of the investment environment created by the investment climate). In the model constructed, R^2 = 92.1%, which means that the data of the variables explain the magnitude of the high probability of FDI. A sufficiently strong relationship indicates the correlation coefficient which is 89%; F-statistic = 0.000000, the probability of accepting the null hypothesis, confirms the need to take an alternative hypothesis, which certifies the significance of the equation as a whole.

According to Fisher's F-statistics, all coefficients of regression equation do not equal zero simultaneously. In our equation, foreign trade, employed population and the globalization index are less than 5%, which improves the quality of the equation.

Further, we check the equation for autocorrelation using the Durbin-Watson test. This Durbin-Watson criterion is d = 1.30. From the Durbin-Watson statistics table we determine the significant points d_L and d_U. For the number of observations 20 and 5 variables at the level of significance α = 1% d_L = 0,60 and d_U = 1,74; at 5% significance level d_L = 0.79 and d_U = 1.99. In our case, the value of DW is in the range of significant points (the interval between it is a zone of uncertainty: it means that we can neither reject nor accept the null hypothesis (and we cannot change the position).

Authors built a model tested for heteroskedasticity using the tests of Breusch-Pagan-Godfrey, Harvey, Glejser, ARCH. These tests are quite widely used in practice. With the test of Breusch-Pagan-Godfrey linear dependence of the dispersion of random errors from a set of variables is tested. Regression is not significant, the probability of accepting the null hypothesis is 86.7%, which is higher than 5% and confirms the absence in the model of heteroskedasticity (Table 5).

Table 5. Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.359607	Prob. F(5,14)	0.8676
Obs*R-squared	2.276279	Prob. Chi-Square(5)	0.8097
Scaled explained SS	1.037343	Prob. Chi-Square(5)	0.9595

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample: 1999 2018
Included observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.62E+08	3.55E+08	-0.738676	0.4723
GDP	-41.71250	90.97152	-0.458523	0.6536
FT	1.822275	423.8637	0.004299	0.9966
I	83191196	95392500	0.872094	0.3979
LM	5058222.	7997990.	0.632437	0.5373
GI	1480984.	3977062.	0.372381	0.7152

R-squared	0.113814	Mean dependent var	25321675
Adjusted R-squared	-0.202681	S.D. dependent var	35432026
S.E. of regression	38857176	Akaike info criterion	38.03201
Sum squared resid	2.11E+16	Schwarz criterion	38.33073
Log likelihood	-374.3201	Hannan-Quinn criter.	38.09032
F-statistic	0.359607	Durbin-Watson stat	2.240609
Prob(F-statistic)	0.867602		

Source: authors' development
Table 5 shows the results of the Breusch-Pagan-Godfrey test on heteroskedoxicity.

The Harvey test is similar to the Breusch-Pagan-Godfrey test and checks the hypothesis of the constant dispersion of residues, and has an alternative hypothesis that heteroskedasticity is observed, namely exhibiting exponential dependence. The results of this test show that the probability of accepting the null hypothesis is 23.3%, which is also more than 5% and confirms the absence in the model of heteroskedasticity (Table 6).

Table 6. Heteroskedasticity Test: Harvey

F-statistic	1.565873	Prob. F(5,14)	0.2332
Obs*R-squared	7.173242	Prob. Chi-Square(5)	0.2081
Scaled explained SS	8.775792	Prob. Chi-Square(5)	0.1183

Test Equation:
Dependent Variable: LRESID2
Method: Least Squares
Sample: 1999 2018
Included observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-22.15405	21.50015	-1.030414	0.3203
GDP	-1.00E-05	5.51E-06	-1.815722	0.0909
FT	-9.44E-06	2.57E-05	-0.367913	0.7184
I	5.154377	5.773747	0.892726	0.3871
LM	0.832538	0.484088	1.719807	0.1075
GI	0.259520	0.240716	1.078117	0.2992

R-squared	0.358662	Mean dependent var	15.27587
Adjusted R-squared	0.129613	S.D. dependent var	2.520917
S.E. of regression	2.351878	Akaike info criterion	4.791630
Sum squared resid	77.43860	Schwarz criterion	5.090350
Log likelihood	-41.91630	Hannan-Quinn criter.	4.849943
F-statistic	1.565873	Durbin-Watson stat	1.873201
Prob(F-statistic)	0.233174		

Source: authors' development
Table 6 shows the results of the Harvey test on heteroskedoxicity

The Glejser test analyzes the regression dependence of the deviation modules. The presence of regression significance is at the level of 68%, which is higher than the threshold value of 5-10%, that is, the model has no heteroscedasticity (Table 7). By varying *k* it is possible to construct different regression equations.

Table 7. Heteroskedasticity Test: Glejser

F-statistic	0.629042	Prob. F(5,14)	0.6808
Obs*R-squared	3.668906	Prob. Chi-Square(5)	0.5980
Scaled explained SS	3.158801	Prob. Chi-Square(5)	0.6755

Test Equation:
Dependent Variable: ARESID
Method: Least Squares
Included observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-38050.96	33215.52	-1.145578	0.2712
GDP	-0.006607	0.008506	-0.776651	0.4503
FT	-0.007762	0.039634	-0.195845	0.8475
I	7140.930	8919.845	0.800567	0.4368
LM	890.6465	747.8662	1.190917	0.2535
GI	265.1853	371.8822	0.713090	0.4875

Table 7 (continued)

R-squared	0.183445	Mean dependent var	3742.247
Adjusted R-squared	-0.108181	S.D. dependent var	3451.508
S.E. of regression	3633.409	Akaike info criterion	19.47706
Sum squared resid	1.85E+08	Schwarz criterion	19.77578
Log likelihood	-188.7706	Hannan-Quinn criter.	19.53537
F-statistic	0.629042	Durbin-Watson stat	2.122347
Prob(F-statistic)	0.680775		

Source: authors' development

Table 7 shows the results of the Glejser test on Heteroskedasticity

The ARCH heteroskedasticity test also confirms the acceptance of the null hypothesis at the level of 98.7%, which is more than 5-10%. The results of this test are shown in Table 8.

Table 8. Heteroskedasticity Test: ARCH

F-statistic	0.000248	Prob. F(1,17)	0.9876
Obs*R-squared	0.000277	Prob. Chi-Square(1)	0.9867

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 2000 2018
Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	22271622	10012325	2.224421	0.0400
RESID^2(-1)	0.003588	0.227892	0.015745	0.9876

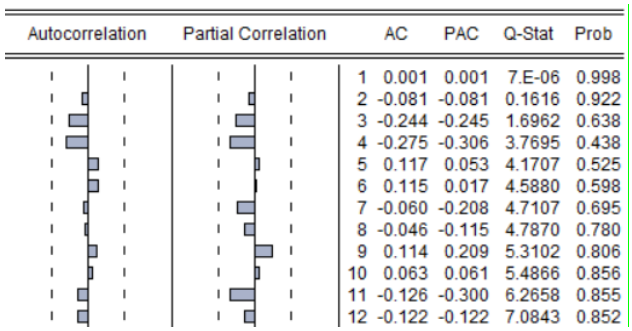
R-squared	0.000015	Mean dependent var	22366966
Adjusted R-squared	-0.058808	S.D. dependent var	33776740
S.E. of regression	34755725	Akaike info criterion	37.66489
Sum squared resid	2.05E+16	Schwarz criterion	37.76430
Log likelihood	-355.8164	Hannan-Quinn criter.	37.68171
F-statistic	0.000248	Durbin-Watson stat	1.833798
Prob(F-statistic)	0.987621		

Source: authors' development

Table 8 shows the results of the ARCH test on heteroskedasticity

Using all the tests for heteroskedasticity, the authors argue for the possibility of a null hypothesis. In all tests for heteroskedasticity, the null hypothesis indicates the absence of heteroskedasticity, that is, an alternative presence. We accepted the null hypothesis because the probability of accepting the hypothesis is much higher than 5% significance level.

Let's check the model for autocorrelation (Fig.1.). The null hypothesis is accepted for the absence of autocorrelation, because at each of the 12 lags the value is significantly more than 5%.



	AC	PAC	Q-Stat	Prob
1	0.001	0.001	7.E-06	0.998
2	-0.081	-0.081	0.1616	0.922
3	-0.244	-0.245	1.6962	0.638
4	-0.275	-0.306	3.7695	0.438
5	0.117	0.053	4.1707	0.525
6	0.115	0.017	4.5880	0.598
7	-0.060	-0.208	4.7107	0.695
8	-0.046	-0.115	4.7870	0.780
9	0.114	0.209	5.3102	0.806
10	0.063	0.061	5.4866	0.856
11	-0.126	-0.300	6.2658	0.855
12	-0.122	-0.122	7.0843	0.852

Fig. 1. Correlogram of Residuals Squared

Source: authors' development

The next step is to test the time series by calculating Jarque-Bera statistics. The graphical characteristics of the variables are shown in Figure 2, which investigates the mean, standard deviation, asymmetry and excess, Jarque-Bera statistics, and the hypothesis probability. To make the decision to accept the null hypothesis, we use an equivalent form of criterion. Based on Fig. 2 level of significance for the Jarque-Bera test is $p = 0.4918$. We compare the threshold value with the threshold value ε=0.05. Since the Jarque-Bera criterion is greater than 5%, the null hypothesis is accepted, which means that the distribution of residues is consistent with the normal distribution and the characteristic property of white noise is fulfilled. It can be argued that the remnants of the model being built are Gaussian white noise.

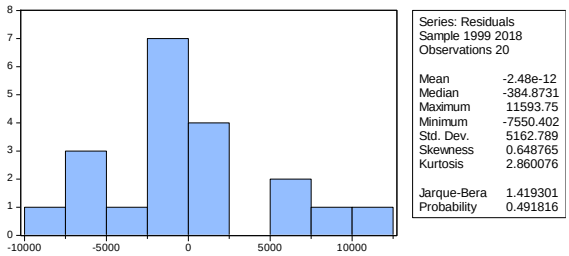


Fig. 2. Descriptive Analysis of Variables

Source: authors' development

We will test the constructed model for explanatory ability. Figure 3 shows how this model clearly displays FDI with the help of variables: the graph where the modeled values (Fitted) fairly accurately represent the actual values (Actual), so the model is completely acceptable by this criterion.

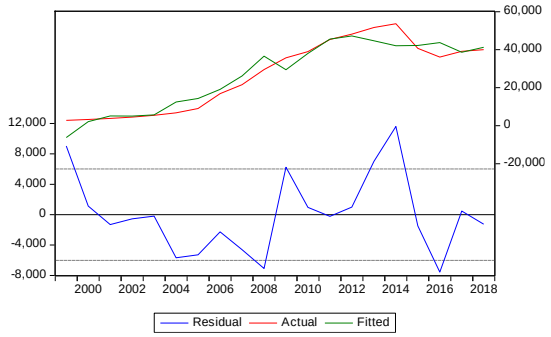


Fig. 3. Explanatory ability of the model

Source: authors' development.

And we test the model on forecast quality. We pay attention on MAPE, which is equal to 34.5, which means acceptable (but not high) accuracy of the forecast (Figure 4).

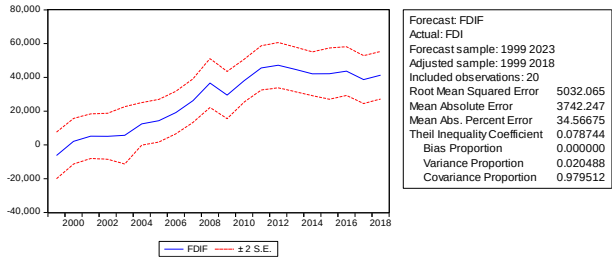


Fig. 4. Forecast of models

Source: authors' development

The general view of the model of dependence of FDI from independent variables in modern terms can be described by the following equation:

Estimation Equation:

FDI = C(1)*GDP + C(2)*FT + C(3)*I + C(4)*LM + C(5)*GI + C(6)

Substituted Coefficients:

FDI = -0.0053*GDP + 0.1693*FT - 5481.5780*I - 2750.5969*LM + 1360.5591*GI - 23976.2688

5. Conclusion

The research of this problem made it possible to disclose the essence and irreversibility of the process of formation of information economy and in its context, the increased role of FDI. There is a transformation of national economies, which characterizes the current stage of civilization development, the scales of TNCs activity are increasing, that lead to the growth of FDI movement, and the information acts as a driving force for the development of countries' economies. For the Ukrainian economy, digitization has advantages; in particular with the help of the main subjects of TNCs, the domestic economy will have technologies, innovations and will lead to economic growth. This is possible due to creation a favorable environment and attracting foreign investments that have a positive impact on economic growth.

Directly in this study, authors analyzed the determinants of foreign direct investments that are necessary for the digital transformation of Ukrainian economy. Attraction of foreign investments was considered in the context of improving the investment climate and investment environment, which as a rule are directed on innovative technologies and on the process of creating new products. The formation of an investment attractive national economy will show new opportunities for economic growth.

The authors paid special attention to forecasting of FDI inflows in the national economy, which showed slow growth trends that could be accelerated according to the authors' views by the digital transformation of the country's economy. This will mean more efficient use of intellectual capital; promoting the creation of new high-tech, innovative and scientific products; the creation of digital platforms that will lead to the increase of volumes of trade due to the speed of turnovers The study confirms that foreign direct investments, as a rule, come from transnational companies, which are leading players on the capital market. Their rapid development and expansion at the end of the last century had a significant impact on the economies of other

countries as well as on the economy of Ukraine. Thus, in terms of global digitization, the role of FDI in the economy of Ukraine is crucial, contributing to its economic prosperity.

In order to increase the rates of economic growth, it is necessary first of all to assist the digital transformation of the national economy and the creation of an attractive investment environment, which will create the basis for further increase of FDI volumes.

Research prospects should focus on support of innovative companies and on the readiness to implement innovate, high-tech, competitive products, create and promote digital platforms, primarily for business. At the same time, further steps are studies that disclose such important questions as: how should be supported companies that invest in innovative, high-tech products and what incentives should be provided to them? What legislative support will be realized in the context of the digital transformation of the national economy? What measures should be taken to attract foreign investors and what conditions should be created? What should be the economic policy in terms of global digitization in order to attract the necessary FDI faster?

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Development and financial support of tourism exports in the digital economy

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Abstract. Tourism is not only big business but also tourism should be seen and protected as perhaps one of the world's premier export products. In this connection, consideration is given to the possibilities of developing the tourism industry as the most important direction of non-primary exports in the medium term in digital age, capable not only of bringing significant revenues to the budgets of various levels, developing domestic tourist infrastructure, but also characterized by inexhaustible resources and forming a favorable image of the country on world markets. The purpose of this article is to consider the problems of preservation and financial support of the travel, tourism and hospitality industry from the standpoint of increasing its export potential in digital age and ensuring a high level of attractiveness of tourist destinations.

Keywords: Tourism, Development, Financial support, Export, Digital economy.

1. Introduction

The development of any economy ultimately rests on the limited domestic consumption market, the impossibility of further development and expansion within one state, the gradual degradation of positioning and management systems, and a decrease in the competitiveness of business entities. International trade is the most important driving force behind the development of the world economy. Organizations in the global economy import and export a large amount of goods, works, services in order to expand production, get more profit, create a favorable world image of the state, strengthen competitive advantages and the economy of their country as a whole. Currently, exports to the state are the most promising and revenue source of the budget [7; 12; 18].

The inbound tourism's characteristic is the creation of an advanced comfortable infrastructure inside and around the traveler attractions, which allows us to talk not only about stimulating the tourism exports development, but also about the formation of favorable living and recreational conditions inside the exporting country. This sets tourism apart from other export destinations, because its development brings a twofold positive effect to the state and its population [7; 9]. In this aspect, the search for effective measures for the development of tourism as a direction of non-primary exports in Russia becomes relevant, including in terms of GDP growth. We need to promote tourism, hospitality, and diversity. Russia does not have the kind of advertising campaigns that can be seen in neighboring countries such as Azerbaijan, Macedonia, Ukraine, etc. These campaigns invite tourists to come and experience the culture and related attractions [27]. For example, the share of tourism in the structure of Ukraine's GDP is 7.8% (in Russia – less that twice). Despite the fact that Ukraine, having a considerable tourist potential for the formation of tourist flows, is ranked 85th among 139 countries of the world in terms of tourism attractiveness [19]. The total contribution of travel and tourism to GDP worldwide in 2019 was just over 9,258 billion U.S. dollars (the direct contribution – 2,893 billion U.S. dollars) [32]. But

because of COVID-19 impact the tourism industry is projected to lose hundreds or even thousands billion U.S. dollars in foreign spending this year. In this regard, an objective need arises to consider tourism as the most promising direction for the development of Russian exports, taking into account the possibilities of increasing its competitiveness in world markets and the formation of an adequate system of industry incentives (including financial support), which will reduce the negative impact of the coronavirus pandemic and help maintain employment.

2. Literature Review

The increase in the implementation of internationalization strategies by firms has led to the rapid growth of international trade and the severity of trade deficit pressures in many countries. This has attracted considerable interest from various researchers, managers, and public-policy makers into understanding the determinants of export choice and degree. In the literature, exporting is considered the most frequently used strategy of internationalization due to it being a flexible and cost-effective mode [15]. S. Krammer advanced a two-stage theoretical model which contends that the export performance of emerging economy firms (EEFs) will depend both upon their firm-specific capabilities and their home institutional environments. Specifically, they argue that EEFs will be more likely to export when facing more uncertainty at home from greater political instability, substantial informal competition, and high corruption [16].

S. Kaliappan regarded services trade as a new source of income, especially for developing countries. The findings imply that the developing countries should focus on formulating appropriate policy measures to enhance the performance of services sector and service export to stimulate the economic growth [14]. E. Hjerpe explored outdoor recreation as a sustainable export industry and its regional economic impacts [12]. Wilderness attracts tourists and generates visitor spending in proximate communities as people enjoy wilderness for outdoor recreation. Wilderness also attracts amenity migrants and out-of-region investments into surrounding regional economies. Designated Wilderness areas in the U.S. collectively provide for substantial national economic contributions, estimated to be over $700 million in total output [11]. Nationally, outdoor recreation services have been estimated to be an $887 billion annual industry in the U.S. with increasing trends expected in both participation and total recreation-related expenditures [38]. M. Mahmoodi examined the causal relationship between foreign direct investment, exports and economic growth in two panels of developing countries (eight European developing countries and eight Asian developing countries). There is evidence of long-run causality from export and FDI to economic growth, and long-run causality from economic growth and export to FDI for both of the aforementioned panels [18].

Russia has a significant potential for tourism export development. Russia remains hindered by numerous issues such as destination image, infrastructure development, workforce training and education, quality management, and sustainable management [1]. One of the main issues in Russia's efforts to enhance tourism competitiveness: to educate a qualified workforce at the university level. Better education at universities enhances students' employability at the time that supports tourism firms to perform better. Both together help to boost tourism destination competitiveness and sustainability, favoring progress and socio-economic development [2].

Strategic management has become an important subject in university-level tourism and hospitality education since it aims to prepare and train future managers to develop a holistic management point of view. F. Okumus critically reviewed and evaluated different methods of teaching the subject. In particular, he provided discussions about the aims of teaching strategic management and referred to the

challenges and difficulties of doing so in tourism and hospitality programs. A number of key conclusions and recommendations for practice and future research are also provided. However, due to contextual factors, changing teaching methods or adapting new methods may not be very easy since doing so may have important cultural, structural, and resource implications for tutors, students, and the institution [22].

Tourism cannot be concentrated only in megacities, and therefore the study of the development of small cities, as well as family business of different generations, is actualized, since this type of business has great chances to enter international markets. S. Berezka analyzed the modern approaches to the development of tourist value proposition and to discussed relevant cases of small cities in Russia. She used a case study approach based on the experience in Vladimir Region with respect to government and its support for tourism development. Several recommendations are offered for developing and improving the tourist value propositions of small cities [5]. D. Pavlov tried to present some conceptual foundations of the small family business as a strategic entity for the future of the non-capital regions. Sustainable territorial development based on the activity of small and medium-sized businesses is one of the research fields currently being intensively developed in the world economic science [24].

M. Sheresheva sheds light on the major shift to domestic tourism that is partly due to the turbulent economic environment that is forcing Russia to search for internal sources of development. People began actively visit the Crimea, the Caucasus, the Republic of Tatarstan, the Far East, as well as numerous small Russian cities that collaborate and cluster on the basis of unique cultural heritage and unique identity. At the same time, the decision to rely on diversity of opportunities and sustainable regional tourism make it possible to have a broad variety of tourist value propositions in almost all parts of Russia. This also makes Russia more attractive to foreign tourists. Still, to make Russia a popular destination internationally, improvement in almost all elements of the Russian tourist product is needed. The Russian tourism market suffers from the poor development of the country's tourism infrastructure, including a shortage of accommodation and entertainment resources and the poor state of many local attractions and road networks. The infrastructure is also poorly adapted for people with disabilities, as well as for foreign tourists, because of a lack of supporting information in English. The discrepancy between outbound and inbound expenditure suggests more can be done for travelers visiting the country [27-29].

For the development of inbound tourism, it is first necessary to create a tourist infrastructure, objects of increased attention of tourists – for example, theme parks and recreation areas. Nowadays theme parks generate billions of dollars in revenue, have a substantial effect on local economies and therefore, are considered a significant driver of the hospitality industry [20]. They will continue to have an impact on society and their roles in destination development and sustainability will continue to grow and affect a variety of demographic and socio-economic sections of the communities in which they operate. Developing new theme parks or adding new attractions into the current theme parks require major capital investments. Therefore, their development in Russia at the present stage is impossible without financial incentives.

Tourist evaluation criteria developed by scientists Lopes, Munoz & Alarcon-Urbistondo on the example of Portugal. To measure the basic offer at each destination, they used three sub criteria: the number of businesses at each destination within the hospitality industry (accommodation, catering and similar), and the lodging capacity at each destination, subdivided into hotel establishments and local accommodation (rural tourism and housing tourism). The complementary offer was measured by examining both the natural environment and the cultural offer [17].

Based on the analysis of various studies of the development of tourism exports in the world, it can be concluded that this problem has many subsystems related to

potential, competitiveness, infrastructure, safety [4; 6], investment, education and behavioral intentions of residents and tourists. This article attempts to outline the range of problems of improving competitiveness and financially stimulating the tourism export in Russia in digital age.

3. Data and Methodology

The Russian economy which is highly dependent on oil and gas exports is now faced with a decline in Petro-dollars because of falling oil prices. Under new circumstances, Russian leaders have to decide how to reduce the energy resource dependence of the economy and, therefore, pay close attention to tourism and hospitality as potential drivers of the national economy [27]. Given Russia's significant tourism potential in the world market, it is necessary to divert the country's economy from product dependence, identifying the main problems of competitiveness and financial support for the tourism industry in digital age in terms of increasing its export potential and ensuring a high level of attractiveness of tourist destinations in the formation of an effective program for the development of inbound tourism.

The authors used such methods as theoretical modeling and analysis. Official statistics and analytical reports of Statista, Inc. [32], UNWTO [33-36], WTCC [39] and Russian federal authorities [25, 31] served as the information basis of the study.

4. Results

Tourism is already the largest industry in the world. Travel is the backbone of economies around the world. It brings in essential currency and inward investment, creates jobs and stimulates every sector. World Travel & Tourism Council (WTTC) data shows travel and tourism contributes to 10.4% of Global GDP and it is responsible of creating one in five new jobs and, for eight successive years, has outpaced the growth of the global economy [39]. About 30% of international tourists visited the following 5 countries of the world: France, USA, Spain, China, Italy. In 2030, UNWTO predicts an increase in international arrivals to 1.8 billion people, with about 40% of those arriving in Europe [33-36]. At the same time, the number of domestic trips per year exceeds 5 billion people, which underlines the direct link between domestic and inbound tourism, based on the country's common tourism infrastructure [9].

Russia is an excellent choice for many different kinds of tourism. It offers a blend of Eastern and Western culture with a wide variety of historic places, diversity of climatic zones and beautiful scenery, outstanding cultural heritage and rich natural resources, including spa resources. There are more than 1,000 cities in Russia, of which around 70 per cent are smaller cities, and any of them have their own peculiarities and unique historical value. As to the big Russian cities, all of them can be a destination for business tourism and big events. Moscow is traditionally the top urban tourism destination in Russia, together with St. Petersburg, with its acclaimed masterpiece of world architecture and culture [27-29]. However, over the past five years since 2013, the export of tourism services in Russia has significantly decreased from the level of 20.2 to 12.8 billion US dollars in 2016. At the same time, the United States, Spain and the Great Britain are steadily increasing their income from foreign tourism. Table 1 shows the main factors of tourism growth and the associated risks.

Table 1. Fundamental factors of growth of world tourism and related risks (UNWTO data)

Drivers of growth	Main risks
Favorable economic environment	Economic slowdown
Strong outbound demand from major source markets	Unstable fuel prices
Consolidation of the recovery in key destinations affected by previous crises	Geopolitical and trade tensions
Enhanced connectivity	Brexit uncertainty

Increased visa facilitation	

Exports of tourism in the world in terms of incomes are approaching such categories as "fuel" and "chemicals", already ahead of "food" and "automotive products". In this regard, we can talk about a high degree of attractiveness of the industry for development and investment. The development of inbound tourism is one of the priorities for the development of non-primary exports to the Russia, along with education, the chemical industry, the automotive industry, etc. Recently, the Russian Export Center, a state institute for supporting non- primary exports, was established and successfully operates in Russia, providing Russian exporters with a wide range of financial and non-financial (institutional, legal) support measures. The main problems in the development of tourism exports are presented in Figure 1.

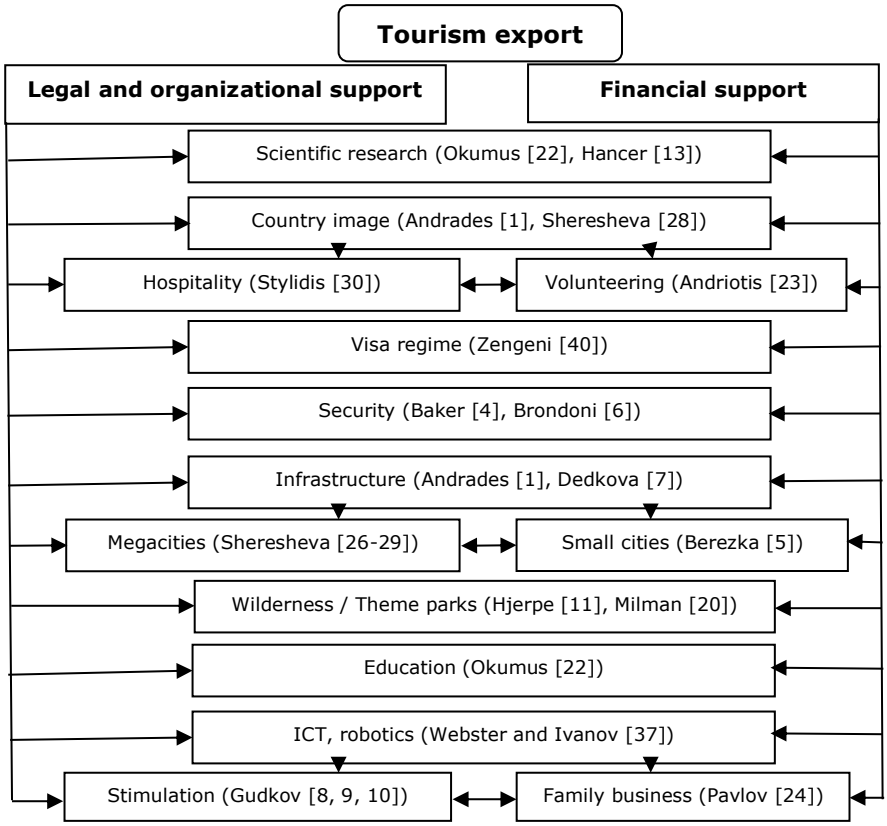

Fig. 1. Actual problems of tourism export development in scientific literature

Effective development of the export component of tourism is possible only in the context of a comprehensive solution to all the problems identified, which can be combined into two large groups – problems of ensuring the competitiveness of a destination and problems of financing the industry. Using the methodology of the Tourism and Travel Competitiveness Index (TTCI) and experience in assessing the competitiveness of tourism in Portugal [17], one can present the criteria for the competitiveness of Russian tourism in Table 2. However, the potential of inbound tourism is far from being fully used. The incoming tourism is mostly limited to visits to Moscow and St. Petersburg or quite traditional routes that are the most famous cultural destinations in Russia (i.e. the Golden Ring). Many Western experts and

potential foreign guests are convinced that Russia is not a «suitable» place for tourists. The reason is partly due to the negative information flow about Russia in Western media [26].

Table 2. The main criteria for the competitiveness of Russian tourism [8]

Criteria	Sub criteria	Sub index TTCI	Priority	Weight
Tourism	Number of accommodation and catering for tourists	C «Infrastructure»	Max	0.2
	Environmental costs	B «Policy and enabling condition»	Max	0.05
	Number of cultural heritage sites, including museums and art objects	D «Natural and cultural resources»	Max	0.1
	Amount of entertainment	C «Infrastructure»	Max	0.15
Environment	The proximity of the international airport	C «Infrastructure»	Min	0.05
	Extensive road network	C «Infrastructure»	Max	0.1
	The development of ICT	A «Enabling environment»	Max	0.1
	Number of university graduates	A «Enabling environment»	Min	0.05
	Crime rate	A «Enabling environment»	Min	0.1
	Level of medical care	A «Enabling environment»	Max	0.1

At the same time, as Andrades and Dimanche underlined, tourism development in Russia remains hindered not only by destination image but also by such issues as infrastructure development, workforce training and education, quality management and sustainable management [1]. There are also difficulties of visa processing for foreigners and insufficient development of road networks in many Russian regions, as well as an acute shortage of entertainment and accommodation resources in almost all attractive regional destinations, especially in small towns that are actually «hidden gems» of Russia [28].

Given the multidimensionality and multifunctionality of tourism, as well as the main trends in modern tourism in digital age, it is possible to offer the main directions of its perspective development in Russia:

1) The organization of flights with stop-overs for tourists traveling from Europe to Asia, from Asia to Europe, from the USA to Asia. In this case, the experience of Istanbul and Lisbon is very indicative, which allow you to get information about the city and country during transfers, ensuring the return of tourists for a longer period.

2) The creation and promotion of mobile applications for tourist attractions in various cities, which significantly increases the awareness of tourists and improves perception. Im and Hancer in their study enhances the understanding of travel mobile application usage behavior by investigating interrelationship of utilitarian/hedonic motivation and self-identity on attitude toward using travel mobile application [13].

3) Travel cards for transportation and discounts that are widely used in Europe, for example, the Berlin Welcome Card or the Lisboa Card.

4) Development of projects for the introduction of carpal lanes or the allocation of bus lanes for tourist vehicles in metropolitan areas, especially in Moscow.

5) Coordinated change in the visa policy of the state. Given the diversity of Russia and the territorial fragmentation of tourist sites, tourists should be given at least annual multivisas with a streamlined filing process, including the possibility of issuing electronic visas, which will significantly increase tourist flow, even if the high level of consular fees remains. The advantages of visa reforms are historically visible in the form of an observed increase in attendance after its implementation (and, conversely, a decrease in attendance while maintaining restrictive measures).

6) Financing and development of theme parks attracting a large number of international tourists, for example, in France, Spain and the USA. It has been scientifically and practically proven that theme parks and attractions significantly affect the socio-economic stability of a tourist destination and its competitiveness in the world [20].

7) Modernization of the education system for the training of specialists in the field of tourism and hospitality with the introduction of mandatory annual international internships.

8) Positioning of cities, tourist attractions of Russia not only within the country, but also on the world stage.

9) Development of federal and regional programs for direct and indirect financial incentives for tourism firms and enterprises. Including tax incentive tools designed specifically to support the tourism industry [9; 21].

It is important to carefully analyze the activities of the leading world cities, which are generally recognized tourist destinations, identify and compare the best practices used by them, and evaluate their applicability in the conditions of the Russian megacities. In terms of the use of advanced foreign experience, it seems appropriate to consider the leading megacities – benchmarks presented in Table 3.

Table 3. The experience of Great Britain, France, Germany, Italy and China of tourism stimulating in megacities [8]

Megacities – benchmarks		
Purpose of stimulation	**Incentive tools**	**Incentive results**
London		
1. Increasing the number of rooms for tourists	The adoption of state programs, the creation of conditions for the development of tourism, the co-financing of socially significant projects, the increase in tourist facilities in order to increase the number of tourists overnight	The number of rooms – 139,72 thousand; The number of nights spent – 75,1 million; Occupancy rate of tourist accommodation – 81,3%
2. Increase in spending of foreign tourist	Providing tourists with different categories of accommodation, the formation of an expanded supply of various indicators to best meet the demand	Costs - $ 16,09 billion.
3. Expansion and diversification of the offers for tourists	London Plan as the main strategic document defining the development of tourism	The flow of tourists even in low season. The increase in the number of tourists
4. The growth of foreign tourist flows	Formation of a favorable tourist image of the city, development of accommodation facilities in the average price range	Foreign tourist flow – 19 million people; Number of rooms in hotels 3-4* – 71169
5. Optimization of the average room rate	Control by the authorities, fiscal incentives, informational support to balance the cost of rooms, the needs of tourists and their capabilities	Average room rate – 160 euros
Paris		
1. Increasing the number of rooms for tourists	Adoption of state programs, creation of conditions for the development of tourism, co-financing of socially significant projects, an increase in tourist facilities in order to increase the number of overnight stays of tourists	The number of rooms – 84,473 thousand; The number of nights spent – 44 million; Occupancy rate of tourist accommodation – 69,4%
2. Increase in spending of foreign tourist	Providing tourists with different categories of accommodation, the formation of an expanded supply of various indicators to best meet the demand	Costs - $ 12,03 billion.
3. Improving of tourist service	Development of hotel and transport tourism infrastructure based on the Tourism Development Plan in Paris	Creating new tourist attractive areas. Ensuring a comfortable environment and safety of tourists. Increased control and attention of the city administration to tourist accommodation facilities
4. The growth of foreign tourist flows	Formation of a favorable tourist image of the city, development of accommodation facilities in the average price range	Foreign tourist flow – 14 million people; Number of rooms in hotels 3-4* – 58001
5. Optimization of the average room rate	Control by the authorities, fiscal incentives, informational support to balance the cost of rooms, the needs of tourists and their capabilities	Average room rate – 230 euros
Berlin		

1. Increasing the number of rooms for tourists	Adoption of state programs, creation of conditions for the development of tourism, co-financing of socially significant projects, an increase in tourist facilities in order to increase the number of overnight stays of tourists	The number of rooms – 55,012 thousand; The number of nights spent – 31,1 million; Occupancy rate of tourist accommodation – 77,1%
2. Increase in spending of foreign tourist	Providing tourists with different categories of accommodation, the formation of an expanded supply of various indicators to best meet the demand	Costs - $ 5 billion.
3. The formation of social responsibility of enterprises in the field of tourism, attention to the interests and needs of the inhabitants	Distribution of relevant regulatory standards to individuals and organizations renting accommodation for tourists	Placement control. Identification of opportunities for the development of a hotel offer to equalize the tourist load in the city and improve the price structure.
4. The growth of foreign tourist flows	Formation of a favorable tourist image of the city, development of accommodation facilities in the average price range	Foreign tourist flow – 5 million people; Number of rooms in hotels 3-4* – 37418
5. Optimization of the average room rate	Control by the authorities, fiscal incentives, informational support to balance the cost of rooms, the needs of tourists and their capabilities	Average room rate – 96 euros
Rome		
1. Increasing the number of rooms for tourists	Adoption of state programs, creation of conditions for the development of tourism, co-financing of socially significant projects, an increase in tourist facilities in order to increase the number of overnight stays of tourists	The number of nights spent – 26,9 million; Occupancy rate of tourist accommodation – 69,3%
2. Increase in spending of foreign tourist	Providing tourists with different categories of accommodation, the formation of an expanded supply of various indicators to best meet the demand	Costs – $ 4,5 billion.
3. Expansion and diversification of the offers for tourists	Strategy for the development of tourism in Italy. Identify opportunities to use the seaside area to create tourist offers non-beach recreation	Transformation of the southwestern part of the city into a seaside recreational zone
4. The growth of foreign tourist flows	Formation of a favorable tourist image of the city, development of accommodation facilities in the average price range	Foreign tourist flow – 9 million people
5. Optimization of the average room rate	Control by the authorities, fiscal incentives, informational support to balance the cost of rooms, the needs of tourists and their capabilities	Average room rate – 148 euros
Beijing		
1. Increasing the number of rooms for tourists	Adoption of state programs, creation of conditions for the development of tourism, co-financing of socially significant projects, an increase in tourist facilities in order to increase the number of overnight stays of tourists	The number of accommodation facilities – 2236; Occupancy rate of tourist accommodation – 63,7%
2. Increase in spending of foreign tourist	Providing tourists with different categories of accommodation, the formation of an expanded supply of various indicators to best meet the demand	Costs – $ 4,6 billion.
3. Higher degree of satisfaction of the population with the tourist industry	General state strategy reflected in five year plans	The comprehensive contribution of the tourism industry to the national economy should exceed 12%
4. The growth of foreign tourist flows	Formation of a favorable tourist image of the city, development of accommodation facilities in the average price range	Foreign tourist flow – 4 million people

5. Optimization of the average room rate	Control by the authorities, fiscal incentives, informational support to balance the cost of rooms, the needs of tourists and their capabilities	Average room rate – 66 euros

Taking into account international experience, we can see how high the level of development of tourism is in the leading destinations of the world. From the other hand modern-day world faces a hostile climate, depleted resources and the destruction of habitats. The dream that growth will lead to a materialistic utopia is left unfulfilled by a lack of ecological and economic capacity. The only choice is to find alternatives to increased growth, transform the structures and institutions currently shaping the world, change lifestyles and articulate a more credible vision for the future and lasting prosperity [3]. This is also confirmed by the problem that the world faced in 2019-2020 – COVID-19. And now many countries try to find alternatives to increased tourism growth using domestic flows. Table 4 presents the new challenges for the tourism industry, taking into account the COVID-19 pandemic.

Table 4. New challenges for the tourism industry due to the COVID-19 pandemic

Challenges	Explanations
Travel restrictions	It's affecting level of travel: travel advisories, companies canceling travel, and traveler behavior. There is a deep risk aversion when a trip is a voluntary activity. Even if a flight exists and borders are open.
Lost jobs	The travel and tourism industry responsible for creating one in five new jobs and, for eight successive years, has outpaced the growth of the global economy. Now worldwide it is asking for relief including tax credits for employee retention, which would give employers an income tax credit for paying workers even while their business is inoperable.
Problem of physical interaction	In accordance with the new social environment because of COVID-19 pandemic, people must avoid physical interaction, and service robots can be a useful tool to ensure a high level of physical distance during the epidemic now and in the future.
Financial problems	Small and medium-sized enterprises (which make up around 80% of the tourism sector) are expected to be particularly impacted. This might affect millions of livelihoods across the world, including vulnerable communities who rely on tourism as a vehicle to spur their development and economic inclusion.

Russia is still a country with elements of a planned economy, market processes are not sufficiently developed, therefore the importance of the state in the processes of regulating the activities of various industries is quite important. Strict legislative regulation of activities on the one hand pursues the goals of ensuring security, preventing financial fraud and deceiving consumers, but on the other hand in practice leads to the formation of too intricate and very restrictive development of norms and rules, which do not allow to appear new businesses. The same applies to the tourism industry, despite the prospects, at present, since 2014, there has been a significant decrease in the profitability of enterprises in the industry, as evidenced, for example, by travel agency surveys [10]. In this regard, a way out of this situation is possible only through state intervention. As already noted, the most significant are the measures of financial and tax support. Fig. 2 presents the proposed hierarchy of financial support for the tourism export.

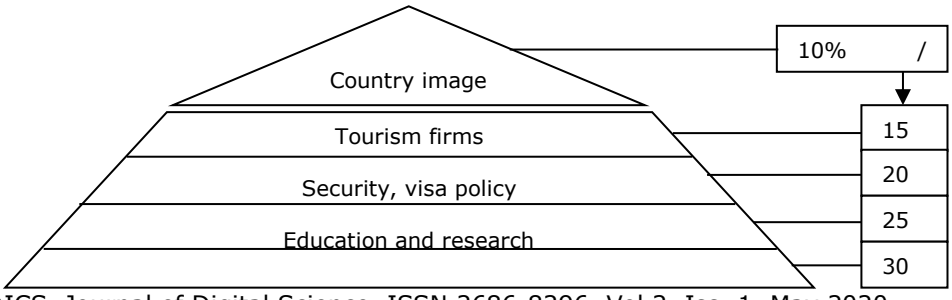

Fig. 2. The hierarchy of financial support for the tourism export [8]

The smallest value of the indicator "image" is explained by the fact that the image of the country as a tourist destination is formed by a combination of subordinate factors that increase its export orientation. It is important to create the Tourism Development Fund. It will invite for applications for grants to support events or projects that will attract additional visitors in Russia and help stimulate the tourism industry even more. In particular, from small businesses and start-ups. Organizations wishing to apply to the Fund should be able to demonstrate that their events or projects will attract more visitors, can attract additional funding from sources in addition to the Fund and create sustainable enterprises in the coming years. Many funds all over the world already have supported numerous successful events and infrastructure development, covering a wide range of tourism initiatives.

According to WTTC data, in 2018, the direct contribution of the tourism industry to the economy of the Russian Federation amounted to 1 215,7 billion rubles, or 1,5% of GDP. The total contribution of tourism (including related industries) amounted to 4 926,7 billion rubles, or 6% of GDP. The number of jobs amounted to 1 million – this is 1,4% of total employment, and taking into account related industries – 5,5% [39]. Financial and economic indicators of tourism in the Russian Federation in dynamics for 2013-2019 according to government data are presented in Table 5.

Table 5. Financial and economic indicators of tourism in the RF in dynamics for 2013-2019, in billion rubles (WTTC data)

Indicator	2013	2014	2015	2016	2017	2018	2019
The direct contribution of tourism to Russia's GDP	1205,4	1268,3	1203,7	1169,3	1166,1	1215,7	1237,8
Total tourism income in GDP of the Russia	4809,3	4761,7	4599,9	4751,7	4753,3	4926,7	5013,4

Today, tourism has become an important sector of the Russian economy, aimed at expanding the country's integration into world tourism. According to WTO estimates, in 2019, in the world ranking of 181 countries, Russia ranked: by the growth of the direct contribution of tourism to Russia's GDP – 39th place (5,8%); in terms of growth of total tourism income in the GDP of the Russian Federation – 137th place (4,6%); in terms of investment growth in tourism – 120th place (2,1%).Targets for tourism development in the Russian Federation until 2035 include those presented in Table 6.

Table 6. Targets for tourism development in the Russian Federation until 2035 (WTTC data)

Indicator	Units	2017	2025 (forecast)	2035 (forecast)
Tourism gross Value Added	billion rubles	3158	6039	16306
Availability for inhabitants	percent	40	60	100
Tourism export	billion US dollars	8,9	16,7	28,6
Investment growth	percent	100	150	300

The data presented show that tourism in Russia has not yet taken a leading position in the country's economy, as is the case in almost the whole world. One of the reasons for this situation is the underdeveloped infrastructure in potentially promising areas, outdated material and technical base, low level of service and high price of tours, weak state support, both economic and legal. With the strengthening of the fiscal function of the state, tourism financing has virtually ceased. However, the new crises make us seriously think about paying more attention to the tourism industry and its financial support. First of all, tourism provides a large number of jobs

and therefore it is impossible to ignore it in modern conditions. In March, 2020 WTTC said up to 50 million jobs in the travel and tourism sector are at risk due to the global COVID-19 pandemic.

5. Conclusion

Tourism is important for the development of the country, as it contributes to the preservation and development of historical, cultural, natural, resort and recreational potential of various subjects of Russia, as well as smoothing the disparities in the socio-economic development of regions. In addition, the tourism industry stimulates the growth of about 50 other dependent sectors of the economy. At the same time, additional jobs are being created, investments are being attracted, small and medium-sized businesses are developing, the amount of tax revenues to the budgets of the budget system of Russia is increasing, and international relations are improving. In Russia, there has been a certain growth trend in domestic and inbound tourism. Domestic tourist flow has increased significantly since 2015. However, at the moment, the tourism industry in Russia has almost exhausted the resources of domestic growth and development, which were given during the annexation of the Crimea, the Olympic Games and the World Cup, the closure of popular outbound areas, which actualizes the solution to the problems of inbound tourism. Demand from Europe that declined dramatically in 2015 and was partly replaced by Asian demand, began to recover in 2016-2017. An important factor in this development relates to depreciation of the ruble: spending in Russia, including accommodation costs, is now much cheaper for clients from Europe due to the change in the currency exchange rate. The entry flow from Asian countries is also growing, primarily from China [29].

Taking into account the goals of Russian programs with a 70% increase in the contribution of tourism to GDP, tourism should show growth twice as much as the growth rate of the entire state economy. This is possible only through the effective distribution of financial support for the industry based on the proposed hierarchy, paying close attention to the main areas of its prospective development in Russia, taking into account the criteria of competitiveness and the experience of megacities - benchmarks of the world's leading tourist destinations. Fig. 3 summarizes the current problems and conditions for the development of inbound tourism.

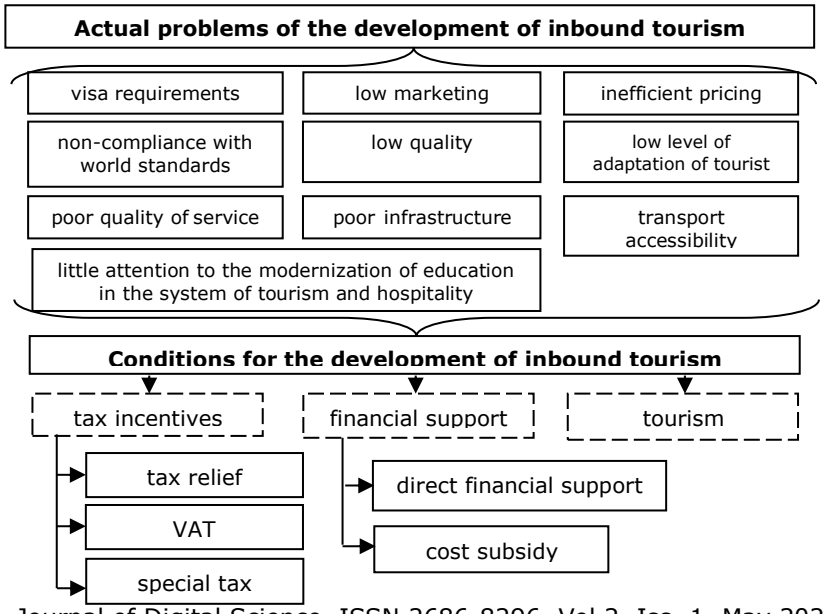

Fig. 3. Actual problems and conditions for the development of inbound tourism [8]

The Russian government is making a huge effort to improve the country's tourism infrastructure and to help the Russian regions in their movement toward sustainable tourism. It is planned to give priority to the cluster approach in tourism and to boost five priority types of tourism: cultural, health, active, cruise and ecotourism. However, the new social environment created by the COVID-19 virus requires more significant measures of financial support for travel, tourism and hospitality industry and the immediate introduction of tax benefits. WTTC suggest that the travel sector could shrink by up to 25% in 2020. It is calling on governments to take several steps to protect the industry, including:

- removing or simplifying visas where possible, as well as reducing costs;
- relaxing "unnecessary barriers" at ports and airports;
- reduce travelers' taxes such as air passenger duty;
- increase budgets for promoting travel destinations.

The experts on tourism economics expect a full recovery by 2023-2024, based on how the travel industry recuperated from past slumps, once the situation has stabilized.

The main results of the study are to comprehensively address the problems of exporting tourism and the main drivers of its global growth, form a set of criteria for the competitiveness, suggest directions for its future development based on the world's best tourist practices and determine the hierarchy of financial support for tourism exports.

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Financial reporting and climate-related disclosures

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Abstract. The article examines disclosures on climate-related risks in financial statements. The conducted study has analyzed corporate reports (financial, integrated, environmental, on sustainable development) of leading Russian metallurgical companies that consider climate change influence or environmental impacts as the most significant. The following conclusion is derived from conducted research. Majority of climate-related disclosures are currently made in broader corporate reports, primarily in ecological, social responsibility and sustainable development reports. There is almost no information about climate-related risks in financial statements, and there are no corresponding cross-references on environmental issues between financial and non-financial reports. Climate-related risks impact most important indicators of financial statements, corporate strategy and business model. Materiality of information on climate change impact on companies` financial position, performance and cash flows need to be considered in the context of financial statements. The aim of the study is to confirm the materiality of climate-related risk disclosure for interested users, existing insufficiency of such disclosures in financial statements and make proposals on filling the identified information vacuum. The article offers recommendations on feasibility of developing a new standard "Climate risks: Disclosures", which should provide users with essential information on the judgments and assumptions related to assessment of climate-related risks` impact on financial statements.

Keywords: financial and non-financial reporting, climate-related risks disclosures, financial consequences of climate-related risks.

1. Introduction

The World Economic Forum on Global Risks 2019 had identified the systemic threats associated with climate change and environmental degradation as the most significant and destructive factors that will threaten the world over the next decade[1]. Climate change is having an increasingly serious impact on socio-demographic processes (for example, mortality, employment, migration) as well as on the economies of countries and individual enterprises. They are associated with the death of people from forest fires, floods, increasing morbidity and mortality rates due to epidemics and exacerbation of chronic diseases. There are studies indicating a link between climate change and epidemics. The consequences of this connection are becoming increasingly disastrous in the context of growing globalization and free movement of people around the world.

A great number of participants in capital markets are becoming aware of the risks and their significance as well as new opportunities that are inextricably linked to climate change. At the same time surveys and interviews with representatives of investment communities [1, 2] indicate the absence of a unified approach to disclosing

[1] World Economic Forum. The Global Risks Report 2020. Available from http://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf 2.

information on climate-related risks. Therefore, it leads to the incompatibility of reporting data regarding to the impact of climate change on the results of companies' operations and prospective cash flows. These factors are becoming the main obstacles for accounting the climate change risks when making decisions by investors, lenders and insurers.

Studies show that investors need to be provided with two types of information: how companies and their businesses affect the environment and how climate change and related risks influences the company's strategy, its business model and ability to create value [1, 3]. The damage caused to large and small businesses by pandemic COVID-19 around the world makes the need to assess the resilience of the business model to such risks particularly relevant.

Today, the investment and analytical community is the leader in the developing the process associated with the consideration of climatic factors and their disclosure in the financial statements [4,5,6].

The main objective nowadays is to build a system for the formation and disclosure of data related to climate change and its financial and other consequences for the stakeholders. The need for such disclosures is in demand by both the expectations of investors and by the desire of companies to ensure the long-term business functioning.

In 2015, the Financial Stability Board at the request of the G20 leaders set up Task Force on Climate-Related Financial Disclosures (hereinafter TCFD), that is a methodological platform, aiming, on the one hand, to assist companies in revealing climate-related risks and their possible financial consequences, and on the other hand, to help financial markets integrate these risks into key instruments. Such an approach allows investors to make financial investments more effectively.

One of the core differences between the TCFD recommendations is included in the approach itself: this is the disclosure of climate impacts *on* the company, rather than the environmental impact *of* the company, that reporting compilers present in most cases currently. In accordance with the recommendations, disclosure of the climate impact on the company's activities involves reporting data in four key areas: management (how the responsibility for managing climate-related risks is shared in a corporate structure); strategy (identifying risks and opportunities over time periods and explaining how they affect strategic and financial planning); climate risk management in the frame of the company's risk management; key and target indicators (i.e. quantitative indicators of the climate influence degree on company's activities, monitoring and analysis of their conduct). This approach may be called as universal and applicable in any organization. TCFD issued official climate disclosure guidelines[2], which later were used as the basis for changes to existing non-financial reporting systems, such as GRI, IIRC and SASB, ESG indexes and ratings. The EU has adopted an approach to corporate social responsibility from the internal and external standpoints of responsibility among economic entities[3].

Preparing relevant information that fully and reliably reflects the business ability to operate in the face of growing climate risks is a complicated issue due to the lack of risk standardization, the methods for risk identification and description, practical guides to report on climate change risk.

The following section provides a literature review that examines the direction of research in the field of climate-related risks disclosures in financial and non-financial

[2] Climate Disclosure Standards Board (2018) Task Force on Climate-related Financial Disclosures. [Online]. Available from: https://www.cdsb.net/what-we-do/task-force-climate-related-financial-disclosures/commit-implement-recommendations-task

[3] European Commission (2017) Communication from the Commission — Guidelines on nonfinancial reporting (methodology for reporting non-financial information) (2017/C 215/01).

reporting. The next section presents the methodology, the approach and sample of this study, followed by a discussion that summarizes our findings.

The conclusion of the paper contains key thoughts, recommendations and directions for further research of public disclosure on climate risks. The paper brings some new insight, which are useful for the scientists as well as managers.

2. Literature Review

Baksaas & Stenheim (2019) argue that the users` benefits from financial statements depend on clear and concise presentation of the underlying economics. The authors conclude that current IFRS regulation on presentation of primary financial statements suffers from some flaws and propose modifications of the current financial statements under IFRS [7].

In general, existing laws and regulations already require disclosing the information related to climate change risks in the cases where such information is considered material (IAS 1 Presentation of financial Statements, IFRS 7 Financial Instruments, IAS 16 Property, plant and equipment, IAS 36 Impairment of Assets, IFRS 3 Business Combinations and some other financial reporting standards).

EY survey (2017), J. Richard et al. (2017) outlined the progress made by governments, stock exchanges, non-governmental organizations and other parties in the field of disclosure systems [4, 8]. However, despite the achievements the disclosure of information related to climate change does not provide the required completeness.

There is a demand in an assessment of the climate change impact on the reporting companies' activities from a financial standpoint. Such an approach will serve as a milestone for developing recommendations on the voluntary disclosure of relevant information in the framework of mandatory financial statements. In general, the disclosure of information related to climate change should be guided by the processes of effective corporate governance. It also should let on the significant factors and their impact on the company's activities, as well as fully reflect the strategy used by a company to manage the relevant risks.

Currently, most companies are still at an early stage of introducing recommendations into practice. TCFD forecasts it will take about five years of voluntary use before companies learn to be aware of their investors' expectations. However, in many cases it is not necessary to get a new start, since the environmental disclosures, that the report compilers have made so far, may be considered as the basis.

M.Kuter et al (2017) argued that historical analysis of accounting development and its particular branches demonstrate the significance and particular impact on it with the economic conditions and stakeholders' requirements [9]. Y.V. Sokolov (2011) identified five paradigms in accounting theory including sociological. The issues of environmental responsibility are related to the sociological theory in the broad sense [10].

The issues of environmental responsibility are mainly perceived as a part of the sociological theory of accounting, which was developed by such scientists as Littleton and Zimmerman (1962), Bedford (1973), Tinker (1984)-[11,12,13].

An analysis of scientific works on this topic reveals the ambiguity of interpretations, the presence of different approaches to the rules for reporting corporate social and environmental responsibility, which is largely due to the existence of various standards for corporate reporting such as GRI (Global Reporting Initiative standards), the conceptual framework of IR (Integrating Reporting), SASB (Sustainability Accounting Board Standards).

Moser D.V., Martin P.R. (2012) argued that the presence of different standards impedes mutual understanding between different categories of utilizers: economic

entities themselves and users of their reporting. On the other hand, reporting in this area expands its utilizers' range [14]. In addition, mutual understanding also requires confidence in the reliability and high quality of reporting. Such an issue is covered in the scientific literature, for example, in the works by Edgley et al (2014), Trotman A. and Trotman K. (2015) [15, 16].

Fernandez-Feijoo B. et al (2014), Gamerschlag R. et al (2011), Hassan A., Ibrahim E. (2012) devoted to the study of disclosure content regarding to specific issues of environmental responsibility [17, 18, 19]. However, such studies are only the basis for a more serious analysis of the further improving the disclosure requirements for climate impacts, related risks and opportunities. For example, there are papers on an analysis of investors' needs in presenting information on the risks connected with the impact of climate factors on business both in the short and long-term prospective [20, 21, 22]. A profound scientific analysis on the conceptual and methodological issues of environmental accounting based on more than 80 scientific sources was carried out by Richard and Altukhova. (2017). The authors proposed CARE model, which is a transposition of a traditional capitalism accounting model into natural and human capital [8]. The authors suggest the idea to establish a new accounting environmental law that ratifies a new vision of both capital and profit concepts for environmental and social management.

In the context of the ongoing pandemic COVID-19, the study of Brenner and Marwan (2018) which indicates the existence of a direct link between climate change and the occurrence of epidemics seems extremely relevant. The study results point out the influence of climate change on pandemics from 1980 until 2040. The presented results focus on the effect that climate change has on spreading patterns of airborne infectious diseases [23]. On the one hand, the pandemic exhibited one of the catastrophic scenario options resulting from climate change. On the other hand, it made it evident that even temporary reduction in the scale of activity had an impact on the environmental situation. Under the circumstances, the quality of climate-related reporting is getting extremely important. The stakeholders should have a clear understanding of any environment-related activity.

3. Data and Methodology

The study has analyzed financial and corporate reports of 9 Russia's biggest metallurgical companies PJSC NLMK Group, RUSAL, Norilsk Nickel, OMK, EVRAZ, MMK, Severctal, Metinvest, TMK, for which the impact of climate change and environmental impact is the most significant. The choice for the analysis of the metallurgical industry is explained by the fact that in addition to the direct environmental impact, their activities are associated with the activities of a large number of other economic entities - mining and transport companies, equipment manufacturers, chemical enterprises, etc. This whole chain has a significant impact on climate change. In addition, these companies are city-forming and their environmental sustainability affects the social security of the population.

An interim conclusion of analysis is following: despite the fact that the performed linguistic analysis has not revealed the mention of such terms as "climate" or "climate-related risks" in their financial reporting, the financial statements of these companies reflect and disclose the estimated obligations associated with environmental activities.

The analysis of the non-financial reports was based on a study of 16 sustainability reports (provided by PJSC RUSAL, Norilsk Nickel, Severctal, NLMK Group, Metinvest), 8 integrated reports (PJSC NLMK Group, OMK, EVRAZ, TMK), 8 corporate responsibility reports (PJSC Norilsk Nickel, MMK) and 3 environmental reports (PJSC NLMK Group, Norilsk Nickel) that were presented on the RSPP website in 2014-2018[4].

[4] http://rspp.ru/simplepage/157

For the purposes of the study, we used linguistic analysis to identify sections and report elements containing references to the terms: "climate", "climate change", "climate risks" and statistical analysis of the presented indicators. The study found that all analyzed reports reflect the environmental impact of these companies and include the indicators that characterize emissions, wastes generation and their usage, energy efficiency aspects.

In accordance with NLMK`s corporate strategy, minimizing the environmental impact is a prerequisite for implementing the strategy. Minimizing the negative impact of the Group's enterprises on the environment is the result of both planned environmental and technological measures outside of the investment process, as well as of NLMK Group's programmatic investment activities[5].

Severctal specifies 2018-2025 Environmental Improvement Objectives in its sustainable development report[6] and notes that its work has been recognized internationally with an 'Outperformer' rank from ratings organization Sustainalytics, a Low Risk Score from ISS and inclusion in the FTSE4 Good index., it is satisfying that its work so far has been recognized internationally with an 'Outperformer' rank from ratings organization Sustainalytics, a low risk score from ISS and inclusion in the FTSE4 Good index.

The Norilsk Nickel`s Sustainability Report goes into detail on how the Company is contributing to the six UN 2030 Sustainable Development Goals that have been identified as the most relevant and prioritised. For the first time ever, the 2019 Nornicel SD report includes the Climate Change Risk Assessment, which evaluates the impact of climate change on the Company's operations and assesses related risks and opportunities[7].

EVRAZ Group's environmental program employs environmental audits (due diligence) to perform environmental liability and risk assessments of existing sites and assets being acquired. Throughout its activity the Group has introduced an environmental management system that is based on the corporate approach and prioritises international certification, which, while not a legal requirement, has led to seven of the Group's sites obtaining ISO 14001 certification, including core operations like EVRAZ NTMK and EVRAZ ZSMK[8].

One of the most important elements of the MMK activity is in improving the quality of life of Magnitogorsk, it is the ultimate goal of the Company's Environmental Strategy and Clean City Initiative.[9]

The environmental reports of these companies reflect topics of environmental management system, goals and programs, financing, negative environmental impact fee, environmental impact indicators, efforts to prevent environmental impact, environmental assessment of projects, innovation in environmental protection.

According to the National Register of Non-Financial Reports[10] of Russian Union of Industrialists and Entrepreneurs, 52% of all non-financial reports registered on the website in 2018 identified the Goal of "taking urgent measures to combat climate change" as a priority.

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5 http://нлмк.рф/upload/iblock/571/annual_report_part_iv_rus_web.pdf

6 https://www.severstal.com/eng/sustainable-development/environment

7 https://www.nornickel.com/news-and-media/press-releases-and-news/nornickel-s-sustainable-development-report-reducing-emissions-and-setting-new-goals-/

8 https://ar2018.evraz.com/en/csr-report/hse/environment

9 http://eng.mmk.ru/upload/iblock/44c/Annual_Report_2018_eng2.pdf.

10 http://rspp.ru/simplepage/475

For analysis purposes we selected companies` non-financial reports that were named among the best in national ratings. However, the analysis of climate-related disclosures showed no relation between these reports and key financial indicators. We can confirm the absence of interconnected links between financial and non-financial reporting. In addition, the reports did not reflect any ways the company plans its future activities in connection with climate change or how climate risks determine the changes in the company's strategy. In our opinion, the most significant drawback is the incoherence between environmental reporting, which nowadays can be almost completely considered to be climate change reporting (in the broad meaning of the term), and financial reporting.

Despite disclosing financial data related to the costs of maintaining and protecting the environment, an assessment of the financial consequences due to climate change and their impact on critical financial statements is not presented in any report. At the same time, the influence of climate-related risks on the most important financial indicators is becoming increasingly significant. Therefore, we can identify the problem as the lack of proper harmonization of financial and non-financial reporting.

The following table presents some requirements in IFRS and non-financial reporting standards that are directly connected with climate-related risks` impact.

Table 1. Climate-related risks as the subject for disclosure in financial and non-financial reporting

Topics for consideration	**Disclosure objects**
Impact on ESG strategy	E - investments in fixed assets and operating expenses for environmental protection; payments for negative environmental impact. S - level of injuries and mortality, diseases associated with climate change, employment. G - environmental impact, including waste generation, harmful emissions into the atmosphere, greenhouse gas emissions; impact on soils and others.
Impact on the business model	Resources – availability and consumption. Business processes - the development of new technologies, energy efficiency, innovation. Products and services - environmental friendliness. Adaptive features of the business model.
Impact on results for investors	EBITDA - adjustments related to the formation of provisions and expenses recognized for EBITDA calculation; FCF – cash flow available for shareholders and creditors; Net Debt / EBITDA.
Impact on cash flows	Operating activities - payments to comply with environmental and social requirements. Investments for the purchase of equipment, machinery, intangible assets: a) related to environmental activities; b) reducing climate risks, c) related to the prevention of negative social and environmental consequences. Financial - loans for environmental and social purposes.
Impact on the value chain	Impact on the supply chain. Impact on business processes. Impact on customers and markets.
Impact on fair value assessment (IFRS 13 *Fair Value Measurement)*	Environmental accounting, including climate-related risk assessment of assets` fair value (especially when using the income approach, and when using the level 2 inputs and level 3 inputs)
Impact on Assets impairment (IAS 36 Impairment of Assets)	1. The calculation of value in use requires the determination of the discounted value of future cash flows expected to be received from an asset or cash-generating unit. These future cash flows will be affected by climate-related risks. 2. The identification of an asset that may be impaired includes both external and internal sources. Both are affected by the risks of climate change.

The content of Table 1 indicates the impact of climate change and climate-related risks on all business aspects, including financial position, financial performance

and cash flows, and therefore should be taken into account when preparing financial statements.

For metallurgical companies, as well as for mining companies and some other sectors mostly affected by climate change, it is possible to predict attributes of asset impairment, which will require annual (or more frequent) asset impairment verifications. An impairment test when a loss is identified in a cash generating unit (CGU) will lead to a decrease or even loss of goodwill, which will inevitably affect an investment attractiveness. In addition, CGUs may be depreciated due to the lack of required resources for the activities and demand for the products.

Another urgent challenge for metallurgical companies at present will be the disclosure of COVID-19 impact on the policy of calculating non-GAAP indicators, such as EBITDA, FCF and others. It is very likely that companies may consider presenting metrics related to COVID-19, or changing the method by which they use to calculate this metric as a result of COVID-19.

4. Results

At present, climate-related risks are mainly discussed outside of financial reporting context. However, as described in the Conceptual framework for financial reporting, such qualitative external factors as the industry in which the company operates, the financial consequences of these risks and investor expectations make the information on these risks quite material and determine the need for its disclosure in the process of financial statement preparation, regardless of the risks' quantitative assessment.

The provided analysis indicates climate change impact on key financial indicators of enterprises as well as the strategy and business model. Moreover, this connection begins from the moment of confirmation of the going concern assumption. The existing and potential climate changes may result in failure to enforce this key assumption, in which case the financial statements can no longer be prepared in accordance with IFRS.

Given the investors' statements on the importance of climate-related risks for decision making, the requirement to disclose all relevant information means that organizations can no longer consider climate-related risks exclusively as aspects of social corporate responsibility, but, therefore, should consider them in the context of financial reporting (at least, this applies to enterprises of certain industries).The expedience of developing a special standard on risk disclosures within the system of financial reporting standards manifested itself in the face of the pandemic. So far there have been standards in the financial statements for information disclosure in relation to financial instruments (IFRS 7 Financial Instruments: Disclosures) and in relation to affiliation with other companies (IFRS 12 Disclosure of interests in other entities). The standard on information regarding operating segments (IFRS 8 Operating segments) may also be partly included. As the world enters the era of true climate change manifestations, we need to recognize the significant impact of business and climate interrelationship.

We suppose it is essential that for all items of the Statement of financial position, the Statement of comprehensive income and the Statement of cash flow addressing climate change issues, relevant disclosures be presented in two aspects - the company's impact on climate and the climate's impact on the company. The information should be presented in such a way that would make the stakeholders understand what climate risks the company creates, what climate risks it is exposed to, and what climate risks the company mitigates or removes.

5. Conclusion

The study aims to confirm materiality of climate-related risk information disclosure in financial statements with the existing insufficiency of such disclosures and make proposals on filling the identified information vacuum. The study based on investigation of information requests of stakeholders and provided analysis of financial and corporate reports of Russia's biggest metallurgical companies, for which the impact of climate change and environmental impact is the most significant. For the purposes of the study, we used linguistic analysis to identify sections and report elements containing references to the terms: "climate", "climate change", "climate risks" and statistical analysis of the presented indicators. The study found out that all analyzed non-financial reports reflect the environmental impact of these companies and include the indicators that characterize emissions, wastes generation and their usage, energy efficiency aspects. However, there is almost no information about climate-related risks in financial statements, and there are no corresponding cross-references on environmental issues between financial and non-financial reports.

The conducted study has certain limitations, concerning the sample size, the choice for analysis of the metallurgical industry, while the impact of climate change is no less significant for some other sectors.

The research brings up the issue of a standard in the system of financial reporting on climate-related risks (impact) in connection with non-financial reporting. Given the investors' statements on the importance of climate-related risks for decision making we recommend developing a new standard "Climate risks: Disclosures", which should provide users with essential information on the judgments and assumptions related to assessment of climate-related risks` impact on financial statements. The IFRS 8 Operating segments, which present management reporting information, can be considered an analogue. The proposed standard may also include management reporting and non-financial reporting information, but the user should be able to see the whole picture - in sufficient scale and in one place. Stakeholders can find the more detailed disclosures in non-financial reporting. We believe in the need to continue the research on the applicability of introducing such a standard, its goals and information tasks, as well as its structure and content.

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Any remaining errors are the authors responsibility.

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Digital universities in Russia: digitization with extra speed

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Abstract. The education sector is subject to significant changes due to the increasingly active spread of digital technologies. Usually, the trends in the implementation of digital technologies in educational and research activities are set by commercial organizations – private universities, business schools, corporate universities. But public universities and institutions start to think more and more about digital transformation. However, evolutionary path of universities' digitization was destroyed by the spread of Coronavirus (COVID-19). It was decided to completely close universities, all students started to study from home. In this paper, we aimed to start a discussion about distance learning satisfaction among professors and lecturers; understand their vision about e-learning and the current stage of universities' digitization. After examination of the current state of university digitization, we have identified major problems which become an obstacle during pandemic.

Keywords: Digital technologies, digitization, digital university.

1. Introduction

The modern world is constantly changing. Innovations are being introduced into various spheres of human activity, which, on the one hand, directs people to continuous development, enhancement their knowledge, skills, competencies, acquirement new types of activities in related sectors of economy. On the other hand, routine work is increasingly transferred to machines, and a person is required to be creative, actively collaborate with colleagues in a search for new solutions, and most importantly have an ability to evaluate information offered, both for its reliability and for logical embedding in current task.

International studies show the lack of highly qualified specialists in most countries. According to Korn Ferry, global human talent shortage will amount to 85.2 million people by 2030. Most (74 percent) of leaders of largest organizations in the world believe that technologies will make a greater contribution to creating business value than the human factor in the future. At the same time, highly qualified personnel are going to be in a high demand [1].

Certainly, innovative methods and technologies are increasingly being introduced into the modern education system, allowing to strength the practical orientation [2]; as well as the emergence of a global knowledge system and information and communication technology represent global forces affecting the higher education [3]. At the same time, it can be noted that the informatization stage is at the final step, since all educational institutions are equipped with computer technology, and teachers and students use information technologies in the educational process (computer classes, internet, mobile applications) [4].

In early March, UNESCO published a report on the rapid transition to distance learning during the active spread of the coronavirus. At that time, in 22 countries around the world, it was decided to partially or completely close schools and universities, about 290 million children studied from home. Absolutely, this is a huge challenge for the entire education system. The People's Republic of China was the first country switched abruptly to online education. The Ministry of Education of the country issued a Guide to the organization and management of online education in colleges and universities. It dealt with free online courses, measures to ensure the quality of education, the rapid opening of a national online learning platform, and the translation of paid educational services platforms into a free format.

From 16 March 2020 the largest Russian higher education institutions switched to a distance education and training in order to prevent the spread of a new type of coronavirus (COVID-19) in the Russian Federation. Undoubtedly, this was a revolutionary step that changed the situation in the industry, what is called "in one day". On 23 April 2020 online lectures are held throughout the country, more than 80% of universities have implemented distance learning.

Our aim in this study was to start a discussion about distance learning satisfaction among professors and lecturers, understand their vision about e-learning and the current stage of universities' digitization. To our understanding, students have long ago been ready for the transition to distance education. But some teachers lack experience in a virtual environment, as well as relevant teaching materials.

The paper proceeds as follows. Section 2 reviews model of digital university, states main principles. Section 3 provides information about data and methodology; we based our research using experience of the Financial University under the government of the Russian Federation and the State University of Management. In Section 4 we made an attempt to evaluate results, summarize main problems and brief conclusions.

2. Literature Review

In our opinion, it would be a mistake to call any university digital only if it has introduced any digital technologies, or a university that trains personnel for the digital economy. Digital University involves the restructuring of internal business processes based on the introduction of modern digital technologies.

Since today in Russia there is no conceptual model of a digital university, we have formed a conceptual model of a digital. Digital University Conceptual Model consists of five levels and a supporting platform [5].

The first level is the most important; it is represented by scientific and pedagogical staff, students, industry and academic partners of university, graduates and applicants. The first level is, in fact, internal and external stakeholders of a university.

The second level is represented by basic information services. Their task is to create a single information space for digital interaction within university using flexible tools. Examples of such services are video screens for lectures and seminars, wireless communications throughout the university (including dormitory), cloud storage for keeping and exchanging data, professional printing etc.

The third level includes services that greatly facilitate the lives of students and teachers in a modern university. For example, a digital library, international databases, etc.

The fourth level is the most resource-intensive in terms of implementation, but at the same time it allows a university to get the highest added value. It consists of services such as digital marketing, research project management, procurement management, interaction with applicants and students.

Digital marketing is a new field for Russian universities aimed at solving the following problems:

• organization of interaction with the teaching support staff, students, applicants, graduates using the entire modern spectrum of digital communication channels;

• monitoring changes in the perception of the university brand in the target markets based on the results of research and monitoring of social networks; conducting preventive and reactive measures to form a positive image of the university;

• stimulating the creation of new digital communities and innovations at all stages of the educational cycle, as well as communication of the content of educational programs and features of student activities for applicants;

• development of personalized marketing materials for target audiences based on analysis of data from various sources.

Interaction with applicants and students includes the following tasks:

• use of digital technologies to interact with applicants and inform them about the stage of processing applications for admission;

• usage of analytics to determine the most promising applicants and increase their enrollment rate;

• use of various communication channels both digital and traditional in order to provide applicants with the most complete information about the university. This task is most relevant for foreign applicants who cannot visit the university and want to form an idea of it using information from the Internet;

• using analytics to identify the most successful and least successful students;

• automation of work, for example, the creation of a "digital student office".

The fifth level consists of digital technologies, which are highly likely to be widely used in the university environment. Such technologies, for example, include drones (unmanned aerial vehicles). In this context, as a first step, universities will actively introduce drone technology into the internal educational and research space, purchasing equipment, setting up laboratories, encouraging students and researchers to test and work with new technology.

A transition to a digital university is impossible without supporting activities aimed at introducing changes at the university. Such events may include:

• development of an optional or compulsory module in the framework of training programs aimed at improving digital literacy among students;

• providing support to scientific and pedagogical workers who set trends in the development of digital skills and are engaged in the development of innovative teaching methods;

• encouraging the advanced use of learning platforms to ensure better student learning outcomes and improve the overall performance of the university;

• assisting teachers with less advanced digital skills.

In our opinion, a university should adequately work with all levels of the digital university model described before and constantly maintain feedback with key stakeholders - students, teachers, industry and academic partners, graduates, and applicants. We emphasize that while creating a "digital university" it is necessary to create a new digital environment that provides learning mobility and new format for students to communicate with teachers and potential employers, university management. The main goal is to make this environment comfortable for everyone, to take into account the individual learning path.

The principles of digital university should be:

1. Educational trajectory. Online courses, blended learning, flexible educational paths.

2. Information content. Creation of services – an online schedule, a single authorization system, a digital portfolio, the integration of information systems into a single space; system of personal accounts, full automation of the university.

3. A new system for assessing achievements. Multivariate assessment based not only on traditional performance indicators such as the total number of teaching staff, Scopus publications per 100 teachers etc., but also on data on training, knowledge of foreign languages, as well as soft and digital skills [6].

The components of a digital university should be:

• An electronic educational environment, including online courses, blended learning courses for the main educational programs of students, as well as a digital portfolio, electronic ordering of books, electronic individual curriculum, etc.

• Online courses for various categories: applicants, students, managers and teachers of educational organizations.

• Creation of the portal "Open educational space".

• Creation of an effective electronic university management system.

In general, it is necessary to create: a single educational ecosystem in which a system for assessing the quality of education will be created; personal educational portfolio based on blockchain technology, a system for assessing people's cognitive skills; service for building a personal development path taking into account professional orientation.

3. Data and Methodology

For our investigation we have taken the experience of State University of Management (SUM) and The Financial University under the Government of the Russian Federation. From 16 March 2020 both of them have started to work in online regime (including lectures, seminars, consultations, student conferences).

We have created the online survey in order to highlight the main difficulties and obstacles professors have faced with. We intentionally did not conduct a student survey, since we believe that it was the teacher who was unexpectedly assigned an unusual role - to transfer the teaching process to digital tracks in lightning fast periods.

The population in this survey was lecturers and professors of State University of Management (SUM) and The Financial University under the Government of the Russian Federation. This was a study where 64 professors were surveyed from 12.04.2020 to 23.04.2020. They belong to different departments and chairs.

We have created a survey based on research made by Yuen and Ma (2008) with paraments, namely perceived ease of use and computer self-efficacy [7]. Each question was scored using a 7-point Likert scale where 1 = strongly disagree and 7 = strongly agree (1: Completely disagree; 2: Disagree; 3: Somewhat disagree; 4: Neither agree nor disagree; 5: Somewhat agree; 6: Agree; 7: Completely agree), which is more frequently used in different investigations.

We selected a total of 7 items for the constructs that were incorporated in the survey, which are included in the following Table 1:

Table 1. Questions for survey

Perceived ease of use	
1.	Learning to use internet programmes for online lectures and seminars was easy for me
2.	I find it easy to interact with computer/mobile devices
3.	Generally, I consider that computer/mobile devices are easy to use
Computer self-efficacy	
4.	It was easy to integrate internet programmes for online lectures and seminars
5.	I can design materials and activities for integrate internet programs for online lectures and seminars without external help
6.	In the beginning of the online lectures and seminars I had enough technical facilities (own computer, microphone, camera etc.)
7.	In the beginning of the online lectures and seminars I had enough technical support from university staff

As well as we used perception of digitization of lecturers and professors. In terms of the formation of an electronic university in Russia, on the basis of our research and model presented in part 2, we have formed the main eight criteria for the implementation of this concept. Each scale has a range from 0 (not exist at all) through to 100 (maximum level of implementation). Google-form, a web–based

survey program, was used to collect data because of simplicity. Later, we performed a comprehensive analysis of the selected constructs and obtained results. The response rate was 100%.

We did not analyze the data using structural equation modeling as we perceived that not that much time has passed from switching to a distance education and training in order to prevent the spread of a new type of coronavirus (COVID-19) and it would be too early to build reliable statistical model.

4. Results

The mean scores for all variables were generally high, ranging from 5.20 to 6.40. The mean scores for variables «perceived ease of use» were around 6.7. This means that teachers were emotionally prepared to teach online.

As for computer self-efficacy, around 80% of lecturers and professor completely agreed that in the beginning of the online lectures and seminars, the technical support from university staff was effective. They were provided with electronic schedule including links to start process of teaching, free access to different programs (Microsoft Teams, Skype, Zoom etc.), an intranet with chat.

The key problem that we have discovered was the lack of technical equipment. Many teachers did not have devices at home that may be needed to work online. For example, a graphics tablet, microphone or camera. Whereas in normal regime (without carnitine), teaching staff are provided with lecture studios, it was not possible in a pandemic era. Our investigation is consistent with results obtained by previous researchers who found that ease of use were critical factors in the use and adoption of e-learning among educational organizations.

The perception of current stage of digitization of Financial University under the government of the Russian Federation (FU) and State University of management (SUM), assuming the maximum target of 100 per cent is presented in Table 2.

Table 2. Current stage of digitization

Criteria	2019		2020		Target
	FU	SUM	FU	SUM	
1. The use of federal state educational standards or own standards in terms of requirements for the formation of digital economy competencies for higher education	90	90	95	90	100
2. The educational programs of all levels of education have been updated in order to use in educational activities common and professional digital tools	90	80	80	80	100
3. The legislative and regulatory legal framework has been updated in terms of organizational and methodological conditions, certification forms, subject programs, teaching materials, etc.	90	90	60	60	100
4. Creating a complementary education system to train competent professionals for the digital economy	80	70	80	70	100
5. Development or selection of an information system for supporting an individual student competency profile	50	30	60	40	100
6. Using e-learning technologies	80	70	80	80	100
7. Development and implementation of education programs, professional retraining, continuous professional development of teaching staff	70	60	50	50	100
8. Creating infrastructure for the management and activities of the university in the conditions of digital economy	90	80	70	70	100

The analysis shows that the process of forming an electronic university progressed quite successfully, especially in the field of the legislative and regulatory legal framework, creation of federal state educational standards which include formation of digital economy competencies for higher education (90% for both universities).

At the same time, one of the main problems is the creation of an individual learning path, personnel and technical problems. Level of development or selection of an information system for supporting an individual student competency profile in State University of Management is only 30% (in 2020 this figure is equal to 40). Moreover, professors' perception of digitization if universities is on average less than our investigation made in 2019 [5].

The effectiveness of distance learning depends on three main parameters: information infrastructure of the university, digital literacy of teachers, online services used by universities. In our opinion, only leading Russian universities possess all three parameters. The main problem in the eyes of the professors was the lack of the necessary technical equipment (especially at the beginning), as well as the lack of training in order to increase skills in teaching online.

As for all others universities there is also the problem of a lack of personnel (both employees and teachers) who are ready and able to carry out an effective digital transformation. In addition, some students demand a proportionate reduction in tuition fees due to the transfer of classes to the online format. Students are unhappy with the fact that initially they paid for full-time or part-time study, and not for the distance format of classes. Therefore, students demand to return half of the amount paid for the current semester or to make a 50% discount for the next semester.

The second major problem is the lack of a single standard for digital solutions and formats - electronic courses, common platforms or requirements for the compatibility of individual services, the lack of harmonized requirements and quality standards for electronic content and online courses, as well as the unresolved issues of digital transformation of the education system. The level of digitization in Russian universities is very different. Universities seek to build these competencies and pool resources to increase competitiveness. However, there are still no unified standards for connecting data and services, and this seriously hinders the development of universities.

5. Conclusion

In the context of globalization and the development of information technology, universities are becoming the center of the construction of new economic concepts based on knowledge and associated with the transition from the computerization of individual business processes to the digitization of business models. During the study, we noted that the digitization of education been at the early stages of implementation enhanced its speed due too unpredictable and unexpectable reason –virus. It exacerbated existing problems such as an absence of developed universal criteria for assessing the quality of the digital format of teaching various disciplines; lack of understanding of the mechanism for creating a system for implementing a digital environment in an educational institution. Moreover, only leading universities have highly qualified specialists with a sufficient set of competencies to provide the very same quality assessment of these disciplines.

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Model of the communication process in a context of reading in French first language and French foreign language

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Abstract. This article aims to analyze, from a didactic point of view, readings offered to students of several schools in Belgium and the choices made by their teachers to support them in their task. This article is devoted to examining the methods used by teachers, explaining why and how they use them, and looking for consistency in their teaching practices. This data, based on theoretical axes, makes possible to know and identify the elements that make teaching devices effective. This research is therefore oriented towards the creation of a model representing the original operating mode on which the students in the French first language and the French foreign language classes worked.
Keywords: meta-communication, pedagogical model, mediations, stereotypes, reading.

1. Introduction

The last decades have been marked by major social changes linked to globalization and increased mobility of people. Undoubtedly, these changes have influenced the world of education because teachers are confronted with increasingly diverse socio-cultural classes.

On this basis, it has become necessary to adapt training skills in order to improve the professionalism of teachers who are already confirmed and to offer future teachers appropriate initial training. In this regard, we wonder whether targeted training aimed at understanding the multicultural educational process as an active dialogue of cultures could be relevant.

The didactic analysis of the readings proposed to the students of several schools in Belgium and the choices made by their teachers seemed precious to us. The research of the methods used by the teachers, the determination of why and how they use them, the clarification and the coherence of their teaching practices allowed us, by mobilizing theoretical axes, to know and identify elements responsible for the effectiveness of educational systems for making concrete educational proposals.

Finally, our research work will also be directed towards the creation of a model representing the original operating mode on which the students in the French first language and the French foreign language classes worked.

2. Research issues

In fact, the children's literature penetrated in the the French foreign language class, highlights its cultural component. It creates the basis for intercultural exchanges, demonstrates differences from a cultural point of view. Children's literature in French as a foreign language class also has linguistic advantages by offering texts written in a common language, correct and at the same time rid of unnecessary difficulties for foreigners. The reader, initially possessing knowledge

accumulated in "collective memory" [7, p. 60], during reading he makes his judgment based on his own values. He can compare his opinion with other texts or other points of view in the classroom. In this necessary communicational interaction, the student-reader realizes the affinities he has with his own culture, perceives differences, learns through his interlocutors. Thus, the reader, having already conceived cultural knowledge, has deepened and clarified it to acquire new cultural knowledge. The teacher notes that his mode of functioning in the classroom where communication reigns agrees well with Michel MARTIN's research [18].

It is a question here of researching towards what problematic the teaching practices are directed during the reading activity of students through the mediation of knowledge in such original learning situations. First, in a classical approach, the analysis of the didactic triangle, a well-known model of HOUSSAYE [11], brings together three different poles or actors: learner or taught, knowledge and teacher, linked by processes: teach, learn and train. According to HOUSSAYE [11], "the professor makes knowledge exist and knowledge justifies the professor" [11, p. 38]. On the other hand, in the multicultural field in the French foreign language class, the teacher is not alone in having knowledge of the language and culture. The students make also their knowledge exist, share it and even transmit it to the teacher or to the other non-passive learners.

Even if the teacher is then assigned the role of mediator, "organizer of a training situation immediately putting the two main stakeholders in contact" [11, p. 42], Julia BELYASOVA [4] specifies that the interaction between two different registers may have been possible and took on its full meaning because of the communication that was very present in class at that time. To the three poles seen above, is therefore added a fourth pole, called communication, as suggested by Michel MARTIN [20], based on Marguerite ALTET [1]. We are here at the beginning of the design phase of the analysis model representing Julia BELYASOVA's research [4].

3. Construction of the research analysis model

It is important that the reception of a literary work by reader-learners is accompanied by a strong concern to establish a link between teaching practices and the progression of students in reading. It is a question of demonstrating that the communication established between the components of the educational process supported by different tools promotes mediations and makes them more effective during the acquisition of knowledge. For the researcher, not only communication must be present in the classroom, but it must also function properly and therefore be discussed with those who practice it, in other words, between the students and their teacher. This is the concept of meta-communication. Just as "metalanguage" speaks of language itself, meta-communication is the fact of speaking.

Remember that to understand and explain what appears in her experimentation which includes multilateral processes and diverse or even complex mediations, Julia BELYASOVA [4] needs more than ever to model her research. Moreover, LE MOIGNE adopts the maxim : "Modeling to Understand" [14]. According to this researcher, each person perceives a phenomenon only by constructing its "artificial symbolic representations"[13].

After these conceptual clarifications, Julia BELYASOVA [4] showed a keen interest in Michel MARTIN's diagram [20] (figure 1), modeling meta-communication in a teaching-learning situation comparable by its originality and its complexity to teaching-learning situations of this research.

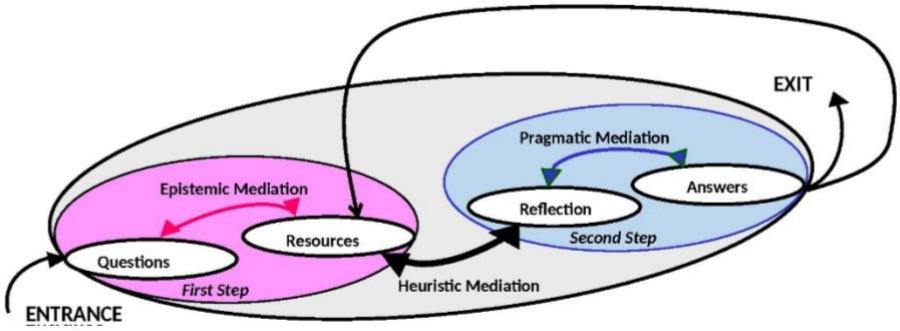

Figure 1. Diagram of the model representing a very complex communication process, [20]

First, let's look at this model from a theoretical point of view. For Michel MARTIN [20] as for Belyasova J. [4], there are three types of Mediation which are implemented to stimulate teaching through communication. The learner is placed in Entrance in the learning situation where he is faced with the task to be accomplished (Questions) aimed at providing valid and relevant Answers in Exit. Observe that the process described on the model is divided into two stages and comprises four successive phases: "Questions → Resources → Reflection → Answers".

At first, the learner understands what about it is, Epistemic Mediation, according to Martin M. [20], makes the link between the Questions asked in terms of objectives [16] to the student and the didactic resources made available to him. These resources are supposed to encourage thinking and evoke the "mental representations essential to adequate reflection" [20, p. 5]. At this point, it is Heuristic mediation proper to each individual who takes the lead naturally, "according to the will of" mother nature "", using the words of Martin M. [20, p. 8].

In a second step, the learner explains what he thinks of the asked Questions given the provided Resources and after Reflection. Generally, when the situations present a certain complexity, the learner needs Pragmatic Mediation to produce satisfactory Answers. For the students of Belyasova J. [4], it is not only a question of reading but one of explaining what each person has understood from what he has read by responding adequately to the multiple asked questions. Thus, reinforcement by a Pragmatic Mediation seems very beneficial for the learners of the teacher who takes responsibility for creating and implementing "a series of very sophisticated instruments" [22] in order to facilitate the genesis of the final production .

4. Table of intervention devices

Inspired by Séverine De Croix's [8, p. 286] overall plan of didactic devices, we adapt it to our own research to highlight the steps, the goals and the time of each tool used in this experiment [5]. Following De Croix [8], these devices are useful for collecting data concerning five axes of our reading model, namely the reading attitude, the value judgment, the reading systems, the identification or distancing from the novel and textual comprehension-interpretation.

We cross this table of devices with Martin's meta-communication model [19] to clarify the place of each device (instrument of Mediation) in the teaching-learning process described in our work. More specifically, we suggest that teachers use the exchange of class notes, the reflective pause booklet that accompanies students

'individual reading, and the questionnaire at the end of the novel in order to facilitate the students' comprehension-interpretation of the novel and to enable them to acquire a reading autonomy with the literary text. We asked for a preliminary interview with each teacher to explain our experience.

We gave them the liberty to organize the reading activity of the novel according to their methods, the time available and the motivation of the students. We nevertheless specified the importance of respecting the three tasks necessary for the correct progress of this experience (Table 1).

Table 1. Three tasks for pedagogical experience [5]

Task 1: take knowledge of the tasks to be done, discuss the first impressions before and during the reading, propose assumptions before and after. It is an epistemic mediation which, through the mediator instrument (oral exchanges), makes the connection between the questions asked (as a goal to be attained) and the resources (the novels to be read).		
Steps	**Goals**	**Support**
1. "Formulation of an opinion on the text" [8, p. 286-290]. 2. "Oral explanation of the answers given in the questionnaire" and comment on his comments in the reflexive pause booklet.	* "Developing of the capacity to appreciate a text (expressing one's appreciation)" [8]. * "Describing one's procedures (to understand and process a questionnaire (and a reflexive pause booklet)) and to self-evaluate one's understanding [8].	- A youth novel to open end "Julie" by B. Coppée [1] - A youth novel-mirror "Since your death" by F. Andriat [2]
Task 2: read individually a youth novel, verbalize one's impressions, understanding, interpretation in the reflective pause booklet. It is a heuristic mediation which is presented as a fusion between the process of reading and the reflections fed by the mental representations specific to each reader. The reflective pause booklet as a mediator helps students to learn the skills.		
Steps	**Goals**	**Support**
1.Reading a rather lengthy youth novel and practice the reflexive pause booklet. 2.Expression of first impressions. 3.Creation of the first reading hypotheses and return on the advanced declarations and their correction. 4."Pointing of reading difficulties" (Ibid.). 5."Prediction of the evolution of the narrative" [8] 6."Elaboration of the possible end of the novel" [8] 7."Individual written reformulation of the end of the novel" [8] 8.Exchanges in class (information, impressions).	* "Mobilize knowledge, collect clues, connect them to formulate hypotheses and create a waiting horizon" [8]. * Exercise certain reading processes: mental representation, memorization of information, textual induction. * Integrate collective exchanges in the reformulation of one's hypotheses.	- A youth novel to open end "Julie" by B. Coppée [1] . - A youth novel-mirror "Since your death" by F. Andriat [2] - Two reflexive pause booklets corresponding to the two mentioned novels.
Task 3: read a youth novel and share one's understanding of the specific elements in a questionnaire. It is a pragmatic mediation that develops and acquires the skills of readers. The mediator instrument (the questionnaire) focuses on students' difficulties with texts and makes it possible to explain their skills acquired or not.		
Steps	**goals**	**support**
1. Description of one's relation to reading, in general, and to the proposed novel, in particular, (pleasure, interest); Description of one's reading mode (place, time, average); Description of one's own reading activity (degree of understanding, difficulties encountered). 2. Individual reading of the novel. 3. "Treatment of a reading questionnaire" [8] aimed at a global understanding of the text, the characters, their relationships and their changes during the novel.	* "Understand the text globally" [8]. * Clarify the role and evaluation of the characters. * "Describe one's relationship to reading and share one's representations"[8].	- A youth open-ended novel "Julie" by B. Coppée [1]. - A youth novel-mirror "Since your death" by F. Andriat [2] - - Two questionnaires of global understanding that correspond to the two mentioned novels.

5. Relationship between the overall understanding of the novel and teaching practice

5.1 The case of the pupils of the technical school of Jumet (Belgium) by analyzing of a youth open-ended novel "Julie" by B. Coppée.

Using of these intervention devices by teachers in different classes helps to establish the relationship between the overall understanding of the novel and teaching practice of teacher. By analyzing the reflexive pause booklets and the French native speaker student's questionnaire, we notice that she has some difficulties in the overall understanding of the novel. This may be due to the lack of a practice of analysis of the literary text, as well as to gaps in the capture of stereotypes. On the other hand, it succeeds in interpreting in a rather coherent way some chosen sentences which can contain a general idea of the novel. For example, the sentence "Life is touching sometimes. She screams "("Julie" by B. Coppée) is interpreted as: Life, it's beautiful peaceful, we keep what we have in ourselves but sometimes it has to happen (the French native speaker student). We think she's talking about Julie (main caracter of Coppée's novel), who keeps her husband's disdain and disgust, for fear of revealing them until the moment when his whole world falls over ...

The detailed analysis of Justine's reflexive pause booklets, as well as the careful study of the work of other Belgian pupils, allows us to confirm certain prejudices concerning the status of the family in Western Europe. Paillet's [23] statements about the current situation of households, the role of women in the family and in society can be verified by reading the responses of young readers. The perception of the family by the children of divorced parents, evoked by Smits [24], is confirmed by the critical examination of questionnaires and reflexive notebooks of Belgian pupils.

We note the same difficulties of interpretation among the other students in this group. Thus, only two readers out of fifteen manage to interpret certain passages of the novel read. It seems, however, that their reading is rather intuitive: they are not really aware of the way in which they have been able to interpret the text.

Seven other students in this group reach the first understanding, very general and very unstable. In other words, they include a certain part of the text to get a rough idea about the development of the story. Their linguistic and cultural background allows them to identify textual references in an intuitive way. They take as banal words ("this beauty"), a whole phrase ("a man who finds you beautiful") or they explain only the situation described ("the husband works and come back late and his wife takes care of the children, the house, the household, the kitchen "). In our opinion, their intuitive grasping is not sufficiently guided so that they can reach a higher level of understanding.

To find explanations, we turn to the written statements of their teacher. We find that, according to her, she does not really adopt a fixed strategy to study novels with her students. Moreover, she avoids offering them long classic texts. She favors a study of extracts, a comparison of several texts, a reading of images. She does not teach the notion of stereotype for fear of her students not understanding the stereotype and not applying it correctly. This teacher, like her other colleagues who work with rather weak classes, relies on the emotional reception of the book to develop the taste of reading rather than to learn literary analysis. Nevertheless, she tries at each study of a new text to solve the problems of comprehension and to answer the questions of her pupils about their reading.

Eight students in this class have difficulty understanding the novel. Through their responses, we note that these readers arrive at a first understanding only thanks to constant help from the teacher. The individual discovery of the text is often done at home. Students are then overwhelmed by their positive or negative emotions and are not able to create the necessary ground for understanding. On their own, these

students find it difficult to establish "topics" on the basis of common knowledge, to explain those already given in the questionnaire, to understand why they like or do not appreciate the passage of the text, the behavior of the character. They need frequent exchanges organized in class by the teacher. They can then express orally their impressions and reactions, ask questions. However, the professor tells us that these readers do not make much progress in their reflections and often answer the questionnaire in the same way. They also tend to judge the characters, and the teacher must lead them to explain, to justify their point of view every time they speak.

5.2 The case of Slovak and Russian pupils by analyzing of a youth novel to open end "Julie" by B. Coppée[1] .

Alica, a Slovak pupil whose work we have chosen as an example to compare with that of the Belgian student, seems to be the most experienced reader: her explanations are more accurate, her understanding deeper . Even in her interpretation, she goes further than the Belgian reader. For example, in two lines she takes up a story of the main characters, drawing a conclusion that life represents a complex whole filled with happiness, joy, but also sadness, hardship and difficult choices: "life takes place well sometimes, but from time to time, everything is destroyed, it seems that nothing remains, everything becomes difficult but then, normal life resumes and we continue to live as we were used.

The stripping of the reflexive notebooks of other Slovak and Russina pupils gives us the same impression: they are readers very attentive to the development of the plot between the characters. They create a lot of hypotheses about the continuation of history, ask themselves pertinent questions. Nevertheless, for most of them, the general understanding of the novel escapes them. This phenomenon is explained by the fact that these readers read in a foreign language and the capture of the innuendoes is not always done correctly.

Moreover, it is surprising to see that their answers reveal that they are wisely mobilizing familiar, stereotyped understandings. For example, they talk about the woman who keeps the unity of the family or the selfish man who thinks only of the satisfaction of his desires: "I believe that this is the way we see men in Tim's flaws, men who are very masculine; it is often said that they think in a simplified way, "explains a student.

Concretely, the group of Slovak and Russsian learners includes, first of all, six pupils who do not show a good understanding. By asking ourselves the question, "why? We realize that the construction of stereotypy is compromised. In fact, the "virtual referents" [25] needed for the creation of the latter are not identified by these students. They have lexical difficulties specific to people reading texts in a foreign language. These obstacles prevent the first understanding, the basis of the textual interpretation. Despite multiple attempts to create hypotheses about the continuation of history, their "topics" [25] collapse. These readers do not manage to locate "places of certainty" [25], necessary for a general understanding, stable and correct.

Then we distinguish seven students who testify to their more or less good understanding of the novel. The path of reflection of these readers enters the schema that we adopted to estimate the level of the understanding of the text. Thus, they build a stereotype to base their narrative assumptions. The location of "topics" [25] allows them to confirm or change them. In any case, these readers reach the level of the second understanding. However, we sometimes find some whites in their explanations or one or the other wrong interpretation.

The testimonies of the Slovak teacher give us some insights. She has a different vision of reading skills to teach her students. She says she has focused on developing language and argumentative skills. We noticed that his students have a fairly good level of language and that they feel very comfortable to express their opinions, to

argue their remarks. This professor also insists on the knowledge of different types of texts and their identification signs, as well as on the possibility of comparing and observing a psychological evolution of the characters. These taught techniques are reflected through the responses of his students. This explains the fact that their copies contain almost no elements of purely literary analysis. They read with their heart and their emotions and show a rather participative reading.

Another element that characterizes the Slovak teacher is the fact that she favors the emotional reception of the book. This is an essential step in her work with her students on the literary text. For the rest, the discovery of the text is generally done in class by the explanation of the vocabulary, the revelation of the theme and the plot. She often organizes debates and exchanges to explain the characteristics of the characters, and she also discusses with her students about the style and choice of the lexicon by the author. She says : "I make sure to teach young people to" read correctly ", in other words, to take pleasure in reading, to appreciate the literary text, to understand it. She doesn't work in depth the textual interpretation and teaches only a few elements of literary analysis.

5.3 Reading attitude of Belgian and Romanian students by analyzing of a youth novel-mirror "Since your death" by F. Andriat [2].

To make the comparison, we take three target classes: eleven Belgian students of the technical school of La Louvière (Belgium), eleven Belgian students of the Decroly general education school and ten Romanian high school students. We believe that the confrontation between two Belgian classes, from backgrounds that are often opposed, may reveal a different appreciation of the same novel and provide some interesting explanations. The parallel between the Belgian public and the Romanian public shows their similarities and their differences which stem from the diversity of the first languages and the cultures of origin.

We would like to present reader's thoughts on the definition of death. They give us the opportunity to grasp the general reading trends of each class and also to focus on the evocative dissimilarities of culturally significant perceptions.

The question: "What does death represent for Ghislain? reveals that Belgian readers of the technical school place more emphasis on abstract values. Their definitions of death are limited to short words without explanation: "woe", "hell", "fatality" and others. They do not seek to justify their statements by the ideas of the text. The same type of answer is given by 27% of students at Decroly School (Belgium). This percentage is less, but nevertheless important. Readers of the technical school read evaluatively, putting forward the ideal and abstract values, those of the Decroly school (Belgium) in a global way with the pessimistic perception of the reality described in the novel. This generalizing perception of the text proposed by Decroly's readers (27%) is reflected in the response that evokes "the disappearance of a loved people, the transition to another world and something terrible that scares everyone. as well as the end of the life of loved people. These global ideas are not unique to the character and can be attributed to anyone. In this way, these pupils implement general categories by which they imagine death. Romanian readers, in 30% of cases, mention death as "something incomprehensible and appalling that causes a lot of sadness and pain". Their testimonies show that they consider the approach of mourning as an individual and punctual action. This finding is explained by a personal approach to the reading mode that is specific to these respondents. We

do not notice the same trend in the responses of Belgian students from two groups.

On the other hand, they raise the feeling of injustice that appears in the words of the young hero. Romanian high school students do not adopt this response strategy. 18.5% of Belgian pupils in technical education as well as 18.5% of Belgian general education students emphasize the feeling of inequity expressed by the adolescent's angry and aggressive behavior. According to them, the hero conceives death as the injustice that gives reason to his irascible behavior. This ability to correlate the facts described and their causes constitutes the characteristic of synthetic or sociological reading. According to our observations, it is more specific to our Romanian public than to the Belgian public. But the answer received does not reveal this correlation. We find the justification for this if we look at this from another angle. We believe that the explanation is due to the fact that it is, in this case, injustice. This notion is related to the society to which each individual belongs. The feeling of injustice is more developed among Belgian pupils in general education, in our opinion. They are ready to defend their opinion in the name of justice and to judge what seems unjust to them.

Thus we find again that the dissimilarity is explained by "an area of indeterminacy". It also shows that there is no really limits between different types of reading. We can only say that this or that part of the public takes hold of one or the other form of reading.

In the conclusion, we say that the testimonies of the Romanian readers have allowed us to note that their reading can be described as synthetic or sociological. They can make a judgment both positive and negative about the hero or his actions, but they do not condemn him, and seek, on the other hand, the link between the facts and their causes. We also notice the personal involvement of these readers and their identification with the character. They follow the progress of the adolescent in his maturity of mind and judgment. We emphasize that this personalizing approach to the conception of grief is lived by everyone individually in their own way. In addition, some Romanian readers make comments that make them think that they adopt the phenomenal reading of Belgian pupilsof Decroly.

As for the Belgian pupils of the Decroly general education school, their reading seems to us to be characterized as phenomenal. Its peculiarity is to treat the reality described in the text as normal, that is to say that the rebellious, aggressive and sometimes shocking reaction of the hero as well as his rebellion against death are judged acceptable by the society and justified by its norms. This reading is also characterized by the global look and pessimistic that it poses on the described reality, as well as by its generalizing perception of the text. Indeed, the readers concerned accurately capture the author's thoughts on four stages of acceptance of death.They use them as global ideas that they do not only attach to the concrete character but attribute to anyone. In this case, we also notice the shift of a minority of these respondents towards the synthetic reading proper to Romanian students.

As for the Belgian pupils of the technical school of La Louvière (Belgium), we think that the evaluative reading characterizes them. This type of reading highlights the ideal and abstract values of the readers who stand out in their definition of death as well as in their critical judgment on the aggressive behavior of the character. However, a small percentage of these readers report a phenomenal reading, like the students at Decroly School (Belgium).

We think that the synthetic reading is specific to the majority of Romanian

readers, but that the testimonies of the Belgian pupils also present the characteristics of this type of reading. Moreover, they express emotional attachment to the character, which is rather the peculiarity of the Romanian reading. We see that these two groups of readers, with their differences, are getting closer and sometimes have similar points of view on how to mourn. Explanations can come from the fact that these students belong to the "elite" of the society to which they belong.

Decroly School (Belgium) is renowned as an institution that only accepts children from affluent families with university parents. The Romanian College "Petru Rares", meanwhile, also offers high quality education accessible to students of high social level. Both groups of readers received a good education, an open mind and an open outlook on the world.

We also want to highlight inconsistencies between the two Belgian groups. Readers of the technical school are, in our opinion, subject to evaluative reading, but at the same time we notice that they see the character in relation to the society around him. We also observe that they judge the inappropriate behavior of the teenager as normal. These characteristics (linked to the standards set by society and perception of normality in the text) are peculiar to the phenomenal reading that dominates readers of Decroly School (Belgium). The rapprochement of these two groups is obvious: they belong to the same European society and can, in principle, have the same points of view on the question of mourning. However, the two publics are differentiated by their social level, by their access to education and by their perception of studies, which is more evident in ideological differences.

In this way, we have shown the peculiarities of each of our target groups, their dissimilarities and their common points, which express themselves through their own values. In the following chapter, we will examine the issue of identifying readers with characters during reading and how they distance themselves from the events described in the novel.

6. Relation of the results observed with the proposed model

Thus, in the situation of Epistemic Mediation (see Figure 1), interactions take place on two fronts: between the teacher and the students, on the one hand, and between the students, on the other hand. Oral exchanges are organized around these two axes. In the first case, the teacher takes a dominant role in stimulating and encouraging learners to express their opinions. According to KERBRAT-ORECCHINIONI [12], the interlocutors act on each other in order to impose their own opinions on a subject discussed.

Note that these exchanges are all the more enriching if the class includes people of various nationalities, from different socio-cultural backgrounds. Learners' literary perceptions can be extremely diverse depending on their own culture. Maingueneau [17] and Colles [6] see in this divergence a possibility of cultural exchanges. However, the gap in these perceptions, depending on the cultural memory of individuals, can be considerable. To find an explanation, hypothesize or confirm ideas, students can use collective research which is even more productive in a multicultural classroom. They then take advantage of the maternal culture of their colleagues for whom the allusion or parody given evokes, perhaps, a historical phase or a religious formulation, depending on the type of work or literary situation.

Contact with the book pushes the reader to Reflect (see Figure 1) which creates mental representations. The waiting horizon and stereotypes play a crucial role at this stage. The literary work evokes implicit references, information already read and

familiar characteristics. Collective memory also comes into play. It brings skills mastered by a given audience and represented in the form of "stabilized collective knowledge" [9, p. 119]. Mental representations are also generated by the interests, needs, experiences determined by the society that surrounds each individual. Consequently, Heuristic Mediation (see Figure 1) spontaneously arose from the merger of the book providing Resources and Reflection.

To facilitate textual understanding and to feed the "natural" link between the Resources (the text) and the Reflections they evoke, Julia BELYASOVA [4] has developed a tool called: "The reflexive pause booklet". In such an approach, Beguin and Rabardel [3] followed by Martin M. [20] call "instrument" this methodological tool adapted to the chosen problem-situation. This instrument allows readers-learners to start reading in a finer way. It educates students, makes them aware of textual information. This system contains fairly specific Questions and Sub-Questions on each chapter of the novel proposed for reading. Readers are therefore invited to stop after each chapter to complete this book of New Resources.

Being confronted for the first time with this type of exercise, the students had to take breaks in their reading to reflect, to become aware of what was read, to reread the poorly understood passages and to express their opinion on the question addressed. in the chapter.

The operation of "The reflexive pause booklet" tool takes place in two phases. During the first phase, described as "generative" by Beguin and Rabardel [3], the student-reader becomes aware of the specificities and characteristics of the text object with which he is about to work. He explores and analyzes, unconsciously in most cases, what he already knows, what the text reminds him of. The second "evaluative and iterative" phase [3] leaves the possibility for the student to confirm and / or modify his first Reflections on the text. An "evaluation of intrinsic viability" [3, p. 6] is of great importance here.

This cyclical functioning of the instrument is part of the model of the communication process developed further by Martin M. [20]. In other words, Heuristic Mediation (see Figure 1) is managed by the instrument (The reflexive pause booklet) developing in two stages. This instrument facilitates the relationship between Reflection fueled by mental representations and by textual comprehension and Answers - the interpretation of the novel asked of readers (see the two-way arrows in Figure 1).

With the help of Martin M. [18], inspired by Pastre [21] and Leplat [15], Belyasova J. [4] concluded that in the teaching-learning process, this happens in two steps (Figure 1). At first, the students are in the process of acquiring so-called "incorporated" skills, in the sense of Leplat [15], in particular using "The reflexive pause booklet". In a second step, the students must explain these skills [21], in other words, "take a step back to externalize their previously incorporated skills" [18, p. 230]. The Answers obtained through the Questionnaire and after reading allow us to see if the students are able to explain their brain activity. It is all the more complicated to assess textual comprehension and interpretation since they can only be expressed orally or in writing. Students must therefore know the vocabulary specific to the situation: for them, this is not obvious.

Furthermore, it should be noted that this oral or written verbalization is not always fair. The reader can demonstrate a good understanding of the text even though the deep meaning escapes him precisely or, on the contrary, he does not express well what he really understood. This is why students need "Exit helpers" [20, p. 462], in other words, a Questionnaire after reading knowing that the provided Answers will circulate towards the Resources to be written in "The reflexive pause booklet", as shown by the arrow going from the Exit towards the bubble Resources of the model of figure 1, and this on a recurring basis until the Answers provided by the students are judged satisfactory by the teacher.

7. Conclusion

It seems important to us to note the originality of J. Belyasova's mode of operation in class [4] which she was able to explain here and in her thesis thanks to the model representing it; perfectly suited model with all the concepts associated with this field of study during collaborative and distance learning with Martin M. [18]. Basically, this work is primarily intended for students of French as a foreign language classes. It is a question of relating the teaching approach of the teacher to the reading activity of the students by mediating knowledge in the non-traditional multicultural teaching-learning situation.

The other innovative aspect of this work is to practice and reference what can be called "inverted classes" [10]. Indeed, this pedagogical approach reverses the nature of teaching-learning activities in the classroom and at home. The teacher is no longer seen as someone who has the knowledge. His role is to advise and guide student learning. This is all the more true in a multicultural context where the exchanges are very enriching as much for the students carrying their culture, stereotypes and cultural memory, as for the teacher.

In this regard, Dufour [10] insists on the fact that there is no single model of inverted class, which leaves it to each teacher to adapt it as best as possible to his objectives. There are nevertheless elements common to all the inverted classes: the student carries out an autonomous work at home (the reading of the novel, in our case) and the verification of the assimilation of knowledge is then done in class through a questionnaire that plays the role of instrument ("The reflexive pause booklet", in our case).

Having developed the mediation instrument which is "The reflexive pause booklet", we hope to provide the model on which any teacher could rely by adopting in his practice the pedagogy of "inverted classes".

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