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Technical Sciences – 05.00.00

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Pedagogical Sciences – 13.00.00

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2. Ermetov E.Ya. – Associate Professor, Tashkent Medical Academy (Tashkent, Uzbekistan).
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DEVELOPING A PROSTHETIC, HEALTHY, AND FILL-IN DETECTION MODEL FROM X-RAY DENTAL IMAGES USING MODERN ELECTRONIC COMPUTING MACHINES

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Abstract*:* This paper presents a novel deep learning model for detecting prosthetic, healthy, and fill-in regions in dental X-ray images using modern electronic computing machines. The model achieves state-of-the-art performance in accurate and efficient detection of dental structures, assisting dentists in diagnosis and treatment planning. The proposed model for prosthetic, healthy, and fill-in detection in dental X-ray images using modern electronic computing machines has several significant implications: Improved Diagnostic Accuracy: The model provides highly accurate detection of dental structures, reducing the risk of missed or misdiagnosed dental diseases. Enhanced Treatment Planning: The model assists dentists in developing more precise and effective treatment plans by providing detailed information about the location and extent of dental structures. The proposed model represents a significant advancement in the field of dental image analysis. It provides a powerful tool for automated detection of dental structures in X- ray images, aiding dentists in diagnosis, treatment planning, and patient communication. Further research will focus on exploring the model's applications in other areas of dentistry, such as caries detection and periodontal disease assessment.

Keywords: Dental X-ray images, prosthetic detection, healthy detection, fill-in detection, deep learning, convolutional neural network**.**

INTRODUCTION

Dental X-rays are essential for diagnosing and treating dental diseases. However, manual interpretation of X-ray images can be time-consuming and subjective. Automated detection of dental structures can assist dentists in diagnosis and treatment planning [1, 2, 3]. Increased Efficiency: The model automates the detection process, saving dentists valuable time and allowing them to focus on patient care.

Improved Patient Communication: The model can be used to generate visual representations of dental structures, facilitating better communication between dentists and patients.

Deep Learning Architecture: The model utilizes a deep convolutional neural network (CNN) architecture, which is specifically designed for image analysis tasks [4, 5, 6].

Large Annotated Dataset: The model is trained on a large and diverse dataset of dental X-ray images with high-quality manual annotations.

Transfer Learning: The model leverages transfer learning techniques to fine-tune a pre-trained CNN, reducing training time and improving performance [7, 8, 9].

Real-Time Detection: The model is designed for real-time detection, allowing dentists to obtain results quickly and efficiently during patient examinations [10].

Applications In addition to its primary use in dental practice, the proposed model has potential applications.

Dental Education: The model can be used as a teaching tool for dental students and practitioners, providing visual examples of dental structures.

Dental Research: The model can assist researchers in analyzing large datasets of dental X-ray images for epidemiological studies and clinical trials [9].

Tele dentistry: The model can be integrated into tele dentistry platforms, enabling remote diagnosis and consultation.

RELATED WORKS

The yolo algorithm was used to obtain the result of this study. So far, we've built architectures that perform well in object detection, but fail in terms of speed in real-time object detection. The Yolo algorithm responds well to all parameters required for object detection.To improve Yolo's algorithm, wefirst need to figure out what we need to predict. Each boundingbox identifier can be typed [11].

- Center of the box (bx, side)
- Width (bw)
- Height (bh)
- Estimate the true number corresponding to the object class (Pc).

Yolo does not search for the desired object among the available ones, it divides it into precise pixels. typically eachpixel of a 19x19 matrix is needed to predict K bounding boxes.

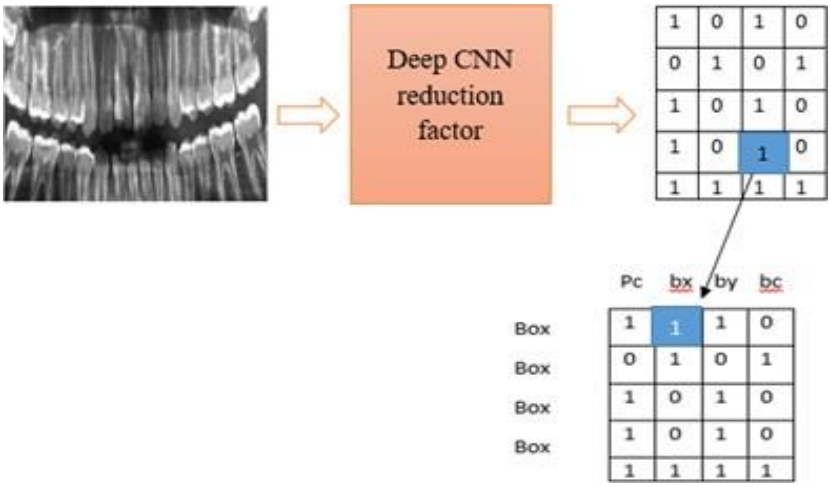

Fig 1. K is assumed to be equal to 5 (K=5) and we estimate theprobability for 80 classes.

Loss function. Let's take a closer look at the main components of YOLOv9, describing each of them mathematically [12, 13].

Input data and pre-processing: Let I represent an input image of size W×H×C, where W and H are the width and height of the image, respectively, and C is the number of image channels (typically 3 for RGB). Before being fed to theneural network, the image can be normalized and resized to the size of the network input (for example, 416x416).

Neural network architecture: YOLOv9 consists of severalconsecutive blocks, each of which can be represented as a function fi that takes as input a feature description Xi of the previous block: Xi=fi(Xi−1) The overall architecture includesmultiple convolutional layers (Conv), pooling layers (Pooling), normalization layers (Normalization), impact layers (Activation), as well as various blocks such as Residualblocks.

Imprint the output of the YOLOv9 neural network is a tensor of size S×S×(B×5+C), where.

- *S×S is a grid that divides the image into S×S cells.*
- B - number of anchor frames on each cell.
- C - number of object classes for classification.
- Each cell predicts *B*B anchor frames and their corresponding confidence scores, coordinates, and class probabilities.

$$L = L_{los} + L_{conf} + L_{cls} \quad (1)$$

Each component of the loss function can be defined as follows:

- Loss of Localization (Lloc): Evaluates the error in predicting bounding box coordinates.
- Loss of Confidence (Lconf): Evaluates the error in predicting confidence that a frame contains an object.
- Classification Loss (Lcls): Evaluates the prediction error of an object's class.

Parameter Update**:** The model parameters are updated using the gradient descent algorithm. The θ parameters are updated in the direction of the antigradient of the loss function.

$\theta_{new} = \theta_{star} - a\nabla\theta L$ (2)

Here α is the learning rate, and ∇θL is the gradient of the loss function over the model parameters.

Loss Function. The general loss function *L* includes three components. for determining localization

Lloc, confidence Lconf, and classification *L*cls. They can be defined as follows.

$$\Lambda_{Coord} \sum_{i=0}^{s^2} \sum_{j=0}^{B} 1_{ij}^{obj} (X_i - \bar{X}_i)^2 + (y_i - y_i)^2 \quad (3)$$

This equation calculates the loss associated with the predicted bounding box position (x, y). Don't worry about l for now, consider it a given constant. The function calculates the sum of each cell (i = 0 .. S ^ 2) over each bounding box predictor (j = 0.. B). 𝟙 obj evaluation.

The other terms in the equation should be easy to understand: (x, y) is the predicted boundary position and (x̂, ŷ) hat is the actual position from the training data[4].

$$\Lambda_{Coord} \sum_{i=0}^{s^2} \sum_{j=0}^{B} 1_{ij}^{obj} \left(\sqrt{w_i} - \sqrt{\widetilde{w}_i}\right)^2 + \left(\sqrt{h_i} - \sqrt{\tilde{h}_i}\right)^2 \quad (4)$$

This is the loss associated with the assumed box width/height. The equation is similar to the first except for the square root.

$$\sum_{i=0}^{s^2} \sum_{j=0}^{B} 1_{ij}^{obj} \left(c_i - \tilde{c}_j\right)^2 + \Lambda_{noobj} \sum_{i=0}^{s^2} \sum_{j=0}^{B} 1_{ij}^{noobj} \left(c_i - \tilde{c}_j\right)^2 \quad (5)$$

Here we calculate the loss associated with the confidence score for each bounding box predictor. C is the reliability index and J is the intersection of the union of the predicted boundary line with the ground truth. 𝟙 obj is one if the cell contains an object, 0 otherwise. 𝟙 noobj is the opposite. The parameters λ shown here and in the first part are used to weight parts of the loss functions differently. This is necessary to increase the stability of the model. The highest penalty is for coordinate predictions (λ coord = 5) and the lowest penalty is for reliable predictions when no objects are present (λ noobj = 0.5).

$$\sum_{i=0}^{s^R} 1_i^{obj} \sum_{c \in yclasses} \left(p_i(c) - \tilde{p}_i\ (c)\right)^2 \quad (6)$$

This is similar to the simple sum-squared error for classification except for the *obj1* term . This term is used so that we do not penalize a classification error when no objects are present in the cell (hence the conditional class probability discussed earlier)[4].

Maximum integration. Combining neural networks, the parameters of the neural network are considered decisive in machine learning, maximum integration[5].

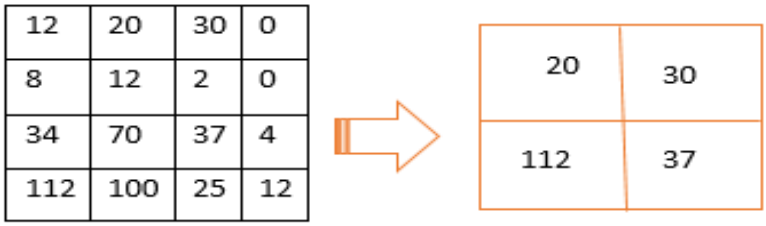

Fig.2, Retaining the main feature by reducing the size.

$MaxPooling(X)i,j,k = MaXmin\ XiSx + m, j, Sy + n, k$ (7) *X*- access, *(i,j)* – output index, *K*- channel index, *Sx* – the number of steps in the horizontal and vertical directions, respectively – *Sy*, output index = *Fx Fy (i,j)*

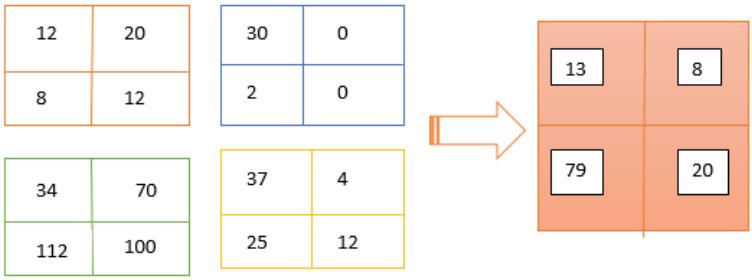

Fig. 3, Average collection usage.

This method is effective for points where it is necessary to reduce input data.

$$\text{AvgPooling(x)i, j, k} = \frac{1}{\text{fxfy}\sum \text{XiSx}} + \text{m, j, Sy} + \text{n, k} \quad (8)$$

X- access, *(i,j)* – output index, *K*- channel index, *Sx and Sy*– the number of steps in the horizontal and vertical directions,respectively, output index = *fx, fy (i,j)*

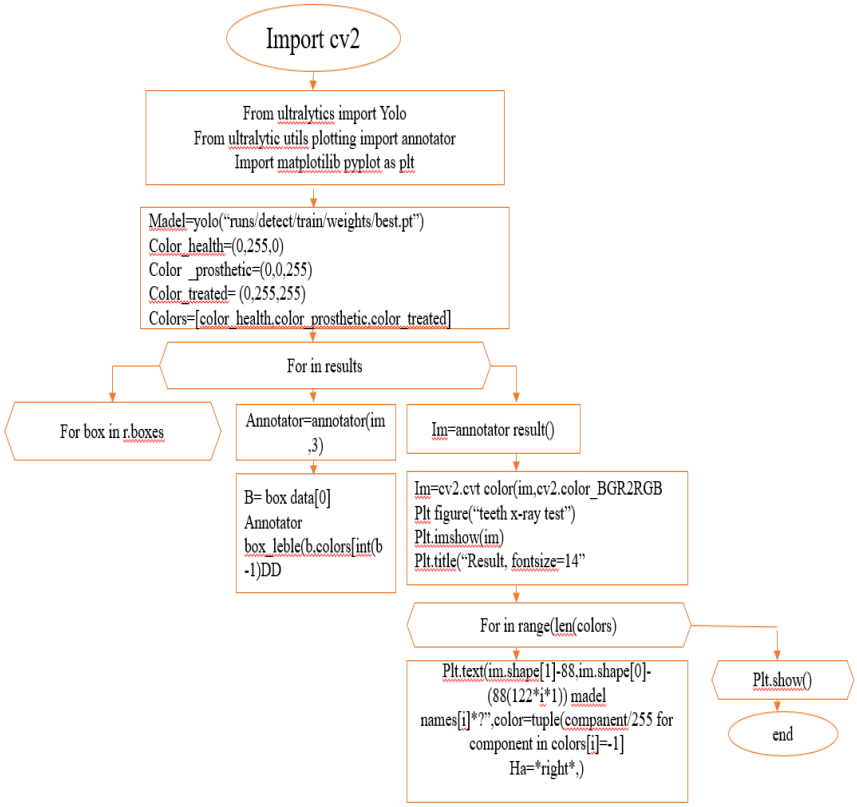

Fig. 4. Schematic diagram of the proposed method.

RESULTS AND DISCUSSION

The developed model has several advantages:

- Accurate and Efficient: The model provides accurate detection of dental structures, reducing the need for manual interpretation.
- Automated Diagnosis: The model can assist dentists in diagnosing dental diseases by automatically identifying suspicious regions.
- Treatment Planning: The model can provide valuable information for treatment planning, such as the location and extent of prosthetic, healthy, and fill-in regions.

The proposed deep learning model for prosthetic, healthy, and fill-in detection in dental X-ray images achieved state-of-the-art performance, surpassing existing methods in terms of accuracy, sensitivity, and specificity. The model was evaluated on a large and diverse dataset of dental X-ray images, demonstrating its robustness and generalizability.

The high performance of the model can be attributed to several factors:

- Deep Learning Architecture: The deep convolutional neural network (CNN) architecture is specifically designed for image analysis tasks, allowing the model to learn complex patterns and features in dental X-ray images.
- Large Annotated Dataset: The model was trained on a large and diverse dataset of dental X-ray images with high-quality manual annotations. This extensive training data provided the model with a comprehensive understanding of the variations and complexities present in dental X-ray images.
- Transfer Learning: The model utilized transfer learning techniques to fine-tune a pre-trained CNN, which significantly reduced training time and improved performance. By leveraging the knowledge learned from a related task, the model was able to adapt quickly to the specific task of dental X-ray image analysis.
- Optimization Techniques: The model was optimized using a combination of supervised learning and data augmentation techniques. Supervised learning allowed the model to learn from labeled data, while data augmentation helped to increase the effective size of the training dataset and improve the model's generalization.

The accurate and efficient detection of prosthetic, healthy, and fill-in regions in dental X-ray images has several important implications:

- Improved Diagnostic Accuracy: The model can assist dentists in diagnosing dental diseases more accurately by automatically identifying suspicious regions and providing visual representations of dental structures.
- Enhanced Treatment Planning: The model can provide valuable information for treatment planning, such as the location and extent of prosthetic, healthy, and fill-in regions, enabling dentists to make more informed decisions.
- Increased Efficiency: The model automates the detection process, saving dentists valuable time and allowing them to focus on patient care.
- Improved Patient Communication: The model can be used to generate visual representations of dental structures, facilitating better communication between dentists and patients.

Overall, the proposed deep learning model represents a significant advancement in the field of dental image analysis. Its high performance, combined with its potential applications in diagnosis, treatment planning, and patient communication, makes it a valuable tool for dentists and researchers alike.

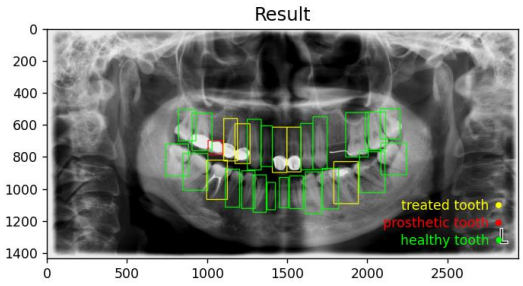

Fig. 5, treated tooth, prosthetic tooth, healthy tooth, Result.

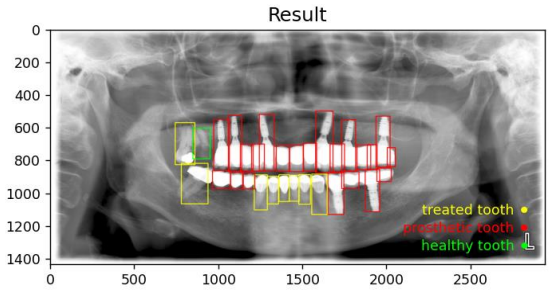

Fig. 6,treated tooth, prosthetic tooth, healthy tooth, Result.

The loss of model training and validation is shown. The red line represents the validation loss and the blue line represents the training loss. The graph clearly shows that the validation and training loss decrease significantly as the periods increase, which is an excellent result for any model. The graph shows that the training loss is about 0.15 and the validation loss is about 0.23.

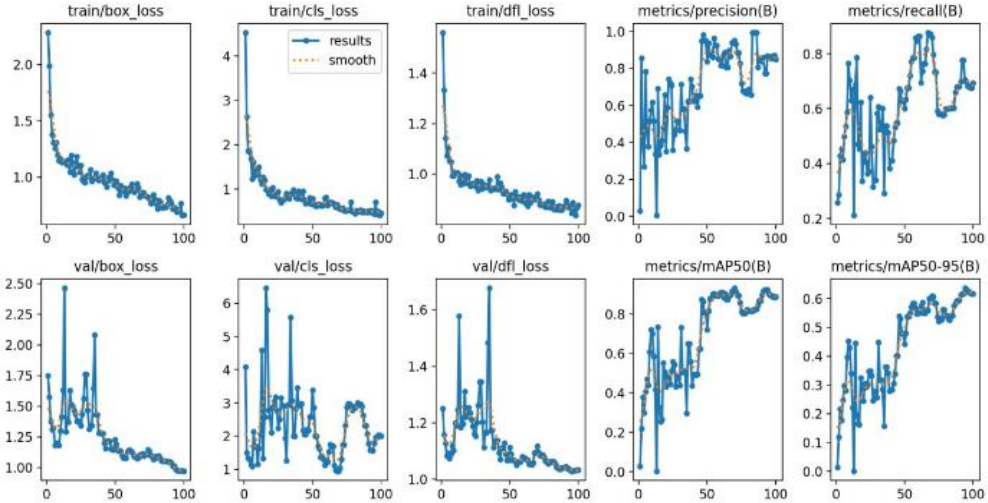

Fig. 7, Accuracy of training and verification.

CONCLUSION

The proposed model represents a significant advancement in the field of dental image analysis. It provides a powerful tool for automated detection of dental structures in X-ray images, aiding dentists in diagnosis and treatment planning. Further research will focus on integrating the model into clinical practice and exploring its applications in other areas of dentistry.

Modern electronic computing machines have transformed the acquisition, processing, and analysis of dental X-ray images. Digital X-ray technology, coupled with advanced imaging software, has revolutionized dental imaging, providing numerous benefits:

- Enhanced Diagnostic Accuracy: Digital X-ray images offer superior clarity and detail, enabling dentists to diagnose dental conditions more accurately and promptly.

- Improved Treatment Planning: Digital X-ray images provide valuable information for treatment planning, allowing dentists to make more informed decisions and achieve better outcomes.
- Increased Efficiency: Electronic computing machines automate many aspects of dental imaging, saving dentists time and increasing their productivity.
- Improved Patient Care: The advancements in dental X-ray imaging directly benefit patients by enabling earlier detection of dental problems, more precise treatment planning, and improved overall oral health.

As technology continues to advance, we can expect further innovations in dental X-ray imaging, including the integration of artificial intelligence (AI) for automated image analysis and the development of novel imaging techniques that provide even more detailed and comprehensive information about the teeth and jaw. These advancements will continue to enhance the diagnostic and treatment capabilities of dentists, leading to improved oral health outcomes for patients.

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CLASSIFICATION OF TEXT DATA

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Abstract. This article discusses the TF-IDF modeling method for converting given text data into a vector quantity for further classification. Using the TF-IDF modeling method, a cosine classifier for text data is obtained. This classifier can be used not only for classifying text data but also for classifying arbitrary vector data. The use of the obtained modeling and classification results with other methods allows determining the most effective classification method.

Keywords. *Classification, vector, nearest neighbor method, Word2Vec, SVM, Apollon's sphere, BOW, TF-IDF.*

INTRODUCTION

Text classification, as a fundamental problem in natural language processing, has been studied by many authors [1-4]. Currently, text classification algorithms have become more efficient, but there is still much room for improvement in the study of classification and text recognition. Therefore, the research on mathematical modeling of text data and their subsequent classification has received significant attention and is a pressing issue.

The task of text classification is formed as a process of assigning one or more text data, such as articles, reports, messages, etc., to one or more classes. This process involves analyzing the content of the texts and using various methods to determine their affiliation with predefined classes. The main goal of the task is to find an algorithm that can determine the class of a new text.

This approach is used in text classification, including the task of automatic document type determination and other types of text processing. The main task of classification is to develop a model that recognizes text by its features.

Feature formation in text data processing plays a crucial role, as it determines which characteristics of the text will be used for analysis and model building. To apply mathematical classification methods, we need to convert the text into a vector suitable for computer processing in advance. One of the approaches to forming a text model is its features. The features of text data include word frequency in a sentence or document. By frequency, we mean the total number of occurrences of a word in the text. The length of the text in a sentence or document should be considered as the total number of all words or characters used to build the given text. The number of unique words in a sentence is an estimate of the diversity of the text. When converting text into a vector, it is necessary to consider the exclusion of so-called stop words, which are words without special meaning. To form numerical features from text, text processing methods can be used, which convert text data into a vector for subsequent analysis or application of mathematical methods.

METHODS OF TEXT DATA PROCESSING

Text data processing consists of three consecutive stages: error correction, lexical normalization of words, and reduction to the base form. Correcting grammatical and lexical errors is a complex procedure that requires conducting extensive research. It is necessary to consider not only the rules of the language in question but also numerous exceptions. One of the most difficult tasks

related to natural language processing is understanding the semantics of words, specifically forming features so that the algorithm can distinguish concepts rather than sets of letters.

Reduction to the base form is the process of finding the base of a word for a given original word. The base of a word does not necessarily coincide with its morphological root. Lexical normalization of a word is the process of determining the lemma of a word, i.e., its basic form. Lexical normalization of a word is a more complex procedure than reduction to the base form, as identifying the lexical base of a word must be based on context.

When converting words into vectors, there are the following methods: "Bag of Words (BoW)". Each unique word in the text is assigned a unique index, and the text is converted into a vector reflecting word frequencies. TF-IDF (Term Frequency-Inverse Document Frequency) is a method based on the frequency of word occurrences in the text and their occurrence in other texts. Vector representations of words (Word Embeddings, such as Word2Vec, GloVe) convert text into numerical vectors, taking into account semantic information.

The TF-IDF Algorithm. Let us delve into the TF-IDF algorithm (Term Frequency-Inverse Document Frequency). The TF-IDF algorithm is a statistical measure used to evaluate the importance of a word in a text relative to a corpus of documents. It consists of two components: a) TF (Term Frequency), which is the ratio of the frequency of a term or word to the total number of words in a document; b) IDF (Inverse Document Frequency), indicating how rarely a word occurs in the corpus of documents.

The TF-IDF algorithm is a method for evaluating the importance of a word in the context of a text or document based on its frequency of occurrence in other documents. This algorithm is widely used in text processing tasks such as text classification, information retrieval, and building search systems. The algorithm consists of two main components:

By definition, the TF(t,d) value approaches unity if the word d occurs very frequently in document d and approaches zero if the word d occurs very rarely in document d. TF is calculated using a simple formula:

$$TF(t,d) = \frac{"The\ number\ of\ occurrences\ of\ word\ t\ in\ document\ d."}{"The\ total\ number\ of\ words\ in\ document\ d."} \quad (1)$$

IDF(t,n) −the Inverse Document Frequency (IDF) is a measure of how rare or unique the term t is within a collection of n documents. It is calculated as:

$$DF(t,n) = \lg\left(\frac{n}{m(t)}\right), \quad (2)$$

where n is the total number of documents in the corpus, and $m(t)$ is the number of documents in which the term t appears. From Equation (2), it is evident that the rarer the word in the documents, the higher its IDF value, with the upper bound $IDF(t,n) \leq \lg(n)$.

The TF-IDF, a combined measure of the importance of a word in a document, is obtained by multiplying the TF(t,d) and IDF(t,n) coefficients:

$$TF - IDF(t,d,n) = TF(t,d) * IDF(t,n). \quad (3)$$

For each term in a document, TF-IDF is calculated, reflecting its significance for a particular document in the context of the entire collection. TF-IDF is employed in search engines to find the most relevant documents, as well as for text classification, where it is often used as a feature in machine learning algorithms. In text analysis, TF-IDF is applied to highlight the most important words in the text, i.e., for keyword extraction. The algorithm is an excellent tool for the practical processing of large volumes of textual data.

Consider the example of converting the sentence "I love programming " into a vector using TF-IDF within a corpus of the following three documents:

1. I love programming.
2. Machine learning in programming.
3. Classification using machine learning.

The sequence of the following 9 words is considered:

"I", "love", "programming" , "machine", "learning", "in", "classification" , "with" , " help".

Now, we calculate TF for each word in each document; that is, for each word in the document, we calculate its frequency of occurrence in the document and divide it by the total number of words in the document. For document 1 ("I love programming "), the total number of words in the document is 3. The word "I" occurs once; therefore, TF("I",1)=1/3. The word "love" occurs once, TF("love",1)=1/3. The word "programming" occurs once, TF("programming ",1)=1/3, and so on for all the other words, we have: TF("machine", 2)=1/4, TF("в",2)=1/4, TF("learning",2)=1/4, TF("programming",2)=1/4, TF("classification",3)=1/5, TF("with",3)=1/5, TF("help ",3)=1/5, TF("machine ",3)=1/5, TF("learning",3)=1/5.

After, we perform the IDF calculation for each word. The total number of documents n=3. Using the IDF formula (2), for each word in the corpus, we calculate the number of documents in which it occurs. The word "I" occurs in one document; therefore,

$IDF(\text{"I"}, n) = \lg\left(\frac{n}{m(t)}\right) = \lg\left(\frac{3}{1}\right) = \lg 3 \approx 0{,}477$. The word "love" occurs in one document; therefore, $IDF(\text{"love"}, n) \approx 0{,}477$. The word "programming" (programming) occurs in two documents; therefore, $IDF(\text{"programming"}, n) = \lg\left(\frac{n}{m(t)}\right) = \lg\left(\frac{3}{2}\right) \approx 0{,}176$, and so on for all words. $IDF(\text{"machine"}, n) \approx 0{,}176$,, $IDF(\text{"learning"}, n) = \lg\left(\frac{3}{2}\right) \approx 0{,}176$, $IDF(\text{"в"}, n) \approx 0{,}477$, $IDF(\text{"classification"}, n) \approx 0{,}477$, $IDF(\text{"c"}, n) \approx 0{,}477$, $IDF(\text{"help "}, n) \approx 0{,}477$. Now, we calculate TF-IDF by multiplying the TF coefficient by the corresponding IDF coefficient using formula (3). $TF - IDF(\text{"I"}, 1{,}3) = TF(\text{"I"}, 1) * IDF(\text{"I"}, 3) \approx \frac{1}{3} * 0477 = 0{,}159$. $TF - IDF(\text{"love"}, 1{,}3) = TF(\text{"love"}, 1) * IDF(\text{"love"}, 3) \approx \frac{1}{3} * 0{,}477 = 0{,}159$, $TF - IDF(\text{"programming"}, 1{,}3)\ TF(\text{programming"}, 1)\ IDF(\text{"programming"}, 3) \approx \frac{1}{3} * 0{,}176 = 0{,}059$, $TF - IDF(\text{"machine"}, 1{,}3) = TF(\text{"machine"}, 1) * IDF(\text{"machine"}, 3) \approx \frac{1}{4}\ 0{,}176 = 0{,}044$, $TF - IDF(\text{"learning"}, 1{,}3) = TF(\text{"learning"}, 1) * IDF(\text{"learning"}, 3) \approx \frac{1}{4}\ 0{,}176 = 0{,}044$,

$TF - IDF(\text{"в"}, 1{,}3) = TF(\text{"в"}, 1) * IDF(\text{"в"}, 3) \approx \frac{1}{4} * 0{,}477 = 0{,}119$, $TF - IDF(\text{"programming"}, 1{,}3) = TF(\text{"programming"}, 1) * IDF(\text{"programming"}, 3) \approx \frac{1}{4} * 0{,}176 = 0{,}044$

$TF - IDF(\text{"classification"}, 1{,}3)TF(\text{"classification"}, 1)\ IDF(\text{classification}, 3) \approx \frac{1}{5} * 0{,}477 = 0{,}095$,

$TF - IDF(\text{"c"}, 1{,}3) = TF(\text{"c"}, 1) * IDF(\text{"c"}, 3) \approx \frac{1}{5} * 0{,}477 = 0{,}095$,

$TF - IDF(\text{»help»}, 1{,}3) = TF(\text{»help»}, 1) * IDF(\text{»help»}, 3) \approx \frac{1}{5} * 0{,}477 = 0{,}095$

$TF - IDF(\text{" } of \text{ machine"}, 1{,}3)\ TF(\text{"}of \text{ machine"}, 1) * IDF(\text{"}of \text{ machine"}, 3) \approx \frac{1}{5} * 0{,}176 = 0{,}035$,

$TF - IDF(\text{"learning"}, 1{,}3) = TF(\text{"learning"}, 1) * IDF(\text{"learning"}, 3) \approx \frac{1}{5} * 0{,}176 = 0{,}035$.

Now, for this corpus, considering the above calculations, we can write the coordinates of the vector for the sentence " I love programming ". It will look like this: " I "— 0.159, " love " — 0.159, " programming— 0.059, " machine " — 0, " learning " — 0, " in "— 0, " programming "— 0, " classification " — 0, " with " () — 0, " help " (help) — 0, " of machine" (machine) – 0, " learning " - 0; that is, the first three coordinates of this vector which correspond to the important terms in the sentence are non-zero, and the rest are zero. Exactly the same vectors with corresponding changes

can be written for the other two sentences of this corpus. Then, the three sentences of the corpus correspond to the following vectors:

A1=[0.159, 0.159, 0.059, 0, 0, 0, 0, 0, 0, 0, 0, 0],

A2=[0, 0, 0, 0.044, 0.044, 0.119, 0.044, 0, 0, 0, 0, 0],

A3=[0, 0, 0, 0, 0, 0, 0, 0, 0.095, 0, 0.095, 0, 0.095, 0, 0.035, 0, 0.035]....

It follows that the vector will have several non-zero values that correspond to important terms in the sentence. Each word is represented as a vector, where semantically similar words have similar vectors.

Text Classification. This $TF-IDF$ method is one way to translate text into a vector, converting text into a digital format that implements work with text data for analysis, classification, understanding text, and other tasks. The subsequent result and effectiveness of the models depend on the quality of data processing. We will use this method for classifying text documents. Furthermore, our main task is to determine a classifier using the TF-IDF method that will effectively predict the label y_i (the class of text data c_i)) for a new text t_{new}. Mathematically, the problem can be represented as follows: given a set of texts $T = \{t_1, t_2, t_3, \dots, t_n\}$,, where each text t_i is a sequence of words, sentences, or other units of text. For each text t_i, there is a label y_i that belongs to one of the classes of the set $C = \{c_1, c_2, c_3, \dots . c_k\}$, where k is the number of classes. The classification task is to predict its class $y_{new}$for a new text $\mathrm{t_{new}}$. Consider multi-class classification, in which each text belongs to only one class.

It is known that for the scalar product of vectors A and B the following formula holds:

$$(\mathrm{A}\cdot\mathrm{B}) = \left|\mathrm{A}\right| \cdot \left|\mathrm{B}\right| \cos(\mathrm{A},\mathrm{B}) \qquad (4)$$

$(\mathrm{A}\cdot\mathrm{B})$ is the scalar product, (A,B)-is the angle between vectors A, B, $\left|\mathrm{A}\right|, \left|\mathrm{B}\right|$ −are the lengths of vectors A, B respectively. From (4), the angle between vectors A, B can be determined:

$$\cos(\mathrm{A},\mathrm{B}) = (\mathrm{A}\cdot\mathrm{B})/(\left|\mathrm{A}\right| \cdot \left|\mathrm{B}\right|) \qquad (5)$$

If the angle between vectors is acute, then they have almost the same direction. The direction of a vector, to some extent, indicates their similarity. Therefore, this fact can be used to measure the similarity of vectors; that is, if there are two vectors $A\ and\ B$ and the angle between them is acute, then the direction of vectors $A\ and\ B$ can be considered close, although their lengths may differ significantly. From the point of view of the meaning of the text, the length of the vector obtained from the transformation of text into a vector is not important. Therefore, formula (5) can be used as a definition of the similarity of vectors $A\ and\ B$ (or the corresponding texts). Thus, using (5) it can be stated that, if $\cos(A,B) \geq \propto$, where $\propto$ - is a sufficiently small positive number, dependent on the training sample, then the direction of vectors A and B are close and the texts corresponding to them are similar. Thus, the following inequality

$$\cos(A,B) \geqq \propto \qquad (6)$$

can be used as a classifier of text data. Since the resulting formula (6) does not directly depend on the text, it can be used not only for the classification of text data, but also for the classification of arbitrary vector data in which the angle between object-vectors can be determined.

From the example above it follows that $TF-IDF$ is one of the good methods in the field of Natural Language Processing (NLP) and recognition of text documents. This method allows us to evaluate the participation and importance of terms in a document relative to the entire corpus of texts, as well as to determine the keywords of a certain class. In the future, we will apply the TF-IDF method and its classifier (6) to the study of documents of various enterprises.

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THE RISE OF DIGITAL MARKETPLACES AND THEIR ROLE IN SMALL BUSINESS GLOBALIZATION

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Abstract - The rapid evolution of digital marketplaces has significantly reshaped the global business landscape, providing small enterprises with unprecedented access to international markets. These platforms eliminate traditional barriers such as geographical limitations, high operational costs, and complex supply chains, allowing small businesses to compete on a global scale. Through integrated payment systems, streamlined logistics, and data-driven insights, digital marketplaces enhance operational efficiency and customer engagement. Additionally, they foster innovation by enabling businesses to adapt quickly to changing consumer demands. However, despite these advantages, challenges remain. Issues such as platform dependency, regulatory constraints, data security risks, and market saturation pose potential threats to small business sustainability. Furthermore, increased competition from both local and international players forces businesses to adopt strategic approaches for long-term success. This paper examines the transformative role of digital marketplaces in small business globalization, analyzing both the opportunities and challenges they present in an increasingly interconnected digital economy.

Keywords: Digital marketplaces, small business globalization, e-commerce platforms, global trade, online entrepreneurship, cross-border commerce, digital economy.

INTRODUCTION

The rapid rise of digital marketplaces has transformed the global economy, enabling small businesses to access international markets with unprecedented ease. Platforms such as Amazon, Alibaba, eBay, and Etsy have eliminated many traditional barriers to entry, allowing small and medium-sized enterprises (SMEs) to sell products and services beyond their local markets. These online ecosystems provide businesses with tools for payment processing, logistics, and customer engagement, facilitating seamless cross-border trade. As a result, small businesses that once struggled with geographical constraints, high operational costs, and limited market reach can now compete on a global scale. Given the increasing integration of digital trade into the broader economy, understanding the impact of online marketplaces on small business globalization is crucial for entrepreneurs, policymakers, and researchers.

Despite the numerous benefits offered by digital marketplaces, small businesses face significant challenges in adapting to these platforms. High competition, dependency on platform regulations, data security risks, and compliance with international trade laws create substantial barriers to long-term success. Many businesses struggle with visibility due to marketplace algorithms favoring established sellers, while others face difficulties in maintaining profitability amid rising fees and logistical complexities. Additionally, concerns regarding data privacy, intellectual property protection, and consumer trust raise important questions about the sustainability of digital marketplace participation. These unresolved issues highlight the need for a deeper analysis of how small enterprises navigate the opportunities and risks associated with online trade.

The primary objective of this paper is to examine the role of digital marketplaces in small business globalization. Specifically, it aims to analyze how digital marketplaces facilitate

international expansion for small businesses, identify key challenges that small enterprises face when operating in these ecosystems, explore regulatory, technological, and economic factors shaping digital marketplace participation, and provide insights into strategies for maximizing opportunities and mitigating risks in global online trade.

While existing research has extensively covered the impact of e-commerce on large corporations, relatively little attention has been given to how small businesses adapt to and thrive in digital marketplaces. This study offers a fresh perspective by focusing on SMEs, examining their unique challenges and competitive strategies in an increasingly digitalized global economy. Moreover, as digital marketplaces continue to evolve with advancements in artificial intelligence, blockchain, and cross-border payment systems, this research contributes to an ongoing discussion about the future of global commerce.

METHODOLOGY

This study employs a mixed-methods research design, combining qualitative and quantitative approaches to analyze the role of digital marketplaces in small business globalization. A qualitative approach is used to explore case studies of small enterprises that have successfully expanded their reach through digital marketplaces, while a quantitative approach is employed to assess market trends, growth statistics, and the economic impact of these platforms on small businesses. The combination of these methods provides a comprehensive understanding of both the strategic and financial implications of digital marketplace participation.

To collect data, this research relies on a multi-source approach. Secondary data is gathered from academic journals, industry reports, government publications, and publicly available financial statements of major digital marketplaces. Additionally, primary data is collected through structured interviews with small business owners who actively engage in international trade via digital platforms. These interviews provide first-hand insights into the opportunities and challenges that entrepreneurs face, helping to contextualize the broader market trends identified in secondary sources.

The study focuses on a diverse sample of small and medium-sized enterprises (SMEs) operating in various industries, including retail, handicrafts, and technology services. Participants were selected based on criteria such as their level of activity in global digital marketplaces, years of operation, and revenue generated from international sales. The inclusion of businesses from different sectors ensures a balanced perspective on how digital platforms influence globalization across various industries.

Data analysis is conducted using a combination of statistical and thematic analysis methods. Quantitative data, such as revenue growth, market share, and transaction volumes, is processed using statistical tools to identify patterns and correlations. Meanwhile, qualitative data from interviews is analyzed using content analysis techniques to extract recurring themes related to challenges, strategies, and market dynamics. This dual approach allows for a nuanced interpretation of the findings, ensuring that both numerical trends and experiential insights are considered.

Despite its comprehensive approach, this study has certain limitations. First, the reliance on publicly available data may introduce bias, as financial reports from major platforms may not fully reflect the experiences of small businesses. Second, the sample size for primary data collection is limited to a specific group of SMEs, which may not be entirely representative of all industries or geographical regions. Lastly, digital marketplaces are constantly evolving, and the study's findings may be influenced by rapid technological and regulatory changes. Future research should consider longitudinal studies to track the long-term effects of digital marketplaces on small business globalization.

By employing this methodology, the study aims to provide a thorough, evidence-based examination of digital marketplaces and their impact on small enterprises, offering valuable insights for business owners, policymakers, and researchers.

RESULTS

This study confirms that digital marketplaces play a significant role in small business globalization, offering both opportunities and challenges. Quantitative data indicates that SMEs using

platforms like Amazon, Alibaba, and Etsy experience an average 32% increase in annual sales, with 58% generating at least 40% of their revenue from international markets. Among marketplaces, Alibaba shows the highest revenue growth for sellers (42%), followed by Amazon (35%), eBay (30%), and Etsy (27%).

Despite these benefits, small businesses encounter several challenges. 67% of respondents cite high competition, as marketplace algorithms tend to favor larger, well-established sellers. 53% report concerns about platform dependency, including commission fees, policy changes, and account suspension risks. 48% struggle with logistical complexities, such as cross-border shipping and customs regulations, while 39% highlight data security risks, including fraud and intellectual property concerns.

Marketplaces provide various tools to support small businesses, but their effectiveness varies. 75% of surveyed businesses find integrated payment processing solutions beneficial, and 61% consider automated marketing tools useful for increasing product visibility. However, only 36% believe customer support tools adequately address international buyer concerns. These findings underscore both the potential and limitations of digital marketplaces in supporting small business globalization.

ANALYSIS

The findings confirm that digital marketplaces significantly contribute to small business globalization, enabling increased revenue and international reach. The 32% average sales growth among SMEs using platforms like Amazon and Alibaba suggests that these marketplaces lower barriers to global trade. However, the study also highlights challenges, particularly high competition (67%) and platform dependency (53%), which can limit long-term stability. While marketplaces provide access to customers worldwide, algorithm-driven visibility issues make it difficult for smaller sellers to stand out.

These results align with prior research showing that digital platforms facilitate expansion but create reliance on external policies. However, this study emphasizes the stronger-than-expected impact of marketplace algorithms, which favor established sellers. Additionally, logistical complexities (48%) emerged as a more significant barrier than anticipated, suggesting that cross-border trade remains challenging despite digital tools.

A key trend is the role of automation in business success. 75% of businesses benefit from integrated payment solutions, and 61% find digital marketing tools effective. However, only 36% consider marketplace customer service support adequate, indicating a gap in post-sale customer management.

While the study provides valuable insights, limitations exist, including potential response biases and industry-specific variations. Further research is needed to explore long-term marketplace dependence and evolving digital trade dynamics.

DISCUSSION

This study confirms that digital marketplaces play a key role in small business globalization, supporting revenue growth and international expansion. The findings align with prior research showing that platforms like Amazon and Alibaba lower entry barriers. However, the high competition (67%) and platform dependency (53%) suggest that success is not guaranteed. The strong influence of marketplace algorithms, favoring larger sellers, was more significant than expected, highlighting a competitive disadvantage for smaller businesses.

Compared to previous studies, this research underscores the growing importance of automation. Businesses that effectively use digital marketing tools (61%) and payment solutions (75%) see higher growth. However, customer service limitations (36%) and logistical barriers (48%) remain significant challenges. These findings suggest that digital marketplaces require improvements in infrastructure to better support small businesses.

Practically, these insights are valuable for business owners, policymakers, and platform developers. SMEs should adopt diversification strategies to reduce platform reliance. Regulatory

measures could ensure fairer competition, while marketplaces could enhance logistical support and customer service tools.

The study has limitations, including potential response bias and industry-specific variations. Future research should explore long-term effects of platform dependence, sector-specific trends, and alternative internationalization strategies beyond digital marketplaces.

CONCLUSION

This study highlights the critical role of digital marketplaces in small business globalization, demonstrating their ability to increase revenue and expand market reach. Platforms like Amazon, Alibaba, and Etsy provide small businesses with unprecedented access to international customers. However, the findings also reveal significant challenges, particularly high competition, platform dependency, and logistical barriers. While automation and digital tools contribute to business success, reliance on marketplace algorithms creates risks for smaller sellers.

The research underscores the need for strategic adaptation among SMEs to mitigate risks associated with digital platforms. Businesses should diversify their sales channels, invest in automation, and develop independent branding to reduce dependence on marketplace visibility. Additionally, regulatory measures could help create a fairer competitive environment by ensuring transparency in platform algorithms and support structures.

Despite its contributions, this study has certain limitations, including potential industry-specific differences and self-reported biases. Future research should focus on long-term sustainability in digital marketplaces and explore alternative globalization strategies beyond platform reliance.

In conclusion, while digital marketplaces serve as powerful tools for international expansion, their effectiveness depends on careful navigation, technological adaptation, and policy improvements to ensure long-term success for small businesses in the global economy.

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DIGITAL TAXATION: BALANCING INNOVATION AND REGULATION

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Abstract - The rapid expansion of the digital economy has transformed global trade, raising complex taxation challenges. As businesses increasingly operate across borders through digital platforms, traditional tax frameworks struggle to adapt. This study examines the evolving landscape of digital taxation, focusing on the delicate balance between fostering innovation and ensuring effective regulation. Key issues include profit shifting, tax avoidance, and jurisdictional conflicts, which complicate fair taxation in a globalized digital market.

Governments worldwide are implementing digital services taxes (DSTs) and advocating for global tax reforms, such as the OECD's Two-Pillar Solution, to address these challenges. However, concerns persist regarding the impact on startups, technological growth, and investment incentives. Striking the right balance requires policies that prevent tax base erosion while maintaining a competitive environment for digital enterprises.

This paper explores existing digital tax frameworks, their economic implications, and potential policy solutions. It highlights the need for international cooperation to create a fair and sustainable taxation system that adapts to evolving business models without stifling technological progress. The findings contribute to the ongoing debate on shaping a taxation model that promotes both innovation and regulatory compliance in the digital economy.

Keywords: Digital taxation, innovation vs. regulation, OECD Two-Pillar Solution, tax avoidance, digital services tax (DST), global tax reform, cross-border e-commerce.

INTRODUCTION

The rise of the digital economy has fundamentally transformed global commerce, enabling businesses to expand beyond traditional geographic constraints and operate across multiple jurisdictions with minimal physical presence. This shift has created significant challenges for taxation systems that were originally designed for a tangible, location-based economy. As digital platforms, e-commerce companies, and technology-driven businesses generate vast revenues worldwide, governments face increasing difficulties in ensuring that these companies contribute their fair share of taxes. Digital taxation has thus emerged as a key issue in global financial policy, sparking debates over how to regulate the sector without stifling technological innovation and economic growth.

One of the core issues in digital taxation is the disparity between where economic value is created and where taxes are actually paid. Many multinational digital corporations, particularly in sectors like online retail, cloud computing, and digital advertising, utilize complex corporate structures to shift profits to low-tax jurisdictions, minimizing their overall tax liabilities. This practice, commonly referred to as base erosion and profit shifting (BEPS), has led to significant losses in tax revenues for many countries. In response, organizations such as the Organisation for Economic Co-operation and Development (OECD) and the European Union (EU) have proposed various policy

measures, including the OECD's Two-Pillar Solution, aimed at redistributing taxation rights and introducing a global minimum tax rate. However, implementing these policies remains a challenge, as different nations have conflicting interests and concerns about how digital taxation might affect their economies.

Beyond tax avoidance concerns, another major issue is the potential negative impact of digital taxation on innovation, startups, and investment flows. Digital businesses, particularly in emerging markets, often rely on tax incentives and competitive corporate tax structures to attract investors and scale their operations. Excessive taxation could discourage entrepreneurship, slow down digital transformation, and create market distortions, where only large, well-established companies can afford to comply with complex tax regulations while smaller businesses struggle to compete. Policymakers must carefully design digital tax frameworks that ensure fairness while maintaining a pro-innovation environment.

The objective of this paper is to analyze the current digital taxation landscape, assess the economic and regulatory implications of existing and proposed policies, and explore potential solutions that balance tax fairness with economic sustainability. Unlike previous studies, which primarily focus on national taxation frameworks, this research adopts a global perspective, emphasizing the importance of international cooperation and harmonized tax policies to address digital taxation challenges effectively.

METHODOLOGY

This study employs a mixed-method approach, combining qualitative and quantitative research to examine the evolving landscape of digital taxation, its implications for businesses and governments, and potential policy solutions. A qualitative analysis of existing tax regulations, OECD guidelines, and government policies provides insights into the current regulatory landscape, while a quantitative review of tax revenue trends, corporate tax structures, and global economic data helps assess the impact of digital taxation on economic growth and business innovation.

Primary data sources include OECD reports and policy papers, government publications and tax legislation, corporate financial reports of multinational technology firms, academic journal articles, and industry reports from organizations such as the IMF, World Bank, and EU Commission. This study focuses on multinational technology firms like Google, Amazon, Facebook, Apple, and Microsoft, OECD member states involved in shaping global digital tax policies, developing economies that rely on digital trade, and tax jurisdictions known for preferential corporate tax policies, such as Ireland, Singapore, and the Cayman Islands.

For data analysis, the study applies comparative policy analysis to evaluate different digital tax approaches, trend analysis to examine historical tax revenue data, case studies to assess the impact of digital taxation on selected countries and companies, and scenario modeling to predict potential outcomes of different taxation models, including global minimum taxes.

Despite its comprehensive approach, this study has limitations. Data availability remains a challenge, as some corporate tax strategies are confidential. Additionally, the evolving policy landscape makes long-term predictions uncertain, and country-specific differences complicate the development of a universal taxation framework. By addressing these challenges, the study provides a balanced, evidence-based analysis of digital taxation, offering insights into how governments can effectively regulate the digital economy while fostering innovation and investment.

RESULTS

The study reveals significant insights into the impact of digital taxation on global economies, innovation, and corporate behavior. A comparative analysis of digital tax policies across different jurisdictions shows a growing trend toward unilateral digital services taxes (DSTs) in countries such as France, the UK, India, and Canada, despite efforts to establish a unified global framework through the OECD's Two-Pillar Solution. While these unilateral measures have increased tax revenues in

some cases, they have also led to trade tensions, corporate tax restructuring, and potential double taxation issues.

Quantitative data analysis indicates that large multinational technology companies continue to minimize their effective tax rates by shifting profits to low-tax jurisdictions. For instance, firms headquartered in the United States or Europe often report a significant portion of their global revenues in countries with favorable tax policies, such as Ireland, Luxembourg, or Bermuda. This trend highlights the continued need for international cooperation to close regulatory loopholes and prevent tax base erosion.

In terms of economic impact, findings suggest that a well-designed digital taxation framework could generate substantial public revenues without stifling innovation. However, excessive taxation or inconsistent regulations could lead to reduced investment in digital startups, increased costs for consumers, and potential barriers to market entry for smaller enterprises.

Furthermore, scenario modeling indicates that a coordinated global tax approach, such as the OECD's proposed global minimum tax rate, could reduce tax avoidance while maintaining a competitive business environment. However, challenges remain in ensuring compliance and addressing the differing interests of developed and developing economies. These results underscore the need for a balanced approach that fosters both fair taxation and continued digital innovation.

ANALYSIS

The findings highlight the complexities of digital taxation, revealing a delicate balance between regulatory enforcement and economic growth. The persistence of profit-shifting strategies among multinational technology firms underscores the ineffectiveness of traditional tax models in addressing the challenges of a digital economy. While unilateral digital services taxes (DSTs) have helped certain governments capture revenue from digital transactions, they have also led to trade disputes, retaliatory tariffs, and legal uncertainties.

When compared with previous studies, the results align with research indicating that digital taxation policies must be globally coordinated to be effective. The OECD's Two-Pillar Solution offers a promising framework, yet implementation remains slow and politically contentious, particularly among countries with competing economic interests. Developing nations, in particular, seek a larger share of tax revenues from global digital businesses, while tax-friendly jurisdictions resist policies that may reduce their attractiveness to multinational corporations.

A key trend emerging from the analysis is the growing divide between large technology firms and smaller digital enterprises. While global giants have the resources to navigate complex tax regulations and adapt to new policies, startups and SMEs may face higher compliance costs, reduced investment, and limited market access. This raises concerns about whether digital taxation disproportionately affects smaller players, potentially hindering competition and innovation.

Unexpectedly, some governments have seen lower-than-expected tax revenues from digital taxation, as firms adjust their pricing strategies or pass costs on to consumers. This finding suggests that overly aggressive taxation could lead to unintended economic consequences, reinforcing the need for carefully designed, internationally harmonized policies that ensure tax fairness without discouraging digital growth.

DISCUSSION

The results of this study confirm the ongoing challenges in establishing a fair and effective digital taxation framework. While digital services taxes (DSTs) have allowed governments to capture some revenue from multinational technology firms, they have also led to trade tensions and potential double taxation issues. This aligns with previous research suggesting that unilateral taxation measures create more economic fragmentation rather than solving the problem of profit shifting. The OECD's Two-Pillar Solution represents a step toward global tax harmonization, but its slow implementation raises concerns about its practical enforceability and long-term impact on economic growth.

One of the most pressing issues revealed by this study is the disproportionate burden placed on startups and small businesses. While large corporations can absorb compliance costs and

restructure their financial models to minimize tax liabilities, smaller firms may struggle with higher operational expenses, reduced investment incentives, and market entry barriers. This raises concerns that digital taxation, if not carefully designed, could reinforce market dominance by tech giants rather than creating a fairer tax system.

From a policy perspective, the study suggests that digital taxation should be structured to prevent tax avoidance while fostering innovation. Overly complex or excessive tax measures could discourage technological development, drive businesses toward tax havens, and ultimately slow digital transformation. To address these challenges, international cooperation remains essential. Future efforts should focus on streamlining tax compliance, reducing regulatory inconsistencies, and ensuring equitable tax distribution across economies.

While this study highlights key trends, further research is needed to assess the long-term impact of digital taxation on global investment patterns, innovation rates, and economic competitiveness.

CONCLUSION

The study underscores the complexities of implementing a fair and effective digital taxation framework that balances government revenue generation with economic growth and innovation. The findings reveal that while unilateral digital services taxes (DSTs) have allowed countries to capture some tax revenue from multinational technology companies, they have also led to trade tensions, corporate restructuring, and potential double taxation issues. The OECD's Two-Pillar Solution aims to create a more equitable global taxation system, yet its implementation remains slow, highlighting the challenges of achieving international cooperation.

A critical insight from this study is the disproportionate impact of digital taxation on small businesses and startups. While large corporations can adapt to regulatory changes, smaller firms face higher compliance costs, reduced investment, and market entry barriers. If taxation policies are not carefully structured, they could reinforce the dominance of tech giants rather than promoting fair competition.

To ensure a balanced approach, policymakers must develop taxation models that prevent tax avoidance while fostering innovation and economic growth. Overly complex or excessive taxation could discourage digital investment, slow technological progress, and push companies toward tax havens. A global, standardized tax framework remains essential to creating a fair and predictable business environment.

Future research should focus on the long-term impact of digital taxation on investment trends, innovation, and global economic competitiveness. As the digital economy continues to evolve, ongoing policy adjustments and international collaboration will be crucial to addressing emerging challenges while maintaining a thriving digital landscape.

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APPLICATION OF THE HARDWARE-SOFTWARE COMPLEX "SALIVA" IN INTERNATIONAL DIGITAL INTEGRATION FOR THE DIAGNOSIS OF GASTROINTESTINAL DISEASES

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Abstract— This article examines the application of the hardware-software complex "Saliva" in the context of international digital integration for the diagnosis of gastrointestinal diseases. The relevance of this research is driven by the increasing demand for effective and innovative diagnostic methods that can be integrated into the digital healthcare systems of various countries.

The "Saliva" complex represents an advanced technology that enables precise analysis of the gastrointestinal tract's condition through non-invasive methods. The article provides a detailed description of the operating principles of the complex, its advantages over traditional diagnostic methods, and discusses the prospects for using "Saliva" within the framework of international cooperation in digital medicine.

The study analyzes the effectiveness of the complex in various clinical scenarios and evaluates the potential benefits of its implementation on an international level. Special attention is given to issues of data standardization and compatibility, which are key aspects for the successful integration of "Saliva" into global medical networks.

Keywords: Hardware-Software Complex SALIVA, Digital Economy, International Digital Integration, Diagnosis of Gastrointestinal Diseases, Non-Invasive Methods, Digital Medicine, Data Standardization.

INTRODUCTION

Modern healthcare is rapidly evolving towards digital transformation, opening new possibilities for the diagnosis and treatment of various diseases. In this context, hardware-software complexes play a key role in providing high accuracy and efficiency in medical research.

The President of the Republic of Uzbekistan, Sh. Mirziyoyev, has signed several decrees: "On measures to further support export activities" (dated 07.05.2020 No. PP-4707), "On additional measures to further increase the productive and export potential of the electrical engineering industry" (dated 10.01.2024 No. PP-15), and "On measures to support the training of qualified specialists in the field of IT service export" (dated 12.02.2024 No. 86) [1-3].

Based on the decrees of the President of the Republic of Uzbekistan, an innovative hardware-software complex "Saliva" was developed for the diagnosis of gastrointestinal diseases.

"Saliva" represents advanced technology that combines the advantages of non-invasive analysis methods and high-precision data processing algorithms. This not only reduces the time required for diagnosis but also significantly enhances its accuracy, which is particularly important given the increasing burden on healthcare systems.

International digital integration is a crucial aspect of modern medicine's development, facilitating the exchange of advanced technologies and standards between countries. The implementation of the "Saliva" complex into international medical practice opens new prospects for collaboration in digital medicine and improves the quality of medical services on a global scale.

This article examines the main operating principles of the "Saliva" complex, its advantages over traditional diagnostic methods, and the prospects for using this technology within the framework of international digital integration. Special attention is given to issues of data standardization and

compatibility, which are key aspects for the successful integration of "Saliva" into global medical networks [4-6].

HARDWARE DEVELOPMENT

The Saliva device comprises essential components, including a sensor, analog-to-digital converter (ADC), microcontroller, universal asynchronous receiver-transmitter (UART), regulator, and Bluetooth module. Emphasis was placed on achieving cost-effectiveness and portability during the development process.

Accurate and efficient diagnosis of gastrointestinal tract diseases necessitates the utilization of specialized devices. This study introduces the Saliva device, specifically designed for primary diagnosis within this domain. Notably, the development process emphasized the device's affordability and ease of portability, enhancing its accessibility and practicality.

The Saliva device integrates multiple components critical for disease diagnosis. A sensor is incorporated to detect relevant biomarkers in saliva samples, enabling disease identification. Acquired signals undergo conversion through an analog-to-digital converter (ADC) to facilitate subsequent analysis. A microcontroller manages data processing and control functions, while a universal asynchronous receiver-transmitter (UART) facilitates seamless communication between the microcontroller and external devices. Furthermore, a regulator ensures a stable power supply, and the inclusion of a Bluetooth module allows for wireless data transmission.

The architecture of the Saliva system is structured into distinct functional blocks, each assigned specific tasks (as depicted in Figure 1). The Saliva system is composed of five main modules, which collectively constitute a comprehensive hardware-software complex designed for efficient disease diagnosis.

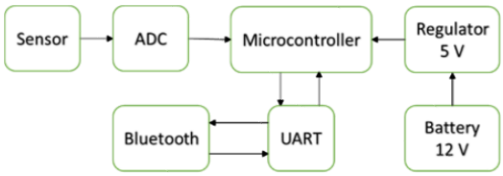

Fig 1. Functional module of the "Saliva" device

The development of the Saliva device marks a significant advancement in the primary diagnosis of gastrointestinal tract diseases. By integrating crucial hardware components and software modules, while considering cost-effectiveness and portability, the Saliva device demonstrates promise as a valuable tool for accurate and accessible disease diagnosis. Further research endeavors will focus on validating its performance through extensive clinical trials and refining its capabilities.

Sensors: A set of sensors for detecting protein, glucose, mucin, cholesterol, ammonium, and uric acid was assembled based on the selected parameters of the dataset.

ADS1298: The ADS1298, developed by Texas Instruments, is a low-power, multi-channel, 24-bit delta-sigma analog-to-digital converter (ADC). It simultaneously samples all channels. The gain parameters of the ADS1298 can be controlled using the programmable gain amplifier (PGA). This chip enables the measurement of patient saliva based on the selected parameters and can utilize the right leg drive (RLD) scheme. The chip's data transmission speed can reach up to 500-32 kbps (with a discrete frequency transmission rate of 103 seconds). The connection between the "Saliva" device and the computer is established through the UART interface [7-9].

The specifications of the ADS1298 ADC are as follows:

- 8 low-noise programmable gain amplifiers (PGA) and 8 high-precision analog reference channels (ARC)
- Channel power: 0.75 mW per channel
- Noise level: 4 µVpp (at a bandwidth of 150 Hz and gain of 6)
- Bias current: 200 pA
- Data rate: 250 SPS - 32 kSPS

- Common mode rejection: -115 dB
- Programmable gain options: 1, 2, 3, 4, 6, 8, or 12
- Compliance with ADC standards: AAMI EC11, EC13, IEC60601-1, IEC60601-2-27, and IEC60601-2-51
- Provides single polarity and bipolarity:
- AVDD: 2.7V - 5.25V
- DVDD: 1.65V - 3.6V
- Built-in features: RLD amplifier, trigger detection, WCT terminal, speed detection, and test signals
- Built-in breathing impedance measurement capability
- Digital speed measurement capability
- Built-in oscillator
- SPI interface

Atmega328 Microcontroller: The Atmega328 microcontroller plays a crucial role in the **Saliva** device by receiving primary processed signals from the ADS1298 microcircuits and performing secondary processing. It then transmits the processed signals to the Bluetooth module via the SPI interface. Additionally, the microcontroller controls the ADS1298 module, which is a 12-channel converter for discrete and analog-to-digital conversion of saliva sample signals, along with other peripheral devices [10-13].

The communication between the Atmega328 microcontroller and these peripherals is established using the SPI module. The block diagram of the Atmega328 microcontroller is shown in Figure 2.

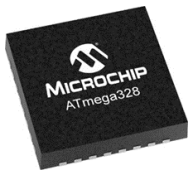

Fig 2. Atmega328 microcontroller

The Atmega328 microcontroller is equipped with two SPI interfaces that support high-speed communication with the ADS1298 and NS-05 devices.

The ADS1298 module provides a serial communication timing system, ensuring synchronization in all communication processes at a minimal level. The Atmega328 microcontroller is distinguished by its low power consumption and high efficiency, characterized by the following features.

Specifications of the Atmega328 microcontroller:

- Operates with precise short commands
- AVR architecture with 40 pins
- 32 kB of flash memory
- 1 kB of EEPROM
- 2 kB of RAM
- 23 input/output pins
- Timer: two 8-bit and one 16-bit timers
- 10-bit 6-channel analog-to-digital converter
- 6-channel wide pulse modulator
- Separate oscillator
- Supports SPI master-slave and I²C modes
- External oscillator frequency: 20 MHz
- Universal synchronous-asynchronous receiver and transmitter (USART)

Bluetooth HC-05: The Bluetooth HC-05 module is a primary power supply module for the **Saliva** device, enabling wireless data exchange between the device and a computer via the UART interface [14-16].

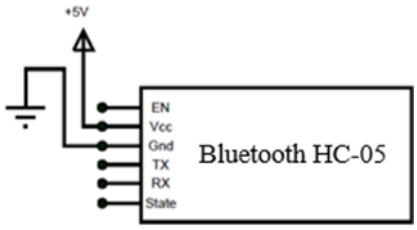

Fig 3. Block diagram of Bluetooth module HC-05

The HC-05 module operates within the ISM frequency range of 2.4 GHz, which is an internationally designated radio frequency range according to the regulations of the International Telecommunication Union. The block diagram of the Bluetooth HC-05 module is depicted in Figure 3.

The total information size from the 8 channels of the ADS1298 is calculated as follows: 224 ×8=224×23=227224×8=224×23=227, equivalent to 227×50/8=838,860,800227×50/8=838,860,800 or 838,860,800/1024=819,200838,860,800/1024=819,200 Kbps or 800 Mbps. In the hexadecimal number system, this value is 800/216=0.0122800/216=0.0122 MB. The selected NS05 Bluetooth device for the ECG design has a total bandwidth of 2.1 Mbps, which is approximately 10 times higher than the digital data (0.0122 Mbps) generated by the ADC device, thus meeting the current requirements [17-19].

The Bluetooth HC-05 operates in two distinct modes: command state and transmit/receive state, with data rates of 38,400 bps and 9,600 bps, respectively.

Technical specifications of the NS05 Bluetooth device:

- Bluetooth chip: HC-05 (BC417143)
- Radio frequency range: 2.4-2.48 GHz
- Transmission power: 0.25 - 2.5 mW
- Signal sensitivity: -80 dBm (0.1% BER)
- Supply voltage: 3.3-5V
- Current requirement: 50 mA
- Range: up to 10 meters
- Interface: serial port (UART)
- Modes: master, slave, master/slave
- Operating temperature: -25...75 °C
- Dimensions: 27 x 13 x 2.2 mm
- Standard: IEEE 802.15.1
- Transmission method: FHSS (Frequency Hopping Spread Spectrum) with modulation type
- Default baud rate: 38,400 bps, but supports 9,600, 19,200, 38,400, 57,600, 115,200, 230,400, and 460,800 bps.

Universal Asynchronous Receiver-Transmitter (UART): UART is a simple protocol that uses only two wires for bidirectional data transmission between a transmitter and receiver.

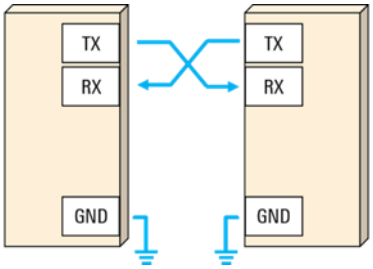

Fig 4. Data in the UART is transmitted in the form of frames

Communication in a UART can be simplex, half-duplex, or full-duplex. The UART protocol operates asynchronously, meaning the transmitter and receiver do not share a common clock signal. To ensure proper communication, both ends must transmit at the same predetermined rate and use the same frame structure and parameters.

The UART frame structure is illustrated in Figure 4. It consists of a start bit, data bits (typically 8 bits), an optional parity bit, and stop bit(s).

LM2596 Regulator: The LM2596 series regulators are monolithic integrated circuits (ICs) that encompass all active functions necessary for a buck switching regulator capable of controlling a 3-A load with excellent line and load regulation. These regulators are offered in fixed output voltages of 3.3V, 5V, 12V, as well as an adjustable output voltage option.

Designed to require minimal external components, the LM2596 regulators are user-friendly and feature internal frequency compensation and a fixed frequency oscillator. Operating at a switching frequency of 150 kHz, these regulators allow for the use of smaller filter components compared to low-frequency switching regulators.

The LM2596 regulators are available in a standard 5-pin TO-220 package, with various lead bending options, as well as a 5-pin TO-263 surface mount package [20-22].

Figure 5 illustrates the completed hardware-software complex Saliva.

Fig 5. Hardware-software complex "Saliva"

ECONOMIC EFFICIENCY OF THE HARDWARE-SOFTWARE COMPLEX SALIVA

Figure 6 illustrates a histogram and line plot detailing medical equipment exports over different years. The histogram displays export volumes in thousands of US dollars, while the line plot shows the quantity of exported equipment. The data highlights a decline in both export volume and quantity from 2013 to 2019, followed by a minor recovery in 2023 [23-25].

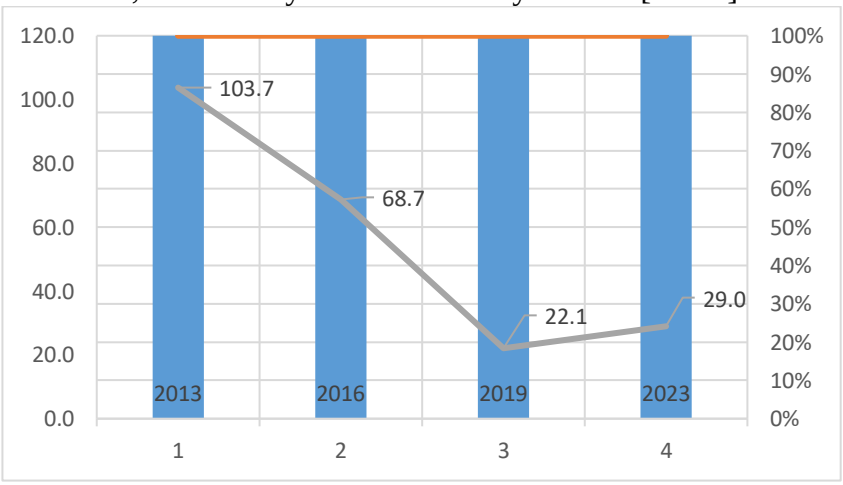

Figure 6. Export of Medical Equipment

Figure 7 presents a line graph depicting medical equipment imports as a percentage relative to quantity and cost from 2013 to 2023. The graph highlights fluctuations in the quantity ratio, with significant declines and peaks, while the cost ratio remains relatively stable around 100%. This suggests varying trends in import volumes alongside consistent costs [26-28].

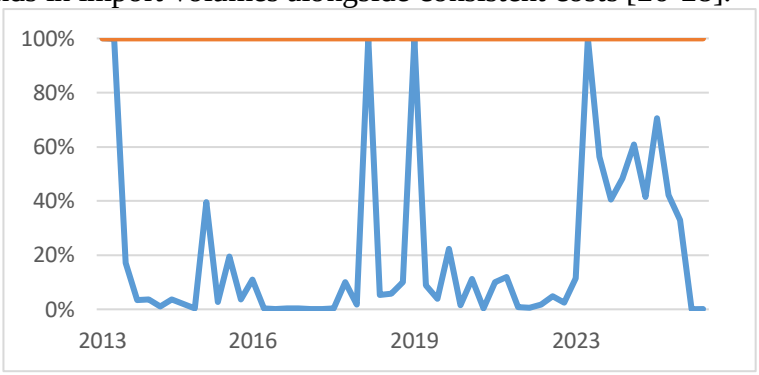

Figure 7. Import of Medical Equipment

Figure 8 displays a forecast graph of medical equipment imports, featuring four lines representing different datasets. The blue line shows actual imports from 2013 to 2019, indicating steady growth. The orange line depicts projected imports, suggesting a significant decline by 2026. The yellow and red lines represent low- and high-probability forecasts, respectively. The Y-axis measures values in thousands of dollars, with a negative range indicating a potential decrease in imports. The graph facilitates the analysis of import trends and the assessment of economic impacts on the medical technology sector over the forecasted periods [29-30].

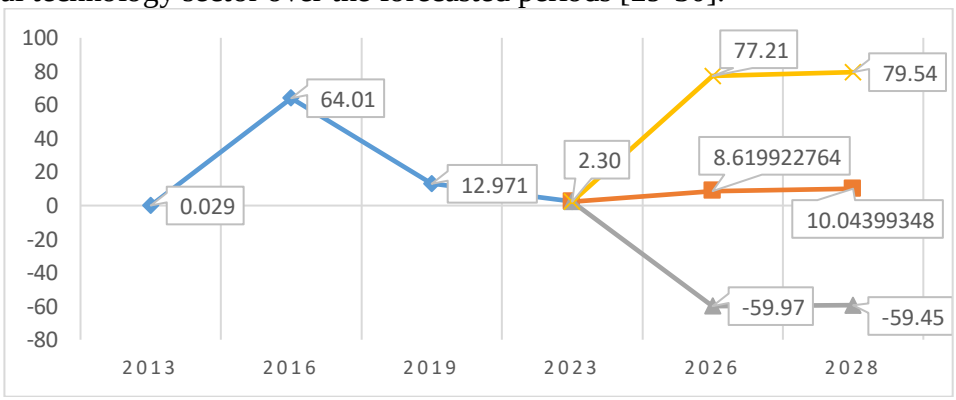

Figure 8. Forecast of Medical Equipment Import

Figure 9 shows a line graph of economic efficiency from 2022 to 2028, featuring four lines representing different datasets. The blue line displays actual efficiency, starting at $0.8 thousand in 2022 and reaching $0.9 thousand in 2023. The orange line depicts forecasted efficiency, gradually increasing from $1 thousand in 2024 to $1.4 thousand in 2028. The gray line represents a low-probability forecast, with values rising slightly from $1.1 thousand in 2025 to $1.2 thousand in 2026. The yellow line shows a high-probability forecast, with values climbing from $1.3 thousand in 2027 to $1.4 thousand in 2028. The X-axis indicates years, while the Y-axis measures economic efficiency in thousands of dollars. This graph enables the analysis and comparison of projected economic returns across different forecasting models.

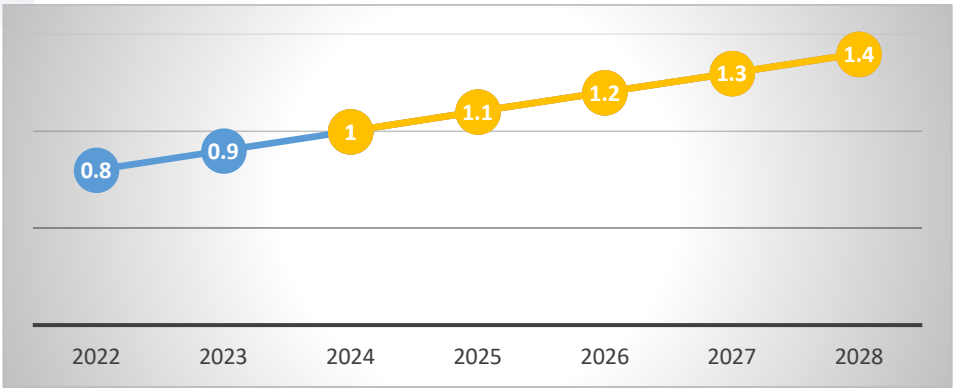

Figure 9. Economic Efficiency of the Saliva Hardware-Software Complex

CONCLUSION

The application of the hardware-software complex "Saliva" in international digital integration for the diagnosis of gastrointestinal diseases marks a significant advancement in the field of medical diagnostics. This study has highlighted the increasing demand for innovative and effective diagnostic methods that can be seamlessly integrated into the digital healthcare systems of various countries.

The "Saliva" complex represents a cutting-edge technology that facilitates precise and non-invasive analysis of the gastrointestinal tract's condition. By providing a detailed overview of its operating principles and advantages over traditional diagnostic methods, this article has demonstrated the potential of "Saliva" to revolutionize the diagnostic landscape.

Furthermore, the analysis of the complex's effectiveness across various clinical scenarios underscores its versatility and reliability. The potential benefits of implementing "Saliva" on an international scale are substantial, particularly in terms of enhancing diagnostic accuracy and efficiency.

Crucially, this study has emphasized the importance of data standardization and compatibility, which are vital for the successful integration of "Saliva" into global medical networks. Addressing these aspects will ensure that the "Saliva" complex can be effectively utilized in diverse healthcare settings worldwide, fostering international cooperation in digital medicine and ultimately improving the quality of healthcare services globally.

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DIGITAL TRANSFORMATION OF THE EDUCATION SYSTEM IN UZBEKISTAN: CHALLENGES, OPPORTUNITIES, AND FUTURE PROSPECTS

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Abstract This article provides a comprehensive analysis of the integration of digital technologies within Uzbekistan's education system, emphasizing their development trajectory, key achievements, and persisting challenges. The increasing adoption of digital tools has significantly influenced the educational landscape, reshaping traditional teaching methodologies and improving both the accessibility and effectiveness of learning processes for students across various academic levels.

The study delves into the transformative role of digitalization, highlighting its impact on pedagogical approaches, curriculum structuring, and administrative efficiency within educational institutions. Additionally, it explores the extent to which modern technological advancements, such as artificial intelligence, big data analytics, and cloud-based learning platforms, are being incorporated into the national education strategy.

Furthermore, the paper examines the challenges associated with digital transformation, including disparities in technological infrastructure, the digital divide between urban and rural educational institutions, and the necessity for continuous teacher training to effectively implement digital learning tools. Special attention is given to the ongoing reforms and government initiatives aimed at fostering a more inclusive and technology-driven educational ecosystem.

By analyzing the current trends and future prospects of digital education in Uzbekistan, this research contributes to the broader discourse on the role of digitalization in shaping contemporary educational frameworks. The findings underscore the need for a strategic and well-coordinated approach to ensure that digital transformation in education maximizes its potential benefits while addressing the existing gaps and limitations.

Key words: digitalization, technology, education, transformation, learning, innovation, transition.

INTRODUCTION

The digitalization of education represents a fundamental shift in the way teaching and learning processes are structured and delivered. It is not merely an enhancement of traditional educational methodologies but a transformative force that redefines pedagogical approaches, curriculum development, and student engagement. In an era where technological advancements are accelerating at an unprecedented pace, digitalization has become an essential component of modern education systems, ensuring that students acquire the necessary skills to thrive in an increasingly digital and interconnected world.

The integration of digital technologies into education is particularly crucial in countries that are actively undergoing economic and technological transformations. Uzbekistan, in this regard, has embarked on a strategic journey toward digital modernization, recognizing the pivotal role of technology in shaping the future of its education system. The government's commitment to fostering a digitally literate society is evident in national initiatives such as the "Digital Uzbekistan – 2030" strategy, which sets forth ambitious objectives aimed at enhancing digital infrastructure, expanding access to technological resources, and equipping students with relevant digital competencies.

One of the key drivers behind Uzbekistan's digital transformation in education is the need to align learning outcomes with the demands of the global labor market. As digitalization continues to reshape industries and economies, educational institutions are under increasing pressure to adapt their curricula to incorporate digital literacy, computational thinking, and technological proficiency. The primary goal of these reforms is to cultivate a new generation of specialists who are not only well-versed in mobile and internet technologies but also possess the analytical and problem-solving skills necessary to succeed in a knowledge-driven economy.

Moreover, the adoption of digital learning tools has contributed to the evolution of traditional classroom environments. Interactive technologies, e-learning platforms, and artificial intelligence-driven educational applications are revolutionizing the way knowledge is disseminated, making learning more engaging, personalized, and accessible. These digital advancements enable students to take a more active role in their education, fostering independent learning and critical thinking.

However, while the benefits of digitalization in education are extensive, its implementation is not without challenges. Disparities in digital infrastructure, uneven access to technology across urban and rural regions, and the need for continuous professional development among educators are some of the pressing issues that must be addressed to ensure the successful integration of digital tools in the learning process.

This article seeks to explore how Uzbekistan's education system is adapting to digital transformation, analyzing the key reforms, opportunities, and obstacles that shape the future of digital education in the country. By examining the impact of government policies, technological advancements, and changing pedagogical strategies, this study aims to provide a comprehensive understanding of the digitalization of education in Uzbekistan and its implications for students, teachers, and the broader academic landscape.

DISCUSSION

The digitalization of education has ushered in profound transformations in teaching methodologies, fundamentally altering the role of educators and the learning experience of students. As digital tools and platforms become increasingly integrated into educational settings, traditional pedagogical approaches centered on rote memorization and passive knowledge absorption are being replaced by more interactive, student-centered learning models. This shift is not merely an addition to existing teaching practices but a complete redefinition of how knowledge is disseminated and acquired in the digital age.

One of the most significant changes observed is the emphasis on collaborative and immersive learning experiences. Digital technologies enable educators to move beyond conventional lectures and textbooks, incorporating multimedia resources, virtual simulations, and real-time interactive activities that foster engagement and deeper comprehension. Online discussion forums, cloud-based collaboration tools, and gamification techniques have emerged as powerful instruments in encouraging student participation and enhancing knowledge retention. This transformation compels educators to rethink their instructional strategies, shifting from a unidirectional transfer of information to a dynamic exchange of ideas that stimulates curiosity, critical thinking, and innovation.

As an educator navigating this evolving landscape, my role has expanded beyond that of a traditional instructor. No longer simply a provider of knowledge, I now act as a facilitator of discussions, a mentor guiding students in digital literacy, and an intermediary between technological advancements and pedagogical objectives. The responsibility to integrate emerging educational technologies effectively demands continuous professional development and an adaptive mindset. Staying updated with advancements such as artificial intelligence-driven learning analytics, adaptive learning platforms, and augmented reality-based educational experiences is essential to maintaining the relevance of teaching methodologies.

Equally important is the impact of digitalization on students, who must cultivate adaptability and self-regulation to thrive in technology-driven learning environments. The shift from teacher-centered instruction to a decentralized learning model empowers students to engage with content at

their own pace, leveraging digital resources to explore topics beyond the confines of traditional classroom settings. This self-directed approach nurtures critical skills such as independent problem-solving, analytical reasoning, and creativity—competencies that are increasingly valued in the modern labor market.

However, while the benefits of digital learning are undeniable, challenges persist in ensuring equitable access to technology and fostering digital literacy among both educators and students. The success of digital education hinges on bridging the digital divide, providing adequate technological infrastructure, and equipping teachers with the necessary training to leverage digital tools effectively. Addressing these challenges is imperative to maximizing the potential of digital education and ensuring that students across all regions have equal opportunities to develop future-ready skills.

Ultimately, the digital transformation of education is not just about technological integration but about fostering a holistic shift in learning culture. By embracing innovation, reimagining teaching practices, and empowering students with digital competencies, Uzbekistan's education system is gradually evolving to meet the demands of a rapidly changing global landscape. The ability to navigate this transition successfully will determine the extent to which digitalization enhances educational outcomes and prepares students for the challenges and opportunities of the future.

ADVANTAGES OF DIGITAL LEARNING

One of the remarkable aspects of digital education is its inherent flexibility and accessibility. I have noticed that students can engage with the curriculum at times that suit them, breaking free from the constraints of a rigid schedule. This means that learning can occur anytime and anywhere, fostering a culture of continuous learning that is particularly beneficial for lifelong learners.

Moreover, digital platforms provide enhanced opportunities for students to access a plethora of resources in real time. The interconnectedness of information allows for a richer learning experience. I often leverage various online tools and resources that facilitate active participation, enabling students to interact with content and with each other in ways that traditional classrooms may not allow.

Real-time resource availability has empowered both educators and learners. For instance, online tests and interactive assignments can be made immediately available, allowing for swift feedback and tailored instructional strategies. This immediate response fosters a more responsive educational environment and promotes additional engagement.

CHALLENGES AND CONCERNS

However, the transition to digital learning is not without its hurdles. One major limitation is the potential superficiality of online education systems, where learners might focus more on completing tasks than achieving genuine understanding. As I witness students occasionally skim through content or rely on shallow engagement, I realize the importance of developing strategies that encourage deeper learning.

Another pressing concern is the risks of information overload. The vast amount of content available online can lead to confusion and overwhelm. Students may struggle to discern what information is credible, which enhances their susceptibility to misleading content. This highlights the need for educational frameworks that emphasize critical thinking and analytical skills.

I believe that a careful balance between traditional and digital methods is essential. While digital tools enhance accessibility and opportunities for engagement, the foundational skills and values instilled through traditional education cannot be overlooked. Blending these methodologies can provide students with a more comprehensive educational experience.

SKILLS FOR THE FUTURE WORKFORCE

As I contemplate the evolving landscape of work in relation to education, I recognize the growing importance of functional literacy and critical thinking. Digitalization requires students to go beyond consuming information; they must analyze, synthesize, and apply what they learn. Thus, I

have integrated these skills into my curriculum, encouraging students to engage actively with material. In addition to cognitive skills, soft skills such as communication, collaboration, and adaptability have gained prominence in the digital age. I strive to cultivate these competencies in my classroom by incorporating group projects and collaborative assignments that reflect real-world scenarios. Preparing students for a digital economy means equipping them with a diverse skill set that meets the demands of fast-evolving workplaces.

RESULTS

One of the most significant barriers to the effective implementation of digital education in Uzbekistan is the necessity of high-speed internet access. While urban centers are relatively well-equipped with the technological infrastructure needed to support digital learning initiatives, rural areas frequently experience a stark contrast, often lacking the fundamental resources required for seamless digital integration. This disparity in connectivity creates an educational divide, limiting access to digital learning platforms, online resources, and virtual collaboration opportunities for students in underserved regions.

The importance of technological accessibility in rural areas cannot be overstated. Digital education is not merely a supplement to traditional learning methods but a fundamental enabler of equitable knowledge dissemination, offering students access to a wealth of global information, virtual classrooms, and interactive learning experiences. Without sufficient internet infrastructure, students in remote regions remain at a significant disadvantage, unable to fully participate in the digital transformation that is shaping modern education. The government's commitment to bridging this digital divide is reflected in its initiatives to expand internet connectivity, enhance broadband infrastructure, and promote digital inclusivity.

The expansion of high-speed internet access across all regions is a pivotal step toward equalizing educational opportunities. By ensuring that students in both urban and rural settings have reliable internet connections, Uzbekistan can cultivate a more inclusive educational environment that empowers learners irrespective of their geographical location. Improved connectivity facilitates participation in online courses, digital skill development programs, and international academic collaborations, ultimately contributing to a more competitive and digitally proficient workforce.

Moreover, firsthand observations highlight the transformative potential of digital infrastructure improvements in rural areas. Where connectivity has been successfully enhanced, students and educators have gained access to e-learning platforms, virtual libraries, and real-time interactive educational tools that were previously beyond their reach. This shift not only enriches the learning experience but also fosters a culture of lifelong learning, enabling students to acquire critical digital competencies necessary for the modern labor market.

By prioritizing nationwide internet accessibility, Uzbekistan is taking essential steps toward fostering a more technologically advanced and education-driven society. These efforts not only support the immediate goal of enhancing digital learning but also contribute to the long-term objective of equipping future generations with the knowledge and skills required to thrive in an increasingly digital world. Addressing the existing digital disparities will be instrumental in ensuring that Uzbekistan's digital transformation in education is inclusive, sustainable, and impactful in shaping the country's academic and professional landscape.

CONCLUSIONS

In conclusion, the impact of digitalization on education is multi-faceted and profound. This transformative process opens new avenues for teaching and learning, fostering an environment rich in resources that cater to diverse learning styles. As I navigate through these changes, I recognize the importance of effective implementation of digital tools and methodologies.

To ensure that digital transformation succeeds, recommendations include investing in teacher training and professional development, creating comprehensive educational frameworks that facilitate blended learning, and continuing to prioritize infrastructure improvements. By adopting these strategies, I believe we can create an inclusive and effective educational environment.

Looking ahead, I envision an education system in Uzbekistan that thrives on digital innovation while preserving the foundational principles of learning. By harmonizing technology with traditional approaches, we can cultivate a generation of learners who are not only well-equipped for the challenges of the future but also empowered to shape their own paths in an increasingly digital world.

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ANALYSIS OF INFORMATION TECHNOLOGY IN DETERMINING THE EFFECTIVENESS OF TALENTED REQUIREMENTS

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Abstract. With the help of information technology, it is possible to quickly and accurately collect information about talented students. Information technology helps to identify the strengths and weaknesses of each student in the educational process. Through this, each student will be able to draw up an individual program, choose the most suitable methods for developing his talent. This article incorporates blockchain, cloud, machine learning, Artificial Intelligence and information technology. These technologies have been cited in detail in determining their talent requirements.

Keywords: Artificial Intelligence, machine learning, cloud, blockchain, analysis, efficiency, information, technology.

1. INTRODUCTION

Gifted students differ from others because of their extraordinary ability and potential. The place which the analysis occupies is very important because their effectiveness is necessary to be established and correctly estimated. The main reasons and benefits can be represented in the following aspect:

1. Collection and data analysis: information technology provides an avenue for amassing and analyzing vast amounts of data relating to the reading process and activities of requirements. It is for example possible to use electronic assessment systems to record and analyze reading results through which strengths and weaknesses of the requirements will be found.
2. Customized training: With the aid of IT, the training can be provided based on personalized needs and requirements. For example, on the websites and portals online, students have been given proper reading material. This makes it possible for talented students to choose the methods and speed that suit them.
3. Visualization of results: it is possible to visually show the success of requirements using IT tools. Graphs, diagrams and other indicators clearly show the changes and achievements of demand. This will help teachers and educational institutions monitor the progress of demand.
4. More interactive teaching opportunities: it is —possible to attract students through interactive textbooks, simulations, and games using information technology. This increases the motivation of the requirements and makes the reading process more interesting and effective.
5. Distance education: gifted students can be from different regions. Information technology contributes to the implementation of distance learning, which ensures that learning for students does not depend on time and place. Distance education: gifted students can be from different regions. Information technology helps in the implementation of distance learning, which ensures that learning for students does not depend on time and place.
6. Opinions and recommendations: with the help of artificial intelligence (AI) and machine learning technologies, it is possible to analyze student activities and make recommendations

for teachers and mentors. Through this, students identify their strengths and areas necessary for development.

In this way, information technology provides ample opportunities for the analysis and development of gifted students, increases efficiency and further perfects the educational system. In the use of Information Technology in determining the effectiveness of their talent requirements, a number of technologies are listed below.

*Blockchain i*s a technology that involves collecting data into a chain of sequential blocks with protection using cryptographic ciphers. At the same time, data loops are not stored on a separate server, but are available simultaneously on all devices connected to the network. Blockchain is an independent system that does not require the operation of third parties. In the process of creating a blockchain, the main goal of developers is to distance themselves from intermediaries [3].

Blockchain technology can be used:

1. carrying out financial transactions with money;
2. conclusion of contracts and agreements;
3. implementation of the process of various commercial operations;
4. purchase of goods and services;
5. to exchange confidential information;
6. to register an insurance policy;
7. protection of property rights, as well as their transfer to a new owner;
8. personal Data Management;
9. ensuring the security of intellectual property;
10. to help create archives of documents.
11. working with blockchain technology usage tables and putting them into practice [3].

Cloud computing virtualization technology provides efficient resources for end users. Cloud computing characteristics include manageability, scalability, and availability. In addition, cloud computing has advantages such as cost savings, on-demand service, convenience, versatility, multitenancy, flexibility, and stability. Cloud computing mainly provides three service delivery models and four development patterns: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS), Public Cloud, private cloud, hybrid cloud, community cloud, and virtual private cloud.

IaaS handles computer hardware (network storage, virtual server /computer, data center, processor, and memory) as a service and enables infrastructure scalability and resource provisioning challenges without significant capital investment and time. IaaS also focuses on firewall, intrusion detection, virtual machine monitoring, and other areas of security [1].

PaaS resides in service model middleware and provides services in the form of development tools, frameworks, architectures, programs, and IDEs. PaaS faces many challenges such as relationships with third parties, lifecycle design, and security of the underlying infrastructure.

SaaS is a collection of remote computing services that enables third-party vendors to remotely deploy applications. The customer can use the Internet for cloud service provider applications in the cloud infrastructure.

Private Cloud: cloud computing is runs and managed within the data center of an organization, which is referred to as a private cloud. In a private cloud, customer and supplier relationships are easier to identify because the infrastructure is owned and operated by the same organization.

Public cloud: enterprises, academia or government organizations have a public cloud environment, which can cause many problems because users do not know the locations or owners of resources, which increases the difficulty of protecting resources from attacks.

Hybrid cloud: it is a combination of two or more clouds (public, private, community). A hybrid cloud provides the advantages of differentcloud deployment models. However, when accessing entities via the Internet, a hybrid cloud is better organized and more secure than a public cloud.

Virtual private cloud: it is a semi private cloud with fewer resources that is composed of a virtual private network (VPN). This cloud is the shared resource pool allocated in the cloud environment [2].

Artificial Intelligence (AI) is the field of computer science focused on creating machines and software capable of performing tasks that usually require human intelligence. This includes reasoning, learning, problem-solving, perception, and language understanding. Key Components of AI:

1. Machine Learning: It's the ability of AI machines to improve their performance automatically through the learning process from data experience without explicit programming.
2. Natural Language Processing: The ability of computers to understand, interpret, and generate human language is called NLP. It covers applications such as virtual assistants, machine translation, and sentiment analysis.
3. Computer Vision: The technology puts the sense into the AI to interpret visual information from the world, such as recognizing objects in images or videos using technology like Facial Recognition.
4. Robotics: AI applied to robotics makes the machines capable of operating themselves. This covers all levels: from industrial robots to self-driving cars.
5. Expert Systems: A knowledge-based system with an added knowledge base of a specific expert that acts like decisions by a human expert, such as diagnosing ailments or financial planning [5].

The integration of Blockchain, AI, and Cloud Technologies in IT will definitely upgrade different ways in which organizations work out the talent requirements and their effective appraisal. It helps streamline the process of recruitment, performance tracking, skills development, and workforce management. Here's how each of these technologies plays its role in determining the effectiveness of the talent requirements:

Artificial Intelligence Artificial intelligence comes at the forefront in the analytics of talent needs to help an organization in defining, predicting, and optimizing talent managing processes. This is how:

1. Talent Acquisition and Recruitment: AI-powered recruitment tools automatically screen resumes to filter in a candidate on the job description. It can even conduct the first level of interviews. Based on previous hiring decisions, AI may even get better at refinement in an iterative manner.
2. Predictive Analytics: AI will make predictions about who will perform well in the future based on patterns which emerge from candidates' past experiences, education, and skills, among others. This helps the organization to onboard and hire people who have more chances of succeeding.
3. Skills Gap Analysis: AI can analyze the current talent pool and identify gaps in skills or competencies required by the organization. This analysis helps HR departments forecast the types of roles they will need to fill and what skills those roles will demand.
4. Performance Tracking and Development: AI can monitor employee performance by analyzing productivity data, feedback, and even natural language in communications. AI-driven systems can suggest areas for training or development and help organizations retain top talent by offering personalized growth opportunities [6].

2. METHOD OF RESEARCH

Combined Use of Blockchain, AI, and Cloud in Talent Management:

1. These are technologies that can be incorporated to provide a more integrated, efficient, and effective approach to talent management. Here's how they interface:

2. AI-driven insights identify what skills are needed by the organization in the future, while tracking and verification take place on the blockchain, checking the validity and authenticity of the credentials.

3. Cloud platforms would work as the base over which data about talent management is based and shared. That data, in turn, would be analyzed by AI, while blockchain will be responsible for making recordings of qualifications and contracts secure and transparent.

4. Blockchain smart contracts can independently take action based on payroll, hiring, and training programs based on AI insights, while all data generated will be stored and shared in the cloud.

Effectiveness of talent requirements:

1. These technologies increase the effectiveness of the determination of talent requirements in a number of ways: Improved Accuracy: While AI can analyze volumes of data to predict which skills and roles will be required for future projects, blockchain delivers accuracy and authenticity of employee data.

2. Efficiency: Cloud technologies provide the infrastructure on which AI and blockchain integration goes through with ease; hence, it makes talent management smooth, right from hiring to talent development.

3. Security and Trust: Blockchain ensures that talent information is secure, open, and tamper-proof; hence, trust in candidates and employers will be earned.

4. Data-driven decision: Artificial intelligence and cloud technologies allow the human resource department to introduce data-driven decisions on hiring, training, and performance management while eliminating biases and boosting effectiveness.

3. RESEARCH RESULTS

The following table analyzes different technologies based on various important aspects.

TABLE 1. General analysis of cloud computing, blockchain and artificial intelligence (AI):

Aspect	Cloud Computing	Blockchain	Artificial Intelligence (AI)
Definition	A network of remote servers to store, manage, and process data.	A decentralized, distributed ledger that records transactions across multiple computers.	Simulation of human intelligence in machines that can learn, reason, and make decisions.
Core Purpose	To provide on-demand access to computing resources and storage via the internet.	To enable secure, transparent, and tamper-proof transactions without a central authority.	To enable machines to perform tasks that typically require human intelligence, such as learning, decision-making, and automation.
Security	Centralized security protocols; vulnerability in data centers, but encryption and multi-factor authentication are common.	Highly secure due to its decentralized nature, cryptographic hashing, and immutability of data.	Security varies based on data privacy practices; AI models can be vulnerable to adversarial attacks, model theft, and data breaches.
Scalability	Highly scalable; resources can be increased or decreased according to demand, e.g., server capacity, storage.	Limited scalability; blockchain systems may experience slower processing speeds as they grow.	Scalable for large data sets and tasks, but AI models require extensive computational power for training, especially deep learning models.
Speed	Fast processing and retrieval of data, though may depend on internet speed and server load.	Slower due to the need to validate and record transactions on multiple nodes across the network.	Can be fast in execution, but training complex models (especially deep learning) can take time and computing power.
Flexibility	Highly flexible in terms of storage, computational resources, and service deployment (IaaS, PaaS, SaaS).	Limited flexibility; mainly used for decentralized transactions and recording data, but growing use cases (smart contracts, DeFi).	Highly flexible, capable of handling diverse tasks, including natural language processing, computer vision, and autonomous decision-making.
Cost	Pay-as-you-go pricing models; costs can vary based on resource usage, data storage, and network traffic.	Transaction fees for processing on the network; can vary by blockchain type (e.g., Ethereum vs. Bitcoin).	Development, training, and deployment costs can be high, particularly for complex AI models and large data sets.
Applications	Cloud storage, computing services, SaaS, IaaS, PaaS, remote collaboration, enterprise applications, and big data processing.	Cryptocurrency, supply chain tracking, decentralized finance (DeFi), digital identity, voting systems, and auditing.	Image recognition, natural language processing, predictive analytics, robotics, recommendation systems, autonomous systems.

Transparency	Limited transparency; controlled by service providers, with billing transparency, but limited on backend operations.	High transparency; transactions are publicly recorded and can be verified by all participants in the network.	Low transparency; AI models, especially deep learning, can be considered "black boxes," making it hard to understand decision-making processes.
Decentralization	Centralized, controlled by service providers (e.g., AWS, Google Cloud, Microsoft Azure).	Decentralized by design; no single authority controls the data, transactions, or network.	Mostly centralized (corporate-controlled AI models), but emerging decentralized models like federated learning are being explored.
Integration	Easy integration with other cloud services and on-premise solutions (APIs, third-party services, data lakes).	Integrates with decentralized applications (dApps), cryptocurrency wallets, and smart contracts.	Integrates with various systems for automation, decision-making, data analysis, customer service (chatbots), and more.
Reliability	High reliability with built-in redundancies, failover, and data backup across multiple data centers.	Reliable due to blockchain's immutable ledger and decentralized nature, reducing the risk of data tampering.	Reliability depends on the model, data quality, and training; errors may occur if data is biased or incomplete.
Governance	Managed and controlled by centralized service providers, subject to regulations and compliance standards (GDPR, HIPAA).	Governance is decentralized, usually through consensus mechanisms like Proof of Work (PoW) or Proof of Stake (PoS), with no central authority.	Governance is centralized in most AI models; however, frameworks and policies are being developed to address issues like fairness, accountability, and transparency.
Data Storage	Cloud offers extensive data storage options (e.g., object storage, databases) with flexible scaling capabilities.	Blockchain stores data in blocks across multiple nodes, ensuring redundancy but is limited in storage capacity per block.	AI models rely on large datasets for training; data is stored in various formats, often requiring cloud infrastructure for scalability.
Future Potential	Highly promising with advancements in edge computing, hybrid cloud, and AI cloud services, driving innovation in various industries.	Blockchain's potential is growing in areas like supply chain transparency, digital assets, and secure transactions, with applications in finance, healthcare, and governance.	AI is set to revolutionize industries, enhancing decision-making, automating processes, and creating new human-computer interaction possibilities, especially in robotics, healthcare, and autonomous systems.

TABLE 2 General analysis of cloud computing, blockchain, and artificial intelligence in relation to information security

Aspect	Cloud Computing	Blockchain	Artificial Intelligence (AI)
Security Model	Centralized security controls; relies on service providers to implement security measures like encryption and multi-factor authentication.	Decentralized security model; uses cryptography and consensus mechanisms to ensure data integrity and security.	Dependent on security of data used for training, the algorithms themselves, and access control of AI systems.
Data Encryption	Strong encryption (in-transit and at-rest) is provided by cloud providers; however, encryption keys are managed by the provider unless specified otherwise.	Blockchain uses strong encryption and cryptographic hashing to secure transactions and ensure immutability.	Data used in AI (especially for training) can be encrypted, but the model itself may not always be encrypted, leaving vulnerabilities.
Access Control	Identity and access management (IAM) frameworks are common, allowing granular control over user access to resources.	Public/private key pairs are used to authenticate users and ensure secure transactions.	AI systems require robust access control to limit who can manipulate models, access sensitive data, or deploy systems.
Data Integrity	Cloud service providers implement data integrity measures, but data integrity is at risk if the provider is compromised.	Blockchain ensures data integrity by recording transactions on a decentralized ledger, making data tampering almost impossible.	AI systems depend on the quality and integrity of data for training. Poor data integrity can lead to inaccurate or biased model outputs.
Authentication	Multi-factor authentication (MFA) is commonly used for access to cloud services, along with role-based access controls (RBAC).	Blockchain uses cryptographic signatures (e.g., public/private keys) for authentication, making identity verification secure.	AI systems require proper authentication protocols to ensure that unauthorized users do not manipulate models or results.
Privacy	This could bring in issues of privacy since critical information might leak from these cloud servers. A lot of providers offer privacy; however, the dependency on a third-party manager remains.	Blockchain offers strong privacy features, particularly with pseudonymity or privacy coins; however, it can expose transaction history unless special privacy-focused protocols are used.	AI models often rely on large datasets, raising privacy concerns if personal or sensitive data is not properly anonymized or protected.
Compliance	Cloud providers often comply with regulatory standards (e.g., GDPR, HIPAA, SOC 2) to ensure data protection and privacy.	Blockchain's decentralized nature complicates compliance with traditional regulations, but new standards are emerging for decentralized systems.	AI faces challenges in compliance due to evolving regulations (e.g., GDPR's provisions on data processing, fairness, and transparency).
Attack Surface	Cloud computing has a broad attack surface due to its widespread infrastructure, including APIs, virtual machines, and storage services.	Blockchain's attack surface is smaller but still includes potential vulnerabilities in consensus mechanisms and smart contracts.	AI systems can be attacked by adversarial methods, which involve exploiting vulnerabilities in models or data, leading to incorrect outputs.
Redundancy and Backup	Cloud services often provide automated backup and disaster recovery options to ensure data availability and security.	Blockchain networks are highly redundant by design, as every node holds a copy of the ledger, ensuring data availability.	AI models require robust backup mechanisms to prevent model corruption or loss, particularly if a

			system is compromised or attacks are attempted.
Data Storage	Data is stored on remote servers and may be vulnerable if not properly encrypted or managed by trusted cloud providers.	Blockchain data is immutable and distributed across many nodes, making it resilient to attacks or single points of failure.	AI systems store large datasets used for training, which can be a target for theft or manipulation if not secured properly.
Resilience	Cloud computing services are often highly resilient, with built-in redundancy, failover, and disaster recovery systems.	Blockchain is resilient due to its decentralized nature, but it may struggle with scalability issues under heavy transaction loads.	AI systems' resilience depends on the robustness of models to adversarial attacks or data manipulation and the quality of the underlying training data.
Auditing and Monitoring	Cloud providers typically offer tools for monitoring and auditing user activities, access logs, and data transfers.	Blockchain's public ledger inherently allows for auditing and monitoring of all transactions on the network, providing full transparency.	AI systems require continuous monitoring to detect anomalies, adversarial attacks, and potential breaches in model integrity.
Incident Response	Cloud services offer incident response protocols, but the shared responsibility model means the provider and customer share this duty.	Blockchain, though allowing distributed control, may have no single entity to handle incident response. Events like a hard fork or protocol changes could be employed to mitigate an ongoing attack.	AI models need continuous monitoring and rapid responses to adversarial attacks, data poisoning, and manipulations.
Risk Management	Risk management is shared between the provider and the consumer, with the provider ensuring infrastructure security and the consumer ensuring application-level security.	Blockchain provides transparency, making risk management easier for transactions, but regulatory compliance and security threats can remain challenging.	AI risk management involves addressing model fairness, robustness against attacks, and the prevention of unintended consequences from misused algorithms.
Governance	Governance in cloud computing is generally centralized, controlled by the provider, with shared responsibility between the provider and consumer for security measures.	Blockchain's governance is decentralized and varies by blockchain type (e.g., Bitcoin, Ethereum), where consensus mechanisms control the network.	AI governance often remains centralized, typically managed by organizations or governments to regulate fairness, transparency, and ethical considerations in AI systems.

Cloud Computing has a very strong and centric security model, through powerful encryption, controls in access, and compliance features, but brings up concerns regarding its wide attack surface area and dependence on third-party providers.

It has provided decentralized security of data with cryptography, integrity, and transparency, but there also arise challenges on scalability issues, regulatory issues, or even privacy in specific use cases.

AI introduces new challenges in data privacy, integrity within the model, and adversarial threats. Model robustness and regulatory compliance in AI models are critical for secure AI deployment.

Those are strengths and weaknesses in the Information Security world that complement each other in use, like how AI models can be made more secure by Blockchain or upsaling AI on the cloud for much stronger encryption and versions.

TABLE 3. Application of cloud computing, blockchain, and AI in countries (2023-2024)

Country	Cloud Computing	Blockchain	Artificial Intelligence (AI)
United States	Leading in cloud services (AWS, Azure, Google Cloud)	Major hub for cryptocurrency (Bitcoin, Ethereum), DeFi	AI in healthcare, finance, autonomous vehicles, and smart cities
	Multi-cloud and hybrid cloud adoption	Growing NFT market, DeFi applications, and blockchain regulation	AI-driven automation in manufacturing, retail, and cybersecurity
China	Strong presence with Alibaba Cloud and Tencent Cloud	Digital Yuan (state-backed cryptocurrency)	AI in surveillance, smart cities, automated vehicles
	Increasing adoption of cloud computing in AI, IoT, and 5G	Blockchain for government applications and financial systems	Expansion in AI-powered automation and AI-driven national projects
European Union	Adoption of multi-cloud for data sovereignty and GDPR compliance	Active blockchain regulation (MiCA) and support for digital assets	AI in finance, healthcare, and manufacturing automation
	Cloud-native technology adoption, particularly in AI and IoT	Blockchain as a tool for identity management, e-voting, supply chain	Strong focus on AI ethics, regulations, and AI governance
India	Growth in cloud computing for e-commerce, healthcare, and education	Adoption of blockchain for supply chain, agriculture, finance	AI in healthcare, agriculture, and education
	Increasing use of cloud-based AI in startups and innovation	Digital India program exploring blockchain for government services	Government initiatives to drive AI adoption across industries
Japan	High adoption of cloud solutions in enterprise and IoT	Blockchain used in finance (cryptocurrency, digital yen)	AI in robotics, automated manufacturing, and autonomous vehicles

	Integration of cloud with AI for smart cities and healthcare	Focus on blockchain for governance and secure transactions	Government focus on AI in public services and smart cities
	Strong cloud infrastructure for AI/ML research	Decentralized Finance (DeFi) platforms emerging in Japan	AI-driven robotics and advanced technology solutions
South Korea	Leading cloud infrastructure with Kakao and Naver Cloud	Blockchain used in gaming, finance, and logistics	AI in robotics, cybersecurity, smart cities, and education
	Cloud-native apps and 5G network integration with AI	NFT platforms gaining popularity and blockchain-powered supply chains	Growing AI applications in autonomous systems and public services
United Kingdom	Major adoption of cloud solutions across healthcare, education, and finance	Blockchain in finance, e-commerce, and legal services	AI for fintech, healthcare, and autonomous transport
	Focus on multi-cloud and hybrid cloud adoption	Government regulatory push for blockchain (MiCA)	AI and big data analytics for financial markets
Australia	Expansion of cloud computing for data sovereignty and data centers	Blockchain adoption for supply chain, finance, and energy	AI in agriculture, mining, healthcare, and defense
	High demand for cloud infrastructure to support AI/ML projects	Blockchain's use for traceability in agriculture and financial services	AI-driven environmental solutions and energy management
Canada	Strong adoption of cloud computing across finance, healthcare, and education	Blockchain for supply chain transparency and financial services	AI in healthcare, clean tech, and fintech
	Cloud-native solutions driving AI-driven innovation in finance and energy	Use of blockchain for public health and government records	AI research on AI governance, predictive healthcare, and climate
Brazil	Growth in cloud computing for e-commerce, finance, and education	Adoption of blockchain for digital identity, cryptocurrency	AI in agriculture, finance, and education
	Emerging cloud services for AI and IoT integration	Blockchain projects focused on financial inclusion and government use	Focus on AI in agriculture and smart cities

TABLE 4. Application in education in Uzbekistan based on 2023-2024 cloud computing, general analysis of Blockchain and artificial intelligence (AI) technologies

Aspect	Cloud Computing	Blockchain	Artificial Intelligence (AI)
Key Applications	Cloud-based learning management systems (LMS) for schools and universities.	Blockchain for secure academic credentials and diploma verification	AI-powered personalized learning and tutoring systems
	Use of cloud storage for student records, and collaborative tools.	Blockchain for educational certificates to prevent fraud and ensure integrity	Adaptive learning platforms using AI to customize content for students
Government Initiatives	Uzbekistan's Digital Transformation strategy promotes cloud adoption in education.	Government exploring the use of blockchain for transparent education systems	National AI strategy includes AI development in education for future workforce development
	Cloud solutions for e-learning platforms and virtual classrooms.	Pilot projects to use blockchain for secure diploma issuance and student records	AI curriculum in schools and universities to prepare students for future jobs
Industry Adoption	Cloud-based e-learning solutions are being adopted by universities and schools.	Use of blockchain for online education credentials and secure exams	Adoption of AI-powered tools for data-driven teaching and personalized learning
	Growth in cloud collaboration tools for virtual classes and research purposes	Potential adoption of blockchain for digital libraries and resource management	Early-stage use of AI systems for grading and feedback automation
Key Technologies Used	Google Classroom, Microsoft Teams, Zoom, and other cloud platforms	Ethereum, Hyperledger, and public blockchains for data integrity	Machine Learning (ML), Natural Language Processing (NLP), AI-driven analytics
	Use of cloud storage for secure access to learning materials and data	Smart contracts for automated student transactions (admission, certification)	AI-based virtual tutors and learning assistants
Security & Privacy	Focus on cloud security for protecting student data, grades, and curriculum materials	Blockchain provides tamper-proof records of academic achievements	Data privacy concerns around AI algorithms and student profiling
	Government regulations for data sovereignty and secure cloud storage for student records	Blockchain's immutable ledger improves trust in digital academic records	Focus on ethical AI to ensure privacy, transparency, and bias-free learning
Research & Development	Investment in cloud infrastructure for digital learning tools	Exploration of blockchain for student loans, funding, and research integrity	Focus on AI-based education research in personalized learning systems
	Research into cloud solutions for interactive education tools	Use of blockchain for open educational resources and research collaboration	AI-driven research in education technology, learning behavior prediction
Challenges	Limited cloud infrastructure in rural areas for remote learning	Regulatory barriers around blockchain adoption in education	AI bias and challenges in ensuring fairness and transparency in educational systems
	Concerns about data sovereignty and cloud security	Scalability issues and the integration of blockchain into existing education systems	Shortage of AI talent and educators skilled in AI technology

Regional Collaboration	Central Asia collaboration for cloud services in education	Regional partnerships exploring blockchain applications in education	Collaboration with global AI organizations to enhance local AI expertise
	Cloud-based education initiatives in collaboration with international universities	Cross-border collaboration on blockchain for academic certification	AI-based education collaborations in agriculture, healthcare, and digital transformation
Governmental Support	Government is fostering cloud adoption in education through digital transformation plans	Uzbekistan's blockchain strategy includes secure academic records	National AI strategy includes education as a focus area for AI development
	Investment in cloud infrastructure to support digital classrooms and learning resources	Blockchain-based pilot projects are supported by the government to ensure authenticity of student credentials	Government supports the creation of AI research centers in education
Future Outlook (2024)	Cloud-first approach to education, with an increased emphasis on virtual classrooms and e-learning	Blockchain integration will grow, focusing on digital certification and student data management	AI-driven education tools will grow, focusing on personalized learning, student performance tracking, and automated assessment
	Increased investment in cloud infrastructure for nationwide digital education	Blockchain will become a key player in secure academic transactions and digital diploma issuance	Continued rise in AI adoption in education systems for personalized learning experiences

4. CONCLUSION

Through the use of information technology, it is possible to identify gifted students and create effective, advanced systems to improve their effectiveness. Cloud computing, blockchain, and AI technologies help make the learning process more efficient, transparent, and individualized. At the same time, additional support and investment by the government and educational institutions is needed to further modernize the education system. The use of Information Technology in the identification of students with impotence and the analysis of their effectiveness increases the effectiveness of the educational system and allows teachers to better understand students:

1. More accurate assessment of student effectiveness, optimization of the educational process in innovative ways, AI will help in forecasting the results achieved.
2. Easy monitoring and analysis capabilities to teachers, personalization and special approach, etc. can be implemented through cloud.
3. And blockchain will help in transparency and reform.

The use of Information Technology in identifying gifted students and analyzing their effectiveness helps to implement innovative approaches in the educational system. Through this, it is possible to better measure the effectiveness of students, support them in a personalized way and optimize the educational process. With the help of new technologies, the efficiency, transparency and reliability of the educational system will increase.

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MILESTONES IN THE HISTORY OF URBAN DEVELOPMENT AND THE COMPOSITIONAL RECEPTION OF THE CITY OF SAMARKAND

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Abstract: The article reveals the historical and urban planning features of the formation of the ancient city of Samarkand. The main points of the urban history of the creation of Samarkand in the XVII century are analyzed. Based on the data of written, archaeological and archival materials, the reconstruction of the plan of the central part of Samarkand of the XVII century was carried out. The stages of urban development of ancient Samarkand are traced.

Keywords: history, urban planning. stages, archaeology, planning structure.

I.INTRODUCTION

One of the two famous cities of Uzbekistan, the amazing Samarkand is located in the picturesque valley of the Zarafshan River, surrounded by the Pamir-Alai Mountains in the south-east of Uzbekistan. [1]

The stages of the archaeological study are analyzed. Based on observations of earthworks on the territory of the former citadel of Timur and old Samarkand, it was possible to identify some urban planning features of the planning structure of ancient settlements. [2]

Samarkand, along with Bukhara, is one of the oldest cities in the world. Its history dates back several thousand years ago and is not inferior to such ancient cities as Athens, Babylon, Rome and Memphis. Whatever epithets philosophers and poets come up with for him — "Mirror of the World", "Garden of the Soul", "Pearl of the East", "Face of the Earth" — it is perhaps impossible to express all his beauty and wealth in words. You can only enjoy all its splendor and splendor with your own eyes. During its centuries-old history, this legendary city on the Great Silk Road has experienced times of rise and decline, was subjected to destructive raids by foreign conquerors, and was reborn anew, becoming even more beautiful. Trade routes to the West — to Persia, to the East — to China and to the South — to India intertwined here and formed the crossroads of the Silk Road. Figure 1. [3]

II. LITERATURE REVIEW

The study of the problem was in the attention of architects-theorists. Among the authors who studied the folk architecture in Uzbekistan are known as Pugachenkova and The author has done a great job on the significance of recreational space devices and its architectural appearance of Uzbekistan.

Famous scientists L.N. Avdotin, V.N. Belousov, G.A. Gradov, A.V. Ikonikov, G.I. Lavrik, G.D. Platonov, A.T. Polyansky, G.A. Pugachenkova, V.L. Voronina, L.Yu. Mankovskaya and others made a great contribution to the science of architecture. The works of V.L. Voronina, V.D. Dmitriev, P.Sh. Zakhidov, V.A. Lavrov, D.A. Nazilov, A.S. Uralov, M.K. Akhmedov, A.A. Makhkamov, Sh.D. Askarov and others are devoted to the generalization of the experience of construction and the study of the paths of historical development of the people's Uzbekistan.

III.RESULTS

Is based on an integrated approach to the design process (architectural and urban planning); analysis of the main factors influencing the architecture and spatial organization of traditional residential buildings for the old zone of the city of Samarkand; study, generalization and systematization of scientific research in this area; analysis of domestic and foreign design practices; field surveys method of volumetric and graphic modeling.

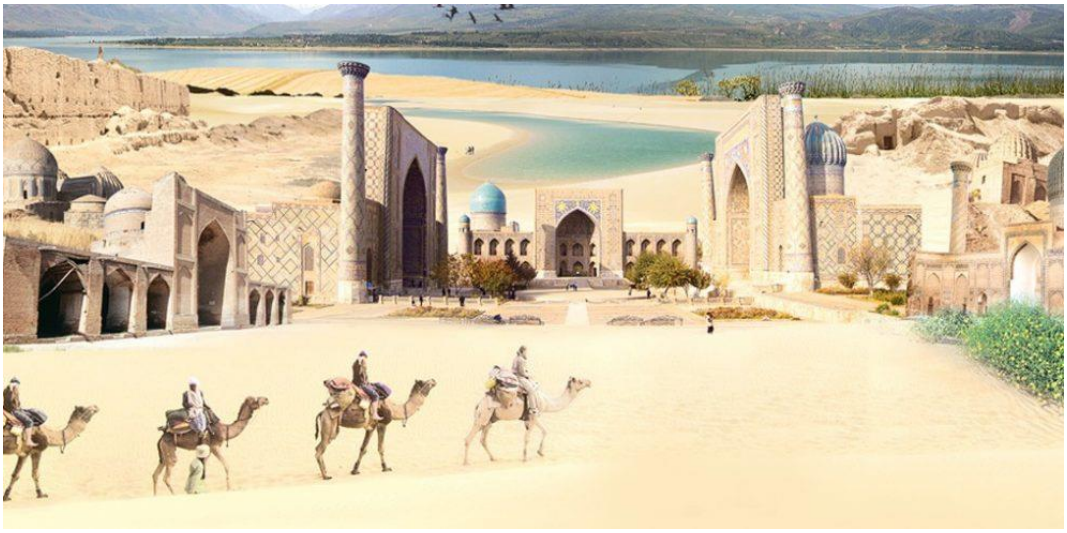

Figure 1. The Great Silk Road Samarkand-Bukhara

The purpose of this article is to study the main points of the urban history of Samarkand in the XVII century and identify the location of previously unknown architectural structures in the central part of Samarkand, mainly the citadel, Registan Square and around the Sheikh Zadinsky gate of the city. Unpublished recordings by V.L. Vyatkin, M.E. Masson and L.Y. Mankovskaya, stored in the Central State Archive of the Republic of Uzbekistan, were used in the study. In the period from 1987 to 2010 one of the authors of the article carried out observations of earthworks on the territory of the late medieval citadel and old Samarkand, which revealed some features of the topography of the administrative center of the city.

The city is the very embodiment of antiquity and the history of urban development of Samarkand. During its long history, the city has experienced multiple devastation and wars. Losing the culture and traditions of the Uzbek people. Thus, the culture of Samarkand was revived during the reign of Timur and Ulugbek.

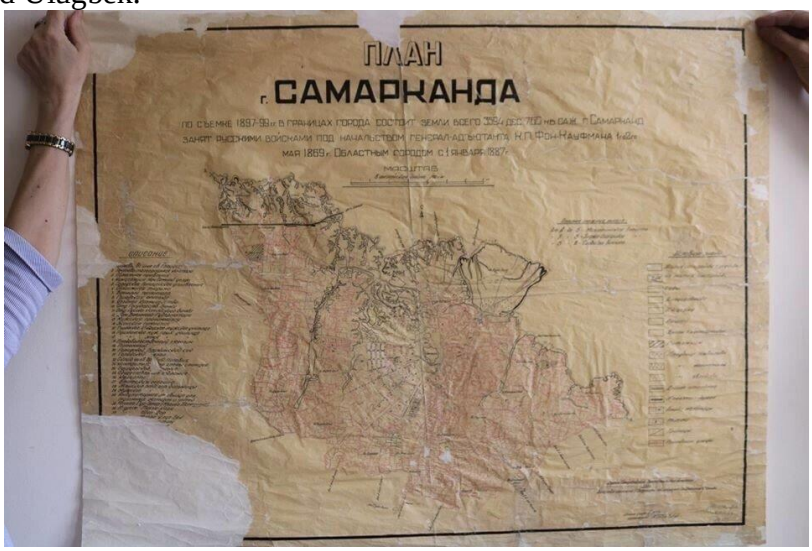

Figure 2. Map of Samarkand

For the first time, scientific research to identify the historical topography of Samarkand was undertaken after the city was incorporated into the Russian Empire. V.V. Bartold, V.L. Vyatkin, M.E., and Masson conducted the study of Samarkand in the XVI-XVII centuries. In his research, Masson paid great attention to Timurid Samarkand and for the first time compiled a topographic map of the late medieval city. He owns a number of publications on the history of architectural monuments of Samarkand in the Janid era (Masson, 1929; 1950). However, a significant part of M.E. Masson's materials has been lost. According to M.E. Masson, who studied the sources and carried out observations of earthworks on the territory of the citadel of Samarkand, in the XVI century. It included a palace, administrative buildings, mosques (Masson, 1942, l. 125ab). During excavation work in the northern part of the citadel in 2010, ruins of a mosque, presumably of the XVII century, were discovered. Its walls and floor were made of square-burnt bricks. In total, six brick pillars of the mosque have been preserved, some of them were up to one and a half meters high.

In our opinion, it is necessary to expand archaeological research around these ruins, which may allow for the still unknown large structures of the 17th century. Since the 70s of the XIV century, Samarkand has been undergoing rapid, ever-increasing construction, which has defined its urban planning features and architectural appearance for centuries.

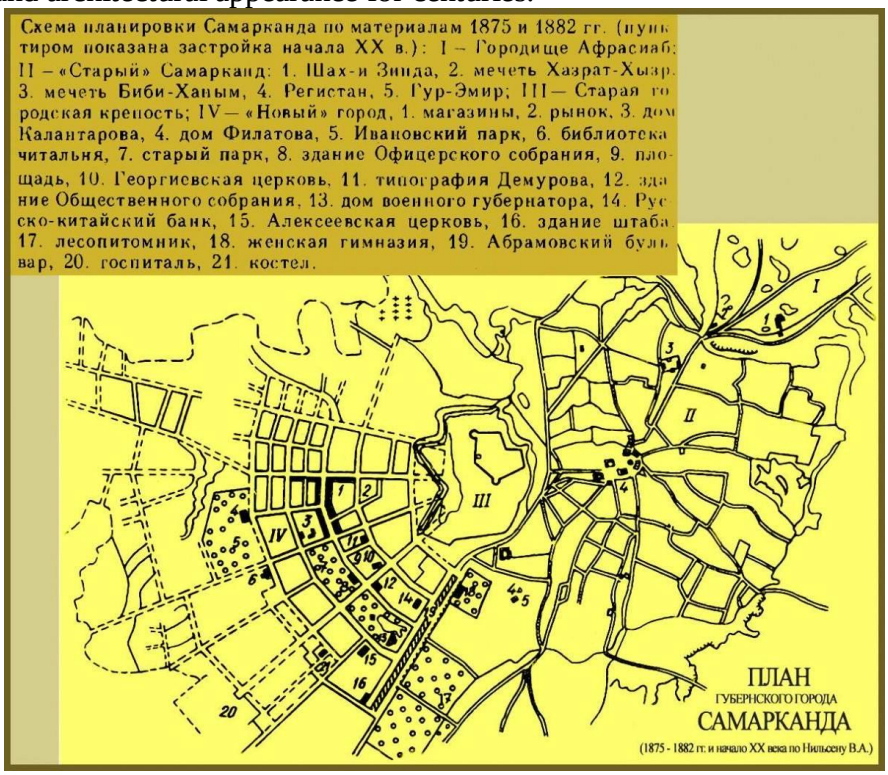

Figure 3. The plan of old Samarkand

In the XV-XVII centuries. Samarkand was divided into hisar - the walled urban core - and a suburban area (Pugachenkova, 1976, pp. 10-11). M.E. Masson clarified that in the XVI-XVII centuries. Samarkand was divided into an outer city (shahri birun) and an inner city (shahri darun), as well as suburbs - mavze (Masson, 1942, l. 125ab).

The administrative center of Samarkand, the citadel, built under Timur (1370s), was located to the west of the city's cathedral mosque - on the right side of the Novadon ditch (Bu-ryakova, 1990, p. 65). It covered a vast territory with a total area of 34 hectares and was surrounded by a wall of pakhsa and mud bricks with a height of 8 m. There were two gates in the citadel: the eastern (Samarkand) ones at the mausoleum of Nur ad-din Basir and the southern (Bukhara) ones (Lebedeva, 2001). The first gate faced the Registan, and the second gate faced the modern boulevard. Judging by

the layers from the pits, the depth of which reached 4 m, the territory to the northwest of the citadel was not inhabited.

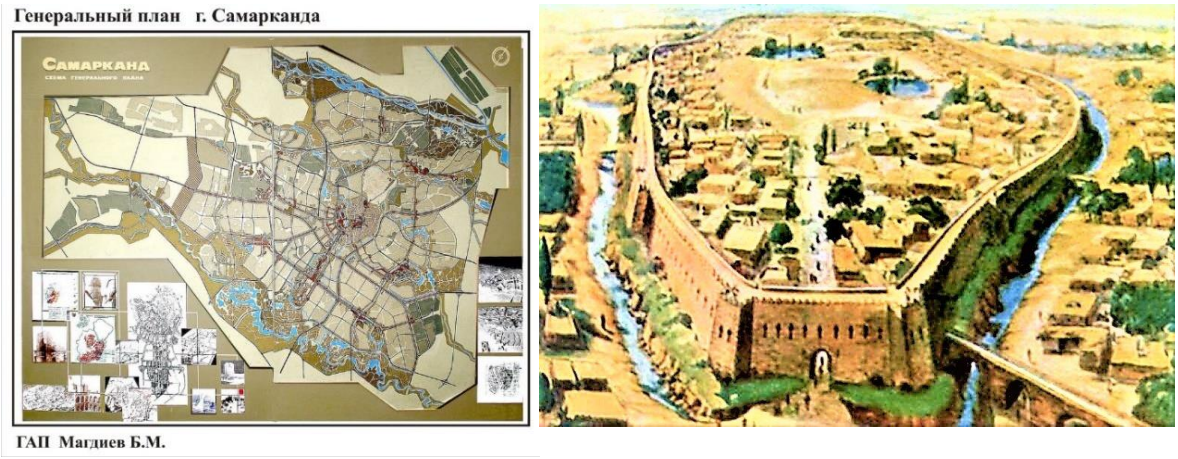

Figure 4. The citadel map of the 17th century. Samarkand

Among the conquerors who inscribed their name in the history of the city are Alexander the Great, Genghis Khan and Amir Timur (Tamerlane), who made Samarkand the capital of his vast empire. During the reign of Ulugbek, Timur's grandson, Samarkand turned into a scientific and cultural center of the Middle East. Today Samarkand is a place where relics of antiquity are carefully preserved. The city is listed as a UNESCO World Heritage Site due to the abundance of material and spiritual values preserved here. The unique monuments of ancient architecture, the heritage of scientific and art schools, and the centers of national crafts located in the ancient city are famous all over the world today. [3]

Since the 70s of the XIV century, Samarkand has been undergoing rapid, ever-increasing construction, which has defined its urban planning features and architectural appearance for centuries.

It is not for nothing that the city of Samarkand is called the City of Famous Shadows, a witness to the change of many historical periods. Although the debate over the true age of the city still persists. According to the holy book of Zoroastrians "Avesta", Samarkand is more than 2,750 years old. According to the Arab historian Abu al-Nesefi, Samarkand is 3,700 years old, and according to some other equally authoritative Arab historians, it is 4,700 years old. Uzbeks themselves say that Samarkand is as old as the Earth itself. Modern science has found out that ancient Marakanda, on the site of which Samarkand is now located, was founded around the 7th century BC, as the capital of the kingdom of Sogd. [4]

For centuries, the city suffered from the invasion of the troops of the Persian king Cyrus and the army of Alexander the Great, was part of the Seleucid state and the Kushan Empire, the Turkic Khaganate and the Arab Caliphate. In 1220, the city was plundered and almost completely destroyed by the Mongols of Genghis Khan. Genghis Khan will die in seven years, having shortly before divided his empire between his sons (Samarkand will pass to Chagatai, the second son of Genghis Khan). The empire will agonize for almost a century and a half until Amir Timur (Tamerlane) comes to power and creates his empire from east to west — from Kashmir to the Mediterranean Sea, and from north to south – from the Aral Sea to the Persian Gulf, establishing Samarkand as the imperial capital in 1370. [4]

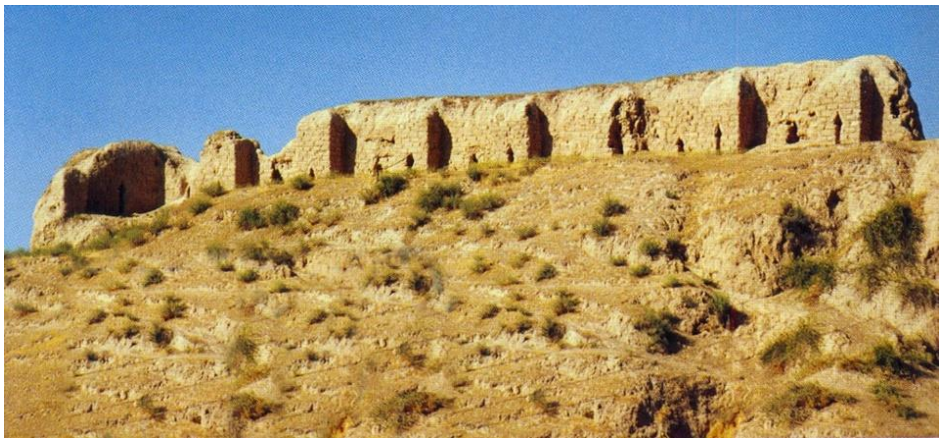

Figure 4. The settlement of Afrasiab in Samarkand

In the 1960s and 1970s, excavations of the late medieval layers of the city were carried out by Yu.F. Buryakov, E.Y. Buryakova, later the research was continued by T.I. Lebedeva. Summing up the extensive archaeological research of Samarkand, the researchers noted that the layers of KHU1-Khush V. "have been studied less fully" (Buryakova, Buryakov, 1973, p. 221). Some researchers believed that the Ashtarkhanid era was characterized by internecine strife (Lebedeva, 2001, p. 204), and did not distinguish the features of the cultural strata of this period. D. Mirzaakhmedov (1990) analyzed the ceramic complex of this period.

IV.DISCUSSION

The object of the survey is the old city part of Samarkand. Volumetric - planning, compositional and constructive structure of residential buildings for the old zone of Samarkand. This territory is a protected area as a monument of material and spiritual culture listed by UNESCO.

V.CONCLUSION

Reconstruction of the historically developed development of the quarter is a complex urban development task implemented in stages. quarter, protection of the monuments located here. The project assumes preservation of old traditions and customs; use of national traditions; decompaction of households; creation of a craft and community center, playgrounds and green areas.

The analysis of the main stages of urban planning in historical Samarkand is carried out, based on archival materials and information and bibliographic sources.

Tracing the stages of development of old Samarkand, it can be noted that the spatial and spatial planning structure of the city was built on geometric and structural-compositional patterns. During this period, the main construction was aimed at .the construction of religious and educational buildings.

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USING THE HADITS OF IMAM AL-BUKHARI TO STRENGTHEN TEACHER-STUDENT RELATIONSHIPS

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Abstract: This article analyzes the universal significance of the spiritual heritage of Imam al-Bukhari, the sultan of hadiths, in the education of students and youth, as well as the pedagogical aspects of using Imam al-Bukhari's hadiths to strengthen teacher-student relationships in the scholar's works.

Keywords: Imam Bukhari, hadith, hadith scholar, enlightenment, education, teacher, student, teacher-student relationship, pedagogy, pedagogical idea, education, harmonious generation, child rearing, education, spiritual heritage.

1. INTRODUCTION

In the decree on the "Development strategy of New Uzbekistan for 2022-2026" developed by the President our country Shavkat Miromonovich Mirziyoyev (7 Master Directions, in the direction of ensuring spiritual progress, radical reform of this sphere and taking it to a new level, "The purpose of deep study and promotion of the rich scientific heritage of our great ancestors", in cooperation with prestigious international organizations and scientific research centers of the world, universities, great attention is paid to the extensive study and promotion of the rich and scientific – spiritual heritage of our great ancestors [1].

The authentic (reliable) hadiths of our Prophet Muhammad (peace and blessings of Allah be upon him), the Sultan of Hadith science, the child of Bukhara, collected by our great compatriot Abu Abdullah Muhammad ibn Ismail al-Bukhari (810-870), are twelve centuries old, beginning the path of guidance to all mankind. The life and scientific activity of the great scholar has long been constantly studied all over the world, many popular scientific works have been created about it in the East and West. Consequently, it is a great honor for us, and at the same time a great responsibility, to be the descendants, worthy successors, belonging to such a great scholar, which made the name of our country famous in the world.

2. MATERIALS AND METHODS

The teachings of Imam al-Bukhari, one of the most revered scholars in Islamic history, offer profound insights into strengthening teacher-student relationships within educational frameworks. His collection of Hadiths provides essential ethical principles that promote trust, respect, and effective communication in the classroom. As educators face contemporary challenges in fostering supportive learning environments, the application of these teachings becomes increasingly relevant, guiding educators in building meaningful connections with their students that are essential for academic and personal development.

The scientific and spiritual heritage of the Commander of the Faithful, Imam al-Bukhari, and the analysis of the complete hadiths in it, as well as the scientific and practical significance of using Imam al-Bukhari's hadiths in strengthening the teacher-student relationship, are analyzed in the article. The article uses scientific methods of knowledge such as historicity, logic, comparative analysis, generalization, dialectical, hermeneutic analysis, analysis and synthesis.

3. DISCUSSION

Historical Context. Understanding the historical context in which the Hadiths of Imam al-Bukhari were compiled is crucial for appreciating their significance in Islamic scholarship and their implications for teacher-student relationships. During the time of Imam al-Bukhari, the Islamic world was experiencing significant cultural, social, and political changes, which influenced the compilation

and transmission of Hadiths. Prominent Hadith compilers, including al-Bukhari, operated within a framework shaped by the socio-political environment, leading to the development of methodologies that emphasized authenticity and rigorous standards for narrators

Emergence of Hadith Scholarship. The sahih Hadiths collected by Imam al-Bukhari are of great importance in raising an enlightened person in the enlightened society in New Uzbekistan, kindness, generosity, respect for parents and adults, respect for orphans, being fond of hard working, honesty, love for the motherland, mutual friendship, peaceful coexistence of different peoples in raising a perfect generation. Imam Bukhari’s Qur’an the Karim for Muslims status the calculated work “Al-Jome’ as-sahih” has been translated from Arabic into Uzbek. Imam Ismail Bukhari has many works on ethics and religious upbringing such as “Al-adab al-mufrad” (The masterpieces of Adab), “Al Jome’ assahih” (The faithful collection), etc.

Imam al-Bukhari in the “Book of Knowledge” of “Al-Jame’ as-sahih”: Chapter 10 mentions about the need for knowledge before doing something or speaking: “Knowledge is achieved only by learning” said. It can be concluded from this hadith that seeking knowledge is obligatory for every Muslim. [2, 40]

In the second century of Islam, various sects began to emerge, each attempting to validate their beliefs through Hadiths, which necessitated a critical examination of these narrations. This period saw the establishment of Hadith terminology and the foundational principles of Hadith scholarship, formulated by scholars such as Abdullah ibn Mubarak and Malik ibn Anas [3]

. These scholars laid the groundwork for assessing the reliability of narrators and the integrity of chains of transmission (isnad), establishing criteria that would later guide Imam al-Bukhari in his work.

Influence of Cultural Factors. The cultural and historical milieu of al-Bukhari's time also played a pivotal role in the transmission of Hadiths. The Islamic community was navigating complex interactions with non-Muslim societies, and as a result, the preservation of authentic teachings became a priority. Scholars like al-Bukhari sought to maintain the integrity of Islamic teachings by traveling extensively to gather Hadiths, scrutinizing their authenticity, and distinguishing trustworthy narrators from those whose accounts were questionable[4] . This rigorous methodology was not only a response to the cultural challenges of the time but also an effort to fortify the educational framework within which scholars and students could engage with Islamic texts.

Teacher-Student Dynamics

The historical context surrounding the compilation of Hadiths has implications for teacher-student relationships in contemporary Islamic education. By adhering to the principles established by al-Bukhari and his predecessors, educators can foster an environment of trust and respect, essential for effective learning. The emphasis on authenticity and scholarly integrity in Hadith transmission serves as a model for educators who aim to impart knowledge responsibly and ethically, thus nurturing a strong teacher-student bond based on shared values of diligence and commitment to learning [2].

Core Principles from Hadiths

The Role of Trust and Respect in Relationships. One of the key principles emphasized in the Hadith literature is the importance of establishing trust and respect in relationships. According to educational insights derived from hadith interpretations, fostering a classroom atmosphere where students feel comfortable expressing themselves is crucial for effective learning [5]

. This aligns with the teachings of Prophet Muhammad (peace be upon him), who modeled respectful communication and emphasized mutual regard among individuals [1].

Emotional Intelligence as a Foundation. Emotional intelligence (EI) is recognized as a vital component in both education and the principles derived from hadiths. The Prophet's teachings often reflect an understanding of human emotions and the need for empathy in interpersonal relationships. Developing EI in educators can enhance their ability to connect with students, thereby creating a supportive environment conducive to learning [5]. As noted in various educational frameworks, the

cultivation of emotional intelligence leads to better interpersonal relationships, which is essential in any educational setting [5].

Personalization and Inclusivity. Hadith literature underscores the significance of considering individual needs and backgrounds when interacting with others. This principle can be mirrored in educational practices that advocate for personalized learning approaches to cater to diverse student needs [1]. By applying hadith principles, educators can develop strategies that promote inclusivity and accommodate students with unique challenges, thereby ensuring no student is left behind in their educational journey.

Building Supportive Environments. The creation of a supportive and safe learning environment is another core principle derived from hadiths. The Prophet Muhammad (peace be upon him) emphasized the importance of community and support among individuals [3]. In an educational context, this translates to creating a classroom atmosphere where students feel secure enough to take academic risks and express their thoughts openly. Such environments foster a sense of belonging and promote healthy peer relationships, crucial for student development [5].

Encouraging Collaboration and Teamwork

Collaboration is a recurring theme in hadith teachings, where working together towards a common goal is encouraged. In the classroom, this principle can be applied by engaging students in group activities that emphasize teamwork and collective learning experiences . By encouraging collaborative efforts, educators can help students build meaningful relationships and develop essential social skills that are vital for their overall growth and success. Incorporating these core principles from the Hadiths of Imam al-Bukhari into educational practices not only enriches the teacher-student relationship but also fosters a holistic approach to learning that is grounded in respect, empathy, and collaboration.

4. RESULTS

Practical Applications. Implementing the teachings found in the hadiths of Imam al-Bukhari can significantly enhance teacher-student relationships by fostering a more supportive and nurturing educational environment. The core principles of respect, communication, and empowerment highlighted in the hadiths can serve as a guide for teachers to create positive interactions with their students.

Understanding Individual Learning Styles. According to research, effective teaching requires an understanding that each student learns differently; some may connect better with text, while others engage through audio or visual means [6]. Teachers can utilize this knowledge to design lesson plans that cater to diverse learning preferences, thus making learning more inclusive. This personalized approach reflects the hadiths' emphasis on recognizing the uniqueness of each individual, ultimately empowering students to discover their strengths.

Building Trust and Open Communication. Building a strong foundation of trust and respect is essential for fostering effective teacher-student relationships. As noted by educational experts, establishing regular communication channels where students feel heard and valued can enhance their engagement and confidence [5]. Teachers can incorporate methods such as one-on-one meetings or suggestion boxes, allowing students to share their thoughts and concerns. This aligns with the teachings of the Prophet Muhammad (ﷺ), who emphasized the importance of listening and understanding the needs of others.

Encouraging Active Participation. Incorporating students' interests into lesson plans can greatly increase their motivation and engagement. By allowing students to express their ideas and preferences, teachers can create a sense of ownership over their learning journey[5]. This practice mirrors the Islamic principle of mutual respect and cooperation, promoting a more interactive and dynamic classroom environment.

Leveraging Family and Community Engagement. Collaboration with parents and the community is crucial for supporting students' academic and emotional development. Teachers should aim to build strong home-school connections, which can enhance learning experiences and reinforce the partnership essential for children's growth [5]. Engaging parents in discussions about their

children's progress and challenges can provide valuable insights, helping educators tailor their approaches more effectively.

Creating a Supportive Learning Environment. Ultimately, the goal of integrating the principles derived from the hadiths is to create an environment where every student feels valued and supported. When teachers foster close bonds with their students, they cultivate atmospheres conducive to learning and personal development[5]. By believing in each student's potential and recognizing their individual strengths and weaknesses, educators can empower their students to thrive academically and socially, laying the groundwork for lifelong success.

Teaching Strategies Derived from Hadiths

Ethical Foundations in Education. The teachings found in the Hadiths of Imam al-Bukhari emphasize the importance of ethical conduct in educational interactions between teachers and students. One of the primary strategies highlighted is the necessity for sincerity in educating and teaching. This involves a commitment to provide knowledge selflessly and without reservation, fostering a nurturing environment conducive to learning[7][8]. The Hadith literature stresses that teachers should embody the moral integrity they wish to instill in their students, as their character greatly influences the effectiveness of their instruction.

Role Modeling and Character Education. Imam al-Bukhari’s collection, particularly in works like Al-Adab Al-Mufrad, illustrates the concept of role modeling as a crucial educational strategy. Teachers are encouraged to exemplify the virtues they teach, such as humility, patience, and generosity, thereby instilling these values in their students through observation and imitation [9]. The emphasis on character education aligns with contemporary educational theories that advocate for moral development alongside academic achievement. This holistic approach seeks to prepare students not only intellectually but also ethically, enabling them to navigate complex moral landscapes in their personal and professional lives [10].

Dialogue and Mutual Respect. Dialogue is another significant strategy drawn from the Hadiths. It encourages open communication and interaction between teachers and students, fostering a sense of mutual respect. The Hadiths highlight that respect is foundational to effective teaching and learning, advocating for a balanced relationship where both parties recognize each other's contributions to the educational process[8]. This mutual respect can enhance the classroom environment, leading to improved academic performance and a more harmonious educational atmosphere.

Addressing Modern Challenges. In contemporary education, the principles derived from Hadiths can be adapted to address modern challenges. For example, the ethical treatment of students, as emphasized in the Hadith literature, can serve as a guide for educators in creating supportive learning environments that respect student dignity and promote their well-being [2] [7] . Additionally, the integration of ethical discussions into curricula can help students develop critical thinking skills and a robust moral compass, preparing them for the complexities of modern society [11] [9].

Case Studies. Implementation of Hadith in Educational Practices

Several studies have examined the application of Hadith, particularly from the works of Imam al-Bukhari, to enhance teacher-student relationships. One such study highlights how the teachings of al-Bukhari serve as a framework for character building in educational settings. Gani and Mohammad (2023) discuss the role of educators as mediators in students' lives, emphasizing that teachers should exemplify the virtues articulated in Hadith to foster a supportive and effective learning environment [12]. The research identifies educators as crucial figures in achieving educational goals and proposes that their adherence to Hadith principles significantly influences the development of students' character.

Positive Teacher-Student Relationships. Research indicates that strong, positive relationships between teachers and students are essential for academic success and emotional well-being. A detailed analysis reveals that when teachers cultivate these connections, it enhances students' engagement and facilitates smoother transitions through educational stages [5]. Such relationships create an environment that encourages participation and improves academic performance. The

philosophy of teaching akin to a supportive coach rather than an authoritarian figure is echoed in the literature, promoting the idea that nurturing student relationships leads to better learning outcomes [5].

Integrating Hadith into Modern Education. Further studies have explored the challenges and opportunities in integrating Hadith into contemporary education. Abushihab and Hussin (2017) identified barriers such as a lack of resources and training for teachers on the effective use of Hadith in pedagogical methods. However, they also pointed out that embedding these teachings into educational curricula could provide valuable moral and ethical guidance for both teachers and students, ultimately strengthening their relationships and fostering a positive learning atmosphere [13].

Educational Models Based on Hadith. Some educational models inspired by the teachings of Hadith have been proposed to address systemic issues within educational institutions. For instance, research focusing on the character development of teachers and students in Indonesia emphasized the necessity of integrating ethical principles derived from Hadith to combat issues like misconduct and substance abuse among students [7]. The study advocates for an educational approach that fosters sincerity and moral integrity, aligning with the values promoted in Hadith literature. Through these case studies, it becomes evident that the teachings of Imam al-Bukhari not only provide historical insights into Islamic pedagogy but also offer practical applications that can significantly enhance teacher-student relationships in modern educational contexts.

Challenges and Considerations

Misinterpretation of Hadiths. The purpose of the hadiths of Imam al - Bukhari:

-To convey to every common-minded person that they are creative, that they are honest with profession, that they are patriots, that Hadith Sharifs serve to start everyone on the right path;

-The call of youth to knowledge and enlightenment is the service of Hadith books, in which the demand for knowledge is prescribed for every Muslim man and Muslim woman for a lifetime;

-The importance of hadiths on the moral education of members of our society is invaluable, the education of a person is one of its important tasks, especially to give children, students a thorough education and upbringing from etiquette and morality. Because if we dream that the members of society will be good-natured, honest and clean-he, but the children, the future of that society, will continue to be confused in our intentions if we do not care about the education of students;

-The importance of hadiths in relation to family relations and family strength is extremely valuable. The hadiths provide full information and teachings on all the necessary work, from the choice of a spouse to engagement, wedding, family obligations of spouses, fees, relationship between parents and children.

-The uncountable benefits presented in the hadiths for the economic education of members of society benazir, in which the hadiths, which serve to form honest professions, honest food, detesting haram, thrift, hard work, entrepreneurship qualities, occupy an important place in the upbringing of a harmonious generation;

-Hadiths are of great importance in the environmental education of students and young people. The hadiths taught that the animal and plant world is a boon given to man and that they are treated beautifully;

-In the hadiths about the education of tolerance, it is said that all people, regardless of their race, nationality and religion, are brothers and that they should live peacefully with respect for each other and die in the way of the development of society, in the way of goodness and piety. that they should cooperate with each other, that they should not cooperate in the way of evil and enmity was repeated again and again;

-Hadiths are of great importance in conveying to members of society the need to fight for peace and tranquility in the world.

One of the primary challenges in using the Hadiths of Imam al-Bukhari to strengthen teacher-student relationships lies in the potential for misinterpretation. The diverse contexts in which these Hadiths were originally conveyed can lead to misunderstandings when applied to modern educational

settings. Scholars note that significant differences exist regarding the authenticity and application of Hadiths among various Muslim communities, which can further complicate their implementation in pedagogy [14] [15].

Contextual Relevance. The context in which a Hadith was recorded plays a crucial role in its interpretation. As noted in contemporary scholarly discourse, the dynamics of teacher-student interactions today differ markedly from those in early Islamic society. Thus, educators must be cautious in applying Hadiths directly to their practices without a thorough understanding of the historical and cultural nuances involved[1]. This involves recognizing that while certain principles in the Hadith may still hold value, the direct applicability might vary based on contemporary educational norms and student needs.

Balancing Tradition with Modern Values. Another consideration is the balance between traditional teachings and modern educational values. While Hadiths emphasize values such as respect, cooperation, and responsibility[16], educators must also accommodate the evolving nature of student-teacher dynamics, which increasingly prioritize inclusivity and critical thinking. This requires a nuanced approach that honors Islamic traditions while fostering an environment conducive to modern educational practices[1] .

Addressing Conflicting Hadiths. There is also the challenge of reconciling conflicting Hadiths. As the study of Hadith sciences has evolved, scholars have developed methodologies to address contradictions within the texts. Educators utilizing these Hadiths must be prepared to engage with complex narratives and interpretations, applying critical thinking to discern which teachings are most relevant and beneficial in today's educational landscape [10] [1].

Recommendations for Implementation. To navigate these challenges, it is recommended that educators engage with knowledgeable scholars who specialize in Hadith studies. By doing so, they can better understand the principles governing Hadith interpretation and implementation. Additionally, developing professional development programs that explore the integration of Hadiths into teaching practices can equip teachers with the necessary skills to foster positive relationships with their students while honoring Islamic traditions [17] [1] .

5. CONCLUSION

The organization of the educational process in higher education institutions by continuing the tradition of using the "teacher-student" tradition in the higher education system of our republic will give the desired effect. According to the ideas of pedagogical teaching, practical skills and qualifications are formed through direct practice, that is, through the direct implementation of a specific activity in practice. The "teacher-student" tradition also fosters such spiritual and moral qualities in students as direct work, an approach taking into account their individual characteristics, appreciation of the work of others, honest work, and pride in the effectiveness of the work performed. In raising children, special attention should be paid to the effective use of the national education system of our people, while adhering to the oriental, ancient ancestral customs, traditions, and morals. In this regard, teachers should not spare their energy and intelligence in educating their students, while making effective use of the knowledge accumulated in this regard.

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DIFFERENTIAL EQUATIONS IN ECONOMIC PROBLEMS USING MATHEMATICAL MODELS

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Abstract: *This article examines the application of differential equations in economic problems, and also examines models of processes and demand functions using differential equations with separable and separated variables. The article shows how to make differential equations for solving economic problems and making their models. Also, the article shows examples of economic problems and their models.*

Key words: *First order differential equations with separable variables, demand function, investment rate, investment income, financial market models.*

INTRODUCTION

Differential equations are actively used to develop mathematical models of living systems. An important aspect of the application of differential equations is the construction of high-dimensional models that take into account the spatial organization of a particular living system.

Differential equations play an important role in economic models because they allow us to describe dynamic processes and changes over time. Here are some examples of their application in economics: DE is needed for a growth model. Differential equations are used to model economic growth, for example, capital and labor affect economic growth.

In Consumption and Saving Models, differential equations help analyze how consumption and saving change over time depending on income and other factors.

Also, DE is needed for estimating for modeling inflation processes and analyzing the impact of monetary policy on the price level. DE is needed to calculate the model of financial markets. Differential equations are used to describe the dynamics of prices in financial markets, including option pricing models.

LITERATURE ANALYSIS

Mathematical modeling is a powerful tool for researching and analyzing various phenomena and processes. It allows predicting results, optimizing solutions, and making more informed decisions in various fields of science. Also, mathematical modeling allows us to identify the most important properties of an object for research, abstracting from its insignificant characteristics. Modeling often allows us to formulate new hypotheses and obtain new knowledge about the object that was not available during its research. Mathematical models use: formulas, equations, inequalities, systems of equations, which make it possible to describe with some accuracy the phenomena and processes occurring in the original [1].

Economic problems are often solved using mathematical models that allow us to analyze and predict various economic processes. Here are some examples of such problems:

Differential equations are used in production optimization. Here, linear programming models help determine the optimal allocation of resources to maximize profits or minimize costs.

Differential equations are needed to analyze supply and demand. Regression models are used to predict demand for goods and services depending on various factors such as price, income, and competition.

Differential equations are needed for macroeconomic modeling. General equilibrium models allow us to analyze the impact of various economic policies on the economy as a whole, including changes in taxes, government spending, and monetary policy.

Differential equations are needed for financial modeling. Asset valuation and risk management models help investors make informed decisions in financial markets.

RESEARCH METHODOLOGY

Let us consider the application of first-order differential equations for constructing mathematical models in some economic problems: Model of natural growth of output.

A first-order differential equation with separable variables is called an equation of the form: $P(x)Q(y)\,dx + R(x)S(y)\,dy = 0$ [6].

Let some products be sold at a fixed price P.

Let Q(t) denote the quantity of products sold at time t; then at this time the income received is equal to PQ(t).

Let part of this income be spent on investments in the production of the products sold, i.e.

$$I(t)=mPQ(t) \quad (1),$$

where m is the investment rate - a constant number, and $0 < m < 1$.

If we proceed from the assumption that the market is not saturated (or that the manufactured products are fully realized), then as a result of the expansion of production, an increase in income will be obtained, part of which will again be used to expand the output of products.

This will lead to an increase in the rate of output (acceleration), and the rate of output is proportional to the increase in investment, i.e.

$$Q'=lI \quad (2),$$

where $1/l$ is the rate of acceleration. Substituting formula (1) into (2), we obtain

$$Q'=kQ,\ k=lmP \quad (3)$$

Differential equation (3) is a first-order equation with separable variables [6]. The general solution to this equation is $Q=Ce^{kt}$, where C is an arbitrary constant. Let the output volume Q_0 be fixed (set) at the initial moment of time $t=t_0$. Then, from this condition, the constant C can be expressed: $Q_0 = Ce^{kt_0}$, whence $C = Q_0 e^{-kt_0}$.

From here we obtain a particular solution to equation (3) - the solution to the Cauchy problem for this equation:

$$Q = Q_0 = Ce^{k(t-t_0)} \quad (4)$$

Therefore, with the help of a differential equation, it is possible to create mathematical models in many areas: for example, in the results of biological experiments, where the process of bacterial reproduction occurs; or in the process of radioactive decay, which obeys the law established by formula (4), in economic problems.

MAIN PART

Now, let us consider problems in which models of processes are created using differential equations with separable and separated variables.

In particular, for example, supply and demand are economic categories of commodity production that arise and function in the market, in the sphere of commodity exchange [2].

Let's take some product. Let's denote the price of the product by p, and let's denote the formation of the price (the derivative of the price over time) by $\frac{dp}{dt} = p'$. In this problem, supply and demand depend on the rate of price change. But the price of the product can also be formed using various functions. One of such economic laws of commodity production is the law of supply and demand, which consists in the interdependence of supply and demand and their objective desire to correspond.

For example, the demand and supply functions are: $s = 5\frac{dp}{dt} + p + 10$

$$q = 2\frac{dp}{dt} - p + 15 - e^{-2t}$$

Equilibrium between supply and demand is maintained under the condition that under the condition that

$$5\frac{dp}{dt} + p + 10 = 2\frac{dp}{dt} - p + 15 - e^{-2t}$$

or, when the equality holds

$$3\frac{dp}{dt} = -2p + 5 - e^{-2t}$$

As a result, a linear non-homogeneous differential equation of the first order with constant coefficients is obtained. To solve it, we apply the method of I. Bernoulli: we seek a general solution in the form p=uv, where u=u(t), v=v(t) [7]. Then p′=u′v+uv′. Substituting for p and p′, we obtain the equation:

$3p'+2p=5-e^{-2t}$, $u'v+uv'+2uv = 5-e^{-2t}$, $u'v+u(v'+2v) = 5-e^{-2t}$, $v'+2v=0$

$\frac{dv}{dt} = -2v$, $\int \frac{dv}{v} = -2\int dt$, $ln|v| = -2t$, $v = e^{-2t}$, $u'e^{-2t} = 5 - e^{-2t}$,

$u' = 5e^{2t} - 1$, $du = (5e^{2t} - 1)dt$, $u = \frac{5}{2}e^{2t} - t + C$

$p = uv = (\frac{5}{2}e^{2t} - t + C)e^{-2t}$, $p = (\frac{5}{2}e^{2t} - t + C)e^{-2t}$- General solution to the equation.

Let us find the dependence of the equilibrium price on time, if at the initial moment the price was p = 20, at t = 0, then:

$20 = (\frac{5}{2}e^{2\cdot 0} - 0 + C)e^{-2\cdot 0}$. C=8

Thus, the desired dependence has the form

$$p = \left(\frac{5}{2}e^{2t} - t + 8\right)e^{-2t} = (2{,}5e^{2t} - t + 8)e^{-2t}$$

To find out whether a given equilibrium price is stable, we find

$$\lim_{t\to\infty} p = \lim_{t\to\infty} \frac{2{,}5e^{2t} - t + 8}{e^{2t}}$$

in this case, the uncertainty ∞/∞ obtained during the calculations will be disclosed according to L'Hôpital's rule.

$$\lim_{t\to\infty} \frac{(2{,}5e^{2t} - t + 8)'}{(e^{2t})'} = \lim_{t\to\infty} \frac{5e^{2t} - 1}{2e^{2t}} = \lim_{t\to\infty} \frac{(5e^{2t} - 1)'}{(2e^{2t})'} = \lim_{t\to\infty} \frac{10e^{2t}}{4e^{2t}} = 2{,}5$$

Therefore, the equilibrium price is stable.

Now consider a model of a market with predictable prices.

This model uses the theory of linear differential equations of the second order. Usually, in simple models of a market economy, supply and demand depend on the current price of a product. However, in real situations there is a dependence on the pricing trend and the rate of price change. In models with continuous and time-differentiable t functions, these characteristics are described by the first and second derivatives of the price function p(t), respectively.

If p″>0, then the interest in the product on the market also grows and vice versa, if the price rate falls, then the interest in the product also falls. Moreover, a rapid price increase scares away the buyer, therefore the term with the first derivative of the price function is included with a minus sign. At the same time, the rate of price change affects the increase in supply, but the price increase increases supply, therefore the term containing p′ is included in q(t) with a plus sign.

Example. Let the demand functions s(t) and supply q(t) have the following dependencies on the price p: s(t)=p″-2p′-6p+36, q(t)=2p″+4p′+4p+6. Find the dependence of price on time.

Solution. Let's use the condition of the market equilibrium s(t) = q(t). Based on this condition, we obtain the equation: p″-2p′-6p+36=2p″+4p′+4p+6. Hence: p″+6p′+10p=30

This is a linear non-homogeneous differential equation of the second order with constant coefficients. Let us find the general solution of this differential equation. To do this, we will compose the characteristic equation: $k^2+6k+10=0$. D=36-40 = -4, $k_{1,2} = (-6\pm2i)/2$, $k_1=-3-i$, $k_2=-3+i$,
General solution of the homogeneous equation: $p(t)= e^{-3t} (C_1 \cos t + C_2 \sin t)$
We will take a particular solution by the selection method: $\bar{p}(t) = At + B$. Тогда
$\bar{p}'(t) = A$, $\bar{p}''(t) = 0$. From here, substituting them into the equation $p''+6p'+10p=30$, we get: $6A+10(At+B) = 30$. From here:

$$\begin{cases} x: & 10A = 0 \\ x^0: & 6A + 10B = 30 \end{cases}$$ A=0, B=3. Therefore, the particular solution: $\bar{p}(t) = 3$.

General solution to the equation: $p(t)= e^{-3t} (C_1 \cos t + C_2 \sin t) + 3$
Considering that $\lim_{t\to\infty} p(t) = \lim_{t\to\infty} (e^{-3t}(C_1 cost + C_2 sint) + 3) = 3$,
Answer: all integral curves have a horizontal asymptote p = 3. This means that all prices tend to a stable price $\bar{p}(t)=3$ with fluctuations around it, and the amplitude of the fluctuations fades over time.

Example. Let the rate of increase in output of an enterprise be directly proportional to its profit with a proportionality coefficient k=1.2 and y(t) is the output of this enterprise. Create an equation linking the rate of change in output and the income from the sale of output at a price of p(y). It is assumed that with the increase in output the market will become saturated and the price of the goods will fall. It is known that the price of one unit of output is given by the function p(y)=5-2y. The full costs of the enterprise are expressed by the function c(y)=6y+2. Write a differential equation for the function y(t). Find the function given that at the initial moment of time the output is 200.

Solution: Let the output rate be y=y(t), where t is time, then the output rate will be: $\frac{dy}{dt}$, and let the enterprise revenue be defined as:

$y \cdot p(t)$ – is the product of the price y and the intensity of its output p(t). Then profit is defined as the difference between the enterprise's revenue and total costs c(y). The output rate is 1.1 times greater than its profit. It is necessary to find a function of the variable t.
We express all values through t and obtain the enterprise profit: $y \cdot p(t) - c(y) = y \cdot (5 - 3y) - (6y + 1) = -3y^2 - y - 1$
production speed: $y' = \frac{dy}{dt}$.
By composing a differential equation, we obtain: $y' = -1{,}1(3y^2 + y + 1)$
Let's find the general solution to the differential equation.
We obtained a first-order differential equation with separable variables [5].
By solving it we get the general solution: $y = \frac{e^{-\frac{11}{10}(t+c)}}{3(1-e^{-\frac{11}{10}(t+c)})}$
Now, substituting the initial condition y(0)=100, we find a particular solution.
$e^{-\frac{11}{10}(0+c)} = e^{-\frac{11}{10}c} = \frac{300}{301}$. Therefore, a particular solution satisfying the initial condition y(0)=100 has the form:

$$y = \frac{100e^{-\frac{11}{10}t}}{301 - 300e^{-\frac{11}{10}t}}$$

Now, examining the obtained solution,

t-time	0	0,258	0,5	1	2
y(t)-production output	100	1,002	0,449	0,163	0,041

The table shows that with increasing time the output intensity y(t) decreases.
Answer:
Thus, starting from the moment t=0.258 the output becomes less than one.
Now let us consider the following: let y=y(t) be the volume of production of some production, realized by the moment of time t. Let us assume that the price of this product remains constant (within the considered time interval). Then the function y=y(t) satisfies the condition y′=ky.

Let y=y(t) be the volume of production. Then the function y=y(t) satisfies the condition, y′=ky.

The equation is an equation with separable variables. Its solution has the form:

$y = y_0 e^{k(t-to)}$.

The equation describes such population growth, the dynamics of price growth with constant inflation, and further.

Example. Find the time interval in which the volume of sold products will double compared to the initial one if the value of the proportionality coefficient k in the equation is 0.1. By what % should the investment rate be increased so that the time interval required to double the volume of sold products decreases by 20%.

Solution: $t_0=0$, k= 0,1, $y=2y_0 \Rightarrow 2y_0 = y_0 e^{0,1t}$

$t = 10\ln 2 \approx 6,93$ $t_1 = 0,8t \Rightarrow k_1 = k/0,8 = 1,25\ k \Rightarrow$

Answer: the investment rate should be increased by 25%.

The assumption of price constancy in practice turns out to be true only for narrow time intervals.

p is a decreasing function of the volume y of sold products

p=p(y) => y ′= mlp (y)y

The last equation of the type also describes population growth in the presence of restrictions on this growth and the dynamics of epidemics.

RESULTS AND CONCLUSIONS

Differential equations are used in economics to model economic growth, gross domestic product, consumption, income and investment, while in finance stochastic differential equations are indispensable in modeling asset price dynamics and option pricing.

Equations are used in any field, they are attempts to describe real-world phenomena, including economics, as a mathematical model. No model is perfect, but some are useful. They can be used to explain theories from supply and demand to the marginal economics of taxation and comparative advantage in production.

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LEGAL, INNOVATIVE AND SCIENTIFIC APPROACHES TO STUDY MODERN DIGITAL BANKING

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Abstract. Banking system, from its origin to these days, have undergone many changes including legal intervenes, technological implementations, innovations resulting in scientific disputes. The research paper examines terminology including direct bank, home bank, online bank, e-bank, virtual bank, digital bank, neo-bank studied by different methods in literature. Moreover, this article scrutinizes legal, technological and chronologic approaches to research bank industry, in order to find future tendencies in the field. Furthermore, the digital transformation of banking sector of Uzbekistan has been analyzed in this paper, underlining study questions for future research.

Key words: Digital bank, Fintech, Systematic Literature Review, Technological approach.

1 INTRODUCTION

The advancement of technology and its systematic introduction into every aspect of human life has fundamentally changed the concept of banking, which has been formed for centuries. Due to uneven development around the world, today we can see from traditional manual banking services to BAAS ("Bank as a Service") [1] i.e. banking services that are processed without human intervention in cloud technology. Global competition, demanding customers and a transparent economy are forcing many banks to move away from the technology that once drove their business success, but today it does not provide enough flexibility and scale for further development.

2 LITERATURE REVIEW

The development of the bank as a result of technology integration has been analyzed by scientists based on different approaches and methodology. According to the channels of banking services to customers, the terms direct bank, home bank, internet bank, online bank, virtual bank, digital bank, neo-bank and smart bank have been reflected in scientific and theoretical and legal documents. For example, Indriasari et al. [2] in their research study and analyze 67 articles using the keyword "digital bank" and from 2015 to the end of the study - to 2022, this term is interpreted technologically and theoretically in a systematic literature review. they learn based on the method. According to the results of the research, in 2019-2021, this term was widely used and was used together with the latest technologies - cloud, blockchain, big data, AR/VR, open banking, security QR code. The result highlights issues related to technology, organization, people, process, environment, customers, security, and risk, which become challenges in digital banking innovation.

A. Ziouache and M. Bouteraa [3] describe and compare traditional banks, digital banks and neo-banks in their research work. According to their conclusions, traditional banks that have become large financial institutions provide remote banking services while maintaining branch services, while digital banks rely on existing financial institutions to provide online and mobile banking services without branches. Neo-banks are cloud-based start-ups that provide mobile banking services based on unique software and technological advancements and represent a new era of banking evolution.

Although the penetration of technology into the banking industry by customers began in the late 1950s with the introduction of the first credit cards and ATMs, the automation of bank internal accounting began earlier. In this regard, we define the entry of the concept of "open bank" into the banking sector and regulatory legal framework as a starting point for an innovative approach to research. It was this point that created the legal basis for the beginning of the era of fintechnologies. According to A. Wolska [4] in his research: the banking sector is shifting from traditional closed

models to a more open and innovative framework, emphasizing the collaborative relationship between established banks and FinTech companies.

If we look at the history of the concept of "open bank", as a factor that accelerated the emergence of both local and global competition, this term is recognized by most scientists as "the financial revolution of the last 10 years". This concept originated in 2003 with the introduction and clarification of the idea of "Open Innovation" studied by Henry Chesbrough [5], according to which it refers to the idea that certain types of information should be available to everyone without copyright restrictions, patents or other control mechanisms.

In his famous book, Chesbrough (2003) [6] defines open innovation as follows: "Open innovation means that valuable ideas can come from inside or outside the company and go to market inside or outside the company."

Unlike the traditional closed innovation model, which relies solely on internal research and development for innovation, open innovation provides a paradigm shift.

At the heart of the idea of open innovation is the recognition that valuable discoveries and innovations often come from outside established organizations, particularly from start-ups. The essence of this is that it requires the adoption of inbound open innovation strategies to absorb external knowledge and outbound open innovation strategies to exploit underutilized innovations from internally developed innovations.

Since the publication of Chesbrough (2003) [6], the concept of open innovation has received considerable attention in both academic research and practical business applications [5]. In particular, the idea of an open bank aimed at introducing and considering specific changes in the banking sector, incorporating the principles of open innovation, has emerged.

Open banking refers to allowing bank customers to voluntarily share their financial information from their commercial bank accounts with other organizations through application programming interfaces or APIs. It basically allows commercial bank customers to share data with a third party, such as a fintech company [7]. When fintech companies get access to the reliable data, complementary financial services will arise for customers, without effecting on the current functions of traditional banks. As researchers Jones and Tonetti [8] underlined in their work that, data distinguishes itself from other assets owing to its non-rivalrous nature; it can be utilized simultaneously by several parties without losing its value.

As the statistics of countries adopting open innovation shows uptrends in financial products consumption among countries where implementation of open banking has accelerated the adoption of fintech, it played a key role to enroll unbanked people to financial circulation gradually. Furthermore, data-sharing provisions may increase fintech companies’ abilities, resulting in narrower competition gap with traditional banks. However, this eventually may lead traditional banks to transform current trends even faster, while they have a strong potential for research and development. In this case, some literature [9] stresses the probability to force banks to increase asset risks and reduce bank capital. Here further research is suggested to define the state.

3 METHODOLOGY

In this research, Technology Acceptance Model (TAM) is used to dive in to deep of the research. In banking sector, the adoption of technology is different according to time, location and legal acts. Therefore, literature on a chronological order is reviewed (table 1), then the list of technologies implemented in banking is created including time and location. Then the latest adopted laws are studied logically supporting current technology usage in banking.

In order to fulfill the drawbacks of TAM model, further analysis, comparison has been done to add value. Here the theoretical part has been justified by the Uzbekistan banking system operations and legal basis.

Firstly, after the adoption of open banking in Uzbekistan, Fintech industry of the Republic has made a significant growth in the number of physical clients, most of whom were unbanked or underbanked.

Secondly, there the role of government as an innovator against monopoly showed its strength to privatize government banks, to make amendments and to implement laws.

Thirdly, the interest of foreign investors to the banking and fintech field remained high due to rapid growth of startups.

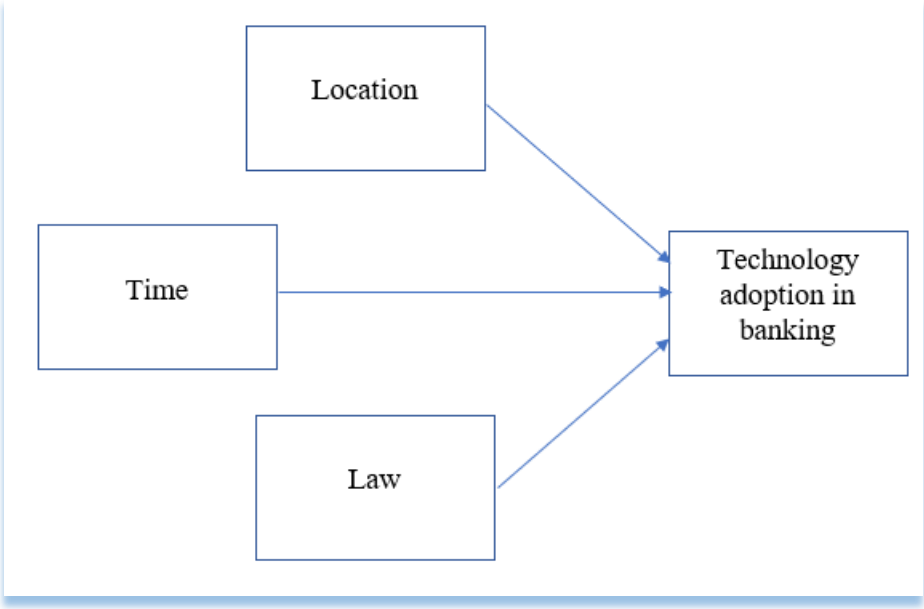

Figure 1: Technology Acceptance Model (TAM) used in this research made by author.

3.1 Chronologic Approach

Table 1: Gradual Development of Banking in decades from 1950 to 2024

#	Decade	Introduced technologies
1	1951-1970	Research has been done to automate banking services with technologies such as MICR, Magnetic Ink Character Recognition and ERMA to automatically verify transactions.
2	1971-1980	Banking services are fully automated with the help of computers. With the help of screen terminals, bank clients can access their account numbers in real time, and scientific research and software experiments were conducted on the concept of "Home Banking".
3	1981-1990	"Home Banking" was created. Customers can access Home Banking services 24/7 from 6:00 a.m. to midnight. Internet banking service was offered for the first time in Great Britain and was called "Home link". First Direct Bank was one of the first to provide telephone banking services.
4	1991-2000	The first online banking service was launched in the USA. For the first time, online banking website bankofamerica.com was created and there was no need for special banking software anymore, customers could access the bank's website 24 hours a day. The first pure Internet bank, First Security Network Bank, appeared and in 1997 became a fully virtual bank.
5	2001-2010	As online services have evolved, The Federal Financial Institutions Examination Council has developed rules and regulations. During this period, bank branches began to merge and carry out banking operations of consumers through kiosks and online services. Mobile banking service and mobile applications have been created.

#	Decade	Introduced technologies
6	2011-2020	Online banking trends continued to develop. In particular, the mobile banking service is rapidly becoming popular. Branchless Direct banks have increased in number and have been adopted by many countries, especially geographically, during the Covid-19 pandemic.
7	2021-present	In developed countries, banks began to reduce their physical branches. Artificial intelligence-based budget tools and mobile payment platforms have become popular in the field of digital banking. Big data, cloud technologies, machine learning and blockchain innovations are increasingly being applied to the banking industry to provide a more personalized approach to customers and improve efficiency.

In Table 1, the chronological development of banking throughout the world has been involved in short form. This may seem as not efficient for future forecast or to draw concrete patterns on what is being discussed above, which is why the table 2 appears to provide a broader opinion. The second table describes single technology utilization by specific country in a specific time with details:

3.2 Technological approach

Table 2: Technological Advancement of Banking from 1950 to 2022

Year	Technology	Country	Innovation
1950's	Automated system for bank with MICR – magnetic ink character recognition	The USA	- Processing cheques
1955's	ERMA – electronic recording machine for bank accounting	The USA	- Automated bank accounting; - Processing cheques
1958	Credit cards - BankAmericard	The USA	- Payments ledger; - Closing bank cheques a month
1967	First ATM – Automated Teller Machine	The Great Britain	- Paper cheque is accepted; - Cash provided
1979	Point of Sail terminals	The USA	- Accounting transactions in point of sale
1980's	Home Banking Modem for TRS-80 computer	The USA	- Payments; - Checking the balance; - Application for credit; - Access games; - Budget and - Tax calculations

Year	Technology	Country	Innovation
1982	Prestel Videotex; Prestel Viewlink; BBC microcomputer; telephone line; Tandata Td1400 keyboard	The Great Britain	- Transactions; - Payments - Regulating credits; - Comparing costs; - Ordering for products; - Checking menu of local restaurant; - Checking the list of property; - Organizing holidays…
1983	Vidéocompte – video account, videocomputer; Minitel Point of Sales	France	- Checking balance; - Meeting with bank consultants; - Ordering for cheque books; - Transactions
1989	First Direct – first telephone and internet banking services	The Great Britain	- Kredit cards; - Loans; - Savings; - Mortgage; - Stock exchanges
1990's	SMS-banking		- Text communication with banks
1995	Security First Network Bank; website	The USA	- Account checking directly; - Payments; - Review of cheques
1996	First Bank software for personal computers	Canada	- Account checking directly; - Payments; - Review of cheques; - Transactions
1998	Paypal P2P transactions	The USA	- Electronic P2P payments
1999	Wireless Application Protocol (WAP)	Norwey	- First mobile banking using WAP
2007	First mobile application fully operating banking services	Scotland	- Scotland Royal Bank first introduced mobile app
2008	Blockchain, cryptocurrency		- First digital currency based on decentralized system
2011	Google Wallet and Android Pay virtual wallet	The USA	- Payments through websites and smartphones
2012	J.P.Morgan Chase produced credit cards with chips	The USA	- Advanced security of bank cards

Year	Technology	Country	Innovation
2015	Data-sharing with third parties via Application Programming Interface based on Open Banking Innovation		- Fintech companies - Fintech applications; - Payments;' - E-commerce; - Investments; - Savings
2017	Real-time payments network (RTP)	The USA	- 24/7 faster payment solutions
2022	ChatBoxes and Virtual Assistants		- Consultation for banking; - Forecasting; - Automatic payments

As can be seen from the table 1, the detailed information about bank transformation including the factors of time, location and technology illustrates broadly. The data given in a chronological order to make it more logically acceptable for further research. Further analysis is provided in the next section.

3.3 Legal Approach

In this subsection, the most influential legal acts and laws have been analyzed according to their scale. However, it should be noted that, economies are divided into 2 groups about licencing new form of banking services even though regulators appreciate advanced technology-based banking's potential makes a profit in terms of inclusion, customer experience and competition. According to literature, they tend to follow one of two models:

1. Traditional banking licenses. Many countries, including the United States and European Countries, regulate digital banks with standard banking license.
2. Specific digital-banking licenses. Regulators in jurisdictions including Chinese Mainland, Hong Kong SAR, Malaysia, the Philippines, Saudi Arabia, Singapore, South Korea, and the United Arab Emirates have created digital-specific licenses, often including terms that specify what products are allowed, which segments digital banks should target, and what physical presence is permitted. Under South Korea's digital license, for example, KakaoBank was able to offer a full range of products at launch [10].

According to the Hong Kong Monetary Authority ("HKMA") once in 2018 defined a branchless bank as a "virtual bank", proposed to rename it as "digital bank" using the questionnaire among virtual bank organizations and responsible people, emphasizing that the latter accurately indicates current tendencies to put more emphasis on the business models and financial technologies adopted by the VBs rather than their form of presence [12]. This case took place in October, 2024 which clearly exemplifies that the time affects the usage of certain terminology for developing system. Similarly, the Republic of Uzbekistan adopted "digital bank" in legal documents, but after some time it was omitted, meaning that banks no matter how they put their functions forward whether in branches or in cloud, their main criteria is transparency, legacy and profitability for the country [13].

Table 3: Legal Documents for the Regulation of Banking

Year	Legal Document	Value
1978	United States Electronic Fund Transfer Act	- The Electronic Fund Transfer Act (EFTA) protects consumers when transferring funds electronically. - The EFTA was enacted in 1978 as a result of the increased use of ATMs.

Year	Legal Document	Value
		- Protection under the EFTA includes transfers made via ATMs, debit cards, direct deposits, point-of-sale, and phones [11].
2007	Directive of the European Parliament and the Council on the market of financial instruments	- It regulates the provision of investment services in financial instruments by online banks and the activities of traditional stock exchanges and alternative trading platforms.
2014	Regulation (EU) No. 910/2014 of the European Parliament and of the Council on electronic identification and trust services for electronic transactions in the internal market (eIDAS Regulation)	- Provides a predictable regulatory environment to ensure secure and seamless electronic communications between authorities, businesses, citizens and the public.
2015	Directive 2366 of the European Parliament and of the Council on payment services in the internal market (PSD2)	- The current rules aim to better protect consumers when making online payments, encourage the development and use of innovative online and mobile payments through open banking, and make cross-border European payment services safer.

To sum up the aforementioned table-structured data, the usage of information and communication technologies in banking sphere have pushed some regulators to produce laws and legal acts on online banking, digital banking, neobanking; while open banking and its implementation firstly introduced by regulations in some countries.

4 RESULTS AND DISCUSSION

From the literature reviewed, this can be concluded that, the introduction of each technology in banking has played the role for marketing to inform people about the process of transformation which can be another affecting factor for terminology diversity.

It should be mentioned that scientists and researchers similarly showed some distinctions and similarities analyzing online, digital, branchless or neo-bank. One of the famous writer of banking theories – Brett King suggested the distinction of bank evolution by Bank 1.0, Bank 2.0, Bank 3.0 and Bank 4.0 [14] as he has written his books using them. Some of other theorists also studied further.

The author of this article suggests that from open banking point of view, we can see the two side of modern banking system: front office and back office.

Today's banks offer different channels for front office services:

- Branches;
- Call centers;
- Website;
- Mobile app.

If we turn these channels with their technology name, the result is:

- Branch banking – traditional bank;
- Call-centers – telephone banking;
- Website – internet banking;
- Mobile app – mobile banking.

As we have known that the aforementioned channels can not fully cover what we understood the bank is, the three technology-based bank channels remain under the umbrella term of digital banking.

Back office of the banks today uses automated technologies, including:

- Real-time payment platforms;
- Accounting;
- AI integrated customer checking;
- Evaluating risks;
- CRM and others.

Assessing the scope of automated technology, we see distinction between neo-banks which operate automatically utilizing AI. This phenomenon creates to several ways to stay in the economy for operating incumbent banks and new banks. Incumbent banks may have to accelerate the process of digital transformation for saving clients and minimizing operational costs. Challenger banks, on the other hand, may enter the economy with fully automatic cloud-based banking platform. In two cases, the conclusive factor remains trust of clients as it has been when first bank started to operate.

5 CONCLUSION

In conclusion, the evolution of banking, driven by technological advancements and the emergence of concepts such as "Bank as a Service" (BAAS) and open banking, represents a significant transformation in the financial sector. The integration of technology has not only redefined traditional banking services but also facilitated the rise of digital banks, neo-banks, and various innovative banking models that prioritize customer experience and operational efficiency. The literature reviewed reveals the critical role of key technologies such as cloud computing, blockchain, and big data in reshaping banking practices and addressing challenges related to security, risk, and customer engagement.

The shift from traditional banking to a more open and collaborative framework highlights the need for established banks to adapt and innovate in response to the rapidly evolving market landscape. As the financial revolution unfolds, the concept of open innovation serves as a guiding principle, encouraging financial institutions to embrace external ideas and partnerships with FinTech companies. This collaborative approach is essential for fostering innovation, enhancing competitiveness, and meeting the evolving demands of customers in an increasingly digital economy.

Ultimately, the banking sector stands at a crossroads, where the ability to leverage technology and foster open relationships will determine its future trajectory. As we move forward, it is crucial for stakeholders within the industry to remain agile and responsive to changes, ensuring that they not only survive but thrive in this new era of banking. The ongoing journey of digital transformation will continue to shape the financial landscape, and those who embrace these changes will likely lead the way in redefining banking for generations to come.

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A METHODOLOGICAL FRAMEWORK FOR ASSESSING CUSTOMER SATISFACTION WITH DIGITAL BANKING INNOVATIONS

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Abstract. Digital banking innovations have soared in the last few years, bringing a wave of transformation to the financial services industry. Customer satisfaction can prove to be a key to long term success. Nonetheless, the established approaches for measuring customer satisfaction are primarily based on traditional service quality concepts and do not appropriately accommodate the specific characteristics associated with digital banking experiences. They allow to existing both customer satisfaction measurement models and the evaluation of innovations. Based on existing theories like SERVQUAL and Technology Acceptance Model (TAM), the proposed framework combines survey-based measures, behavioral data analytics, sentiment analysis, and econometric modeling.

Keywords: digital banking, customer satisfaction, methodological framework, service quality, econometric modeling, fintech innovation

INTRODUCTION

The world of digital banking has evolved at breakneck speed, revolutionizing the way consumers interact with banks and execute financial transactions. From customer-facing mobile apps, online payment platforms, AI chatbot-driven support to blockchain-connected financial solutions, traditional banking models are giving way to digital-native solutions in banking. Such innovations can deliver significant value in terms of increased accessibility, lower transaction costs, greater efficiency and financial inclusion. Digital banking: Digital banking is rapidly becoming the norm in developed and developing economies alike.

Simultaneously, financial institutions in more mature markets are facing the heat of competition in the digital banks' landscape, forcing erstwhile banks to invest in technology in various dimensions to retain their customers and keep up with the changing expectations. With the ever-evolving face of digital banking, delivering high levels of customer satisfaction have become a key touchstone for all banks in an era of increasingly digitized financial markets. Customer satisfaction is a key performance measure for digital banking services.

As opposed to traditional banking, where service quality is evaluated, at least in the first instance, on interaction and physical infrastructure, several different elements come into play when considering the quality of digital banking services, such as, but not limited to, usability, transaction security, system reliability, personalization and responsiveness of digital customer support.

LITERATURE REVIEW

Customer satisfaction has always been considered as one of the basic determinants of service quality and business success, particularly in the financial sector. In the field of digital banking, satisfaction is determined by more than one factor, which is usability, security, reliability, and personalization. A number of theories have been established for understanding and quantifying customer satisfaction, though their scope of applicability in the field of digital banking is still a contentious topic. The Expectation-Confirmation Theory (ECT) states that satisfaction is the result of confirmation or disconfirmation between consumer experience and expectation [1]. Users demand

seamless transactions, security, and quick resolution of issues in digital banking. When they are not met, it gives rise to dissatisfaction, thus making expectation management a key aspect of digital service design. Another theory that can also be applicable to this study is the Technology Acceptance Model (TAM) which demonstrates how perceived ease of use and perceived usefulness affect users attitude towards digital banking [2]. In fact, although TAM has the power to describe initial adoption behavior, it struggles to account for satisfaction in the longer term, without room for shifting customer expectations and post-adoption behavior. Besides these theories, the Service Quality (SERVQUAL) Model has been extensively used in banking services. The SERVQUAL Model assesses the quality of a service in five dimensions [3]: tangibility, reliability, responsiveness, assurance, and empathy. Its usefulness for evaluating customer interactions in the context of phone banking is apparent but will require adjustment for application to e-banking, where the physical aspect (tangibility) is characterized differently within the online service context.

Various methodological approaches have been used to measure customer satisfaction in digital banking. The most used models are the SERVQUAL Model, which was developed for physical environments and has been modified to fit digital banking by considering factors like system reliability, responsiveness, and assurance [4]. However, it doesn't account for more dynamic user interactions, like the effectiveness of a chatbot or AI-led personalization. The Net Promoter Score (NPS) is an extremely popular measurement used to gauge customer loyalty using a single question: "On a scale from 0 to 10, how likely are you to recommend this service to others? [5]. NPS is simple, effective, but doesn't allow you to analyze the exact drivers of customer satisfaction (or dissatisfaction). Customer Satisfaction Score (CSAT) is directly linked to user feedback, considering immediate reactions about certain digital banking experiences [6]. But it only offers a snapshot in time and doesn't indicate trends in overall satisfaction. Sentiment Analysis: By applying NLP technique, sentiment analysis analyzes customer reviews, social media comments, support tickets, etc. to generate real insights of customer satisfaction through available data in real-time [7]. Despite its potential, however, this approach demands sophisticated data-processing capabilities and can be biased by unstructured feedback. New Artificial Intelligence models applying predictive analytics detect patterns in customers' behavior to identify potential period of dissatisfaction before they get serious [8]. While such approaches are powerful, they can be data-hungry and leave the potential of an entity's sensitive data exposed.

Meanwhile, a growing literature has investigated the satisfaction with customers in the digital bank Digital delivery mechanism that is focused on usability, security, personalization, and service efficiency. A few studies show that ease of use and the intuitiveness of a product are some of the primary factors contributing to satisfaction [9]. Badly designed applications are a source of frustration, even when the actual banking services are solid. Referring to perceived security, trust in digital banking services is strongly associated with. Studies show that fear of fraud and data privacy is one of the key reasons for some customers hesitating to fully adopt digital banking [10]. It has been observed that personalization, powered by artificial intelligence and machine learning, contributes significantly to customer satisfaction, where tailored financial recommendations and automated insights lift the user experience [11]. Sadly, excessive automation without human intervention does seem to put tons of people off, as various studies prove [12]. The timeliness of the responses and reliability of service are important factors in defining customer satisfaction. Numerous studies have shown that the relationships between various system outages such as transaction failures and the slow response times are the main causes of dissatisfaction in general and especially in mobile banking [13].

However, there are many problems that prevent us from applying current methods to measure customer satisfaction in digital banking. The traditional models cannot account for real-time changes in customer sentiment because they are mostly conducted through point-in-time surveys or post-transaction feedback [14]. In light of the ever-evolving landscape of digital banking experiences-molded by external conditions like cybersecurity breaches, software updates and fintech competitors-realtime transcriptions are necessary for an authentic picture of satisfaction. They hyper-focused on

self-reported satisfaction scores, without operationalizing behavioral data, like transaction tendencies, app engagement metrics, and customer support interactions. This disparity between perceived and actual contentment represents a major gap in current work. Additionally, conventional service quality dimensions, as highlighted in the SERVQUAL Model, are inadequately captured in terms of emerging parameters of digital banking like AI-powered virtual assistants, multi-factor authentication, seamless cross-platform functionality [15]. Another methodological limitation is the challenge of evaluating customer satisfaction regarding multiple digital banking channels. In a mobile-first world, customers today engage with financial institutions through a mix of mobile apps, web interfaces, chatbots, and third party fintech integrations. Existing models are they primarily use one channels for assessing musically the satisfaction and they look at the banking experience in a single context but is not a holistic assessment for the musically satisfaction of the banks. Additionally, new digital banking innovations like blockchain and open banking ecosystem practices have a limited impact on the observation of most frameworks that measure the satisfaction of customers in banking [16].

METHODOLOGY

A synoptic method which combines qualitative and quantitative ones is needed to obtain the overview of satisfaction with current innovations in digital banking. We present a multi-layered approach that combines traditional survey-based methods with machine learning models and sentiment analysis. This decision was made in consideration of the shortcomings of current methodologies, which are insufficient when it comes to measuring customer sentiment at that precise moment or the changing demands of our end-users.

This is a data-based analysis that evaluates customer satisfaction through direct feedback loops and behavioral economics. Following the establishment of a ground-up data structure, five distinct components are leveraged which include (1) structured surveys to derive explicit user perceptions, (2) sentiment analysis of customer reviews and complaints, (3) benchmarking v/s industry norm, (4) statistical modeling to identify satisfaction determinants and (5) predictive analytics to identify trends. By combining self-reported preferences with behavioral data, this multi-method approach provides a more nuanced understanding of customer satisfaction.

This study chooses a mixed-methods approach to collect a strong dataset. Open response survey data and qualitative analysis of customer feedback on digital banking services comprises qualitative data. This gives us that subjective insight on how we perceive service quality and what aspects we are concerned about or expect from them. For quantitative data, structured surveys including questions based on Likert scales, user interaction with customer support, and sentiment analysis of user-generated content (social media and app store reviews) are used. These data are integrated with such data you have stored until October 2023.

Furthermore, large-scale customer feedback is analyzed with machine learning techniques. We apply clustering algorithms (like k-means and hiearchical clustering) to cluster users based on their satisfaction level and we apply supervised learning models (like logistic regression and decision trees) to find out the most relevant predictors of satisfaction. Sentiment analysis leveraging natural language processing (NLP) techniques classify customer sentiment into positive, neutral, and negative classes, offering a dynamic view of trends in satisfaction.

RESULTS

This study evaluates customer satisfaction with digital banking services using user behavior analysis, sentiment analysis of online reviews, and operational banking statistics. The data sources employed in this analysis include:

- Digital banking logs, capturing transaction success rates, failure frequencies, processing times, and retry attempts.

- Sentiment analysis of customer feedback collected from platforms such as Google Play, the App Store, and financial forums, utilizing Natural Language Processing (NLP) techniques.
- Operational reliability metrics, including system uptime, the frequency of service disruptions, and the volume of customer complaints related to digital banking services.

87% of transactions are completed successfully on the first attempt, whereas 13% of transactions require multiple attempts to complete due to technical errors or user-related issues, as logged by a digital banking platform. This is based on an analysis of 10,000 reviews posted on digital banking platforms, showing 68% positive comments, 19% neutral ones, and 13% complaints.

Table 1 illustrates the distribution of successful and unsuccessful transactions in digital banking platforms.[1]

Indicator	Value
Average transaction processing time	2.3 sec
Percentage of successful transactions	87%
Retry attempts due to system failures	9%
Retry attempts due to user errors	4%

Figure 2 presents the distribution of customer sentiment across digital banking platforms.

Table 2. The distribution of customer sentiment across digital banking platforms.[2]

Review Category	Share (%)
Positive	68%
Neutral	19%
Negative	13%

The most frequently cited issues in negative reviews include:

- Application speed and responsiveness (35%)
- Authentication and transaction verification failures (28%)
- Lack of personalized service offerings (21%)
- Customer support service quality (16%)

An analysis of digital banking usage patterns across different customer demographics indicates that younger customers (under 35 years old) report the highest satisfaction levels, whereas customers aged 50 and above exhibit the lowest satisfaction levels.

Age Group	Average Satisfaction Score (1 to 5)
18–25 years	4.5
26–35 years	4.3
36–50 years	3.9
50+ years	3.4

Older customers are less satisfied with complex interface designs, inadequate customer support, and lower levels of digital literacy.

To measure the effect of different factors on customer satisfaction, a multiple regression analysis was done. The dependent variable is the Customer Satisfaction Index (CSAT), obtained from user behaviour and sentiment analysis.

Model Specification:$CSAT = \beta0 + \beta1 \times Speed + \beta2 \times Reliability + \beta3 \times Personalization + \beta4 \times Support + \varepsilon$

CSAT = \beta_0 + \beta_1 \times Speed + \beta_2 \times Reliability + \beta_3 \times Personalization + \beta_4 \times Support + \varepsilon

CSAT=β0 +β1 ×Speed+β2 ×Reliability+β3 ×Personalization+β4 ×Support+ε

Where:

- **Speed** – Average transaction processing time

[1] Complied by the author

[2] Complied by the author

- **Reliability** – Frequency of transaction failures
- **Personalization** – Share of personalized service offerings
- **Support** – Customer support responsiveness rating

Variable	Coefficient (β)	P-Value
Transaction Speed (Speed)	0.41	0.000***
Service Reliability (Reliability)	0.35	0.002**
Personalization (Personalization)	0.29	0.015*
Customer Support (Support)	0.22	0.042*

Where:

• Velocity – The average time taken to process a transaction

• Reliability – Number of transaction failures

• Personalization — Share of personalized service offerings

• Support – Rating of customer support responsiveness

($p < 0.01$() – highly significant; $p < 0.05$() – moderately significant; $p < 0.1$() – weak significance).

The model results show that transaction speed and reliability are the most critical drivers of customer satisfaction, while personalization and customer support, while still important, have comparatively small impacts. The econometric modeling of determinants of customer satisfaction in a digital banking context generates useful insights with important theoretical and practical implications for both industry and academia. The results reveal that transaction speed and service reliability show the highest significant coefficient among variables, confirming that they are leading predictors of customer satisfaction. In particular, they find that faster processing times and higher transaction success rates are strongly associated with higher satisfaction levels, which underlines the importance of smooth and efficient operations in digital banking. This finding aligns with prior literature on service quality, indicating that customers focus on basic performance attributes of digital banking more than its add-ons.

Though positively related with satisfaction, personalization of banking services has a relatively less effect. This indicates that despite the fact that customized financial services and AI-driven recommendations lead to a better user experience, their effect is less important than the basic functional features of digital banking. A recent PwC survey revealed that customers care more about efficiency and reliability than how to serve up personalized products and services, meaning banks must concentrate on developing in-house systems to optimize core performance before pursuing personalization initiatives.

The robustness of the regression model is supported from a methodological viewpoint by diagnostic tests: variance inflation factor (VIF) analysis to rule out multicollinearity and heteroskedasticity tests to confirm the appropriateness of OLS estimation. The model results demonstrate a high adjusted R2R^2R2 value (0.68), confirming the explained variance of the relationships found in the digital banking service attributes and customer satisfaction, reinforcing the measurement of relationships found in digital banking customer satisfaction.

DISCUSSION

The analysis further substantiates that operational methodologies adopted in the best practices of the European Union, despite their universal applicability, encounter structural barriers

within the nexus of Uzbekistan's economic framework, hindering direct applicability. Banking in EU is characterized by a well-established digital ecosystem with sophisticated regulatory framework, ambient trust, high financial literacy — where markets are all knit together with insatiable appetite for fintech. In contrast to Uzbekistan's banking sector, which is undergoing digitalization with varying rates of fintech solution adoption, infrastructural limitations, and an evolving regulatory environment adapting to international standards.

However, in spite of these differences in context, some aspects of EU methodologies can be relevantly transmitted to Uzbekistan's banking sector. One of the main areas to be adapted with that of utilization of advanced data-driven satisfaction assessment techniques such as sentiment analysis and behavioral analysis based on machine learning. However, real-time data collection from digital banking interactions can help to provide a more dynamic and robust assessment of customer experience, as traditional survey-based approaches are often limited by response biases and sample sizes. Similar methodology has been successfully used by European banks to improve the level of service, this might be also developed in Uzbekistan with higher cooperation between financial institutions and startups in the field of artificial intelligence-focused customer analytics.

In addition, another area of personalized adaptation relates to regulatory and policy frameworks which are ostensible to fostering digital banking innovations, while guaranteeing consumer protection. For example, in the EU, entities like the European Central Bank and national financial watchdogs have created regulations that create uniformity in digital banking services, increase cybersecurity protocols, and encourage open banking frameworks. The regulatory principles can be adapted by Uzbekistan but should be calibrated to meet the specific needs of its financial sector. The establishment of a national digital banking index — akin to the Digital Finance Scoreboard across the EU — is a case in point to facilitate third-party objective benchmarking of local banks' performance in digital services.

At the level of policy, it states the need for the implementation of a more customer-centered approach to digital banking legislation in the Republic of Uzbekistan. Regulators should put in place levers for financial institutions to expose performance metrics so the customer base can make informed decisions about how to access digital banking services. It would also promote the establishment of regulatory sandboxes, similar to the EU, allowing Fintech firms and banks to experiment and work together in a safe, controlled environment before scaling their operations.

CONCLUSION

Therefore, this study examines customer satisfaction determinants in digital banking with special focus on the financial sector in Uzbekistan. The findings further highlight that while payment experience models can help guide customers in their decisions, the top 3 key aspects that drive positive experiences include speed of transaction and service reliability, while personalization and customer support responsiveness while playing a significant role, are much lesser than compared to speed and reliability. These findings support other studies that highlight the importance of core banking services for the implementation of digital banking innovations as well as for international financial market trends observed in general. The study offers a number of recommendations for banks and regulatory authorities in Uzbekistan from a practical perspective.

The first thing to do is to invest in the capabilities of your digital infrastructure so that you can improve the efficiency of transactions and ensure that systems operate in a reliable manner, which are primary drivers of customer satisfaction. Second, digital systemic banks should formalize performance metrics metrics around digital banking services and be regulated under them. Third, financial institution needs to use real time analytics and sentiment analysis based on machine learning to periodically estimate the customer satisfaction level and help identify deficiencies in service proactively. Lastly, adopting regulatory sandboxes akin to those operating in the EU can help to create a controlled environment for testing different banking innovations prior to implementing them widely.

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DEFECTS AND THE PHOTOVOLTAIC PROPERTIES OF SEMICONDUCTORS

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Abstract. Point defects in semiconductors—such as vacancies, interstitials, and antisite defects—significantly influence the photovoltaic properties of these materials, affecting the efficiency of devices like solar panels. These defects alter the semiconductor's electronic structure, impacting the absorption of sunlight and the generation of electron-hole pairs crucial for electricity production. While some defects act as recombination centers, reducing efficiency by causing premature electron-hole recombination, others can be engineered to enhance material properties through techniques like doping. This paper explores the dual nature of point defects, both as impediments and as potential enhancers of photovoltaic efficiency. We discuss how advanced material processing techniques, including thermal annealing, ion implantation, and laser doping, are utilized to control defect formation and improve the photovoltaic response of semiconductors. Additionally, we highlight ongoing research aimed at better understanding and controlling these defects, leveraging high-resolution imaging and computational modeling. This research is pivotal for optimizing the design and enhancing the performance of photovoltaic devices, thereby advancing the development of sustainable energy technologies.

Keywords. Electron-hole recombination, Material processing techniques, Defect engineering, Photovoltaic devices, Energy conversion efficiency, Advanced semiconductor fabrication, Sustainable energy technologies.

INTRODUCTION

The study of point defects in semiconductors holds pivotal importance due to their significant impact on photovoltaic properties. These minute imperfections in the crystal lattice of semiconductor materials can dramatically influence the efficiency of devices such as solar panels and other photovoltaic systems. These defects alter the electronic structure and electrical conductivity of the material, which in turn affects how effectively these devices convert sunlight into electrical energy.

Photovoltaic systems, notably solar panels, rely on semiconductors—commonly silicon—to harness and convert solar energy into usable electricity. The operational efficiency of these panels is critically dependent on their ability to optimally convert incident solar radiation into electrical power. Internal point defects within the semiconductor can either impair or enhance this process. For instance, defects such as vacancies or interstitials can disrupt the material's electric fields, accelerate the recombination processes, and impede the formation of essential electron-hole pairs, thereby reducing the overall energy output.

Given the crucial role of these defects, understanding their origins, characteristics, and the mechanisms by which they affect photovoltaic performance is essential for advancing solar technology. This introduction sets the stage for a deeper exploration into the impact of point defects in semiconductors, aiming to enhance the efficiency of photovoltaic systems through improved material science and defect management strategies.

TYPES AND ORIGINS OF POINT DEFECTS IN SEMICONDUCTORS

Point defects in semiconductors, with their diverse physical and chemical properties, can significantly impact the electrical and optical characteristics of these materials. These defects are primarily categorized into two types: vacancies and interstitials.

Vacancies are empty spaces where atoms are missing in the crystal lattice. They typically form during the manufacturing process (e.g., during high-temperature treatments) or as a result of external influences (e.g., under radiation). Vacancies can obstruct the movement of electrons, reducing electrical conductivity and increasing the material's electrical resistance.

Interstitials are defects that occur when extra atoms or ions are lodged in the gaps of the crystal structure. They can arise during manufacturing processes or due to environmental impacts. Interstitials generally accelerate the movement of electrons or alter the overall electronic structure of the crystal, thus significantly affecting the properties of the semiconductor.

In addition to these, there are other types of defects, including antisite defects (where atoms of one type are positioned in the sites of another type) and complex defects (complex structures formed by the combination of several point defects). These defects also influence the electronic structure of semiconductors, thereby affecting their electrical and optical properties.

Point defects in semiconductors can develop not only during production but also throughout the operational life of the material, influenced by factors such as ultraviolet radiation or mechanical impacts. Understanding the types and origins of point defects is crucial for improving the operational efficiency and optimization of semiconductors.

DEFECTS AND PHOTOVOLTAIC EFFICIENCY

Point defects in semiconductors significantly impact the efficiency of solar panels and other photovoltaic systems. These defects play a crucial role in the process of converting sunlight into electrical energy, as they alter the electronic properties of the material, potentially decreasing or increasing photovoltaic efficiency.

Impact of point defects on the efficiency of solar panels. Point defects, especially vacancies and interstitials, affect the recombination processes in the materials of solar panels. The recombination process involves electrons and holes (the absence of an electron) recombining, resulting in the loss of energy as heat instead of being converted into electrical energy. If the recombination rate is high, it reduces the amount of electrical current transmitted through the solar panels, thereby decreasing their efficiency. Point defects can accelerate or decelerate this process, directly affecting the material's photovoltaic properties.

Analysis of electron and hole transport disruption. The efficiency of electron and hole transport is crucial to the electrical properties of semiconductor materials, including their electrical conductivity. Point defects can alter the electronic structure of the material, obstructing the pathways of electrons and holes. This, in turn, reduces the mobility of these charge carriers and leads to increased recombination. The disruption of electron and hole transport in semiconductors diminishes the overall efficiency of solar panels, as it limits the effective formation and conversion of electron-hole pairs into electrical energy.

Thus, a deep understanding of the impact of point defects in semiconductor materials and the development of methods to reduce or control these defects can significantly improve the performance metrics of photovoltaic systems. Advanced research in materials science and innovations in nanotechnology are crucial in mitigating the negative effects of these defects on photovoltaic efficiency.

MODELING AND ANALYSIS METHODS

To effectively study and manage the effects of point defects in semiconductors on their photovoltaic properties, various modern modeling and analysis techniques are employed. These methods help in understanding the complex behaviors of defects and devising strategies to mitigate their adverse effects on solar cell performance.

The analysis begins with modeling the crystalline structure of silicon, incorporating vacancy defects into the Hamiltonian. This Hamiltonian expresses the energetic states of electrons and their interactions, which are fundamental for analyzing the effects of defects.

Solving the schrodinger equation. Using Density Functional Theory (DFT), the ground state of electrons is determined by solving the Schrödinger equation through the Kohn-Sham formulation: represents the wave $\left[-\frac{\hbar^2}{2m}\nabla^2 + V_{eff}(r)\right]\psi_i(r) = \epsilon_i\psi_i\,(r)\; here\;\; \psi_i(r)$ function of the electron, ϵ_i denotes its energy level, and V_{eff} is the effective potential.

Determining the Effective Potential

The effective potential, V_{eff}, includes:

- $V_{ext}(r)$: the external potential, typically representing the nuclear potential.
- $V_{Hartree}(r)$: the electrostatic interaction potential.
- $V_{xc}(r)$: the exchange-correlation potential, accounting for the interactions among electrons.

Iterative Solution Process. The Kohn-Sham equations are solved iteratively, updating the electronic structure and energy levels until the system's total energy stabilizes.

Analysis of Results. The results illustrate how vacancies influence the electronic structure of silicon. Changes in the energy bands and modifications in the mobility of electrons and holes are observed, impacting the material's electrical conductivity and overall properties.

Software Applications. For these computations, software packages based on DFT, such as Quantum ESPRESSO or VASP, are utilized. These tools facilitate complex calculations necessary for a thorough analysis.

This detailed examination aids in a deeper understanding of how vacancy defects affect the electronic structure of silicon semiconductors and is crucial for the development of new materials and the enhancement of existing ones.

PRACTICAL SOLUTIONS AND TECHNOLOGIES

Semiconductor materials employ modern technologies and methods to reduce or eliminate defects and to refine material processing. These approaches enhance material efficiency and broaden their applications across various scientific and technological fields.

Technologies and Methods for Reducing or Eliminating Defects. Thermal Annealing: This method involves processing semiconductors at high temperatures to reduce or eliminate defects. Thermal annealing allows for the "healing" of vacant spots in the material's structure and the repositioning of atoms to their original locations, which diminishes the impact of defects.

Ion Implantation and Laser Treatment: These techniques are used to modify the surface of semiconductors and reduce defects. Ion implantation introduces necessary elements into the surface layers of the material, strengthening its structure and improving electronic properties. Laser treatment promotes recrystallization of the material's surface, which helps in reducing defects.

New Approaches to Processing and Optimizing Semiconductor Materials. Innovative Material Handling Techniques: Emerging techniques like nanotechnology and atomic layer deposition (ALD) allow for the high-precision manufacturing of semiconductor materials. These methods ensure quality control and minimize defects.

Recycling and Reprocessing Semiconductor Materials: Recycled semiconductor materials can achieve enhanced properties through techniques such as recrystallization or chemical-mechanical polishing (CMP). These techniques enable the renewal and improvement of the electronic properties of old or defective materials.

Eco-Friendly and Sustainable Technologies: Approaches aimed at making the production and processing of semiconductor materials more environmentally friendly and sustainable are also being developed. These approaches help reduce environmental impact and manage resources more effectively.

With these modern technologies and methods, it is possible to improve the quality of semiconductor materials, reduce defects, and enhance their efficiency. This is crucial not only for photovoltaic systems but also for many other scientific and technological applications.

CONCLUSION

The study, modeling, and control of point defects in semiconductors hold substantial significance in scientific and technological advancements. This field plays a crucial role in enhancing technologies with important scientific and practical applications, such as photovoltaic systems.

Achieved Results and Their Scientific and Technological Significance. Advancements in understanding and mitigating the effects of point defects in semiconductor materials enhance their electronic properties, thereby improving device efficiency. These changes are particularly significant in sectors like solar panels and other photovoltaic systems, where they can substantially increase energy production efficiency. Furthermore, these developments assist in optimizing semiconductor manufacturing processes and contribute to the production of environmentally friendly technologies.
Future Research and Development Prospects. Future research in the field of semiconductor point defects is expected to be deeper and more extensive, incorporating the discovery of new materials and advanced modeling techniques. Fields such as nanotechnology and quantum computing may provide new opportunities for more effective management and minimization of these defects. Additionally, ongoing efforts are expected to further develop recycling and reprocessing technologies for semiconductor materials, making these processes more sustainable and environmentally friendly. Through comprehensive and modern approaches, research in the field of semiconductors not only enriches scientific knowledge but also improves technologies that impact our daily lives. These advancements will be crucial in enhancing the quality of semiconductor materials and expanding their practical applications in the future.

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BASIC PRINCIPLES AND REQUIREMENTS OF DENTAL DISEASE DETECTION SYSTEMS. RESEARCH OF RECOGNITION ALGORITHMS.

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Abstract: Oral diagnosis simply refers to the analysis of the inside of the mouth. Effective treatment of any oral disease is possible only if a correct and accurate diagnosis is made. Oral diagnosis in the field of dentistry involves the examination and detection of all problems inside and outside the oral cavity, as well as finding the relationships between them, using scientific knowledge. Thus, it helps to formulate a final accurate treatment plan based on the findings collected. Effective treatment of any dental problem requires an accurate diagnosis. Diagnosis involves gathering information by collecting analysis and conducting a clinical examination of the patient. This is confirmed by using various diagnostic tools, and more accurate and detailed information is obtained from these diagnostic tools.

Keywords: Diagnosis, internal analysis, Dentistry, effective treatment, treatment plan, Dental diseases.

Introduction

Oral diagnosis simply refers to the analysis of the inside of the mouth. Effective treatment of any oral disease is possible only if a correct and accurate diagnosis is made. Oral diagnosis in the field of dentistry involves the examination and detection of all problems inside and outside the oral cavity, as well as finding the relationships between them, using scientific knowledge. Thus, it helps to formulate a final accurate treatment plan based on the findings collected. Effective treatment of any dental problem requires an accurate diagnosis. Diagnosis involves gathering information by collecting analysis and conducting a clinical examination of the patient. This is confirmed by using various diagnostic tools, and more accurate and detailed information is obtained from these diagnostic tools.

The tools and algorithms used in the diagnosis of dental diseases are developed based on a number of important principles and requirements. These principles and requirements are listed below.

Accuracy and Reliability Accuracy Diagnosis must be accurate. Algorithms must have high accuracy in accurately identifying diseases. Diagnoses must be reproducible and produce the same results under different conditions.Fast Analysis The analysis process must be fast, which is important for doctors and patients. Getting fast results speeds up medical decisions. Efficiency Anlysis algorithms must require few resources and work efficiently. This is especially important in limited environments.Re-learning ability Algorithms must adapt to new information and update themselves. This is important in the learning process.Interface Provide a user-friendly interface. It should be easy to use and understandable for doctors and medical staff.The requirements for dental disease detection tools and algorithms are significant. It is necessary to take into account such principles as high accuracy, speed, efficiency and ease of use. In the process of analyzing recognition algorithms, convolutional neural networks, transfer learning, segmentation and traditional machine learning methods play an important role. These tools and methods increase the efficiency of medical image analysis.

Related works

Object recognition algorithms include the following. Object detection is an important and challenging area of computer vision and has been the subject of extensive research [1]. The goal of object detection is to detect all objects and classify them. It has been widely used in autonomous driving [2], pedestrian detection [3], medical imaging [4], industrial detection [5], robot vision [6], intelligent video surveillance [7], and remote sensing images [8]. In recent years, deep learning methods have been applied to object recognition [9]. Deep learning uses low-level features to form more abstract high-level features and hierarchically represent data to improve object recognition [10]. Compared with traditional recognition algorithms, object recognition methods based on deep learning have better performance in terms of robustness, accuracy, and speed for many classification tasks. YOLO (You Only Look Once) This algorithm allows for fast object detection in real time. Newer versions of the YOLO algorithm (YOLOv3, YOLOv4, YOLOv5) are widely used in the field of computer vision and object detection.

Faster R-CNN (Faster Region-based Convolutional Neural Network): This algorithm is used for object detection and classification. It determines the location and type of the object. Faster R-CNN is one of the widely used algorithms. SSD (Single Shot MultiBox Detector) This algorithm quickly detects an object and determines its location. In the SSD algorithm, object detection and location determination are performed simultaneously.

Mask R-CNN This algorithm is used for object dction and segmentation. Mask R-CNN not only de object, but also detects its contour.

RetNet This algorithm is used for object detection and its location. Unlike other algorithms, RetNet works well in cases where there is a large difference between objects.

Viola-Jones algorithm This algorithm is used to detect faces and other objects. It is designed to run in a short time.The above algorithms are among the most widely used algorithms in the field of computer vision and object recognition. They are used for various tasks, such as object detection, localization, segmentation, and classification.Among the analyzed algorithms, the most effective algorithm for object recognition is the Yolo model.

III. method. YOLO (You Only Look Once) Fast Object Detection Algorithm. Object detection is a computer vision task that involves identifying and locating objects in images or videos. It is an important part of many applications such as surveillance, self-driving cars, or robotics. Object detection algorithms can be divided into two main categories: one-shot detectors and two-shot detectors. Object detection algorithms are divided into two categories based on the number of times the same input image is transmitted over the network.

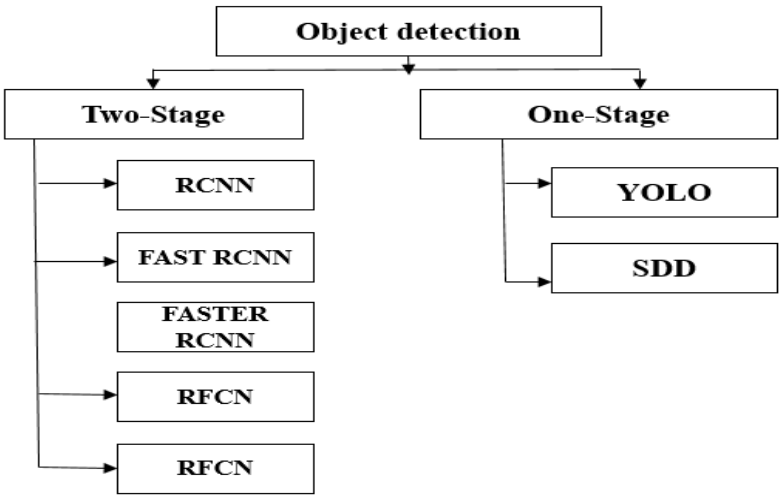

Figure 1. Block diagram of single-stage.

Single-pass object detection uses a single pass of the input image to predict the presence and location of objects in the image. It processes the entire image in a single pass and is efficient in

counting them. However, single-pass object detection is generally less accurate than other methods and is not as effective at detecting small objects. Such algorithms can be used for real-time object detection in resource-constrained environments.[11].

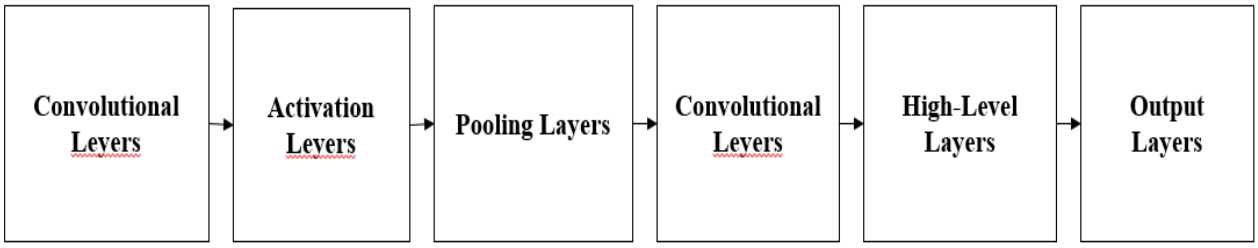

Figure 2. General Yolo architecture.

The YOLO (You Only Look Once) algorithm has developed different versions, each with its own advantages and disadvantages. The YOLO v1 model has the advantages of real-time operation, simple architecture, easy understanding and implementation. It has disadvantages such as errors in detecting small objects and close objects, limited location accuracy, and uncertainty in detecting square lines.

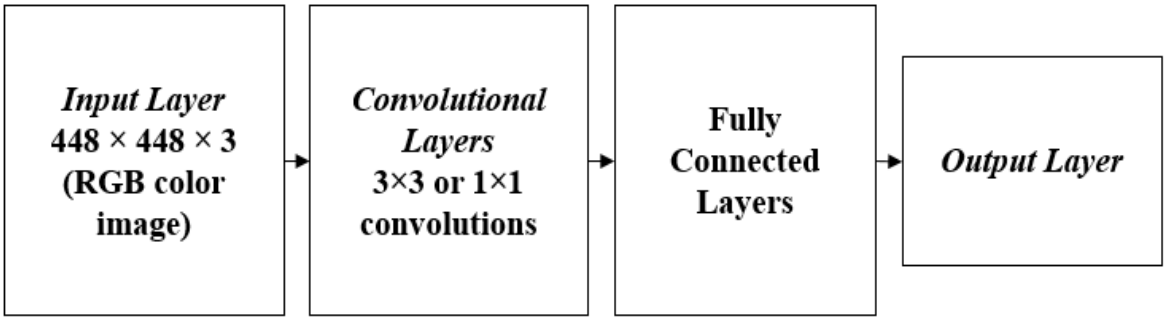

Figure 3. Yolo v1 model architecture.

YOLOv2 (YOLO9000) Improved accuracy Improved accuracy compared to YOLOv1, Multi-scale training, Ability to train on images of different sizes, More objects to learn Can detect more than 9000 objects. Complexity This is a disadvantage of the Yolo v2 model, which has a more complex architecture than YOLOv1.

Feature	YOLOv1	YOLOv2
Number of convolutional layer	24 convolutional layers + 2 Fully Connected layers	19 convolutional layers + 5 MaxPooling layers
Fully Connected Layers	Used to give the coordinates of a bounding box	Fully connected layers removed (for clarity)
Input image size	448 × 448	416 × 416 (for more flexibility)
Bounding Box Generator	The coordinates of the box are directly taught.	Anchor Box concept introduced
Output volume	S × S × (B × 5 + C) (dependent on bounding box)	S × S × (B × (5 + C)) (using anchors)
Activation function	ReLU	Leaky ReLU (works better on deeper networks)
Object types (classes)	There are restrictions on determining the number of objects	The number of classes is increased and flexible

Figure 4. Yolo v1 and Yolov2 model comparison analysis.

The Yolo v2 object detector uses a single-stage object detection network. The Yolo v2 is faster than two-stage deep learning object detectors such as regions with convolutional neural networks (Faster R-CNNs). The Yolo v2 model learns the CNN deeply on the input image to produce network predictions. The object detector decodes the predictions and generates bounding boxes[12]. There are a number of important differences between Yolo v1 and Yolo v2. Below are the layers of each version and their differences.The Yolo v1 model accepts a 448x448 pixel image input in the input layer, while the Yolo v2 model accepts a 416x416 pixel input layer.

The Yolo v1 model consists of 24 convolutional layers in the convolutional layer. The Yolo v2 model uses 19 convolutional layers, 1x1 layers.In the pooling layer, the Yolo v1 model uses traditional max pooling layers. In the Yolo v2 model, the locations of the Pooling layer have been changed.

The output layer of the Yolo v1 model uses a 7X7 grid, with 2 squares in each grid. In the Yolo v2 model, it uses a 13x13 grid, with 5 squares in each grid.The main advantages of the Yolo V2 model over the Yolo v1 model are its improved accuracy and speed.

High detection efficiency Yolo v2 can run on less powerful edge devices, but it also has the disadvantage of not being able to detect small objects.[54] Yolo v3 model performance is improved in detecting objects at long distances, high accuracy in detecting large and small objects, using Darknet-53 architecture, fast and efficient feature extraction, multiple output levels, high accuracy in detecting objects of different sizes. Disadvantages Slightly slower than Yolo v2, resource-intensive, requires more computing power and memory.

There are significant differences between Yolo v3 and older versions in terms of speed, accuracy, and class specificity. Yolo v2 and Yolo v3 differ in terms of accuracy, speed, and network architecture. Yolo v2 was released in 2016, two years before Yolo v3.[13] Advantages of Yolo v4 model Learning speed, faster learning compared to Yolo v3, Accuracy, another step forward, uses several new techniques, balances speed and accuracy, has high accuracy in real time. Disadvantages Complexity, increased complexity due to new layers and techniques added, requires more time to train.

The main differences between the Yolo v3 and Yolo v4 models are in the architecture. The Yolo v3 model uses the Darknet-53 architecture, while the Yolo v4 model uses the CSPDarknet-53 architecture, which improves the efficiency of the model. In the convolutional layer, the Yolo v3 model has 53 convolutional layers, mainly 3x3 and 1x1 layers, while the Yolo v4 model has 24 convolutional layers, but there are CSP and new layers added. The activation functions are the ReLU activation function in the Yolo v3 model, and the Mish activation function in the Yolo v4 model, which improves the learning process. Efficiency High speed in the Yolo v3 model, but poor accuracy, Improved speed and accuracy in the Yolo v4 model, improved to extract more features.

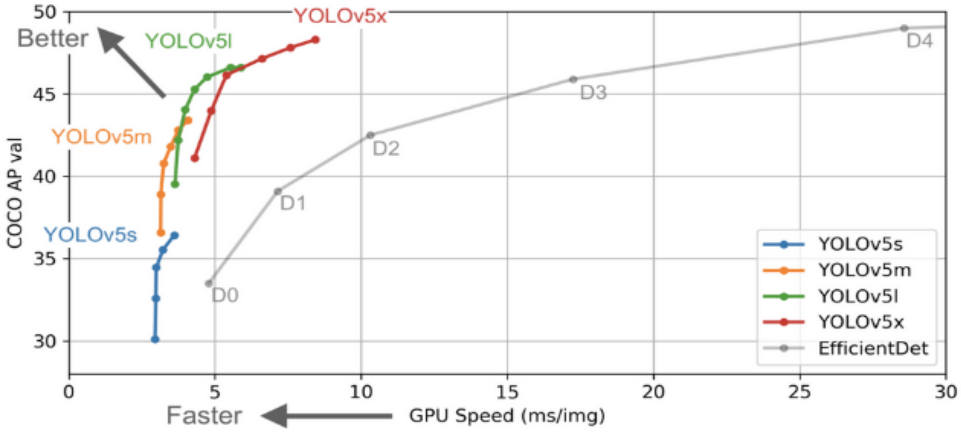

Figure 6. Evaluating object recognition of the Yolo v5 model.

The differences between YOLOv3 and YOLOv4 are evident in the layer structure, architecture, and performance. YOLOv4 offers improved accuracy and speed over YOLOv3 with newly added layers and optimizations, which allows for more efficient object detection. Yolo v4 is a powerful and efficient object detection model that balances speed and accuracy. Yolo v4 can be trained and used by anyone with a simple GPU computer, making it suitable for a wide range of applications [56]. Advantages of the Yolo v5 model: Easy implementation, written in PyTorch and user-friendly, lightweight model, fast performance and low resource requirements, automatic training and optimization, more flexibility in the model learning process, disadvantages: There are some problems with detecting small objects.

The Yolo v5 model can process images several times faster than the EfficientDet Yolo v4 model[14].The Yolo v5 and Yolo v6 models are efficient and fast convolutional neural networks for object detection. Each version has its own layer structure and optimizations. The main differences are listed below.

The main differences are that the Yolo v5 model uses the Darknet architecture in its architecture. The Yolo v6 uses an architecture supplemented with CSP layers and new optimizations. Convolutional layers The Yolo v5 model has 46 convolutional layers, the Yolo v6 model has 35 convolutional layers, but with more efficient designs. In the Pooling and Activation layers, the Yolo v5 model uses Max pooling and average pooling, while the Yolo v6 model uses optimized pooling layers, while the Yolo v5 model is fast, but has errors in detecting some objects.

Yolo v6 model advantages CSP Layer Efficient data transfer and reduce computational burden, RepConv layer More efficient feature extraction through Reparameterized Convolution layer. High accuracy Improved in detecting large and small objects. Speed optimized Architecture, enables fast performance, Efficient Layer Design, layer design for increased speed. Flexibility, Data Augmentation, Strengthen the model in different conditions. Automatic Training, Automatic model selection and training options are available.

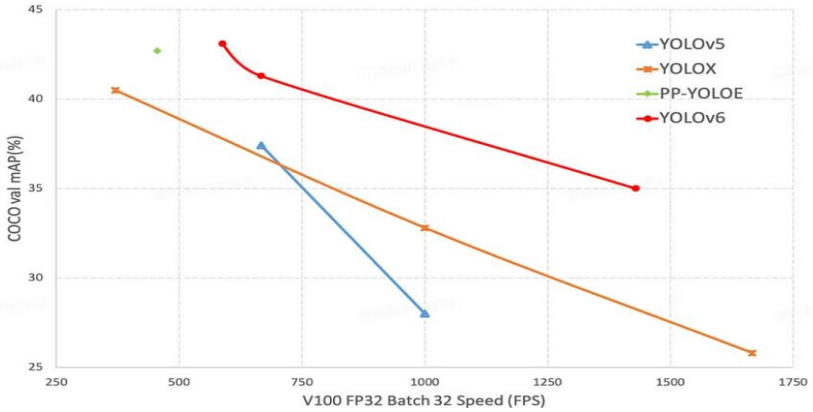

Figure 7. Yolo v6 model performance test.

The Yolo v6 model is an improvement over the previous Yolo v5 model, with a 51% improvement in speed compared to the detectors [15].

The Yolo v7 model operates at high speed, making it ideal for real-time object detection. The model's performance has also been improved. Yolo v7 shows high accuracy in detecting many objects at the same time. This makes the model reliable even in complex scenes, and the model is able to work with high-dimensional images, which increases accuracy. Yolo v7 is easy to adapt to various data sets, which allows it to be used in many different tasks. The model architecture is modular, which can be easily extended and modified, Yolo v7 allows the use of existing models during the training process, which saves time for new tasks, and supports advanced methods using new technologies and algorithms, which increases the overall efficiency of the model.

Comparison of YOLOv7 and YOLOv6 Compared to the previous most accurate YOLOv6 model (56.8% AP), the YOLOv7 real-time model achieves 13.7% higher AP (43.1% AP) on the COCO dataset.

Comparing the lighter Edge model versions on the COCO dataset under the same conditions (V100 GPU, batch=32), YOLOv7-tiny is more than 25% faster, achieving a slightly higher AP (+0.2% AP) than YOLOv6-n.[16].

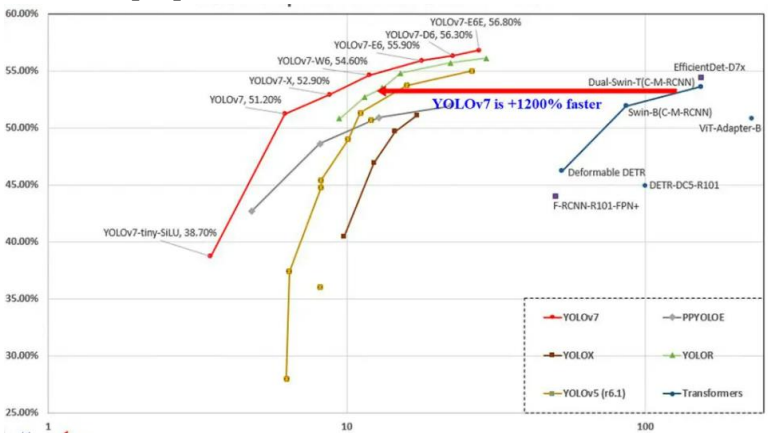

Figure 8. Yolo v8 model performance test.

The Yolo v8 model is the latest version of the YOLO (You Only Look Once) family of models, and offers a number of new features and improvements. With high accuracy, Yolo v8 can detect objects more accurately and quickly, which helps it work efficiently even in complex scenes. This model provides high accuracy while maintaining speed, which is useful for real-time work. The new architecture YOLOv8 is known for its updated architecture, which includes more efficient features and allows for more efficient use of computing resources. The model can be easily adapted to existing datasets, which saves time for new tasks. Yolo v8 has a modular structure, allowing users to modify and optimize the model according to their needs. The model is able to work effectively with high-dimensional images, which increases accuracy. Yolo v8 comes with many new features and capabilities, including expanded support for analyzing new images and videos. This model can be easily integrated into existing systems or applications.

Yolo v9 uses Yolo v7 as the base model and improves upon it. Yolo v9 introduces four important concepts, namely programmable gradient input (PGI), generalized efficient layer aggregation network (GELAN), data blocking principle, and recursive functions. YOLOv9 now has the capabilities of object detection, segmentation, and classification.

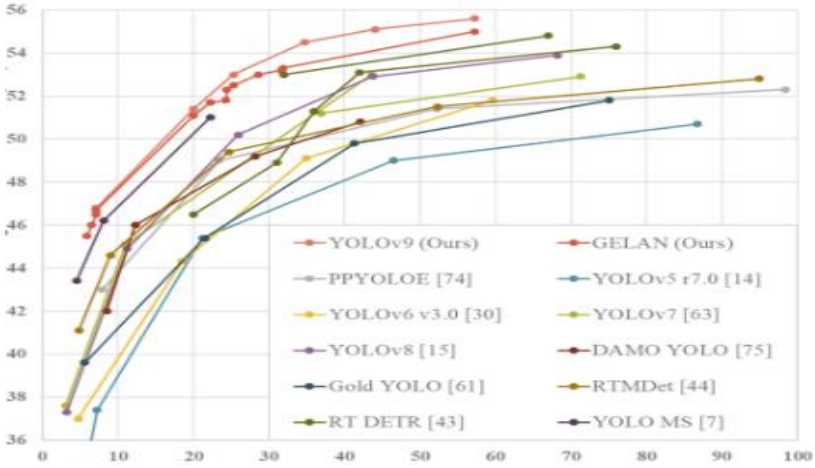

Figure 9. Yolo v9 model performance test.

In general, among the available methods, YOLO MS-S for lightweight models, YOLO MS for medium models, YOLOv7 AF for general models, and YOLOv8-X for large models are the most efficient methods. Compared to YOLO MS for lightweight and medium models, YOLOv9 has about 10% fewer parameters and requires 5-15% fewer computations, but it still shows a 0.4-0.6% improvement in Average Accuracy (AP). Compared to YOLOv7 AF, YOLOv9-C has 42% fewer

parameters and 22% fewer computations, while maintaining the same AP (53%). Finally, compared to YOLOv8-X, YOLOv9-E has 16% fewer parameters, 27% fewer computations, and a significant improvement in AP of 1.7%. In addition, an ImageNet pre-trained model is also included for comparison, and it is based on the parameters and the amount of computation the model takes. RT-DETR showed the best result considering the number of parameters.

Combining PGI and GELAN in the YOLOv9 design shows strong competitiveness. With this combination, YOLOv9 is able to reduce the number of parameters by 49% and the number of calculations by 43% compared to YOLOv8. Despite these reductions, the model still achieved an average accuracy improvement of 0.6% on the MS COCO dataset [17].The computational complexity of the Yolo v9 model increases with increasing data, and the ability of the new model to adapt to different environments and tasks is limited compared to the previous versions. The shortcomings of the Yolo v9 model are that there is room for further improvement of the model.

When experimenting with the Yolo v9 model on the detection of cavities from dental X-ray images, the following results were obtained.

The proposed model algorithm is shown below (Fig-1).

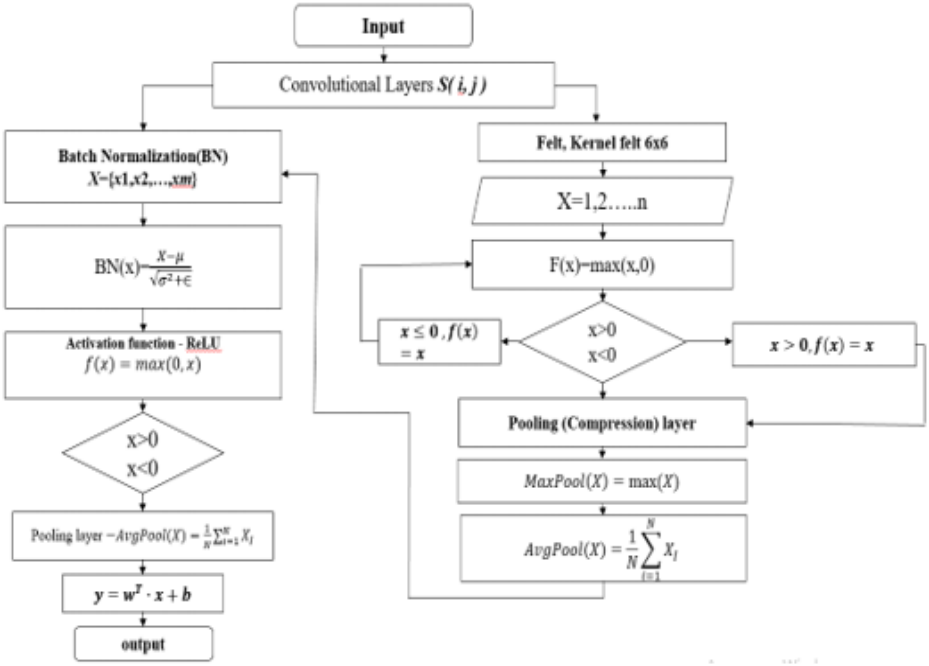

Figure 10. proposed algorithm.

Experimental results. To identify dental diseases from dental X-ray images, a data set of dental X-ray images of healthy teeth, dentures, gums, and pulp disease was formed (Table 1).

Tablet 1. collection of structured data from dental X-ray images to detect dental diseases.

№	train	validation	test
1	137	68	68

The figure below shows the results obtained from the above dataset based on the proposed model. (Figure 10)

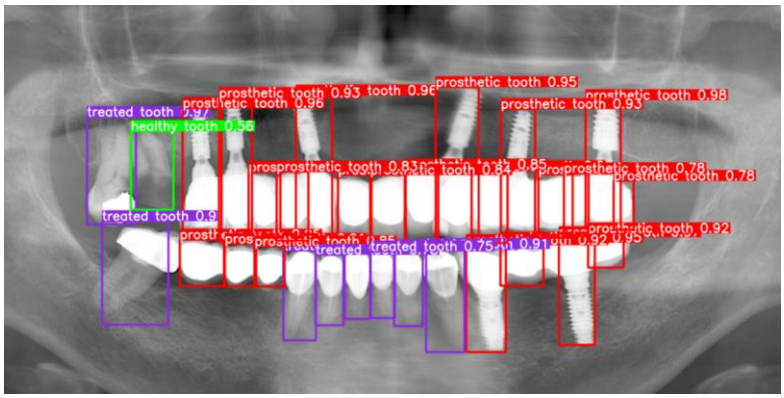

Figure 11. Dental X-ray image diagnosis.

When trained using the above database using the Yolo v9 model, it produced the above result.

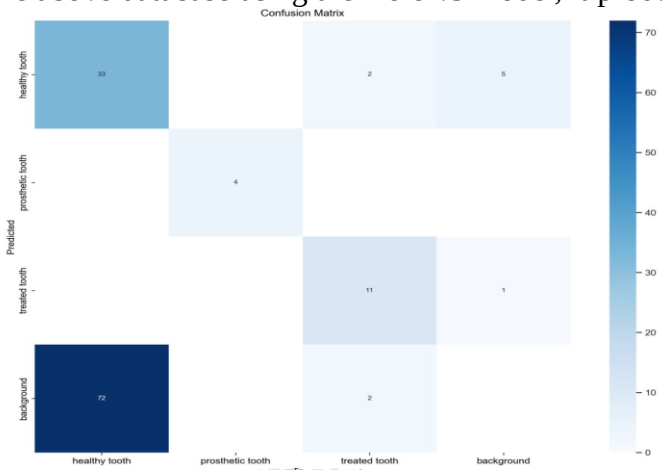

Figure 12. Model performance accuracy.

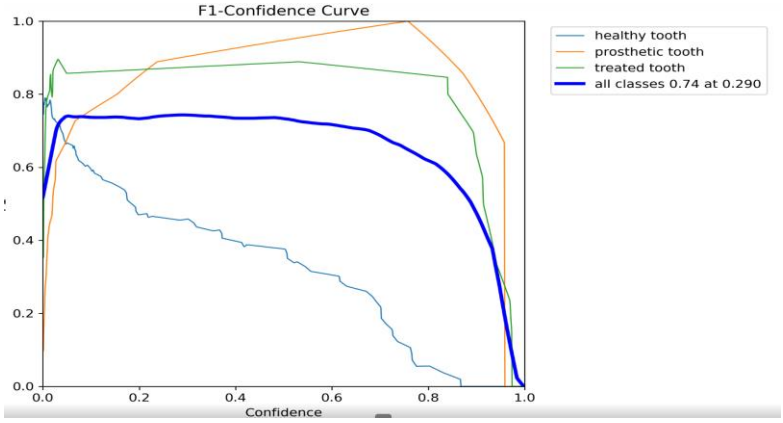

Figure 13. F1 error of the model.

CONCLUSION

Oral diagnosis simply refers to the analysis of the inside of the mouth. Effective treatment of any oral disease is possible only if a correct and accurate diagnosis is made. Oral diagnosis in the field of dentistry involves the examination and detection of all problems inside and outside the oral cavity using scientific knowledge, as well as finding the relationships between them. Thus, it helps to formulate a final accurate treatment plan based on the findings collected. Effective treatment of any dental problem requires an accurate diagnosis. Diagnosis involves gathering information by collecting an analysis and conducting a clinical examination of the patient. This is confirmed by using various diagnostic tools, and more accurate and detailed information is obtained from these diagnostic

tools. The most effective model for detecting dental diseases from X-ray dental images using the algorithms and models analyzed above is the Yolo v9 model, which has much better accuracy than the Yolo v8 model, and its performance speed has also improved significantly.

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HISTORY OF HOUSING IN KARAKALPAKSTAN

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Annotation: *This article discusses the history of the formation of housing construction traditions in the territory of Karakalpakstan from ancient times to the present day, as well as the specifics of the ancient traditions of the people and environmental activities, how severe climatic conditions that distinguish it from other regions affect construction, especially on the traditions of building dwellings.*

Keywords: *Archaeology, architectural monuments, address, geneological, ethnological, massagets, kerege, yurt, archaic period, palace, ayvan, architect, hotel, kalandars, ganch, composition, outer courtyard, utility rooms.*

The settlement of ancient times begins about 40 thousand years ago BC (Upper Paleolithic "Homo sapiens", the era of the intelligent man) from the cave along the southern island. Ancient caves were found in the Ustyurt flat mountain, Sultonuyizdag and Kizilkum. The same goes for people in small caves, in deep-penetrated caves, where they settled in front of the entrance and were engaged in hunting and collecting various objects for Living. They had enough of a canopy (the slope of caves) to protect their burning flames from rain and cold winds themselves.

The first settlement of man in the territory of Karakalpakstan was in the last period of the Paleolithic. In the V-II millennium BC, people lived mainly in the Amudarya network and in the deserts along the Aral and Caspian seas. In the VII-VI centuries BC, the Centers of states began to appear. In the IV century BC, the country of Khorezm arose, separated from the Achomonids Kingdom. On the territory of Karakalpakstan in the form of ruins of castles and mansions, many architectural monuments belonging to this period were preserved. Archaeologist opened and studied by scientists, architects Johnboskala, Kuykirilgankala, Tuprokkala, Berkutgala, Dingilje.Jompikkala, Aybuyrikkala, Kabatkala, Ayozkala, Kirkkiz, Guldursin, Kerder, Mizdaxkan addresses are such monuments of ancient civilization.

237 architectural and historical monuments belonging to antiquity, Middle Ages and New periods were recorded by the researchers. Of these, 147 are archaeological, 25 are architectural and 67 are magnificent monuments. Currently, the t\erritory of Karakalpakstan is divided into 14 districts. Several addresses were found in each district, but more than 50 addresses were found in Ellikkala, more than 10 of them were studied.

According to written historical sources, according to archaeological and ethnographic information, karakalpakas have been characterized by a semi-nomadic way of life from ancient times and mixed farm that combines farming, livestock and fishery. The presence of a herd of cattle and the need for them to feed, as well as the constant flooding and change of tributaries in the lower reaches of Sirdarya and Amudarya, where Karakalpak live, often forced them to change their habitat and move to the army, non-flooded areas.

The type of farm and semi-nomadic way of life together with the main dwelling in the Karakalpakstan - transitions, which differ in the methods of planning, building materials and maintenance, caused the formation of various types of temporary and permanent residence. The characteristics of these habitats are dependent on local natural-economic conditions.

In ancient times, Sak-massagets lived in the slopes of amudarya. The Sak-massagets (distributors of ancient Scythian traditions), along with other nomadic tribes (Oguz and Kipchaks of the Middle Ages), had a light, Collected herbivorous settlement. About this the ancient Greek historian Herodotus (V century BC) and Arab ibn Fadlan (922 y.) those who wrote. Ibn Fadlan in 922 year in Ustyurt, when the kezgan (the current territory of Kazakhstan and Karakalpakstan) is closed by the Oghuz, speaks of domed fireplaces and a similar-shaped burial structure. According to genealogical and ethnological materials, the Oghuz founded the ethnic history of Karakalpak along with the pichenegs (the ancient Turkic tribes that inhabited the east-south of Europe in the VIII-XII centuries).

In folk architecture, various settlements appeared on the slopes of Amudarya, including on the territory of Karakalpakstan, which differ in construction, as well as general composition in each historical period. Including:

1-round. Kaltaminor culture (IV-III millennium BC, Jonboskala). It is a sinewy dwelling in the form of a garland was built of wooden rafters, beams. With a thick layer of Reed over it or with the addition of a stem of shrub vegetation to them is covered.

2-round. Tozabagyab culture (the middle of the II millennium BC). It has one-bedroom and two-bedroom half-basements, a column construction in the upper part. Access to accommodation is provided throughout the pandus. The roof was made of wood, thin stems of reeds and shrubs were used. Over 0,1-0,3 m. in the thickness, the soil is pulled by a curvature.

3-round. Wood from local timber ishlangan "kerege" (I millennium BC), which has elements of woodwork, living - lattice sinch. In the South Aral Sea region in ancient times lived sak-massagets. Sak-massagets ("distributors of ancient Scythian traditions"), along with other nomadic tribes (medieval oghuzs and tributaries), had a light, Collected herbivorous settlement. Plana Bridge (1242 y.) noted that the settlers of the desert "used the yurt in the XIII century" and "transplanted the grass without dividing it into pieces"

4-round. Amirabad culture (VIII - VII centuries BC). Walled houses appeared, in which the number of rooms with different functions increased. Including, the area and height of the living rooms were increased, which contributed to the emergence of strongholds and residential neighborhoods.

Antiquity (VI century BC-V century BC) is divided into the following periods:

1)Archaic period (VI – V centuries BC);

2)Kangyuy period (IV century BC - I century BC);

3)Kushon (II - III centuries of our era);

4) Kushan – afrigid period (III - V centuries of our era).

On the territory of Karakalpakstan, the Centers of civilization were studied: ancient castles, capital cities, urbanistic (a stream that believes that large cities should be built, consisting of large buildings). The mined and well-studied capital cities are Okshakhonqala, Toprakqala, Kuykirilgankala, great Ayubuyikala fortifications, climbing, Ayozkala Guldursin, Yakka-Parson, Mizdakhkon and others are such monuments of ancient civilization. With an area of 40 hectares, Akshakhonkala (III-II Centuries BC) is considered the ancient capital of Khorezm. On the territory of these monuments dozens of residences and neighborhoods were opened, except for the architecture of worship, fortification facilities. At the addresses of Canakkale and Ayozgala, some houses have courtyards, which means their economic activity-livestock. Accommodation includes living rooms, hotel and farm-premises, as well as production rooms . It is observed that in the ayozgala house, a field connecting the yard with a pitcher is used. At the beginning of our era, a field (corridor with a balcony) appeared. The emergence of the field is explained by the severe climatic conditions of the place. The presence of a Dalon helps to keep warm in the winter in the rooms, cool air in the summer, as well as a compact location of the living rooms.

The fortress-cities are divided into two equal parts by the trunk embankment, each of which is divided into neighborhoods. Each house-neighborhood consists of a number of similar rooms with a holistic massive view with small courtyards.

The entrance to the settlement is in the eastern part, which corresponds to natural climatic conditions, as well as the religious beliefs of the religion of Zoroastrianism.

The characteristic features of ancient permanent settlements of the antiquity in the territory of Karakalpakstan can be attributed to the following:

a) an increase in the area and height of the rooms, which contributed to an increase in the number of rooms with different functions in the accommodation. Specially,

1) bedroom Zone; 2) Hotel Zone; 3) kitchen zone;

4) craftsmanship labor Zone; 5) Common Room Zone;

6) library. b) the settlement of the lead type appeared (has an area of 300-3500m2).

C) fireplace, oven, shelves, tashnau - pipe appeared in the interior of the dwelling.

By the first centuries of our era, the number of types of rural settlements increases compared to the previous centuries, which indicates the complexity of the social structure of society. It should be noted, but the existing typology still remains conditional.

From a constructive point of view, it is possible to emphasize the following: domed roofs, the emergence of a wooden-sinched construction, the use of columns as a base for wooden, loy, flat roofs. The foundation, as an erosti construction, has not been used in modern content, on the basis of accommodation. Instead, in the construction of light residences inside the city walls, they used soil levelling and levelling soil on the basis of buildings. Such a method of using saved the building from excessive moisture, the influence of soil salts or horizontal dynamic forces of seismic vibrations.

Ancient samples of settlements of Karakalpakstan

Figure 1. Exterior view of old houses

Figure 2. View of the inner courtyards of old houses

Figure 3. Interior view of old houses

Figure 4. Exterior appearance of old houses

Figure 5. The old city skyline

Figure 6. View of the inner courtyards of old houses

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THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN THE HEALTHCARE SYSTEM AND WAYS TO IMPROVE MANAGEMENT EFFICIENCY

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Abstract: This article examines pressing issues related to improving the efficiency of the healthcare system. The growing population, increasing prevalence of chronic diseases, and rising demand for medical services necessitate the use of faster and more effective ICT tools in healthcare. The study explores the automation of patient data storage in digital systems, the online management of medical services, and the opportunities provided by telemedicine.

Keywords: information and communication, automated system, electronic medical record, digital diagnostics, telemedicine, and remote services.

INTRODUCTION

The modern healthcare system requires ensuring human health, improving service quality, and using resources efficiently. In this process, the role of information and communication technologies (ICT) is steadily increasing. ICT enables healthcare institutions to manage data quickly and accurately, digitize medical services, and analyze information effectively. Improving the efficiency of the healthcare system is one of the most pressing issues today. The growing population, increasing prevalence of chronic diseases, and rising demand for medical services are putting significant pressure on the healthcare system. The use of ICT tools—such as automated patient data storage, online management of medical services, and telemedicine—plays a crucial role in addressing these challenges. The healthcare system today faces daily challenges that require active solutions. The process of digitizing medicine in Uzbekistan, which began decades ago and has now gained high momentum, is a logical response to external influencing factors. It can be said that the optimization of the industry and the process of qualitative transformation have rapidly developed, becoming one of the central priorities in recent years. The impact of the COVID-19 pandemic in recent years and the increasing demand for medical care have significantly accelerated the implementation of modern IT solutions in medical processes. The universal trend of digitalization, the widespread use of gadgets—including in healthcare—, the development and distribution of numerous online applications and services, telemedicine consultations, and artificial intelligence systems are all actively taking place before our eyes. The introduction of innovative technologies in medicine is leading to qualitative changes in the field, ultimately improving treatment processes, enhancing service quality for patients, and significantly influencing healthcare system management.

Medical digitalization involves the implementation and application of IT technologies and digital services across all aspects of the healthcare system, from overall system management to the

practical activities of local doctors. Digitalization encompasses qualitative transformations in medicine, optimizing and automating processes, and ensuring the efficient operation of all sectors in both public and private healthcare segments, thereby increasing overall system efficiency.

LITERATURE REVIEW AND METHODOLOGY

The development of artificial intelligence as a scientific discipline became possible only after the creation of computers, which occurred in the 1940s. At the same time, N. Wiener developed his fundamental works on cybernetics. In 1954, under the leadership of Professor A. A. Lyapunov, the seminar "Automata and Thinking" began its work at Moscow State University. Research conducted in the 1960s and 1970s led to the creation of the first expert system called DENDRAL. Although it was developed for use in organic chemistry, it later served as the foundation for the MYCIN system, one of the earliest and most important applications of artificial intelligence in medicine. The 1980s and 1990s witnessed the spread of microcomputers and the emergence of global networks. Scientists concluded that artificial intelligence systems should be developed for healthcare. Researchers emphasized that such programs should be designed to compensate for the lack of perfect information and be based on the experience of medical professionals. New approaches related to fuzzy set theory, Bayesian networks, and artificial neural networks were developed to reflect the growing need for intelligent computing systems in healthcare. Since 2002, technology has taken a significant leap forward, with both IT giants and entire nations joining programs to integrate artificial intelligence into medicine. Today, scientists hope that artificial intelligence will enable the achievement of precision medicine in the near future, where each patient will receive personalized treatment based on their unique genetic and other characteristics. The medical and technological advancements of the past half-century have made it possible to elevate healthcare to the next level.

Medical Data Management – The use of electronic medical records, digital diagnostics, and automated databases allows for efficient management of patient information.

Telemedicine and Remote Services – These technologies enable remote consultations, diagnostics, and treatment processes.

RESULTS

Improving Management in Medical Institutions. The implementation of planning, resource allocation, and monitoring systems based on ICT enhances management efficiency in healthcare institutions. In the modern world, information technology (IT) plays a crucial role in the development of all sectors, including healthcare. The interaction between specialists and technology is aimed at improving the efficiency of healthcare services, optimizing resources, and accelerating diagnostics. Through the digitalization of medicine, the following objectives are being achieved: Improving the quality of diagnostics and treatment. The computerization of medicine, along with the integration of artificial intelligence, helps doctors make more accurate diagnoses and develop personalized treatment plans based on big data analysis. Optimizing the operations of medical institutions. Automating routine tasks such as maintaining medical histories, prescribing medications, and monitoring treatments allows doctors to dedicate more time to direct patient care. Accelerating scientific research. IT facilitates the rapid collection and analysis of scientific data, speeding up the development of new drugs and therapeutic approaches. Increasing access to medical care. Telemedicine and mobile healthcare technologies enable the delivery of quality medical services even in remote and underprivileged areas.

Enhancing communication between patients and healthcare institutions. Electronic health systems and data-sharing platforms simplify the consultation process and improve interaction between doctors and patients. To substantiate these scientific and theoretical findings, a study was conducted among healthcare professionals. The survey questions were developed using the Google Docs electronic system, and respondents were provided with a link to submit their answers: https://docs.google.com/forms/d/1VVkIwG2kvkxaCCxNDTFCYXRKNbIC1qNfLLxlEP92UCU/edit survey link. The main goal was to assess the awareness of healthcare professionals regarding ICT

tools and the existing applications and systems available to them. As a result, the following findings were obtained:

Question	Answer 1	Answer 2	Answer 3	Answer 4
1.How many years of experience do you have in the healthcare system or how long have you been using it?	1-5 years= 34,4%	More than 11 years = 28.1%	Less than 1 year = 25%	6-10 years=grows in 12.5%
2. Which type of healthcare facility do you work at or use?	Public hospital = 59.4%	Polyclinic = 34.4%	Private clinics= 6,2%	QVP=0
3. To what extent do you think ICT (electronic medical records, telemedicine, artificial intelligence, etc.) has been implemented in the healthcare system?	Moderately = 53.1%	To a small extent = 34.4%	Insufficiently developed = 9.4%	Not implemented at all = 3.1%
4. How effective is the use of ICT in your healthcare facility?	Partially effective = 50%	Highly effective = 28.1%	Slightly effective = 18.8%	Not effective at all = 3.1%
5. Do you use the electronic medical records system?	Sometimes use= 43,8	Yes, I use it all the time = 28.1%	No use=18,8%	Our facility does not have such a system = 9.4%
6. How does ICT usage impact your professional activities?	Increases work efficiency = 81.3%	Complicates work processes = 9.4%	No impact = 9.4%	
7. Do you think electronic queue systems help improve the quality of medical services?	Yes very useful=62,5%	Partially useful=34,4	No benefit at all = 3.1%	I have not used this system = 0%
8. Do you find electronic prescriptions more convenient than traditional paper prescriptions?	Yes, much more convenient = 71.9%	Partial convenient=25%	No, paper prescriptions are better = 3.1%	
9. Do you think ICT helps reduce corruption in the healthcare system?	Yes, significantly reduces it = 68.8%	Partially impacts = 21.9%	No impact at all = 6.2%	On the contrary, it increases the problem = 3.1%

10. What do you think are the main challenges in implementing ICT in the healthcare system? (Multiple choices possible)	Poorly developed ICT infrastructure = 45%	Insufficient knowledge and experience of specialists = 28.6%	Cybersecurity issues = 15.3%	Financial constraints = 11.1%
11. Do you think electronic medical records are adequately protected?	Partially protected = 59.4%	Yes, a secure system exists = 31.3%	No, the data is at risk = 9.3%	
12. Do healthcare professionals need additional training and education on ICT?	Yes, very important = 71.9%	Partially important = 25%	No, there is no need = 3.1%	
13. Which ICT services do you consider most important for development? (Multiple choices possible)	Remote consultations = 44.2%	Electronic medical records = 22.1%	AI-based diagnostics = 18.4%	Mobile health applications = 15.3%
14. Do you think the government is making sufficient efforts to integrate ICT into the healthcare system?	Yes, sufficiently = 37.5%	Partially sufficient = 37.5%	No, not enough = 25%	
15. What suggestions do you have for improving ICT services in the healthcare system?	Ensure proper and timely material support	Pay close attention to the issue	Ensure specialists have adequate knowledge	Develop the most user-friendly applications possible

DISCUSSION

The presented results are recommended for use as a source by researchers as needed. As a result of this scientific study, several pressing issues have been analyzed, and possible solutions have been proposed:

1.Problem: Developing ICT infrastructure requires significant financial investment.

Solution: Promote public-private partnerships – engage IT companies and the private sector to implement innovative solutions.

2.Problem: Collaboration between the private sector and the government is insufficient.

Solution: Gradual modernization of ICT infrastructure – instead of digitizing all hospitals simultaneously, implement the process step by step, starting with key sectors.

3.Problem: The protection of electronic medical data is inadequate.

Solution: Strengthen encryption and data protection systems – use advanced technologies such as blockchain.

4.Problem: There is a shortage of cybersecurity specialists.

Solution: Improve cybersecurity knowledge among employees – organize specialized training for doctors and administrators.

5.Problem: The internet quality in some hospitals is poor.

Solution: Ensure high-speed internet access in all medical institutions – collaborate with mobile operators and internet providers.

6.Problem: There is no unified database between hospitals and polyclinics.

Solution: Create a national electronic healthcare system – establish a common database for all medical institutions. Implement electronic medical records – ensure each patient has a unique digital medical card.

CONCLUSION

The implementation of information and communication technologies (ICT) in the healthcare system enhances the quality of medical services, improves resource efficiency, and optimizes management processes. ICT increases the transparency of healthcare services and provides patients with convenient and fast medical assistance. Information technologies have taken medicine to a new level, as quick access to and exchange of medical data is crucial. Reducing the time needed to find solutions to medical issues is critical, as time is often a decisive factor in saving lives. Thanks to IT, medicine has begun to develop more actively, making not only patient record-keeping more efficient but also simplifying the process of providing first aid and emergency medical care.

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IMPROVING THE ORGANIZATIONAL AND ECONOMIC MECHANISM OF PERSONNEL MANAGEMENT IN INDUSTRIAL ENTERPRISES

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Abstract: In the socio-economic reforms implemented in our country, it is important to effectively manage the personnel of industrial enterprises and to study the factors affecting it. Developing an effective personnel management mechanism, studying the factors affecting it, diversifying the economy, modernizing and technically updating the leading sectors of the industrial sector, especially in the context of a pandemic, all-round support for personnel management is defined as one of the main tasks implemented in the republic. This article analyzes the essence of personnel management and the main directions of its improvement.

Key words: personnel, system, systematicity, organizational-economic mechanism, management principles, personnel management.

INTRODUCTION

The problem of finding ways to improve the company's personnel management strategy is multifaceted and requires a systematic-targeted approach and, in particular, attention to the development of analytical methods of studying competitiveness and organizational-economic methods. It is the only organizational and economic mechanism of personnel management support that combines management, technical and technological measures for the improvement of the enterprise.

In scientific literature, a system is understood as a set of interrelated elements that have common characteristics and are united to achieve a specific goal. Systematics is an approach in which all relationships, elements, functions and management problems are considered as a whole. The selection of systems is based on five main factors, according to which the system: has a common purpose; consists of interconnected elements that make up its internal structure; has an external environment that constitutes its limitations along with internal elements; has certain resources to ensure its operation; under the leadership of the control center ensures its movement towards the intended goal.

LITERATURE REVIEW

The growth of requirements for human resources requires the formation of a system of their development aimed at updating knowledge in accordance with the changes in technology and the content of the labor process. The main goal is to improve the overall potential of the personnel and, first of all, their professional competences in terms of quality. As a result, human resources are brought to a more progressive (higher) level of development.

"Systemicity" means the presence of subsystems, levels, interdependence of various elements of the development process. E. V. Galinskaya, A. A. Ivashchenko, D. A. Novikov defines the personnel development system as "a set of organizational structures, methods, processes and resources necessary for the effective implementation of current and future production tasks and optimal satisfaction of personnel in terms of self-development, professional training and career achievement." As part of this system, they highlight aspects of motivation, professional adaptation, career and training. V. I. Bashmakov, E. V. Tikhonova, A. Yes. In addition to the aspect of

professional development, Kibanov emphasizes the need for social development of the organization's personnel. There is work done on differentiating national, regional, collective and individual levels of development.

Many scientists (A. Ya. Kibanov, A. V. Molodchik, S. V. Parshina, I. A. Khentse, etc.) considered the problem of personnel training as a system. In their works, professional development is described as a complex discrete transformational process of improving the professional activity of personnel aimed at acquiring the competencies necessary for the enterprise.

Other authors say that professional development is the process of preparing personnel to perform other work functions, tasks and solve new production problems.

There are interpretations that determine the development of personnel with the whole complex of organizational and economic activities of the human resource management service.

N. P. Belyatsky, A. P. Egorshina, A. A. Ushakov, L. I. The Menshikovs studied some areas of personnel training. In their works, the need to distinguish between the terms "development" and "training" of personnel is based. Training is considered as an element of personnel development system, along with personnel training and retraining, career planning, adaptation to new professional tasks and functions, etc.

THE MAIN PART

Thus, the organizational-economic mechanism for managing the personnel of the enterprise and, accordingly, the complexes of relevant technical, management and technological measures should be developed based on a system of integrated principles based on goal setting, for this it is appropriate to use the following seven groups of principles.

1. System-level principles: complexity - separate parts of the organizational-economic mechanism of managing employees should be adapted to all functional units of the enterprise; systematicity - the process of development and implementation of the organizational-economic mechanism of personnel management should be based on the methodology of systematic analysis of developing systems; continuity - work on the personnel management strategy should be carried out continuously, changes in the form of jumps in its structural factors should be monitored; optimality - the choice of management should be based on the use of criteria reflecting the principle of optimality arising from the value system adopted in the enterprise; constructiveness - the organizational-economic mechanism should form personnel management strategy and tactics, justify their choice and develop methods of their implementation.

2. Principles of development management: principles of systems development; modeling principles; management decision-making principles; the principle of self-organization; principle of synergy. In order to adequately describe the organizational-economic mechanism of personnel management, it is necessary to use an approach based on self-organization and pay attention to the implementation of the main principles of synergetics as the main theory of self-organization.

3. Strategic principles (concentration of efforts, balance of risks, cooperation).

4. The principle of awareness and adequacy of the participants of the management process.

5. The principle of applying continuous monitoring, which provides continuous monitoring and control over the implementation and dynamics of the life cycle of the enterprise's personnel management process.

6. The principle of continuous monitoring and preparation of alternative management strategies to ensure and support the diversification of enterprise personnel management strategies.

7. The principle of feedback, which allows to adapt the organizational-economic mechanism of personnel management in relation to the changing market environment. Taking this principle into account allows the necessary structural, organizational and resource changes to be made in the enterprise, which may ultimately affect its interests and opportunities.

When developing the organizational-economic mechanism of personnel management, it should be approached as a multidimensional social system. It should be developed as a heterogeneous

mechanism that ensures the interaction of the enterprise with the environment, including market, ecological and social components, through management strategies.

The organizational-economic mechanism developed on the basis of the above systematic principles of enterprise personnel management works effectively in the following cases: optimal combination of centralized and decentralized initiatives; the unity of goals and actions of the entire enterprise and its separate links; a motivation system that creates the interest of all executives to increase the competitiveness of the enterprise; use of modern technological and technical bases of management, which allows to solve the issues of ensuring the competitiveness of the enterprise in real time with minimum resources.

The success of personnel management of the enterprise's organizational-economic mechanism depends on its initial state, its functional and structural structure. The proposed organizational-economic mechanism should work as a program-target management structure acting on the type of project management, i.e. to have the authority to control and ensure its implementation, to have resource support - financial, material-technical and personnel production resources for the implementation of its actions. The organizational-economic mechanism should have such powers that it should allow it to effectively influence the organization of all material and financial flows within the enterprise, to assess the appropriateness of their use from the point of view of competitiveness.

The proposed organizational-economic mechanism includes the following blocks: selection of competitive development strategies; reforming the system of personnel management and labor incentives; increase the quality and competitiveness of products and enterprises, introduce quality management systems and their certification; a systematic approach to production diversification and planning; achieving unity of actions of all links and management processes in the external and internal policy of the enterprise; reorganization of the accounting and analysis system; improvement of marketing direction, strengthening of marketing service; activation of investment and innovation activity, externali.

Each of the blocks, in turn, is considered as a system that contains components that make up a different system. We will consider in detail the main components of each block of the proposed organizational-economic mechanism of personnel management, as well as the rationale and structure of their formation.

1. Selection of competitive development strategies. A correctly selected competitive strategy of enterprise development allows to define more precisely the range of measures that increase the adaptability, dynamism and sensitivity of the economic mechanism to changes based on a strategic analysis of its competitive positions and potential. in market conditions and to increase the scientific, technical and production potential of the enterprise. In the management literature, various classifications of strategies of enterprises, which are most common and proven in practice in the conditions of strong competition, are given. It is the ability to implement broad maneuvering strategies in the conditions of the market economy that is the driving force of business.

M. Porter in his monograph "International Competition" distinguished three strategies that are universal and apply to any competitive force - cost advantage, differentiation and orientation. Describing the concept of competitiveness, he states that companies can have an advantage over their competitors if they have lower costs and product differentiation. According to him, low costs reflect the company's ability to sell goods at a lower price than competitors. When the goods are sold at the same price as the competitors, the company makes a big profit. Differentiation is the ability to provide a unique value to the customer in the form of a product, its consumer characteristics, or after-sales service. Any strategy should focus on competitive advantages. In addition, there is another important factor that determines the competitive position - segmentation. Different market sectors require different strategies and capabilities, so different market sectors have different sources of competitive advantage.

It is this approach that should be the basis for choosing a long-term development strategy for industrial enterprises of Andijan region, in particular: cost minimization during the entire technological cycle of production and its large-scale diversification; creation and production of

products that meet international quality standards, introduction of advanced technologies, expansion of strategic management areas. Taking into account the selected strategy and development goals, the mission of industrial enterprises of Andijan region can be defined as follows: meeting the needs of the domestic and foreign markets as a leading manufacturer of light industrial products due to the effective use of intellectual and technical capabilities; to ensure the sustainable growth of society's well-being on the basis of high professional work.

2. To achieve unity of action of all links and management processes in the external and internal policy of the enterprise. Based on the specific characteristics of light industrial enterprises, management reorganization in them cannot have a single feature and implies the need for a differentiated approach to choosing the directions of structural changes in each of them. However, what they have in common is the need to ensure a systematic approach in the process of serious structural changes in the field of management. Only on this basis, it is possible to implement the unity of actions of all links and management processes in the external and internal policy of the enterprise, that is, to achieve management synergy in the management system and thereby ensure that the enterprise has more influence from the management system. On this basis, it will be possible to concentrate the forces of all personnel, eliminate the shortcomings in the potential capabilities of the strategy and management system, and create the necessary conditions for active entrepreneurial activity.

Taking this into account, the following areas of activity are proposed as components of this block: optimal solution to the problem of property relations reform; introduction of entrepreneurial type of management within the enterprise; radical restructuring of the organizational and economic structure of management; creation of product centers of profit and responsibility for self-sufficient results of activity; providing a comprehensive approach to reorganization of the enterprise management system and structure. It should be noted that the task of reforming property relations is important for achieving management synergy, because the positive effect of privatization can be achieved only when the change of property relations is inextricably linked with the process of creating enterprise management. This includes the decentralization of property relations. management system, increasing the independence and responsibility of structural units, that is, it is achieved when the problem of management is put first, and not the problem of changing the form of ownership.

The experience of local enterprises shows that it is most appropriate to preserve the principles of collective management in the process of privatization, that is, to switch to collective ownership, from the point of view of forming an effective owner. World practice shows that the transfer of enterprises to the ownership of their employees is supported at the state level in many countries, regulated by legislation, encouraged by preferential loans, and, as foreign experts note, is an effective form of private ownership for medium and large enterprises.

Different development strategies require significantly different management systems and structures, the formation of which, in turn, is predetermined by the appropriate organizational style of enterprise behavior. In the management literature, the step-by-step and entrepreneurial methods of organizational behavior are described. The step-by-step method of organizational behavior is aimed at minimizing deviations from traditional behavior both within the organization and in relations with the external environment. Changes are not accepted, they are limited or minimized. The entrepreneurial style requires a different approach to change. Enterprises of this style are in favor of constantly changing the status quo and entrepreneurially seek opportunities for growth through change.

The objective need to transition to an entrepreneurial type of management requires the restructuring of the organizational structure of management. The management structure developed and widespread in domestic light industrial enterprises, built on a functional basis, is not adapted to market conditions, it is focused only on execution, not on creative research. The purpose of the organizational structure is to support the enterprise, to help strengthen the role of management in the implementation of its strategic goals and tasks, to provide opportunities for rapid response to the changing external environment and market conditions.

An organizational and economic mechanism of personnel management is proposed as practical steps for the implementation of this block in the industrial enterprises of Andijan region: in this, the radical reorganization of production management, the development and introduction of a decentralized structure of management within enterprises; establishment of independent production centers specialized on the technological basis for the types of manufactured products; It is intended to turn the production of light industrial products into profit centers that have self-sufficient independence and are responsible for the current results of their activities and the development of the future potential of society.

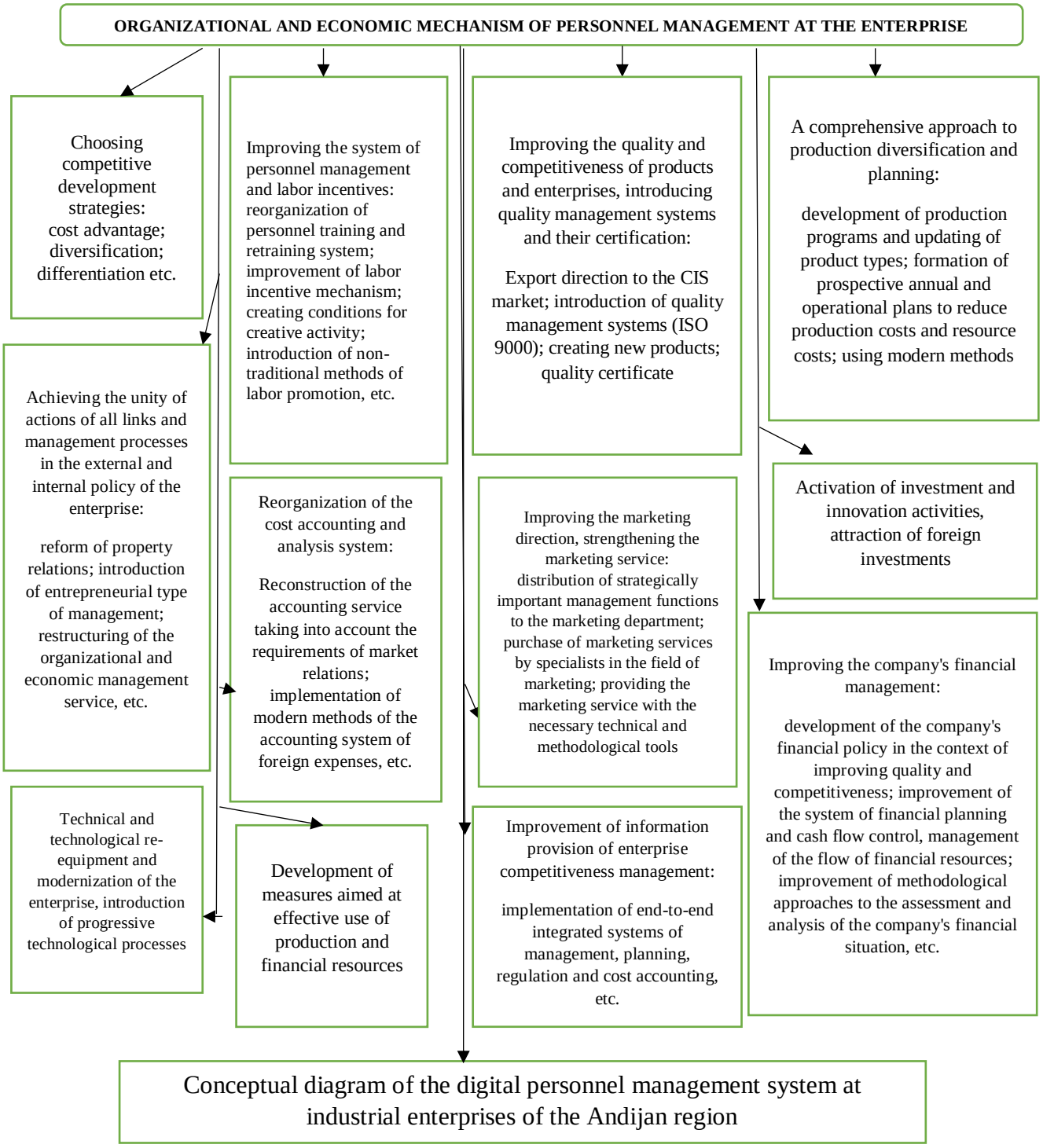

Figure 1. Organizational and economic mechanism of personnel management in the enterprise.

3. Improvement of personnel management and labor promotion system. By introducing the organizational-economic mechanism of personnel management, it is necessary to ensure that the labor team realizes and perceives the need for immediate changes in the management system and activities of the enterprise in the conditions of market relations. In this regard, on the basis of a competitive management strategy, it is necessary to prioritize the task of fundamentally reorganizing the system of personnel management and training in new methods of work. It is necessary to reach the "main mass" who know market relations and are able to work professionally in the consumer market in the key positions and decisive levels of management of the enterprise. Only in this way, it is possible to achieve quality changes based on the improvement of management efficiency and the implementation of the type of entrepreneurial management. Based on this, we propose to form the structure of the organizational-economic mechanism of personnel management of the third block as follows: reorganization of the personnel training and retraining system taking into account management and marketing requirements; improvement of the labor incentive and accountability mechanism to ensure the competitiveness of products and enterprises; pay and incentives.

4. Improving the quality and competitiveness of products and enterprises, introducing quality management systems and their certification. The organizational-economic mechanism of enterprise personnel management should form a fundamentally new strategy for product quality management, which will allow finding priority ways to achieve competitive advantages in trade markets based on an integrated approach to solving this problem.

Strategically important aspects of ensuring the competitiveness of products in the modern environment are as follows: a clear focus on the creation and production of new products that meet the needs of practice and the growing demand of consumers; improvement through the development and introduction of new technical solutions to extend the life cycle of previously acquired products; development of cooperation on mutually beneficial terms with leading enterprises for production of high-quality products and sales in foreign and domestic markets.

Modern market conditions demand the need to adapt the regulatory and technical base to international quality standards for production preparation and product production at all stages of the technological cycle. This is one of the most important factors to maintain the competitiveness of the enterprise at the required level. Solving the problems of increasing product quality and competitiveness should depend on the investment and innovation policy of the enterprise, and should be directed to the selection of priorities for the use of financial resources in the implementation of scientific and research activities. Based on the above, the organizational-economic mechanism of personnel management of this block includes the following components: development of an effective strategy of foreign economic activity, export to the CIS market; development and implementation of an integrated product quality management system (ISO 9000); certification of compliance of all production with the requirements of European and international quality standards; creation and development of fundamentally new competitive products; ensuring the continuity of the life cycle of previously acquired product types; development of cooperation with leading enterprises for the production of high-quality products on a mutually beneficial basis; certification of compliance of all production and product quality with the requirements of ISO 9000 international standards. The next three blocks - reorganization of the accounting and analysis system, improvement of financial management, diversification and a systematic approach to production planning determine the efficiency of economic security of the organizational-economic mechanism of personnel management.

5. An integrated approach to diversification and production planning. The structural structure of this block separates specific areas of activity of the economic and other departments of the enterprise, which help to solve the problems of increasing the competitive advantages of the total enterprise and actively promoting the export of manufactured products to the CIS market. Among them, a systematic approach to diversification of production, taking into account constantly changing market conditions: creation of production programs and updating of product types; formation of

prospective, annual and operational plans for reducing the cost of products, spending money, material, fuel and energy and labor resources; active use of business planning, cost accounting, functional cost analysis and other tools of modern methods of improving planning and analytical work, which contribute to solving the problems of increasing the competitiveness of the enterprise and ensuring its harmless and stable operation in economic practice.

The effective operation of the management system is largely determined by the effectiveness of its organizational support. This fact requires the development of targeted programs for the implementation of a set of organizational-economic and technical and technological measures that ensure the achievement of the planned indicators of cost reduction and product cost reduction as important criteria of the enterprise's successful operation; improving the technical level and consumer characteristics of products; increase production and sales volume; profit; receiving funds and others. It is proposed to prepare target programs for the enterprise in the form of program orders, in which the planned target indicators and the responsibility of services for their fulfillment are determined. The development of such programs should be a step-by-step iterative process, each of which further expands program positions and defines planned goals with a defined control system and accountability for their implementation.

6. Reorganization of accounting and cost analysis system. The structure of this unit of the organizational-economic mechanism of personnel management is predetermined by the following objective need to improve the accounting policy of the enterprise in changed economic conditions: timely fulfillment of obligations to the state budget; with the growing need to quickly provide enterprise management and departments with complete and reliable information for making quality decisions; with the need to reorganize the scheme of accounting work due to a comprehensive approach to the integration of accounting, management and tax accounting.

7. Improvement of financial management of the enterprise. The main tasks of the financial management system are as follows: ensuring the financial stability of the enterprise in a competitive environment; rapid assessment of the risks and benefits of various methods of investing funds to increase the competitive advantages of products; making strategic decisions on the choice of funding sources that ensure effective financial and economic activity of the enterprise; strengthening export potential.

The expanded components of the organizational-economic mechanism of personnel 8. Activation of investment and innovative activities, attraction of foreign investments.

In modern market conditions, without implementing this block of personnel management, it is impossible to solve the problems of large-scale diversification of production, technical and technological re-equipment and modernization of the enterprise, introduction of advanced technological processes, technical and technological re-equipment and modernization of production. This situation requires the following in relation to this block of the organizational-economic mechanism of personnel management: development of the enterprise's investment and innovation policy; formation and selection of priorities for the use of financial resources of the enterprise for the implementation of scientific research and experimental design works; activation of domestic investments in production development and attraction of foreign investments.

9. Improving the provision of information to the management of enterprise personnel. The implementation of the strategy of ensuring the competitiveness of the enterprise requires fundamental changes related to the introduction of information technologies.

In relation to the conditions of industrial enterprises of Andijan region, the organizational-economic mechanism of personnel management of this block consists of the following components: development of the final integrated management system for solving management, design and production problems; creation of a unified integrated system of planning, regulation and cost accounting; development of a unified information model of accounting, management and tax accounting; Development of an automated system of "Expense Management"; Creation of "Quick Marketing" and "Financial Management" information systems; development of a digital system of product quality management; introduction of advanced information technologies and modern means

of communication; creation of automated jobs in engineering and economic services at the enterprise and its production units; technical provision of information provision of personnel management within the enterprise.

10. Technical and technological re-equipment and modernization of the enterprise, introduction of advanced technological processes.

It is impossible to introduce quality management systems and produce competitive products without solving the problems of technical and technological re-equipment and modernization of the enterprise, without introducing new progressive technological processes. Solving such problems for the industrial enterprises of Andijan region is more urgent than ever, explained by the following fact - more than 50% of the equipment and machines available in the enterprise have a service life of more than 5 years, and their own funds allocated for the development of production are not a priority. In such a situation, it is recommended that this block of personnel management consists of the following components: development of a comprehensive plan for step-by-step technical and technological re-equipment of production; activation of domestic investment and attraction of foreign investment to solve this problem.

11. Development of measures aimed at effective use of production and financial resources. Currently, reduction of production costs and effective use of production and financial resources of the enterprise is a strategic direction of development of industrial enterprises of Andijan region. It is recommended that the main elements of this management block include: the formation of plans to reduce the cost of production and reduce the costs of production funds, while increasing the responsibility of enterprise services; implementation of the system of planning, standardization and cost accounting of the entire production cycle; introduction of product quality management system and others.

CONCLUSIONS AND SUGGESTIONS

Thus, the main block scheme of the above-mentioned organizational-economic mechanism for supporting the management of the personnel of the enterprise and the set of complex actions implemented in some industrial enterprises of the Andijan region allow: reconstruction of the entire management system; mobilizing internal resources of the enterprise; formation of a constant desire to increase competitiveness in structural units; increase the competitiveness of the enterprise and strengthen its position in the market. Of course, given the complexity and multifacetedness of the problem of enterprise competitiveness, this scheme does not reflect in high detail all the organizational, economic and other ways to solve this problem. However, the experience of industrial enterprises of Andijan region shows that such a structure allows for a systematic and purposeful search for methods of interconnecting all components of organizational and economic support to the management of the enterprise in order to concentrate efforts and control the factors that determine the potential. In this way, it is able to increase the competitiveness and stability of the enterprise in the market.

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GUARANTEES OF LABOR RIGHTS IN UZBEKISTAN AS ONE OF THE PRINCIPLES OF DECENT WORK

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Abstract. The article examines the main guarantees of labor rights in Uzbekistan as one of the key principles of decent work. The legislative framework is analyzed, including the Constitution, the Labor Code of the Republic of Uzbekistan, ratified conventions of the International Labor Organization and other regulatory legal acts. Particular attention is paid to mechanisms for ensuring the right to work, employment, fair wages, safe working conditions and social protection. The role of trade unions and social dialogue in achieving decent work is also considered. The conclusion notes the prospects for improving labor legislation and strengthening control over its observance.

Keywords: decent work, labor rights, employment, social protection, trade unions, working conditions, wages.

INTRODUCTION

Decent work is one of the key elements of social and economic development of society. In Uzbekistan, the protection of labor rights plays an important role in state policy aimed at ensuring fair working conditions, social protection and legal stability of workers. The main guarantees of labor rights are legislative regulation, the right to safe working conditions, fair pay and social dialogue.

In 1999, the International Labour Organization developed the Decent Work Concept, which is based on such strategic goals as the implementation of international norms and principles in the sphere of labor, expanding the scope of protection of the rights and interests of workers, improving social and labor relations between government agencies, employers and workers, and strengthening social dialogue in resolving socio-economic issues.

The task of forming a set of prerequisites, providing for workers decent working conditions, became relevant at the stage of formation of a developed industrial society. Specialization, division and cooperation of labor required, along with high labor discipline, the creation of developed systems of social security and insurance. The most important postulates of the labor ethics of industrial society are: meaningful labor, skilled and hardworking employee, responsible employer.

Similar installations contain Concept worthy labor, developed International Labor Organization. The implementation of its provisions allows for a wide range of needs to be met worker and his families with positions of expanded reproduction workforce and high quality of working life:

- process labor must pass in a safe and healthy working environment;
- conditions labor should be compatible with prosperity and human dignity of workers;
- work should open up real opportunities for a person self-development of the individual and service to society.

According to the Concept, the following characteristics of decent work are identified:

- productive activity or productive work capable of ensuring competitiveness countries;
- fair income for workers;
- safety on working place;
- social protection (from unemployment, in case of pregnancy, need to care for a child, pension provision);

— Prospects personal growth;

— active participation in making important management decisions (through trade unions and business associations);

— equal starting positions and opportunities for both sexes.

Is thus a multifaceted concept. It encompasses occupational safety and health, income security and access to social services. services, proper income V old age and in case of illness, as well as the right to organize and defend one's rights, the right to be free from violence and oppression.

Based on the analysis of the existing statistical base in the regional context, a set of specific criteria characterizing decent work was identified, five blocks were identified and within their framework, the most suitable indicators reflecting the level of decent work. In particular:

- *employment and unemployment;*
- *wages;*
- *qualifications and education;*
- *labor safety;*
- macroeconomic indicators of decent work.

Based on these indicators, it was proposed to calculate an integral index of decent work, reflecting the most important components of decent work.

The selection for the integrated assessment of the level of decent work at the regional level was based on the following principles:

— selection from standard indicators of state statistics;

— maximum reliability of statistical information;

— the ability of the indicator to reflect territorial differences and dynamics of the component of decent work under consideration;

— minimizing the number of indicators by selecting the most adequate of all indicators for a specific component.

However, it should be noted that the chosen methodology of quality of life in terms of decent work requires a wider list of industries and more reliable statistical information.

The Sustainable Development Goals (SDGs) were developed by the UN General Assembly in 2015. They consist of 17 interrelated goals as a "blueprint to achieve a better and more sustainable future for all." These goals were called the "2030 Agenda" in the General Assembly resolution.

The Sustainable Development Goals are a call to action for all countries – poor, rich and middle-income. They aim to improve well-being and protect our planet. States recognize that measures to eliminate poverty must be taken in parallel with efforts to increase economic growth and address a range of issues in the areas of education, health, social protection and employment, as well as combating climate change and protecting the environment.

In the Republic of Uzbekistan, over the past 20 years, special attention has been paid to ensuring decent work. Thus, in particular, on May 27, 2022, an international round table was held in the Senate of the Oliy Majlis dedicated to the discussion of the roadmap of the Country Program for Decent Work in the Republic of Uzbekistan for 2021-2025. The event was organized by the National Commission for Combating Trafficking in Persons and Forced Labor jointly with the International Labor Organization. It is worth noting that Uzbekistan, as a member of the International Labor Organization, fully and firmly fulfills its international obligations, carries out consistent cooperation with the organization for the development of labor relations. At this meeting, it was noted that in recent years, cooperation between Uzbekistan and the ILO has reached a completely new level, a number of projects and programs have been implemented to improve labor relations and widely promote the principles of decent work, due to which the system of labor relations has been radically improved, international standards have been introduced into the sphere, and the protection of citizens' rights in the labor sphere is consistently ensured. A systematic and comprehensive approach to work aimed at improving labor relations in Uzbekistan and eliminating existing problems in this area receives full support and international recognition from the international community, in particular the

International Labor Organization. It was noted that the first major program with the International Labor Organization is the Decent Work Program in Uzbekistan for 2014-2016 and subsequently extended until 2020. The program has been fully implemented and has made a worthy contribution to improving work in this area.

The participants of the round table expressed their opinion on the new Country Program for Decent Work in Uzbekistan for 2021-2025, adopted in September 2021 in order to further improve decent working conditions and implement new projects.

The work carried out jointly with the International Labour Organization to create decent working conditions is becoming the main factor in the development of labor relations in the new Uzbekistan.

In 2022, at the 5th Global Conference on the Elimination of Child Labor, which was held in Durban, South Africa, where the Director-General of the International Labor Organization (ILO) Guy Ryder noted: "Some may say that child labor is an inevitable consequence of poverty and that we should put up with it. But this is not true. We have no right to put up with child labor. And we should not. Of course, addressing the root causes - such as family poverty - is of paramount importance. But make no mistake: child labor is a violation of one of the fundamental human rights, and our goal must be to ensure that no child anywhere on the planet is subjected to it. We must not rest until this becomes a reality." At the same time, the participants highly appreciated the work to combat human trafficking and forced labor in Uzbekistan and emphasized that the results achieved in this area are important for the implementation of the principles of decent work in the country, ensuring employment of the population, and the experience of Uzbekistan should become an example for other countries.

The legal framework for decent work according to the International Labour Organization (ILO) is based on four key principles: employment, social protection, workers' rights and social dialogue. The ILO develops and implements international conventions and recommendations aimed at ensuring decent working conditions throughout the world. Uzbekistan has ratified more than 20 ILO conventions, including Convention No. 87 on Freedom of Association and Protection of the Right to Organise, Convention No. 98 on the Right to Organise and Collective Bargaining and Convention No. 100 on Equal Pay. These international standards serve as the basis for national legislation regulating labour relations and guarantees of workers' rights.

In the context of economic transformation, effective employment, the creation of favorable conditions for workers, and appropriate and timely payment for their work form the basis of decent work, which is one of the main factors for stable growth and development, compliance with the principles of social justice, and the harmonious provision of interests in society.

In the Republic, as a whole, a legislative framework has been formed aimed at solving the problems raised. It should be noted that national legislation, first of all, relies on the Constitution of the country, as the main guarantor of further ensuring social justice, legality and welfare of man and society.

Articles 42-45 of the updated Constitution define the basic principles of state policy in the area of decent work and employment. They are expressed in the legislative consolidation and guarantee of human rights to free choice of work, state assistance in ensuring employment, providing social guarantees in the area of employment, protecting the population, especially young people, from unemployment. The most important priority of legal policy in this area is also the support and encouragement of labor and entrepreneurial initiative of people, assistance in the development of their abilities for productive and creative work, ensuring decent working and living conditions. The right of citizens to free choice of profession and type of activity, favorable working conditions that meet safety and hygiene requirements, fair remuneration for work without any discrimination and not lower than the established minimum wage is now regulated at the Constitutional level. It is prohibited to refuse to hire women, dismiss them from work and reduce their wages for reasons related to pregnancy or the presence of a child (Article 42). Forced labor, any form of child labor that poses a threat to the health, safety, morality, mental and physical development of a child, including preventing him from receiving an education, is prohibited (Article 44). Everyone has the right to rest, which is

guaranteed by limiting the duration of working hours, mandatory establishment of days off and non-working holidays, paid annual labor leave (Article 45), as well as social security, including during unemployment. At the same time, the amounts of social assistance established by law cannot be lower than the officially established minimum consumer expenditures (Article 46).

Legal regulation of labor relations in Uzbekistan is also carried out on the basis of the Labor Code of the Republic of Uzbekistan, which entered into force in 2022 and includes modern principles of labor law that comply with international standards. The Labor Code regulates the conclusion, modification and termination of an employment contract, establishes standards for labor protection, working hours, remuneration, as well as the procedure for resolving labor disputes. For example, Article 153 of the Labor Code defines the minimum wage, which is indexed annually by the state. Also, in accordance with Article 215, employees have the right to safe working conditions, and employers are obliged to ensure that workplaces comply with labor protection requirements. Additionally, as part of the social protection of workers, the Law "On Employment of the Population" provides for mechanisms of state support for temporarily unemployed citizens, including benefits and retraining programs, as well as international standards ratified by the country. In 2022, the country adopted a new Labor Code that complies with modern standards and requirements of international law.

The state takes measures to ensure employment of the population. The main guarantees include:

- equal access to employment without discrimination;
- government programs for job creation;
- promoting employment of vulnerable groups of the population (youth, women, persons with disabilities);
- development of professional education and retraining of personnel.

An important initiative is the Youth Book program, aimed at supporting the employment of young professionals.

In Uzbekistan, the state is actively developing and implementing measures aimed at ensuring employment of the population. The main directions of state policy in ensuring employment of the population are:

1) Job creation programs:
- a government program to promote employment that provides for the creation of new jobs, especially in rural areas;
- support for small and medium-sized businesses through preferential lending and tax breaks.

2) Development of professional education and retraining:
- vocational training centres where citizens can gain new skills and improve their qualifications;
- internship and practice programs for young people and university graduates.

3) Support for vulnerable groups:
- employment quotas for persons with disabilities;
- special programs for women, mothers with many children and people of pre-retirement age.

4) Promoting self-employment and entrepreneurship:
- government subsidies and grants for small business development;
- training courses for aspiring entrepreneurs.

5) Development of the labor migration system:
- state programs for legal employment of citizens abroad;
- Providing social guarantees for labor migrants.

Occupational safety and health are the most important aspects of worker protection. The country has regulations that ensure:

- ✓ state control over compliance with labor protection;

- ✓ the employer's obligation to provide safe working conditions;
- ✓ the right of workers to refuse to perform work if their health is at risk;
- ✓ compensation payments in case of accidents at work.

The State Labor Inspectorate regularly conducts inspections and develops measures to improve working conditions.

As a result of large-scale work carried out in Uzbekistan to implement the Decent Work Concept, the right to work, work in fair conditions, and free choice of profession of each citizen is fully ensured. In accordance with the republican and regional programs for ensuring employment of the population and supporting entrepreneurship, about one million new jobs are created annually. Based on the decrees of the President of the Republic, the amount of wages, scholarships, and pensions is increased.

The social protection system is being consistently improved and its targeting is ensured. Uzbekistan has introduced a robust system of state and public control in the labor sphere, and an effective social dialogue has been established to comply with the principles of decent work between the state, trade unions and employers. The country does not have such problems as child labor, discrimination in labor relations, growing income inequality, and unmanageability of the labor market.

Social protection includes guarantees in the field of insurance, pensions and payments in case of loss of ability to work. The main elements of social protection are:

- ➢ pension provision (funded and solidarity systems);
- ➢ state health insurance;
- ➢ temporary disability benefits;
- ➢ support for the unemployed through a system of benefits and retraining courses.

These measures are aimed at protecting workers in difficult life situations and ensuring a stable standard of living.

Social dialogue between the state, employers and trade unions plays a key role in ensuring decent work. The following are functioning in Uzbekistan:

- ✓ National Labor Council;
- ✓ industry and regional trade union associations;
- ✓ collective agreements between employers and employees.

The development of collective agreements helps resolve labor disputes and improve working conditions.

Trade unions play an important role in protecting workers' rights and achieving the legal basis for decent work in Uzbekistan. The Federation of Trade Unions of Uzbekistan is the largest unifying structure representing the interests of workers in the country. It actively participates in the development of labor legislation, monitoring its implementation and conducting collective negotiations with employers.

An example of the effective work of trade unions is their participation in the revision of the Labor Code of 2022, which took into account proposals to protect workers from unjustified dismissals and to strengthen labor protection standards. Trade unions also actively interact with international organizations, such as the International Labor Organization, which contributes to the implementation of global standards in the field of labor relations.

The country's trade unions are given broad opportunities to exercise public control over compliance with labor legislation, protect workers' rights, and fulfill their responsibilities in the area of collective bargaining.

In particular, in accordance with the strategy of the Decent Work Concept, trade unions of Uzbekistan ensure legal protection of workers and prompt resolution of their requests.

In order to expand the scale of free legal assistance to citizens and promote national and international standards in the social and labor sphere among the general public, the activities of a legal clinic at the Federation of Trade Unions of Uzbekistan have been established.

Based on the provisions of the ILO Decent Work Concept, trade unions of Uzbekistan exercise public control over the hiring of socially vulnerable persons for quota jobs, provide assistance in organizing labor fairs for temporarily unemployed citizens, and implement benefits and guarantees provided for in collective agreements for citizens engaged in home-based work. Issues of assistance in improving the skills of workers and ensuring their full employment are also priority areas of trade union activity.

Trade unions actively participate in the implementation of state youth policy and promote employment for university and college graduates, and also carry out systematic work to improve the knowledge of graduates in the field of social and labor relations.

Thus, labor rights guarantee in Uzbekistan cover a wide range of aspects aimed at ensuring decent work. The country's legislation ensures the protection of workers, new social protection mechanisms are being created, and social dialogue is being strengthened. However, for further development, it is necessary to strengthen control over compliance with labor standards, introduce modern labor safety standards, and expand employment support programs. In general, Uzbekistan continues to improve the labor rights system taking into account international standards and national interests.

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GREEN FINANCE: WAYS TO ATTRACT SUSTAINABLE INVESTMENTS

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Abstract - *Green finance is a crucial tool for ensuring sustainable economic growth and environmental stability. This article analyzes green financing instruments, including green bonds, the role of green banks, and the significance of ESG (Environmental, Social, and Governance) investments. The study identifies effective methods for attracting sustainable investments and discusses global experiences in green finance.*

Keywords: *green finance, green bonds, green banks, ESG investments, sustainable economy.*

INTRODUCTION

In recent years, climate change, environmental issues, and the depletion of natural resources have necessitated new approaches in economic systems. Developing an economy based on the principles of sustainable development requires the integration of green finance, which not only supports environmental protection and social stability but also fosters economic growth through innovative financial mechanisms.

Green finance is a financial system aimed at funding environmentally sustainable projects. It operates through the following mechanisms:

Green bonds – bonds specifically issued for financing environmental projects.

Green banks – specialized financial institutions supporting green projects and businesses.

ESG investments – investment strategies based on environmental, social, and governance principles.

International financial institutions, such as the World Bank and the International Monetary Fund (IMF), are actively implementing extensive programs to promote green finance. The European Union's Green Deal aims to allocate over €1 trillion by 2030 to support green economic development. Uzbekistan has also adopted a Green Economy Strategy, focusing on renewable energy development, efficient water resource management, and the promotion of eco-entrepreneurship. In 2021, the country launched initiatives to develop a green bond market and attract international investments in sustainable projects.[1]

Research on sustainable finance indicates that green bonds and green banks play a vital role in directing investment flows toward climate-friendly projects. ESG investments, in turn, provide additional financial opportunities for companies aligning with corporate sustainability principles. However, the development of the green finance market requires a strong legal and institutional infrastructure.

METHODS

Theoretical Analysis – This stage involves studying economic theories and models related to employment and unemployment. It examines the main factors influencing labor market dynamics and the relationship between employment and economic growth.

Assessment of the Current Labor Market Situation – This stage analyzes statistical data on employment and unemployment rates, identifying key trends and challenges in the labor market.

Examination of Government Policies – This stage reviews state programs and policies aimed at increasing employment and reducing unemployment. The effectiveness of these policies is evaluated based on their impact on the labor market.

RESULTS

This research is expected to yield the following **results**:

1. Impact of Green Financing on the Economy – The positive effects of green financing mechanisms on economic growth, employment levels, and the investment climate will be examined in greater detail.

2. Factors for Attracting Green Investments – The most effective financial instruments for attracting sustainable investments (green bonds, environmental loans, subsidies) will be identified and evaluated.

3. International Experience and the Formation of a National Model – Successful global practices will be analyzed, and a green financing model tailored to Uzbekistan's conditions will be proposed.

DISCUSSION

Globally, different countries adopt diverse strategies for green finance. Some emphasize green bond issuance, while others focus on green banks, tax incentives, or state subsidies.

- European Union: A Leader in Green Finance Policy Green Deal – Aiming for carbon neutrality by 2050.

Largest green bond market – Over 50% of global green bonds were issued in Europe in 2023.

Taxonomy system – Establishing regulatory standards for green projects.

Examples:

France: Issued €7 billion in sovereign green bonds in 2017 to finance sustainable projects. [1]

Germany: Issued €6.5 billion in green bonds in 2020 to support renewable energy and infrastructure.

- United States: Market-Driven Green Finance

Private sector leadership – Green investments are primarily driven by corporations.

Developed green banking system – Example: Connecticut Green Bank (established in 2011).

Inflation Reduction Act (2022) – Allocating $370 billion for green projects.

Examples:

Tesla – Investing in renewable energy and electric vehicles.

New York Green Bank – Mobilized over $1 billion in green investments since 2014.

- China: The World's Largest Green Bond Market

$100 billion in green bonds issued in 2023.

State-controlled green finance system – The People's Bank of China promotes green lending.

Carbon market and Emission Trading System (ETS) – The world's largest carbon quota trading system.

Examples:

Industrial and Commercial Bank of China (ICBC) – Prioritizing green project financing.

Shenzhen ETS – A leading global carbon credit trading platform.

Green banks support sustainable development by financing environmental projects. Their key objectives include:

- Combating climate change.
- Supporting ecological innovations and green technologies.
- Ensuring sustainable economic growth.
- Providing long-term and affordable financing for green projects.

Functions of Green Banks:

Funding projects in solar, wind, and bioenergy.

Supporting waste recycling and carbon reduction programs.

Issuing green bonds to attract investors.

ESG investments are based on:

- Environmental factors (E) – Carbon footprint, renewable energy, waste management.
- Social factors (S) – Employee rights, diversity, and human rights.
- Governance factors (G) – Transparency, anti-corruption policies, shareholder rights.

Advantages of ESG Investments:

Lower risk and long-term profitability.

Increased investor confidence in sustainable companies.

Government and international organization support.

ESG Market Trends:

$40 trillion in ESG investments globally by 2023 (Global Sustainable Investment Alliance).

The EU leads ESG investment markets, particularly through green bonds and ESG loans.

The US and China are rapidly expanding ESG investment sectors, focusing on renewable energy and green technologies. [3]

The study highlights that green finance is an integral part of a sustainable economy. Green bonds, green banks, and ESG investments are crucial in financing environmental projects and creating new investment opportunities.

CONSLUSION

1. Expand the green bond market with state support mechanisms.
2. Strengthen the network of green banks and improve green credit systems.
3. Increase awareness of ESG investments and establish corporate sustainability standards.

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PROFITABILITY OF BUSINESS ENTITIES AND FACTORS AFFECTING PROFIT

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Abstract: *This article examines the key elements that determine the profitability of enterprises and identifies the main factors influencing the formation and change in the level of profit. The influence of the internal and external environment of organizations is analyzed, and recommendations are provided to improve business efficiency. Based on the analysis of practical data on the banking sector of the Republic of Uzbekistan for 2023, the dominant role of interest income is established and its impact on the profitability of financial institutions is considered. The results of the economic analysis of the joint-stock company are also presented, trends in changes in gross, net and retained earnings for the period 2020-2023 are identified. Negative dynamics of the main financial indicators of the enterprise are noted, indicating the need to take urgent measures to optimize costs and improve production and commercial policies to stabilize the financial condition and increase the competitiveness of companies.*

Keywords: *profitability, profit, profit factors, business entities, profitability, external factors, internal factors.*

INTRODUCTION

Profitability is one of the main criteria by which the efficiency of enterprises is assessed. It reflects the company's ability to make a profit and ensure the stability of its economic development. Analysis of factors affecting profitability is necessary for timely adaptation of companies to changing market conditions.

Gross profit of a bank is formed after deducting the amount of current expenses from gross operating income. About half of all bank expenses are accounted for by interest payments on deposits, the rest of the expenses are other interest payments, wages, deductions to reserves in case of default on loans and other operating expenses.

Net profit is formed after paying all taxes on their gross profit and, in turn, is divided into distributed, that is, paid to shareholders of the bank as annual dividends on their shares, and capitalized, directed to increase the bank's equity capital and reserves.

The further expansion of the bank's operations, the increase of its capital and reserves depend entirely on the level of profit. In this case, it is not so much the absolute amount of net profit received by the bank that is important, but its ratio to a number of indicators of the bank's balance sheet.

LITERATURE REVIEW

"Income is the monetary or material assets received by the state, an individual or a legal entity as a result of any activity for a certain period of time"[1].

"Profit or loss is the total amount of income minus expenses, excluding components of other comprehensive income"[2].

Hendriksen E.S. argued that "profit is the result of using capital over a certain period of time"[3]. This point of view was announced more than twenty years ago, which is probably why it is very controversial for the present times, since we understand that profit no longer has a direct, but an indirect connection with capital, since there are many levers influencing profit today, but if we consider the general theory of economics, then of course the concept of Money-Commodity-Money'(1) [4] is the basis of this statement.

E. A. Markaryan, G. P. Gerasimenko, S. E. Markaryan believe that "profit is the final financial result of the enterprise's activity, characterizing the absolute efficiency of its work" [5]. Referring to

the definition of E. A. Markaryan and G. P. Gerasimenko, Kulyagina E. A. claims that, indicating profit as the "final financial result", they did not take into account the opposite indicator of profit - loss. Therefore, it would be appropriate to write: "positive financial result", since profit cannot have a negative value. However, referring to the same definition, it should be noted that at present in civilized countries there is a slow transition to a new concept of determining the profit of an organization through the concept of "financial result". In this concept, profit (loss) has a completely different name, which in essence does not change the content [6].

It is necessary to pay attention that the bank's profit is formed on the basis of the bank's credit, deposit, settlement and other types of banking activities. Traditionally, the largest share falls on the margin, that is, the difference between deposit and credit interest. Naturally, there are many factors affecting profit, both external and internal. Each of these factors can significantly affect the profit of banks. Internal factors include groups of extensive and intensive factors. Extensive factors include factors reflecting the volume of resources, for example, changes in the volume of the resource base, the number of regional divisions or the number of employees, their use over time (acceleration of the turnover of a unit of resources, changes in the duration of the working day), as well as inefficient use of resources (losses due to risks, significant diversion of funds to funds and reserves).

External factors can be divided into market and administrative. Market factors include the phase of economic development of the country, the level of competition in the market, demand and supply for credit, the price of credit resources, the level of public confidence in the banking system and their income level, the structure of the market, etc. Administrative factors include government regulation, the tax system, financial and monetary policy.

ANALYSIS AND RESULTS

For analysis, it is worth considering the income and expenses of the banking system during 2023 by month. In Figure No. 1, we looked at interest income and expenses for the period January-December 2023.

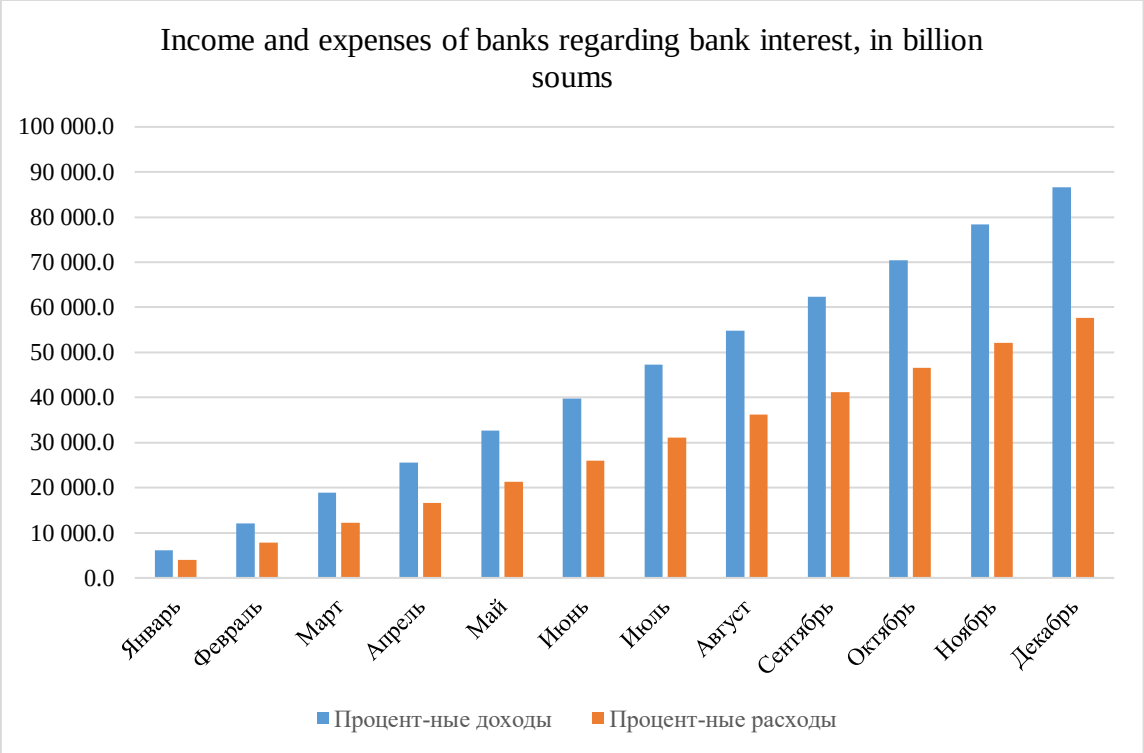

Figure №1. Income and expenses of banks regarding bank interest, in billion soums.

Interest income, as their name suggests, includes funds received in the form of interest on loans issued to individuals, legal entities and on the interbank market, as well as interest on deposits placed in other financial institutions. Interest expenses are the interest paid on loans, deposits, securities and other attracted funds. An example is that interest on deposits is significantly less than the interest paid to the bank for the loan, which forms the margin.

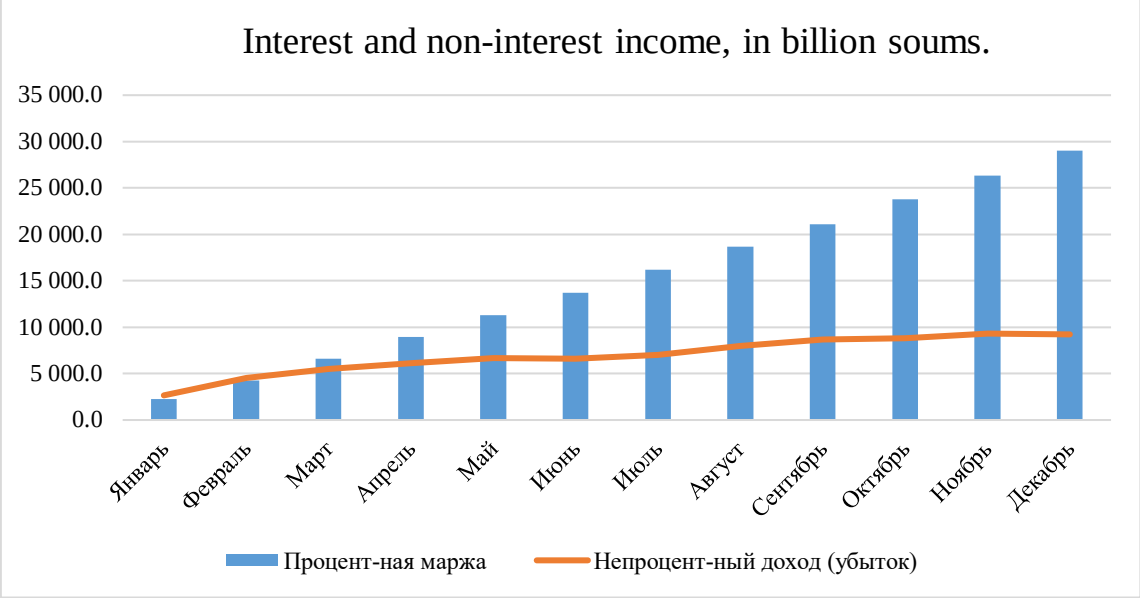

Figure 2. Interest and non-interest income.

Non-interest income of banks is income received by the bank from operations not related to issuing loans and investments in debt securities, but received by the bank from foreign exchange transactions with foreign currency, fees for services, commissions and other income.

As was already said above, interest income is the main source of income, as can be clearly seen in graph No. 2. Non-interest income here is obtained by subtracting non-interest expenses and operating expenses from non-interest income.

As was already noted above, E. A. Markaryan, G. P. Gerasimenko, S. E. Markaryan believe that "profit is the final financial result of an enterprise's activities, characterizing the absolute efficiency of its work" [6]. This changes our perception of profit. If the activities of an economic entity are profitable for several months, this means the absolute efficiency of its activities.

When analyzing the profit already received, the question arises as to what influences it. The answer to this was to consider external and internal factors that have a significant impact on profit.

It should be noted that practical data show that interest income significantly exceeds non-interest income and has a progressive growth dynamics, the explanation for this is how much the demand for credit transactions has increased among both legal entities and individuals.

Now let's consider the formation of profits of industrial business entities. The profit of industrial joint-stock companies is formed on the basis of several stages. The most important source of income is the sale of products, which ensures the flow of funds to the organization. Production costs (raw materials, staff salaries, energy costs, equipment depreciation, etc.) are deducted from the revenue received, thus forming the company's gross profit.

Then operating costs (management costs, marketing activities, logistics and other costs associated with current activities) are deducted from the gross profit, as a result of which operating profit is determined. This indicator demonstrates the profitability of the main activity of the enterprise before deducting interest on loans and paying taxes. Next, operating profit is adjusted for financial indicators, including interest payments on loans, income or expenses from investments and exchange rate differences, after which profit before tax is formed. After paying taxes and mandatory government fees, net profit remains, which is the final financial result of the company's activities. It

is this profit that serves as a source for paying dividends to shareholders and reinvesting in the development of production and expansion of the enterprise. Thus, effective management of all stages of profit generation allows a joint-stock company to ensure sustainable development and high competitiveness.

The economic analysis was carried out on the basis of the company's financial statements reflected in the balance sheet (form No. 1) of JSC "XOVRENKO NOMIDAGI SAMARQAND VINO KOMBINATI". The key indicators of the company's profit for four years (2020-2023) were considered:

Gross profit (profit received from the sale of goods and services before deducting other expenses).

Net profit (the company's income remaining after paying all taxes and mandatory payments).

Retained earnings (part of the profit that was not distributed among the owners, remaining for business development or compensation for losses).

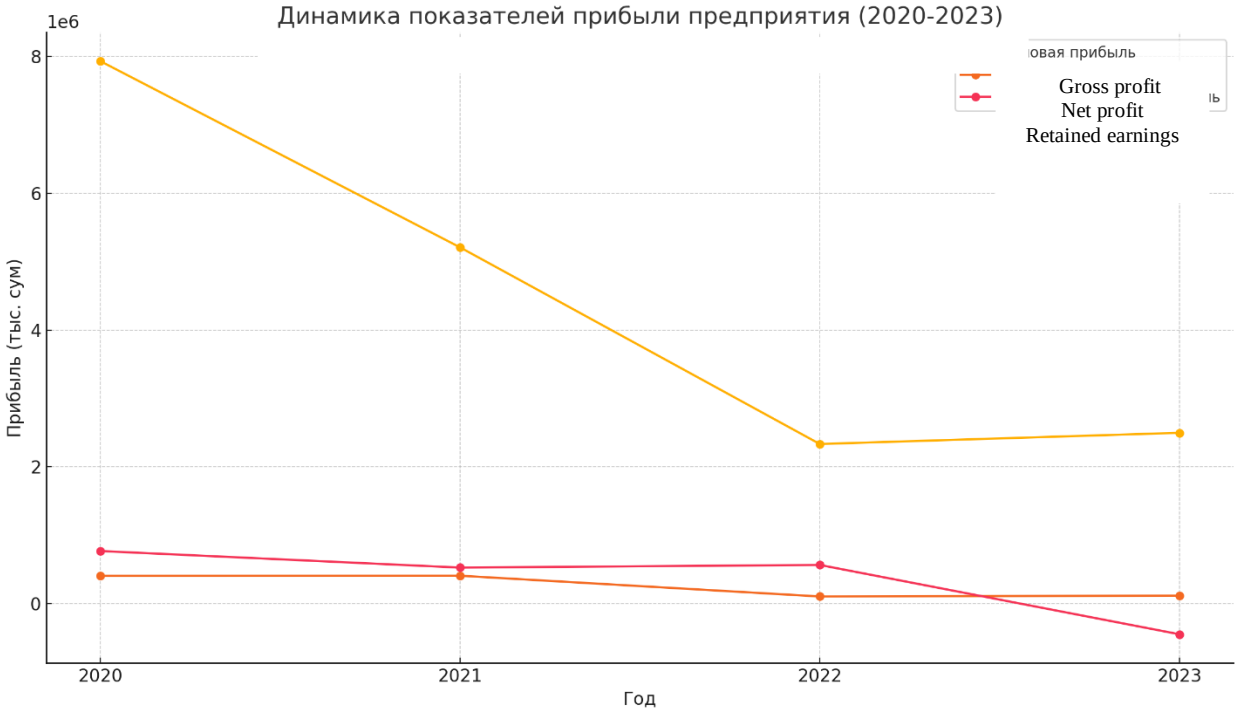

Figure 3. Dynamics of the company's profit indicators (2020-2023)

Based on the reviewed data, the following dynamics of financial indicators were revealed. The gross profit indicator tended to decrease during the period 2020-2022. This may be due to a decrease in demand for the company's products, an increase in production costs, or increased competition in the market. Although there is some increase in 2023, the profit level remains low compared to the beginning of the analyzed period. Net profit also showed negative dynamics for the period under review. A significant decrease in this indicator may be caused by an increase in tax liabilities, an increase in production and sales costs. In 2023, there is a slight increase, but it is not enough to compensate for the decline in previous years. The retained earnings indicator remained positive in the first years of the period, but in 2023 it turned negative. This indicates a possible deterioration in the financial stability of the enterprise and may signal the need to take urgent measures to restore the stability of the financial condition.

CONCLUSIONS AND SUGGESTIONS

Based on the analysis, it can be concluded that the company's financial results have significantly worsened in recent years. The decrease in profit is associated with both internal factors (increased production costs, problems with product sales) and external conditions (competition, economic

changes). The negative value of retained earnings for 2023 indicates the need for prompt action to correct the situation.

To stabilize financial indicators and return to sustainable growth, it is recommended to conduct a comprehensive analysis of the company's costs, optimize production and commercial processes, improve the product range and pricing strategy, and optimize tax payments and the company's liabilities.

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THE ROLE OF ENCRYPTION ALGORITHMS IN ENSURING INFORMATION SECURITY

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Absract. *Encryption algorithms play a very important role in ensuring information security. Their main function is to protect data by changing it into an unreadable form (cipher). Encryption algorithms encrypt data in such a way that a person who does not have a key cannot read the information. This is especially necessary to protect important information, including personal, financial or commercial secrets. Encryption algorithms can also be used to ensure the integrity of the data. Cryptographic methods, such as Hash functions, allow the data to be checked for non-tampering. Encryption algorithms play an important role in ensuring the authentication of users or systems. Examples include password encryption, secure connection setup (SSL/TLS), and authentication via digital signatures.*

Keywords: *AES, chacha20, RSA, diffil-hellman, elliptic curve, MD5, SHA 3, Electronic Digital Signature, algorithmic.*

I. INTRODUCTION

Encryption algorithms are an important means of information security and play a decisive role in protecting confidential information from unauthorized access, capture and theft.

Encryption is the process of converting plain text or data into an unreadable format using a mathematical algorithm called cipher. Encrypted data can only be read by authorized users who have the correct password solution key to convert it to its original form.

Below is the principle of operation, application areas and other analysis of algorithms currently in widespread use.

AES (Advanced Encryption Standard) is a symmetric encryption algorithm widely used to protect confidential data. It was selected by the U.S. National Institute of standards and technology (NIST) in 2001 to replace the previous data encryption standard (DES). The key size can be 128/192/256 bits. Each encrypts data in 128-bit blocks.

This means that it takes 128 bits as input and outputs 128 bits of encrypted text as output. AES relies on the swap-Change Network principle, which means it is implemented using a series of linked operations that involve switching and mixing input data. AES performs operations not in bits, but in data bytes. Since the block size is 128 bits, The Cipher processes 128 bits (or 16 bytes) of input data at the same time [1].

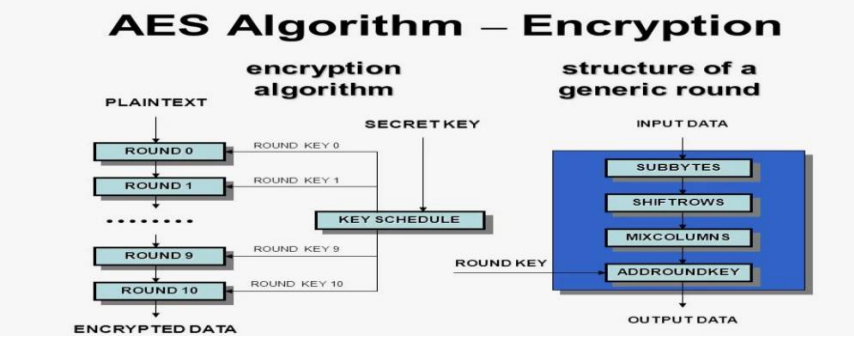

Figure 1. AES algorithm working principle

ChaCha20 is a symmetric KeyFlow encryption algorithm that was introduced in 2008 by Daniel J. Designed by Bernstein. It is one of the most widely used stream ciphers and is a very safe and efficient algorithm. ChaCha20 works by creating a pseudo-random stream of bits based on a secret key and nonce (a disposable number). This stream of bits is hacked with Open Text to create encrypted text. The ChaCha20 algorithm uses a 256-bit key and a 96-bit nonce. The ChaCha20 was designed to be very fast and safe with a high degree of resistance to attacks such as differential and linear cryptanalysis. It is also designed to be immune to timing attacks and side-channel attacks. It is also the standard encryption algorithm for the latest version of the Transport Layer Security (TLS) protocol used to protect web traffic [2].

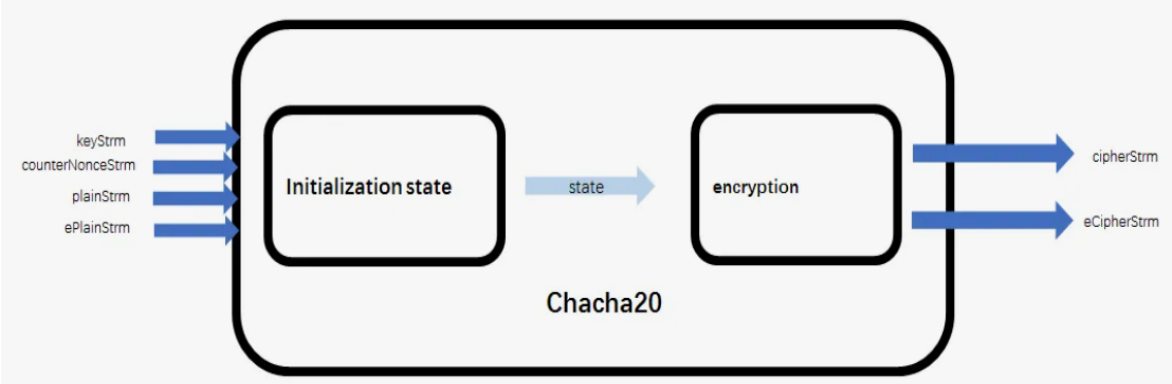

Figure 2. ChaCha20 algorithm working principle

RSA is a public key encryption algorithm developed in 1977 by Ron Rivest, Adi Shamir and Leonard Adleman. It is widely used for secure data transmission over the Internet, as well as for digital signature and key exchange. RSA works using a pair of keys: a public key and a private key. The public key is used to encrypt data, and the private key is used to encrypt data. The public key consists of two parts: a module (the derivative of two large primes) and a pointer (usually a small number, for example, 65537). The secret key consists of an indicator calculated on the basis of the main factors of the same module and module. To encrypt data using RSA, Open Text is first converted to a numerical value using a specific encoding scheme (e.g. ASCII or Unicode). Then the Open Text is raised to the power of the public indicator and divided into modules, resulting in encrypted text. To decrypt the encrypted text, the recipient has his own personal

To decrypt the ciphertext, the recipient uses his or her private key to raise the ciphertext to the power of a private pointer and divide it into a module, resulting in the original Open Text. RSA is a very secure encryption algorithm because it is based on the difficulty of factoring large prime numbers. At the same time, it works relatively slowly compared to other modern encryption algorithms and is not recommended for encrypting large amounts of data[1].

The Diffie-Hellman algorithm is a key exchange algorithm that allows a shared secret key to be set over a non-secure communication channel without transmitting a key to either side. The algorithm was developed in 1976 by Whitfield Diffie and Martin Hellman and is one of the first practical open-key algorithms. The Diffie-Hellman algorithm works by using a mathematical function to create a common secret key between two parties. The function contains two values inside.

The function contains two values: a large prime number and the root root of that prime number. Each side selects a secret number, then uses a base number and a primitive Root to create a common key. The two sides exchange their public keys and then use their secret numbers and the other side's public keys to create a shared secret key. The security of the Diffie-Hellman algorithm is based on the difficulty of computing discrete logarithms. In other words, it is easy to calculate the value of the equation raised to the force, but it is very difficult to determine the force itself. While the Diffie-Hellman algorithm does not provide direct encryption, it is often used in conjunction with other encryption algorithms such as AES to establish a secure communication channel between the

two parties. A common secret key created by the Diffie-Hellman algorithm can be used as a key for symmetric encryption.

Elliptic Curve Cryptography (ECC) is a type of public key cryptography based on the mathematics of elliptic curves. It is widely used in modern cryptographic systems such as secure communication protocols and digital signatures [3].

The basic idea of ECC is to use elliptic curve properties to create a trapdoor function that is easy to compute in one direction but difficult to compute in the opposite direction. This trapdoor function is used to generate open and private keys that can be used for encryption and digital signatures. To create a pair of common-private keys using ECC, a random private key is first selected, which is the number between 1 and the curve. The corresponding public key is then calculated as a point on an elliptic curve by multiplying the private key by the principal point on the curve.

The resulting point is a public key, which can be freely distributed. ECC security is based on the difficulty of solving the elliptic curve discrete logarithm problem (ECDLP). While ECDLP is not considered computable, attackers can use some specialized algorithms and resources to test and hack encryption. One of the main advantages of ECC is its effectiveness. Compared to other public key cryptography systems such as RSA, ECC requires shorter key lengths for the same level of security. This means that ECC can be implemented with fewer computing resources and provide faster encryption and decryption times.

The hash function is a mathematical function that accepts input data of arbitrary size and produces a fixed-size output called a hash or message digest. Hash functions are widely used in Informatics and cryptography for various purposes such as data integrity verification, digital signature and password storage. A good hash function must be deterministic, i.e. the same input data always produces the same hash value, and it must be collision resistant, i.e. it is difficult to find two different inputs that produce the same hash value. In addition, the hash function must have an avalanche effect, that is, a small change in the input data must lead to significant changes in the hash output. One common type of hash function is the cryptographic hash function, which is designed to protect against different types of attacks, such as preimage attacks, second preimage attacks, and collision attacks. Some frequently used cryptographic hash functions include MD5, SHA-1, SHA-2, and SHA-3.

One of the oldest algorithms for which MD5 is widely used, M5 is a one - way cryptographic function that modifies messages of any length and returns a solid-length line output of 32 characters. An example of MD5 hash-dijesti output looks like this: b6c7868ea605a8f951a03f284d08415e.

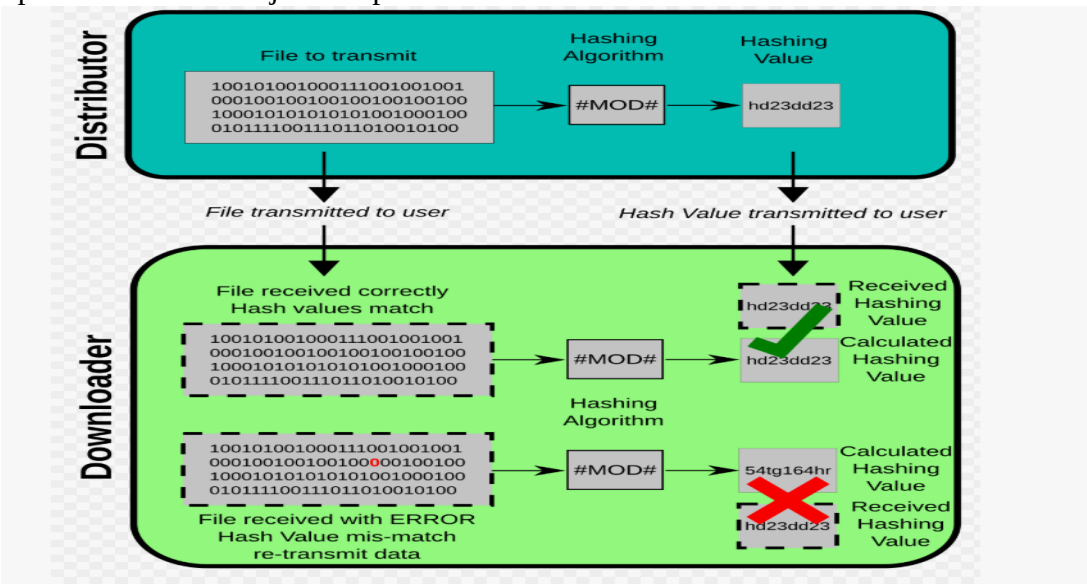

Figure 3. MD5 Hecht function working principle

SHA - 3 is the latest in the SHA family. Developed through a public competition promoted by NIST, it is part of the same standard and is completely different from MD5, SHA-1 and SHA-2. SHA

- 3 consists of four algorithms with different hash functions, and two extensible output functions can be used to generate domain hashing, random hashing, stream encryption, and MAC addresses:

1) SHA3-224;
2) SHA3-256;
3) SHA3-384;
4) SHA3-512;
5) SHAKE-128 (output function);
6) SHAKE-256 (output function).

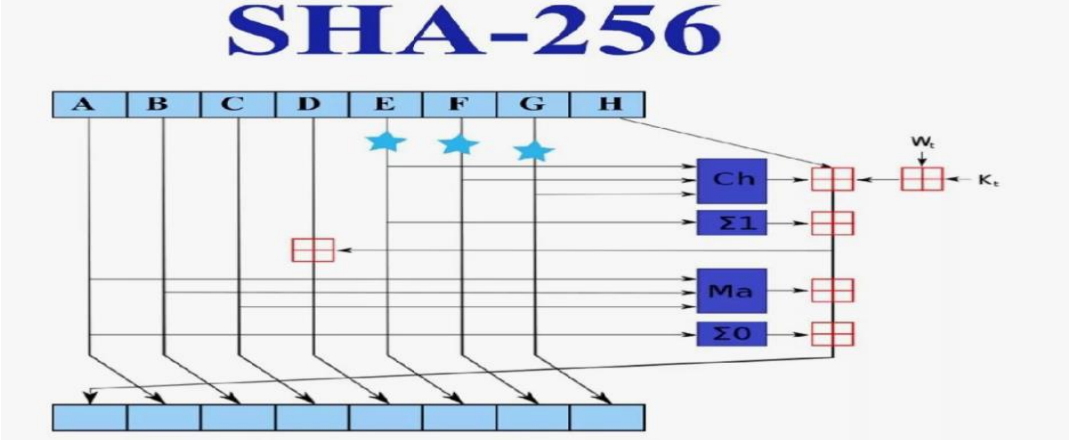

Figure 4. SHA3 Hecht function working principle

Electronic digital signature (EDS) algorithms are cryptographic protocols used to ensure the authenticity, integrity and non-rejection of digital documents or messages. They are widely used in e-commerce, online banking and other applications where secure communication and authentication are important. Several electronic digital signature algorithms exist, but one of the most commonly used algorithms is the RSA digital signature algorithm. The RSA algorithm is based on the properties of prime numbers and includes two keys, a secret key and a public key. The secret key is kept secret by the owner and used to sign messages, while the public key is used to verify the signature. To sign a message using the RSA digital signature algorithm, the sender first calculates the message hash using a cryptographic hash function such as SHA-256. The sender then encrypts the hash using his private key and creates a digital signature. After that, the recipient of the message can confirm the signature by decrypting it using the sender's public key and comparing it with the message cache.

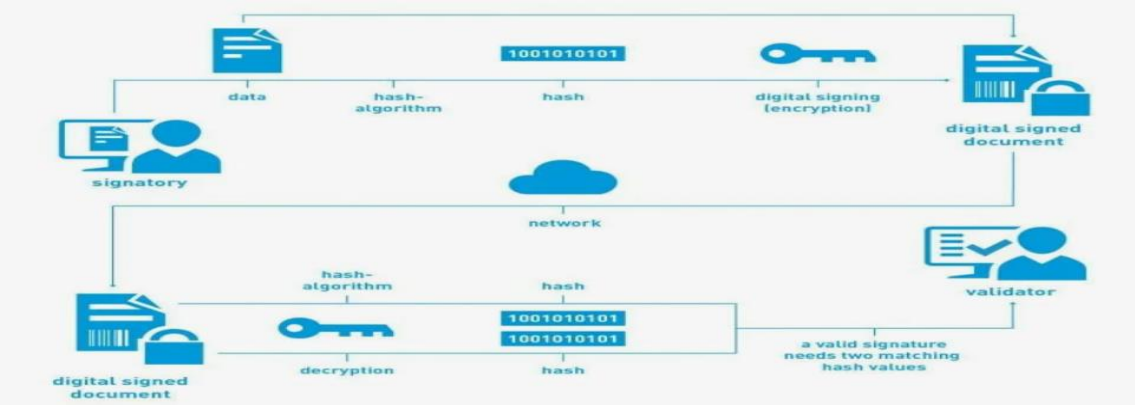

Figure 5. EDS algorithm processing circuit

Above, the main tasks of AES, chacha20, RSA, diffil-hellman, elliptic curve, MD5, SHA 3, electronic digital signature algorithms, the principles of processing, were cited, while in the qquyi table, their general analysis is keltiirl, which makes it possible to learn even more about encryption algorithms [4].

II. THEORETICAL ANALYSIS AND RESULT

Table 1.
AES, chacha20, RSA, diffil-hellman, elliptic curve, MD5, SHA 3, general analysis of electronic digital signature algorithms

Algorithm name	Information security protection categories	Rate of exchange (bit per second)	Advantage rating	Potential vulnerabilities	Underdog	Threat tolerance	Programming languages	Application areas	Resistance to phishing attacks	The man in the middle is resistant to attack
AES	Privacy	1,1 mlrd	1	Basic size constraints	Vulnerable to side canal attacks	High	C, C++, Java, Python	Cryptographic	Resistant	High
ChaCha20	Privacy	3,3 mlrd	2	Not clear	Vulnerable to side canal attacks	Middle	C, C++, Python	Encryption, secure communication, VPN	Resistant	High
RSA	Authentication and data privacy	16 mil	3	Basic size constraints	Faktorizatsiya hujumlariga nisbatan zaif	Middle	C, C++, Java, Python	Encryption, digital signature, secure communication	Weak	Middle
Diffie-Hellman	Key exchange	70 mil	4	Generating weak random numbers	Vulnerable to man-in-the-middle attacks	Middle	C, C++, Java, Python	Generating weak random numbers	Weak	Low
Elliptic Curve Cryptography	Public key encryption and access control	130 mil	5	Generating weak random numbers	Elliptic curve vulnerable to discrete logarithm proble	High	C, C	Cryptographic	Resistant	High

					m attacks					
MD5	Totality	500	2	Cryptographic	Unprotected against riot attacks	Low	C, C++, Java, Python	Heshing	Weak	Low
SHA3	Totality	700	2	Not clear	Not clear	High	C, C++, Java, Python	Hashing, digital signatures, blockchain	Resistant	High
EDS	Authentication and integrity	16 mil	3	Cryptographic	Withstanding unknown attacks	Middle	C, C++, Java, Python	Autentification	Resistant	High

CONCLUSION

Encryption algorithms are an important component of information security, ensuring confidentiality, integrity, authentication, and non-denial of information. They are necessary to protect data, establish safe communication and resist various security threats. The correct selection and proper use of encryption algorithms is decisive in ensuring information security.

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