# Fusion Methodologies of the Assessment of the Effectiveness of Digital Technologies in Commercial Banks

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**Abstract**

The introduction and active use of modern digital technologies in commercial banks is becoming a modern trend in the banking sector and allows for improved quality of service to customers. At this point, the importance of assessing the effectiveness of the introduction of digital technologies in industries is increasing. Foreign methodologies for assessing the effectiveness of the introduction of digital technologies in various fields were studied, compared, analyzed, and identified. There are a few methodologies for assessing the effectiveness of digital technologies in the banking industry. The novelty of this research is the fusion of methodologies for assessing the development of digital technologies in commercial banks and determining the level of use of digital technologies offered by commercial banks. To increasing the effectiveness of the introduction of digital technologies in commercial banks, measures of a strategy are developed and recommended by the researcher for the effective development of digital technology offers by commercial banks in Uzbekistan.

**Keywords:** fusion methodologies, mechanism; digital technologies; commercial banks; effectiveness; assessment; digital services

## 1. Introduction

We can see that our state and government are carrying out extensive reforms aimed at actively developing the digital economy in our country, especially in the banking sector. The banking sector is one of the branches of the national economy, and the quality and number of innovative banking services provided to legal entities and individuals who are users of banking services. Based on Schlich et al. (2018), a large number of global banks are expected to become more digitally mature over the next couple of years by optimizing their operational and client interfacing processes through the adoption of digital technologies as part of a firm-wide digital investment plan [1]. The focus on digital technologies and digital transformation in banking organizations has increased notably over the last decade as the Fourth Industrial Revolution unfolded [2]. Digital technologies are increasingly creating a connected ecosystem offering banks advanced functionality and analytics that can enhance decision-making and support strategic actions [3].

In recent years, commercial banks are also transforming their organizational structure and product channels with the help of other digital technologies such as big data and artificial intelligence [4]. The digital transformation in commercial banks is the integration of digital technology into all banking areas, fundamentally changing the way commercial banks operate and provide value to customers, such as developing financial and banking software, digital banking, mobile banking solutions, fintech, etc., be able to meet the demand of customer about interest rate liberalization, big data, mobile finance, risk management, internet finance, and customer relationship management [5, 6].

The provision of high-quality banking services to the population in conditions comparable to those of modern world banks is carried out through the use of digital technologies. Guo et al. (2017) and Hasan et al. (2020) emphasize that with the support of digital technologies such as big data, artificial intelligence, and blockchain, digital financial technology has achieved rapid development and promoted financial development [7,8,9]. In recent years, digital technologies represented by big data, artificial intelligence (AI), and the Internet of Things



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(IoT) have led to dramatic changes in many industries [10,11]. With the rapid development of digital technology, digital financial service is increasingly impacting the operation and profitability of commercial banks [12,13,14]. In this case, it is easy to understand the necessity and importance of introducing new and/or improved digital technologies in the activities of local commercial banks from the complications that have arisen in the provision and use of banking services over the past years.

In accordance with Cheng et al. (2023), commercial banks with a high technology orientation will gradually increase their digital awareness and put digital technology development and application at the forefront of their development. Further, commercial banks will continue to accumulate the knowledge base of digital technology, and they will actively acquire and apply new digital technologies to push the digital transformation of their current business [15]. An important consideration in the digitalization transformation of a commercial bank is that digital technology is not always uniformly implemented throughout the financial organization [3].

Currently, the number of studies aimed at assessing and determining the effectiveness of the introduction of digital technologies in commercial banks is limited. Scholars and researchers are restricted to determining the contribution and/or impact of digital technologies on the overall performance of commercial banks. Nowadays, conducting scientific and methodical research aimed at assessing the effectiveness of the introduction of digital technologies into the activities of commercial banks is an urgent topic.

The purpose of this study is to develop fusion methodologies to assess the development of digital technologies in commercial banks and to develop methods for determining the level of use of digital technologies offered by commercial banks.

The rest of the paper is organized as follows: section 2 presents the related work; section 3 presents the methodology of the research; section 4 is dedicated to results and analysis; and section 5 presents the conclusion and recommendations. Besides the section of references, the appendices section is provided for readers by the researcher.

## 2. Related work

A comparison was proposed based on seven indicators of the effectiveness of the investment project in the purchase and implementation of digital technologies, according to the methodology for assessing the economic effectiveness of the use of digital technologies in the public administration system, which was developed by Uzbek economists A.S. Turdiev and M. Ya. Isokhujaeva [16]:

1) comparison of the total profitability of the investment project with the average percentage of the bank loan;
2) comparison of the profitability of the investment project with the average inflation rate in the country;
3) comparison of projects by the volume of required investments;
4) comparison of projects by terms of coverage;
5) assessment of the stability of annual (monthly, quarterly) revenues from project implementation;
6) comparison of the total profitability of the investment project without taking into account the time factor, that is, the discounted income;
7) comparison of the overall profitability of the investment project, taking into account the time factor.

Uzbek researcher Fayzieva (2022) offered a methodology for the assessment of the effectiveness of the development of digital technologies in commercial banks of Uzbekistan. This methodology consists of five types of indicators, such as the effectiveness of the number of customers; the effectiveness of the number of transactions; the effectiveness of the total amount of transactions; the effectiveness of the non-interest revenue; and the effectiveness of the non-interest expense [17].

Russian economist A. G. Gululyan (2017) proposed to divide the models for assessing the effectiveness of using digital technologies in the oil industry into four groups, which are [18]:

- Investment Oriented Models;
- Cost-Oriented Models;
- Environmental/Contextual Oriented Models;
- Quantification models.

According to the Italian economists Urbinati et al. (2017), the use of digital technologies appears to be a widely discussed topic in the literature. Today, due to the significant changes characterizing companies and their innovative activities, management and innovation are becoming more important in the fields [19].

Currently, innovative developments are being carried out within the framework of the transition to the digital economy and digital transformation, and companies are developing methods for assessing the level of digitalization of their organizations based on the concept of "Industry 4.0" and "Industry 4.0" maturity indices. It is known that the "Industry 4.0" maturity index was created by the German National Academy of Science and Engineering (Acatech), which is the founder of the "Industry 4.0" concept, and it allows defining the stages of the enterprise's digital transformation process [20]. Based on Vietnamese economists Tan et al. (2021), the fourth



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industrial revolution has created a driving force for the application of technology in business activities. With the powerful development of high-speed internet, cloud computing, and blockchain technology, Industrial Revolution 4.0 is changing the way enterprises operate, the way they do business, and the behavior of consumers [21,22].

Effectiveness of the development of digital technologies in commercial banks of Uzbekistan was assessed by Fayzieva (2023) and this assessment depends to the indicators of offerings of the digital technologies by the banks and at the same time the indicators of the net profit of the banks. According to her research, the banks that are effectively developing digitally have been identified in line with these indicators. In compliance with the assessment results, "Uzmilliybank" JSC, "Uzsanoatkurilishbank" JSC, "Ipoteka-bank" JSCMB, "Asakabank" JSC, and "Anor Bank" JSCS ranked in the high position on the list of digitally developing banks. With regard to using the digital technologies that are offered by the banks to their customers, the most commonly used digital technologies were: remote banking services—100%; issuance of bank payment cards—97%; online money transfers—100%; online deposit—85%; API interface—97%; online conversion—85%; and mobile applications—97% [23].

Digitization was a novelty in the activities of industries and sectors, but in the period when information and communication technologies were widely and consistently introduced, assessment of the effectiveness of information and communication technologies was studied by many other scientists [24-28].

## 3. Research methodology

Foreign studies and methodologies for assessing the effectiveness of the introduction of digital technologies in commercial banks were studied. The developed methodologies were compared and analyzed, and as a result, a mechanism for assessing the effectiveness of the introduction of digital technologies in commercial banks was developed.

There are three assessment methodologies in the mechanism, and two assessment methodologies are highlighted as fusion methodologies in the research paper. The first assessment methodology is the assessment of the development of digital technologies (Figure 1), and the second methodology is the assessment of the level of use of digital technologies, which is proposed by a commercial bank (Figure 2).



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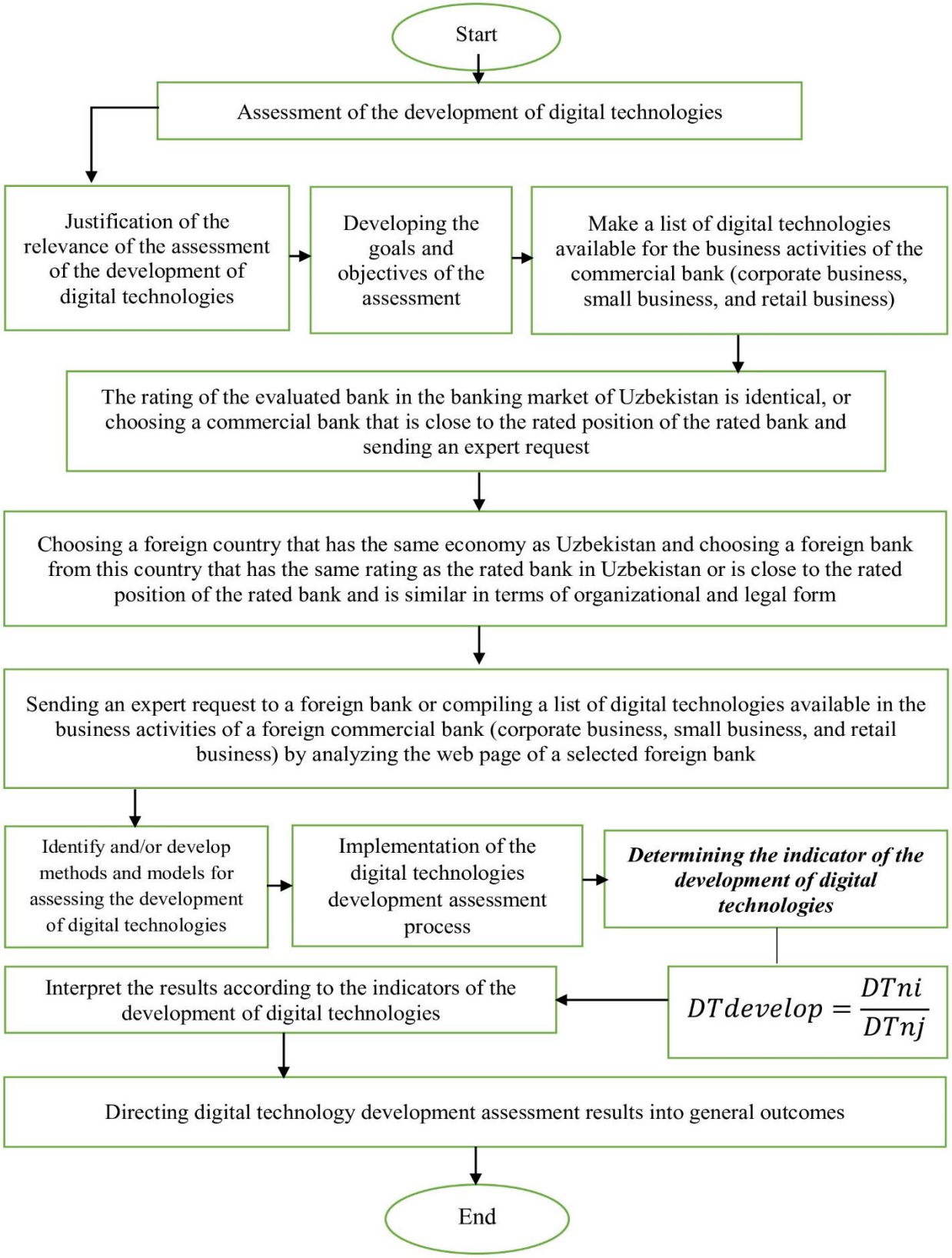


Figure 1: Algorithm diagram for assessing the development of digital technologies



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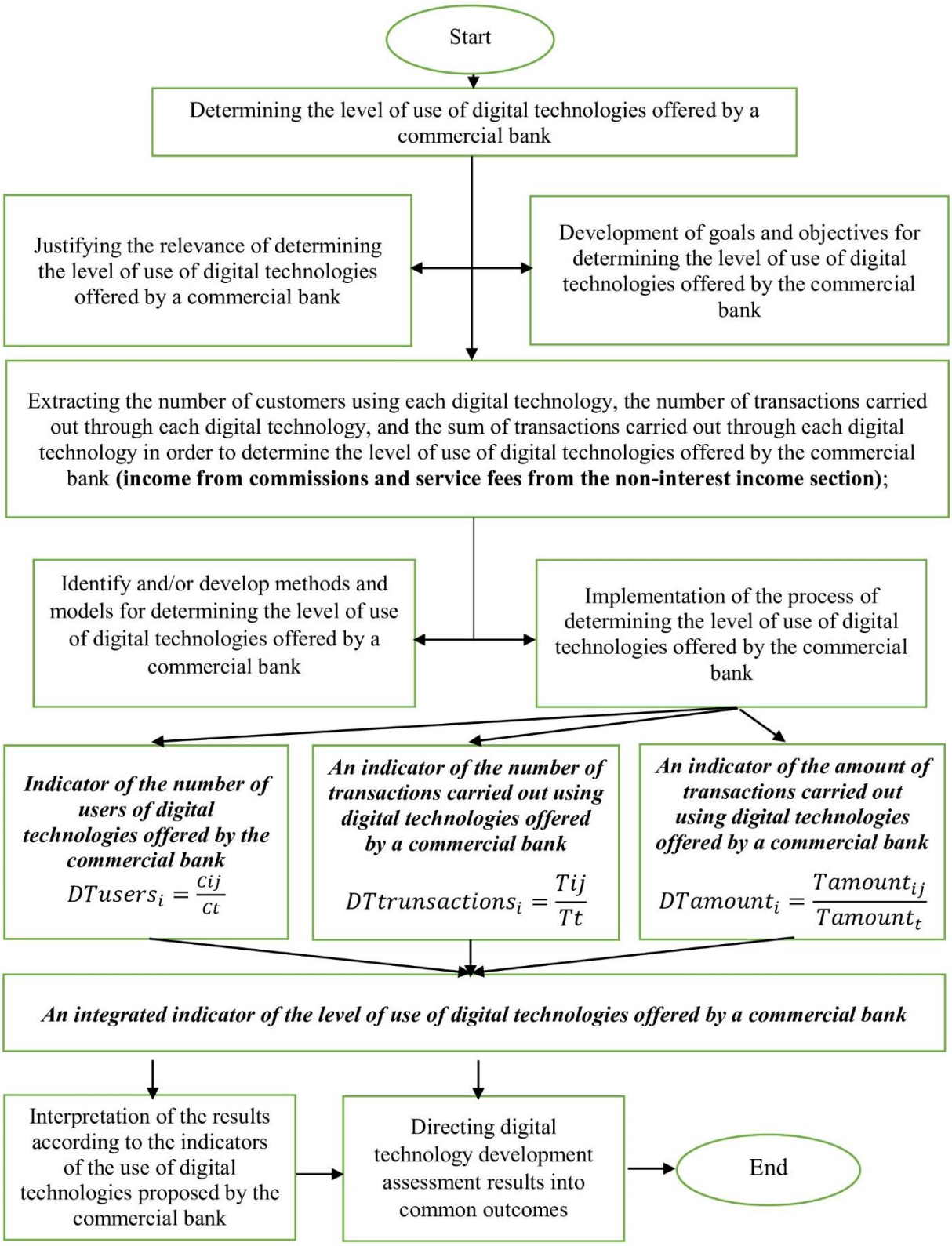


Figure 2: Diagram algorithm for determining the level of use of digital technologies proposed by a commercial bank



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## 4. Analysis and Results

It is mentioned above that this research paper's methodology consists of the mechanism, which is involved in three assessment methodologies. Two assessment fusion methodologies are provided by the researcher in the section on analyses and results. They are: A methodology for assessing the development of digital technologies; and a methodology for determining the level of use of digital technologies offered by a commercial bank.

***1. A methodology for assessing the development of digital technologies***

Digital technologies are the target of development assessment:
- to determine the level of digital technologies used by the commercial bank according to the digital technologies available or in use in the commercial bank.

In order to achieve the above-mentioned goal of assessing the development of digital technologies, the following tasks are defined:

- designation of the person responsible for the assessment process of the development of digital technologies (management);
- assessment of the digital competence of the person responsible for the assessment of the development of digital technologies (with the help of the "Expert" model used in foresight studies);
- determination of methods and models for assessing the development of digital technologies (responsible person);
- carrying out an assessment of the development of digital technologies and determining the indicator of the development of digital technologies based on the result of the assessment (responsible person);

In order to implement this assessment process in a qualitative way, the assessment algorithm is explained in the following order:

Stage 1: Justification of the relevance of the assessment of the development of digital technologies;
Stage 2: Developing the goals and objectives of the assessment;
Step 3: Compilation by the responsible person of the list of digital technologies available in the commercial bank's business activities (corporate business, small business, and retail business);
Step 4: Select a commercial bank that has the same rating as the rated bank in the banking market of Uzbekistan or is close to the rated position of the rated bank and send an expert request (responsible person);
Step 5: Choosing a foreign country that has the same economy as Uzbekistan and choosing a foreign bank from this country that has the same rating as the rated bank in Uzbekistan or is close to the rated position of the rated bank and is similar in terms of organizational and legal form;
Step 6: Sending an expert request to a foreign bank or compiling a list of digital technologies available in the business activities of a foreign commercial bank (corporate business, small business, and retail business) by analyzing the web page of a selected foreign bank (responsible person);
Step 7: Identify and/or develop methods and models for assessing the development of digital technologies;
Step 8: Implementation of the digital technology development assessment process;
Step 9: Determining the indicator of the development of digital technologies (responsible person);

***Digital technology development indicator DTdevelop*** is calculated using the following formula:

$$DTdevelop = \frac{DTni}{DTnj} \quad (1)$$

here,
$DTni$– the number of $n$ digital technologies related to the existing bank business activity in the assessed $i$-commercial bank;
$DTnj$ – the number of n digital technologies related to the bank's business activity in the $j$-commercial bank under comparison.
Step 10: Interpret the results according to the indicators of the development of digital technologies.
The indicators of the development of digital technologies are explained in Table 1.

Table 1: Explanations of the indicators for the assessment of the development of digital technologies

| Explanation | Indicator |
|---|---|
| The development of digital technologies in commercial banking is at its highest level | 1≥ |
| The development of digital technologies in commercial banking is at a high level | 0,75-0,99 |
| The development of digital technologies in commercial banking is at a good level | 0,5-0,74 |
| The development of digital technologies in commercial banking is at a medium level | 0,25-0,49 |
| The development of digital technologies in commercial banking is at a low level | 0-0,24 |



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Step 11: Directing digital technology development assessment results into general outcomes.
The drawing of the above digital technology development assessment algorithm is described in Appendix 1.

## *2. A methodology for determining the level of use of digital technologies offered by a commercial bank*

The aim is to determine the level of use of digital technologies offered by the commercial bank:
-to determine the level of use of digital technologies offered by the commercial bank from the number of customers using the digital technologies offered by the commercial bank, the number of transactions performed by them, and the amount of transactions.

- In order to achieve the above-mentioned goal of determining the level of use of digital technologies offered by the commercial bank, the following tasks are defined:
  - designation of the person responsible for determining the level of use of digital technologies offered by the commercial bank (management);
  - assessment of the digital competence of the person responsible for determining the level of use of digital technologies offered by the commercial bank (using the "Expert" model used in foresight studies);
  - determination of methods and models for determining the level of use of digital technologies offered by a commercial bank (responsible person);
  - to determine the level of use of digital technologies offered by a commercial bank and to determine the indicator of the use of digital technologies offered by a commercial bank (responsible person).

In order to implement this process qualitatively, the algorithm of the process is explained in the following order:
Stage 1: Justifying the relevance of determining the level of use of digital technologies offered by a commercial bank;
Stage 2: Development of goals and objectives for determining the level of use of digital technologies offered by the commercial bank;
Step 3: Extracting the number of customers using each digital technology, the number of transactions carried out through each digital technology, and the sum of transactions carried out through each digital technology in order to determine the level of use of digital technologies offered by the commercial bank **(income from commissions and service fees from the non-interest income section)**;
Step 4: Identify and/or develop methods and models for determining the level of use of digital technologies offered by a commercial bank;
Stage 5: Implementation of the process of determining the level of use of digital technologies offered by the commercial bank;
Step 6: Determining the indicator of the level of use of digital technologies offered by the commercial bank (responsible person).
The system of indicators (2-4) that take values from 0 to 1 determines the integral indicator of $LDTusing_i$:

***DTusers$_i$ - the number of users of the digital technology offered by the commercial bank for the i-digital service*** is calculated using the following formula:

$$DTusers_i = \frac{Cij}{Ct} \qquad (2)$$

here,
$Cij$ – number of customers who used the *i*-number service in the *j*-period (month, quarter, year);
$Ct$ - the number of total customers of the commercial bank who used all digital services in the *j*-period (month, quarter, year).

***DTtransactions$_i$ - the number of transactions carried out using the digital technology offered by the commercial bank for the i-digital service*** is calculated using the following formula:

$$DTtrunsactions_i = \frac{Tij}{Tt} \qquad (3)$$

here,
$Tij$ – *i*-raqamli xizmatdan *j*-davrda (oy, chorak, yil) amalga ochirilgan tranzaksiyalar soni;
$Tt$ – the number of total transactions of the commercial bank in the *j*-period (month, quarter, year) made by customers who used all digital services.

***DTamount$_i$ - the amount of transactions carried out using digital technology offered by a commercial bank for i-digital service***, is calculated using the following formula:

$$DTamount_i = \frac{Tamount_{ij}}{Tamount_t} \qquad (4)$$

here,
$Tamount_{ij}$ – the amount of transactions made from the *i*-number service in the *j*-period (month, quarter, year);
$Tamount_t$– the sum of total transactions of the commercial bank in *j*-period (month, quarter, year) made by customers using all digital services.



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***The determination of the integral indicator of the level of use of digital technology offered by a commercial bank*** for *i*-digital service is determined using the following equation according to the perfect point method:

$$q_i = \sqrt{\sum_{j=1}^{m} v_j (q_j * - q_{ij})^2} \quad (5)$$

The equation was reduced to the following form without the weighting factor:

$$q_i = \sqrt{\sum_{j=1}^{m} (q_j - q_{ij})^2} \quad (6)$$

here,
$q_i$ - indicator of the use of *i*-digital technology offered by a commercial bank;
$m$ - the number of factors in the *i*-digital service;
$q_j$ - the best indicator ($q_j$=1) by j-criterion;
$q_{ij}$ - the indicators on factors for i-digital service ($DTusers_i$, $DTtrunsactions_i$, $DTamount_i$)
According to equation (6), ***the integral indicator of the level of use of the i-digital technology offered by the commercial bank*** (LDTusing) is determined using the following formula:

$$LDTusing_i = \sqrt[2]{(1 - DTusers_i)^2 + (1 - DTtrunsactions_i)^2 + (1 - DTamount_i)^2} \quad (7)$$

***The integral indicator of the level of use of digital technologies offered by the commercial bank*** for n digital services used in the business activities of the commercial bank is determined using the following formula:

$$LDTusing = \frac{1}{n} \sum LDTusing_i \quad (8)$$

Step 7: Interpretation of the results according to the indicators of the use of digital technologies proposed by the commercial bank.
The integrated indicators for determining the level of use of digital technologies offered by the commercial bank are explained according to Table 2.

Table 2: Explanation of integrated indicators for determining the level of use of digital technologies proposed by the commercial bank

| Explanation | Indicator |
|---|---|
| The level of use of digital technologies offered by the commercial bank is high | 0.8-1.0 |
| The level of use of digital technologies offered by the commercial bank is good | 0.6-0.79 |
| The level of use of digital technologies offered by the commercial bank is medium | 0.4-0.59 |
| The level of use of digital technologies offered by commercial banks is low | 0.2-0.39 |
| The level of use of digital technologies offered by commercial banks is very low | 0-0.19 |

Step 8: Directing the results of determining the level of use of digital technologies offered by the commercial bank to general results.
The diagram of the algorithm for determining the level of use of digital technologies proposed by the above commercial bank is described in Appendix 2.

## 5. Conclusion and Recommendations

Comparing the effectiveness of digital technologies in commercial banks with the digital development of local and foreign banks and constantly determining the level of use of digital technologies offered by commercial banks will allow the acceleration of digital transformation processes in these commercial banks and the improvement of their digital infrastructure.
Below are the measures developed by the author in the strategy of effective development of digital technology offers by commercial banks in Uzbekistan in order to increase the effectiveness of the introduction of digital technologies in commercial banks:
- formation of mutually beneficial relations with the central bank, commercial banks, fintech, and IT companies.
- to expand cooperation with higher education institutions and online platforms in the continuous improvement of staff qualifications.
- creation of a separate organizational structure for the development of innovative technologies.
- reorganization of the bank's management and strategy to meet the requirements of the new business model;



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- based on the client's needs, introducing convenient digital technologies;
- expanding and developing the functional capabilities of remote banking services;
- study and in-depth analysis of the financing of programs and projects down to the lower layers;
- continuous modernization of the bank's infrastructure;
- improvement of the marketing system in order to increase the interest and trust of clients in banking services;
- development of a roadmap for the introduction of digital services and products;
- establishing and developing cooperation relations with professional organizations on the introduction of innovative IT technologies;
- to constantly assess the effectiveness of the introduction of digital technologies.

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