The Use Of Linguistic Methods of Text Processing for the Individualization of the Bank's Financial Servise

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Abstract

The article deals with the application of morphological analysis of text processing to solve the problems of individualization of card services for bank customers. The level of interest in this linguistic tool in Ukraine and the world was determined using the Google Trends service. Based on a customer survey, a morphological analysis was conducted regarding personalizing the bank's card services. The results empirically determined the priority of forming loyalty programs, for example, a combination of criteria for choosing non-financial card product services and options for client settings. It is proposed to deepen the application of methods of using linguistic systems in the banking sphere through the introduction of the morphological analysis algorithm and automated decision-making products. A possible option for implementing a decision on the selection of card services through the Decision-Making Helper program is presented, making it possible to speed up the data processing process and consider the client's individual needs more effectively.

Keywords
Linguistics, word processing, morphological analysis, card product personalization, Google Trends, Decision Making Helper.

1. Introduction

Electronic texts in natural language are the primary way of storing and transmitting information in the 21st century. With the development of the social industry of document circulation, which is constantly increasing, there was a need to solve the tasks of processing these texts by automation, the purpose of which is to identify their content, structure, implementation of machine translation, etc. Also, the issue of the need to create and improve linguistic support for information processing systems in the economic crisis due to the COVID-19 pandemic [1] and martial law in Ukraine has become more relevant, which has increased the level of demand for electronic media. There is a comprehensive list of programs and methods of linguistic text processing to solve the listed tasks. Moreover, systems of analytical processing of textual information are used in various fields of activity.

To take into account the personal characteristics of each client, which is the basis of the regulation of relations in the field of consumer rights protection [2], service providers carry out an analytical analysis of requests for the most popular requirements for products, using real-time operational data processing technologies based on the database of conducted surveys. A promising trend that emphasizes the need to use automation of production processes but also integrates the idea of individualizing orders without cost loss by conducting big data analytics for different management decisions is the application of Industry 4.0 technologies [3]. That is, the issue of automated text processing for process or service personalization is a modern challenge with promising directions of development for any type of activity, particularly financial.

In banking, it is crucial to have appropriate systems for analyzing financial transactions for customer segmentation to focus on working with the client. The technologies of pre-processing of electronic texts allow you to set various restrictions on the searched combinations of words, which makes it possible to solve individual tasks of determining the categorical meaning or morphological characteristics of the words used in the text, including in the process of providing financial services in the bank. One of the possible options for such an interaction of linguistics and banking is the use of morphological analysis to personalize card services in the bank.

2. Analysis of publications

The result of determining the main topics of consumer financial services research between 2000 and 2020, their relative scale and interrelationship, as well as the evolution of the industry, was a study of 1,227 articles taken from the Social Science Citation Index, Emerging Sources Citation Index, and Scopus [4], which showed , that the most important thing in consumption is customer satisfaction, the introduction of innovations, and the level of consumer acceptance of digitalization of financial services.

The general concept of current regulation of the financial system for the development of financial inclusion, therefore, increasing the involvement and availability of financial services, involves finding tools to meet the needs of different consumers, in particular, through mobile means of communication, where test messages and their stimulating individualized nature have a key impact on satisfaction and involvement customers to the consumption of financial services became the subject of a study of the influence of digital financial inclusion on the transition from the informal financial market to the official financial system, which is carried out precisely through the individualization of the provision of financial services at the bank [5]. Bank current account providers must understand the importance of digital and non-digital service attributes in different customer segments in order to achieve market relevance for a particular service in the face of digitization. Individualization of the service is important in digital banking. A discrete choice experiment on customer preferences for current accounts in Germany is described [6]. It was noted that an innovative segment of Fintech customers is forming, which prefers a digital, data-driven operating model in banking. The application of morphological analysis to determine the value of using chatbots that individualize the provision of financial services, reducing the workload of employees when handling customer calls, in the field of marketing research on 24/7 customer service is devoted to research [7], which is aimed at structuring options for solving problems and increasing future research opportunities.

The issue of automated morphological analysis of texts was dealt with by domestic and foreign scientists such as D. F. Liuher [8], who researched ways to solve complex linguistics problems through artificial intelligence systems V. Varshavska [9], in her works, examined the theoretical and applied problems of linguistics in more detail and emphasized the structural features of morphological analysis as the most important type of indexing, which assigns each word form from the text its morphological characteristic. O. Shypshynska [10] drew attention to the need to use automated morphological analysis to determine the specifics of synthesis programs, including the researcher emphasizing the need for knowledge from a separate subject area used in these models. In addition, in her works [10], the scientist independently developed a system of automated morphological analysis, which allows the coding of word forms to further use the results as input information for syntactic or lexical analyses. In addition to the needs of linguistics, morphological analysis can also serve the purposes of other sciences. For example, scientists L. M. Shulhina, Ye. V. Hnitetskyi [11] uses it to

solve educational tasks to identify discrepancies between the ones approved in regulatory documents and the actual characteristics of education seekers' value orientations.

Regarding the issues of using morphological analysis as a research tool in banking or the economic sphere, the study by I. O. Hordieieva [12] is significant, which obtained evidence of the significance and presence of different types of the closeness of the connection between competitive strategies and phases based on the comparison of morphological statements life cycle of the organization. Also, many banking sector scientists use morphological analysis to form the author's concepts according to the key components of the resulting factors. Thus, in the works of I. M. Chmutova and V. Yu. Biliaieva [13, 14], the concept of "financial stability of the bank" was generalized. Its connection with related categories was analyzed to determine the most important signs of bank stability. In turn, O. M. Kolodizev, and O. V. Kotsyuba [15] use the results of a morphological analysis of the essence of the concept of "compliance" as a basis for harmonizing legislation in matters of bank financial stability. Despite the high diversity and interest in the method of morphological analysis by modern researchers in aspects of the application, including in the banking sphere, the topic remains not sufficiently disclosed. It needs a practical addition, which will allow not only to expand the functions of computer linguistics but also solve the banking problems of the demand for financial services by customers, for example, in the process of personalizing card services in the bank.

3. Database for morphological analysis

The popularity of the morphological analysis method in Ukraine and the world is confirmed not only by the publication activity of scientists but also by the level of public interest in this tool, measured using the Google Trends web application [16]. Having formed the request "морфологічний аналіз" in Ukrainian and "morphological analysis" in English, the search frequency of word combinations in Ukraine and the world, respectively, is determined. The search results in the Google system are shown in Fig. 1.
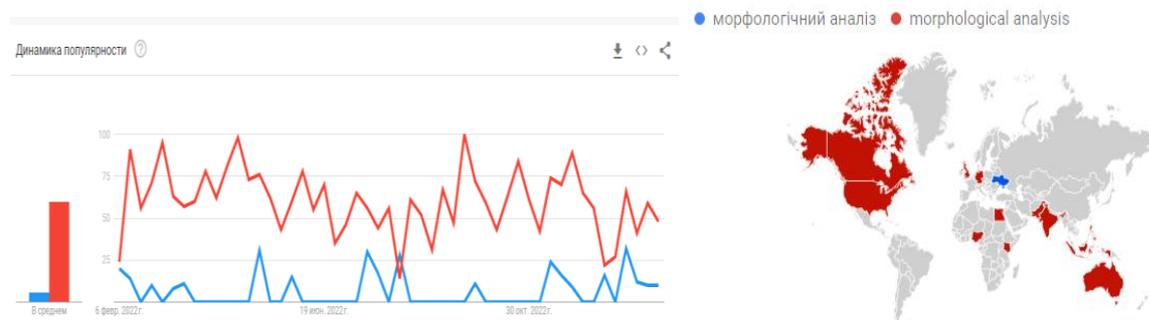

Figure 1: The level of interest in morphological analysis in Ukraine and the world

As can be seen from fig. 1, during 2022 the level of interest in the topic of morphological analysis in the world was in the range of 70 to 100 points according to the index of search dynamics. On the other hand, in Ukraine, this level is half as low (blue line), which indicates the prospects of applying the method in the country and the possibility of integrating morphological analysis to solve banking tasks. Thus, the formation of a database for morphological analysis should be carried out, considering the level of popularization of the issue in the country. As of January 2023, the overall average demand indicator in the morphological analysis was two requests per month, making it possible to form a sample for further research in the number of two interviewed customers.

The formed database for the morphological analysis includes the evaluation criteria of the bank's card projects (F_1 -F_6), which are defined by the Law of Ukraine "On Payment Services" [17] and takes into account the analysis of the bank's card programs, which presents the types of service parameters related to the process of individualizing card services in a financial institution. The classification is based on the principle of interrelationships between the parameters of the individualization of card services. However, to confirm the obtained structure and highlight significant combinations, it is

necessary to conduct an expert evaluation, which aims to obtain an optimal list of personal card products based on the client's demand [18]. Also, the need to apply such an assessment is due to the novelty of the investigated problem and the lack of information regarding the criteria for individualizing the card product.

The database was created based on customers' needs, which is characterized as follows: it is necessary to determine which type of service is most interesting for them and evaluate its positive or negative impact on deciding to use a certain financial service. The results of the customer survey on classification parameters for morphological analysis are shown in Table 1.

Table 1
An example of the morphological classification of the parameters of the task of deepening the individualization of the bank's card services

Financial services of the card product	Non-financial card product services	Additional financial services	Non-financial services of bank partners	Options for client settings	Customer loyalty tools
F1	F2	F3	F4	F5	F6
Payment	Card issue	Currency exchange	Insurance	Period	Bonus
Withdrawal of cash		Investment	Connection	Limit	Cashback
Replenishment	Receipt	Credit	Utility payments	Currency	Mark
Transfer to the card	SMS banking	Term deposit	Sport	Sum	Discount
	Extract		Parking	Date	Gift
International transfer	Additional card		Gas station	Frequency of operations	Additional interest
Overdraft	Locking		Financial assistant	Template	Grace period
Deposit upon request	Unlocking		Buying tickets		Privilege
	Setting the PIN code				
	Annual maintenance		Concierge service		
	Consolidation of accounts				

Source: based on [17]

Table. 1 shows six parameters with a list of alternatives singled out in the morphological classification. Classification by the morphological analysis method, the bank can solve various types of tasks for the individualization of card services, in particular: the formation of options for the customer to set up standard banking services of the payment card (combinations of alternatives of parameters F1 and F5); formation of offers of other banking and non-banking services to the card product (combinations of alternatives of parameters F1, F2, and F3, F4); forming the conditions of an individual loyalty program by type of services (alternative combinations of parameters F1, F2, F3, F4, and F6), etc. Based on sorting out combinations of alternatives according to the morphological table, solutions are obtained that are evaluated and chosen individually by customers.

4. Application of morphological analysis for individualization of bank financial services (method)

The development of the bank's proposals for the individualization of card services can be carried out, as mentioned above, using such a linguistic method as morphological analysis. The Swiss astrophysicist developed this universal and flexible method F. Zwicky, for researching the

relationships of elements in complex objects (technology, product, system, process) and finding solutions for their improvement or building new ones [19, 20, 21].

The essence of the method of morphological analysis is the streamlining of the process of proposing and considering different options for solving the problem. The method consists of constructing a field of all possible combinations by selecting the object's structural or functional morphological features (parameters). A sign (parameter) can describe an element, function, sub-process or other components of the object on which the solution to the problem depends.

A set of options or alternatives is made for each parameter. Parameters with alternatives are arranged as a morphological table, sometimes called a morphological box (box or matrix). The morphological table allows you to build a search field through alternatives. The obtained combinations reveal new options for solving the problem, which might not have been obvious. For clarity of application of morphological analysis, its implementation algorithm is presented in a general form by steps, which are divided into stages of evaluation of alternatives (Figure 2), which allows you to organize the research process by method and delimit it concerning the decision-making procedure regarding the optimal choice of the result.
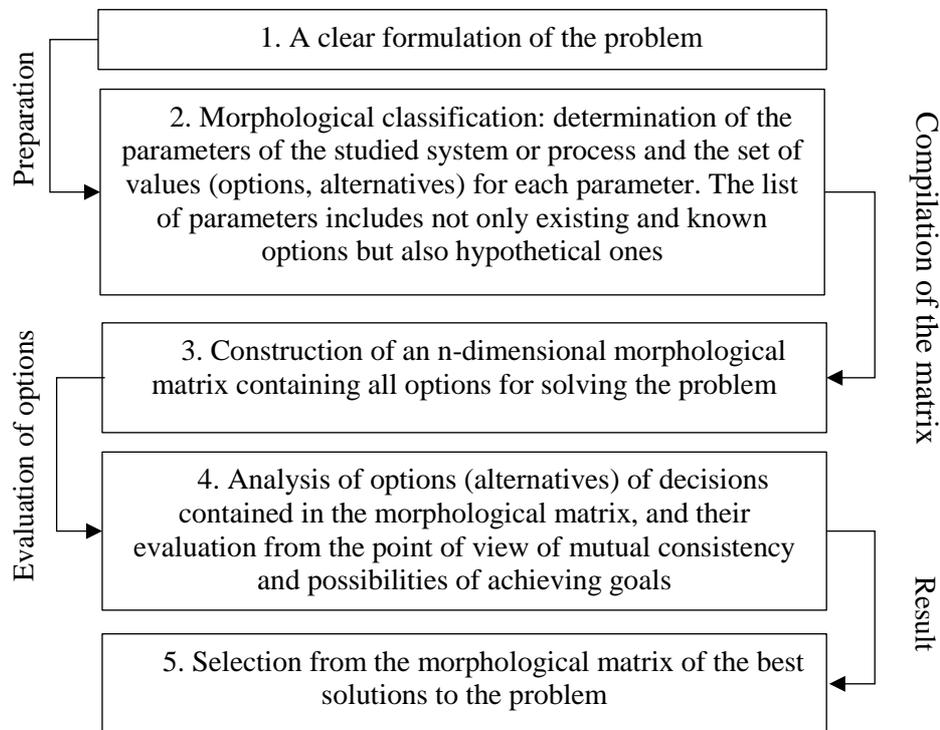

Figure 2: Agglomeration of morphological analysis
Source: based on [20]

As can be seen from fig. 2, all of the above steps of morphological analysis require the use of a systematic and creative approach, even in formulating the problem, compiling a list of parameters of the researched object, and finding alternatives for each of the parameters. The general view of the morphological table (classification) is shown in Figure 3.

Task parameters					
F_1	F_2	...	F_i	...	F_n
$a_1^{(1)}$	$a_1^{(2)}$	...	$a_1^{(i)}$	...	$a_1^{(n)}$
$a_2^{(1)}$	$a_2^{(2)}$	...	$a_2^{(i)}$	...	$a_2^{(n)}$
...	...	...	...	...	...

...	...	...	$a_j^{(i)}$	...	...
...	...	...	...	...	...
$a_{k1}^{(1)}$	$a_{k2}^{(2)}$	...	$a_{ki}^{(i)}$	...	$a_{kn}^{(n)}$

Figure 3: General view of morphological classification

Source: based on [18]

In the classification schematically depicted in a general form in Fig. 3, it is shown that all n parameters (morphological features) have a different number of alternatives (variants). F_i is the i_{th} parameter of the problem, $a_j (i)$ is the j_{th} alternative of the i_{th} parameter. The f_i parameter contains k_i alternatives. The total number of all possible decision options N equals to [18] :

$$N = \prod_{i=1}^{n} k_i. \tag{1}$$

The next stage is a systematic study of all possible options and an expert assessment of each decision option's consistency and functional value. Miller's scale [14] can be used to evaluate alternatives: experts assign a score from (-1) to $(+1)$ to each combination of parameter values, which characterizes the degree of consistency of the combination concerning the selected criterion. A score (-1) means absolute inconsistency of the alternatives in the combination, score $(+1)$ – means complete consistency.

The received answers from experts are processed, and a numerical matrix of mutual consistency of combinations is formed to determine the most appropriate alternatives. Morphological classification, in combination with a matrix of mutual consistency, provides a highly flexible model for decision-making. The model can be used separately to analyze the relationships between the alternatives of the parameters of the object under study, the probability of their implementation or their joint effectiveness when combined. The model can be taken as a basis for a new morphological analysis of another problem of the same object.

5. Individualization of banking services (experiment)

For the individualization of banking services, the possibility of applying the method of morphological analysis on the example of surveys of customers, potential customers of any bank, which aims to satisfy them in the personal program of the card product, is considered. The most important criteria among F_1 - F_6 were determined through interviews based on the collected parameters (Table 1) and compared to each other for consistency. Combinations of criteria F_1 / F_5 and F_1 / F_6, F_2 / F_4, F_4 / F_6 are chosen by customers according to personal preferences to form an individual card product. Examples of the survey are given in Table 2 and Table 3.

Table 2

First customer survey results

Non-financial card product services / Options for client settings		Non-financial services of bank partners / Customer loyalty tools	
$F1\_ / F_5$		$F1\_ / F_6$	
Payment / Period	+1	Payment / Bonus	+1
Cash withdrawal / Limit	+1	Cash withdrawal / Cashback	+1
Replenishment / Currency	0	Replenishment / Bal	0
Transfer to the card / Amount	-1	Transfer to the card / Discount	-1
International transfer / Date	-1	International transfer / Gift	0
Overdraft / Frequency of operations	-1	Overdraft / Additional interest	0
Demand deposit / Template	-1	Demand deposit / Benefit	0
In total	-2		+1

Source: compiled by the authors

Table 2 shows the priority areas of personalization for the first client are the combination of

financial services with loyalty tools (+1). In addition, the program desired by the client should include interdependent processes of making payments and bonuses for them and contain cashback for cash withdrawals. On the other hand, a potential client negatively perceives a discount for transferring to the card, indicating the need to exclude such a function when forming a personal program.

Table 3

The results of the survey of the second customer

Financial services of the card product / Non-financial services of the bank's partners		Financial services of the card product / Customer loyalty tools	
$F2\_/F_4$		$F4\_/F_6$	
Issue of card / Insurance	0	Insurance / Bonus	+1
Receipt / Communication	0	Contact / Cashback	+1
SMS- banking / Utility payments	+1	Utility payments / Bal	+1
Excerpt / Sports	-1	Sports / Discount	-1
Additional card / Parking, gas station	-1	Parking, gas station / Gift	0
Locking, unlocking / Financial assistant	+1	Financial assistant / Additional interest	+1
Annual maintenance / Concierge service	+1	Concierge service / Benefit	0
In total	+1		+3

Source: compiled by the authors

According to the Table 3, the priority areas of personalization for the second client are the formation of the conditions of an individual loyalty program by types of services (+3). To meet the client's needs in the individualization of card services, it is necessary to combine the accrual of bonuses when carrying out insurance, cashback for communication, and accrual of points for paying utility bills in the bank. In addition, the personal program must consider additional fees for using the paid service of a 24-hour financial assistant.

The carried out morphological analysis of the personalization of card services in the bank corresponds to the purpose of banking activity in terms of optimizing customer service and allows determining their priorities for forming a special loyalty program. As it was found out during the survey, individualization is organized by changing the service and the list of conditions for its provision. Considering the fact that most banks of Ukraine have their own Internet service and a corresponding mobile application, the individualization of the card service can be done by the client through optional selection of components of the card product: disconnection or connection of services in "one-click", setting conditions. Self-customization by the consumer of the product line, setting of operations and conditions, and selection of necessary additional banking and non-banking services in the mobile application of one's phone will undoubtedly increase customer loyalty to a particular bank and increase income.

However, introducing new banking technologies using payment cards requires a balanced systemic approach. Innovations in payment card services must be understandable and convenient to customers. In addition, it is necessary to fulfill such requirements for card operations as their efficiency, promptness, reliability, and security, the implementation of which is possible through automatic decision-making regarding the selection of card service conditions. Therefore, the results of the morphological analysis can serve as input data for a more in-depth study of the personalization of bank card services related to the automation of the process of individualizing card services for the bank client to speed up the client's decision-making process.

Thus, automated decision-making programs are often used to process previously further obtained research results [22, 23]. One of the possible ways to implement these tasks is to implement Decision Making Helper technology [24, 25]. Decision Making Helper© is a universal decision support system (software product) that allows you to select any object according to the specified criteria. For applying this software product within the scope of research tasks, a significant indicator was additionally

introduced for each criterion F_1 - F_6. This software product assesses importance on a differential scale from 1 to 5 (from low to high). It is also necessary to evaluate the importance of the criteria of each option from (-5) "low level" to (+5) "high level", 0 - neutral level. Customer ratings are entered into the program indirectly, allowing you to get a result at the average industry level. Decision Making Helper automatically calculates the value of the decision for each alternative, in percentages from (-100%) to (+100%) and verbally "unsatisfactory / quite unsatisfactory/neutral / quite positive/positive" [26]. In the example of the results of the Table 2, the process of determining the best alternative when developing a loyalty program for the first client is demonstrated (Fig. 4).

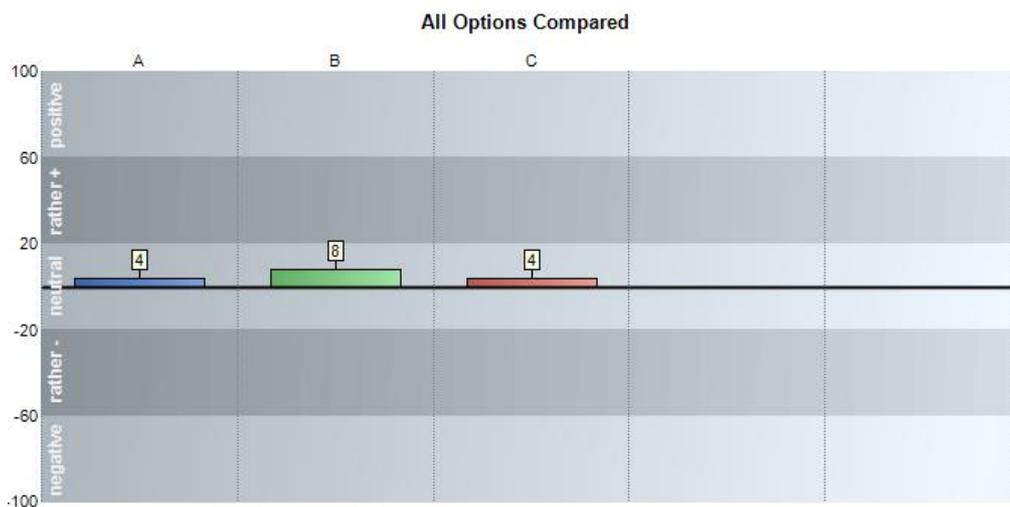| Criteria	Option A	Option B	Option C
Title	Платіж	Знаття готівки	Поповнення
Score	+4%	+8%	+4%
Ranking	neutral	neutral	neutral
1. Період Importance 4 of 5	Rating +1 of ±5	Rating 0 of ±5	Rating +1 of ±5
2. Ліміт Importance 3 of 5	Rating +1 of ±5	Rating +2 of ±5	Rating +1 of ±5
3. Валюта Importance 2 of 5	Rating -1 of ±5	Rating +1 of ±5	Rating -1 of ±5

Figure 4: Processing results of the morphological analysis of determining the optimal combination of personal criteria of the card product by the Decision Making Helper program (the first client)
Source: compiled by the authors

According to the table. 4, for the first customer, the priority function of the loyalty program is changing the conditions of cash withdrawal, where, among other criteria, the period of interest-free withdraw has the most importance. Automating the decision-making process in the presence of a preliminary morphological analysis makes it possible to quickly and more deeply study the client's needs to determine the priority component of card service personalization. In the future, the agreed best options can be integrated into the functionality of the bank's mobile applications to directly form the personal program of the client's card product.

6. Conclusions

During the study, a customer survey was conducted, which became the input data for a morphological analysis regarding the personalization of the bank's card services. On concrete

examples, the priority of forming loyalty programs is determined, for example, the combination of criteria for non-financial services of a card product and options for client settings.

According to a practical example of the application of morphological analysis and its subsequent possible automated processing, it can be concluded that in order to achieve efficiency in the personalization of banking services, a wide list of all card account options of a financial and non-financial nature is needed, which will be systematized according to certain criteria. Implementing innovative methods of individualizing bank card services through the client's selection of the necessary set of operations from a wide range of financial institution capabilities is a priority direction for developing payment card services in the banking sector. However, for the competitive development of transactions with payment cards in the bank, it is important to implement a wide range of measures, including those based on modern technologies and innovations, focusing on providing customers with the most convenient services and high-quality card products.

In further research, it is worth paying attention to the promotion of innovations in the development of services of retail banking institutions [27], which would consider the recommendations of key international organizations to achieve a high level of customer expectations in service:

1. Follow what customers want. Ensure that the bank knows and acts according to what customers need and value; constantly look beyond the banking institution and financial industry to ensure alignment with the best customer experience in everyday life. Thinking outside the box is key to building a customer-centric business.

2. Perform innovative tasks energetically. Break down the changes into specific steps and develop a sequence of their implementation and implementation. Continue to evaluate whether the change was successful. Implement and analyze small changes that add to a significant and impactful transformation.

3. Take on today's challenges with resilience and determination, be ready to expect unexpected results, fail and learn while rapidly changing and improving innovation.

4. Keep the opportunity for the client to communicate with bank employees. While introducing new technologies such as artificial intelligence and automation will likely be critical to developing a more seamless customer experience, remember that you also need to preserve the real customer experience.

5. Use new technologies. Explore new technologies to help you serve customers better or organize your business more easily. Experiment with the possibilities available through the cloud, machine learning, and advances in data.

These recommendations should be considered through the application method of morphological analysis during the development and evaluation of customers of decisions regarding innovative innovations of the bank. Also, the observance of such principles will allow a deeper assessment of the prospects of satisfying the individual needs of customers using linguistic systems aimed at streamlining the nomination process and considering various options for solving the problem.

Artificial intelligence innovations are an integral part of Industry 5.0, which aims to integrate automation and human intelligence [28]. Further research should be aimed at exploring and describing the application of artificial intelligence in the banking industry, the use of artificial intelligence in banks to better serve customers by providing them with a personalized experience.

7. Acknowledgements

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