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MACHINE LEARNING ALGORITHMS APPLIED IN A SERVICE PLATFORM FOR PROFESSIONAL SERVICES CASE STUDY

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Abstract

This paper presents alternatives for the implementation of a Market Place called “Clic”, considering the technological infrastructure necessary for its operation based on Machine Learning algorithms. During the elaboration of this paper, surveys were conducted to both users qualified as "Clients" and "Professionals" about the intentionality of use and the probability of payment for the publication of their services in the platform. This paper presents the recommended steps for the composition of the Clic company, the way the information is collected for Machine Learning and the data obtained from the users, the recommended environments for the development of the application, the results of the surveys carried out, the feasibility of the Machine Learning algorithm, numerical data of financial feasibility for the execution of the project.

Key words

Digital Transformation, Professionals, Machine Learning, Marketplace, Service Platform.

1. Introduction

In Peru, there is still no web-based portal of professionals and technicians that allows direct contact with customers who need services ranging from psychological care, math classes, legal guidance or even requesting home repairs.

For this reason, the present research describes a technological solution for a Marketplace where a search can be made among options of professionals, comparing prices and qualifications, making the payment online and coordinating the attention of the service in a virtual way. Likewise, the Marketplace "Clic" referred to above, will allow professionals to have greater visibility and opportunity to offer their services in a reliable, safe and easy way. The functioning of the Marketplace will be powered by preference algorithms that use machine learning to make personalized recommendations for both clients and professionals considering aspects such as score, location, need or interest.

The importance of this project is that it can help reduce the unemployment gap in metropolitan Lima, currently estimated at 443,600 people and increase the income of professionals according to the (INEI - National Institute of Statistics and Informatics 2023).

1.1 Objectives

Overall objective

To give visibility to the potential reception of a marketplace in the Lima market where qualified professional services are offered.

Specific objectives

- Present a recommendation system that could be considered to match requirements and profiles considering Machine Learning algorithms.
- Establish implementation costs for the project, as well as sources of income to make the project viable in the Peruvian market.

2. Literature Review

The authors Cañazaka, et al. (2018) details how a virtual platform for independent professionals and small business can generate revenue outside regular working hours. Among the categories of all professional could be graphic design, translation, web programming, digital marketing, technology equipment maintenance, legal, accounting and finance consulting, among others. Health-related services such as psychology, medicine or veterinary medicine are not included. In addition, proposes it also uses a pay per ad system based on exposure and additional functionalities such as entering more than one request, possibility to get ratings/recommendations and more.

For Minaya (2021) a business plan to determine the viability of creating a digital platform of Home's general services using Gamification to retain clients. It is divided into 4 categories: rewards, competitions, socialization, and dynamics. Thus, it consists of turning the app into a game using rating stars, comments, badges, among other tools that Clic could have. What is also interesting is that it is focused on a category that Clic wants to include, which is home services focused on A, B and C segment customers. At the revenue flow level, it also contemplates generating cash from Subscription, Commission per service and Advertising.

Movie recommendations is powered with the Collaborative Filtering algorithm for the article by Fang et al. (2022) which is the most widely used by technology companies in the recommendation system in which it assumes that users with similar interests may like similar products and relies on data such as viewing history, user rating to other movies and more *inputs* to be effective in recommending the target user. This is important for Clic because it will use machine learning algorithms.

The thesis of Rivera (2022) on an air traffic flow control system for airports in which he provides details on the costs associated with an application in Firebase as the one proposed in Clic along with details of why he goes with that platform and compares it with Heroku as well. In addition, he provides information on the use of the Design Thinking methodology in the solution of problems that arise in the project.

Alvarez de la Vega, J. et al (2022) describes the problems, from the freelancers' point of view, with the mastery and use of applications such as Upwork and Fiverr. This article describes results obtained by conducting five focus groups with freelancers to identify design benefits of the platforms and identify areas of concern that are detrimental to their work. The article mentions that, for research purposes, a fictitious platform was simulated where, in a focus group among freelancers, certain important aspects related to the platform were discussed. Among these aspects, there is the feeling that it is difficult to start having projects on a freelance platform, that is, when you create your account, register and start with the configuration of your profile. For this, it is commented that some "Apprenticeship Program" is seen in a very positive way. It is also very important that in the freelancer's profile there can be some kind of verification of the years of experience you have in the job or field.

For Barrett et al. (2016), an important area of interest for the present project is raised and what value-added features the community around a platform usually values. In our case, Clic is developed through Client and Professional profile users who interact with each other. The community that is formed after these interactions is of interest because it will allow us to make better decisions for the ease of hosting the Marketplace. The article gathers information on 38 interviews that were conducted regarding different axes used in a fictitious platform. As results, it was found that, to have a good rating system, it was first necessary to distinguish the information shared and uploaded by the user in profiles, so that it shows the target audience to which it points. It is also mentioned about the importance of giving users the ability to choose and evaluate the metrics, since they are the ones who have had direct contact with the service. Finally, it is emphasized that the creation of value in the communities must be done through online social material through company strategies, digital platforms and considering the stakeholders, all in a digital environment that allows association with the target community.

A chatbot is important to every app especially a medical one that assess parents about children's regular diseases. In the thesis made by Benate (2020), a Natural Language Processing technique is used with a Naïve Bayes model to classify each intention the user has behind the inquiry and using a Random Forest model that can result in a pre-diagnostic if the minor has higher possibilities to have a certain disease or not with a 95% of accuracy for an ill child. This is an important topic, as a user can be guided through the chatbot to specific medical experts in Clic app.

Another great feature for the app could be that according to the user need of IT professionals, the platform can recommend certain people with specific required technological skills. The thesis by Sanchez (2020), also uses NLP and classification algorithms such as Naïve Bayes too but combined with Fuzzy String Searching, Jaro-Winkler Algorithm and Levenshtein Distance. Each TI skill can be represented in a vector that through similarity analysis and grouped skills can output a list of recommended TI workers that can fit the User needs.

In the article by Sühr et al. (2021), a discussion is opened on how platforms like Clic but in the North American market, use algorithms to make the "match" corresponding to their business. However, the purpose of this research is to ensure that programmed algorithms are not taking away visibility opportunities from groups without much representation. They seek answers to the questions of whether there is bias for some jobs and whether some employers search with a gender bias. They analyzed different sources of information regarding gender bias in hiring platforms such as job context, candidate profile and inherent employer bias. It could be concluded in the study that, at the time of building the algorithm for Clic, a fair ranking can be obtained that helps underrepresented groups by giving an important weight to the candidate's profile, so that the algorithm can present on the respective platforms according to what is stated in the profile.

In the paper developed by Cem et al. (2019), suggest that to consider fair metrics when elaborating the Click algorithm. In this paper they mention that they managed to improve search queries with representative results without affecting business metrics. Likewise, they also warn that when feeding the information so that the machine can learn through the prediction models, it should be considered that the machine itself, with erroneous or biased data, could learn and even reinforce the recruitment biases that may be present. The paper presents a framework for quantifying and mitigating biases created by the algorithm in systems designed to evaluate and classify profiles.

The authors Waldkirch et al. (2019), tries to understand how HR administration activities are executed within the world of digital platforms from the perspective of workers. Among the considerations to consider for the HR administration activity for Clic, in the article they recommend, among their conclusions, to develop new mixed methodologies that are distinguished from the HR practices of traditional organizations, to have a hybrid methodology that prioritizes productivity oriented to the achievement of objectives and some elements of traditional control.

In the scientific paper by Faruk et al. (2022) also uses preference algorithms using K-nearest neighbors used in book recommendations in the Amazon Kindle Store Book which is used as the basis for the current model. It works by recommending items to users based on preferences of users with similar characteristics. Rawat et al. (2022) discusses, in their article, the development stages and different categories of an AI recommendation system using user preference patterns. This is important because it allows to understand the steps to be considered within the project Gantt, as well as the challenges and solutions that this implies together with current trends in recommendation algorithms.

For Boratto et al. (2022), it is important to increase the engagement that professionals generate with users during the time they spend chatting or calling with them. To do this, end-user-based algorithms can be used to help the practitioner understand what type of customer they are serving and target their strategy to what they need best. The article considers an e-coaching system for brokers, the idea being that users are equally served by coaches. First, it uses an algorithm to rank users and group them according to their historical performance in a second algorithm.

3. Methods

Currently in the Lima market, there is a trend towards the use of applications or digital services to facilitate the daily work of the population, especially in sectors A, B and C. Businesses such as Fiverr, Agéndalo.IO and LinkedIn are good examples of companies that, within their portfolio of products and services, can connect professionals with their respective customers at a superficial level. 53% of professionals in the NSE A, 31% NSE B and 24% in the NSE C (Ipsos Peru, 2020) have an account on LinkedIn and use it to contact companies and apply for jobs. Fiverr's clients, mostly freelancers, interact with clients around the world offering their services in English and the target audience of (Agéndalo 2023) are Peruvians looking to organize and simplify procedures related to nutrition, therapy, or counseling sessions. Although Fiverr could be a direct competitor to what Clic offers, the freelance services that can be found on its page are in English and, being Peru a developing country whose main language is Spanish, the language barrier is a determining factor when doing business in the country.

On the other hand, Agéndalo has a more specific focus on physical and mental health professionals and does not take advantage of the potential of the rest of the university and non-university professions that can be found in the capital. Finally, LinkedIn focuses, mostly, on connecting professionals with companies that may require it. However, it leaves aside those professions that can decide on their attention capacity and the flow of income they expect to receive, such as freelancers, communicators or graphic designers, who

usually have multiple companies to which they provide services through fees. Even conventional careers such as engineering, architecture, medicine, or law, may have odd jobs that they can do in their spare time, balancing additional services they perform with their work in a company while on payroll. In conclusion, currently, there is not a strong competitor for this marketplace project.

On another hand, for the implementation of an application such as Clic, four major stages must be considered.

Stage 1: The Business Planning stage must first be accompanied by the objective, vision, mission of the company and its constitution. An analysis of the market and target audience must be carried out to make a projection of the expected demand for at least 5 years of operation for the business, as well as the definition of the prices to be offered for the use of the application both for professionals who publish in it and for clients who seek to satisfy their needs. Additionally, at this stage it should be defined what would be the ideal MVP.

Stage 2: Construction of IT and Necessary processes, we illustrate all systems related to the correct functioning of the Professionals and Users System Flow, both are shown in Figures 1 and 2.

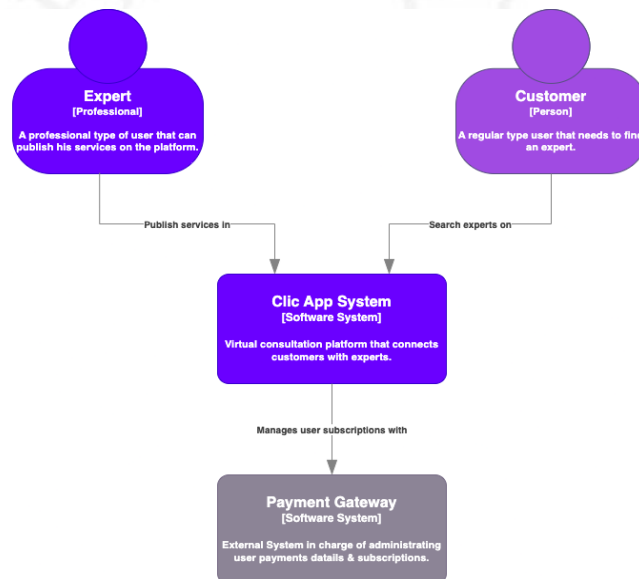


Figure 1. System Flow of Clic app on C4 - Container layer

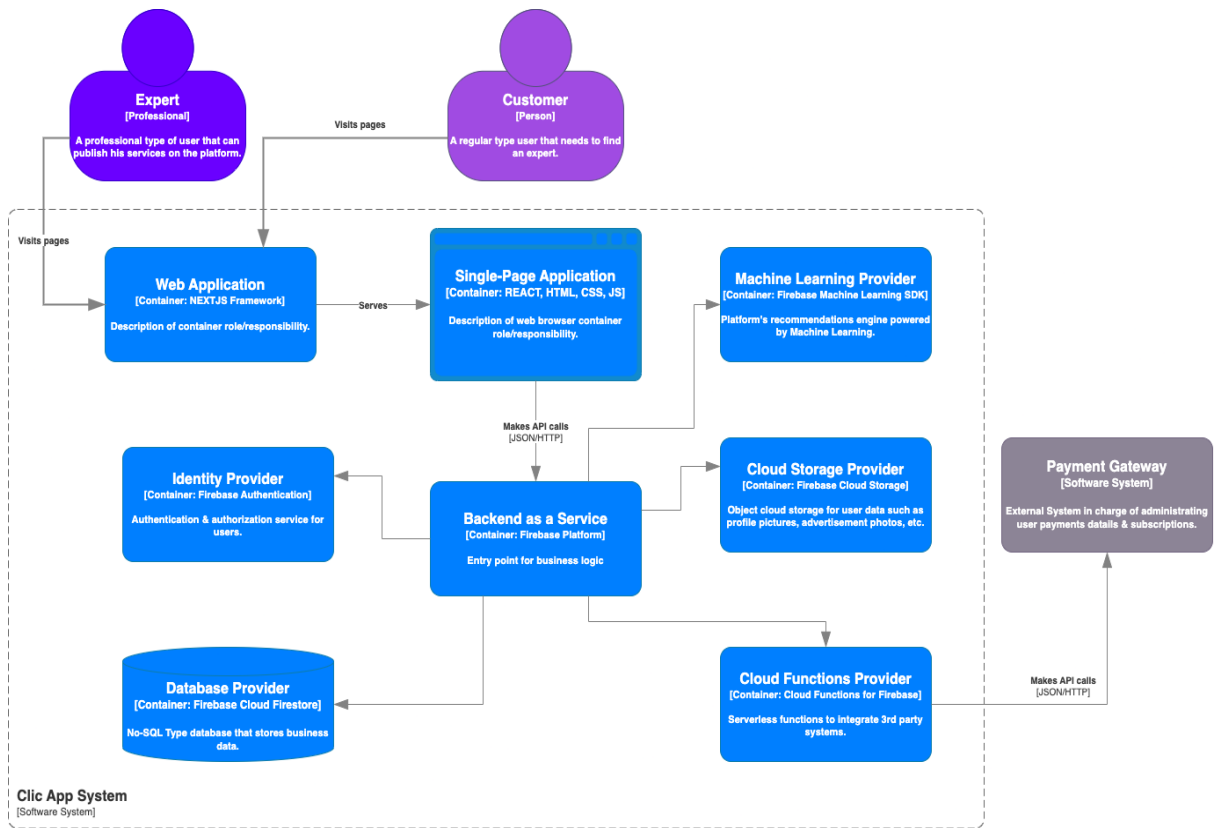


Figure 2. System Flow of Clic app on C4 - Context Layer

Stage 3: The Development of the project that consist in three main steps:

- Initial Development (MVP): In this environment all the code will be created and validated that it runs according to what is needed according to the MVP.
- QA: within this environment, the IT team will be used for Clic testing, which will consist of stress tests, load tests, black box, white box, user experience (UX), integration, unit testing, among others, which will be scheduled for periodic implementation to ensure that the flow works correctly and that everything necessary for its scaling is in place.
- Production: once everything is validated to be working correctly, including the payment gateway in Sandbox mode, the site goes into production, where it is Live for the public on the web, Google Store and App Store.

Stage 4: The Continuous service improvement and maintenance, are adjustments to the application depending on bugs or improvements that users have been able to recommend through the comments section of the corresponding store. Also, according to growth, the increase of payment for the use of Google Firebase will be evaluated and a review of objectives, mission and vision should be done at least annually, to continue with the growth and strengthening of the business.

Case Study

Peru's Ministry of Economics and Finance, MINSA (2022) Multiyear Macroeconomic Framework, explains that in terms of GDP, the Peruvian economy will increase in 3.3% on average for the next coming years mainly due to higher private consumption, resilience of exports and a greater boost to public investment along with measures to be implemented. This news provides a favorable climate for the demand of services such as Clic due to a stable and growing economic outlook.

There has been an increase in healthcare prices in Peru, among which are mental health risk. However, Gestion (2019) in the Latin American Medical Trends Report, indicates that almost "60% of insurers are actively investing in educating the user. Thus, virtual medical consultations/telemedicine continues to be an innovative solution to provide a high quality of health, while minimizing operating costs." This impulse

on the part of insurers could be key for them to opt to have a virtual space within Clic that they manage directly.

This is a project that was tested and launched in real life in 2020, finalist of the Primer Paso Entrepreneurship Program from the University of Lima (2021).

4. Data Collection

Two surveys were carried out in which aspects such as behaviors and conducts on the application were considered, as well as control questions that will help us to predict the intentionality and calculation of demand for Clic both for those users who will use the "Clic Professionals" and "Clic Users" interfaces. To determine the number of surveys to be applied to obtain representative data, the following infinite population formula was applied:

$$n = \frac{Z^2 \times p(1 - p)}{e^2}$$

Where:

n= number of the sample to be obtained

p= success rate, probability estimated a priori with a value of 0.5.

z= 90% confidence level with a z of 1.645.

e= estimation error of 0.1 (+/- 10%)

Since there are more than 100,000 inhabitants of Metropolitan Lima and economically active people, according to the previous points, it is considered that there is an infinite population.

To reach a representative sample, we had to carry out at least 67.65 surveys of both clients and professionals.

In the case of Professionals, 84 surveys were collected, and with respect to clients, 96 surveys were collected, of which the regularity with which they usually access the services of professionals (psychologists, lawyers, veterinarians, doctors, among others) during the year.

As mentioned above, a supervised Machine Learning system will be used, since the task will be to predict a target or in this case to predict if a type of ad that a customer is shown in the "Recommended for you" section generates a purchase. The information will be based on important features such as account activity, past ad clicks, time in Category, rebound rate by Categories, etc. In addition, it is monitored because the model will be trained and calibrated with new information that will be added in certain periods of time. An important point to consider is that the use of Firebase ML allows the implementation of a customized model of which, in order not to go for the paid version, it is necessary to be as efficient as possible about the amount of computational resources needed (CPU, memory space, disk space, etc.). The objective of the Machine Learning model is to predict that an interesting listing of ads in the "Recommended for you" section will generate a purchase according to the type of user. The main Open-Source tool is Google Tensorflow (2020), which incorporates a library of recommendation models. The technology company has been exploring new Deep-learning techniques in recent years to provide a better recommendation system with multi-tasking learning, reinforced learning, better user representations and Fairness Indicators that lead to its product Tensorflow Recommenders (TFRS), which is based on TensorFlow 2.x and Keras and is also compatible with Google Firebase 2023.

The following figure details the architecture of the neural network model to be used in Google TensorFlow (2022), which can be based on models such as Hillstrom's model with data from 64,000 customers who last shopped in twelve months. These customers participated in an email test to measure conversion:

- 1/3 were randomly selected to receive an email campaign with recommended products for men.
- 1/3 were randomly selected to receive an email campaign with recommended products for women.
- 1/3 were randomly chosen not to receive an email campaign.

Two weeks after the e-mail campaign, we followed up on the results and seek to analyze whether the e-mail campaign with recommendations for men or women was successful. Based on such a model for both mailing and web campaigns, the most important Datasets are first assembled from which the necessary information can be obtained as in Figure 3.

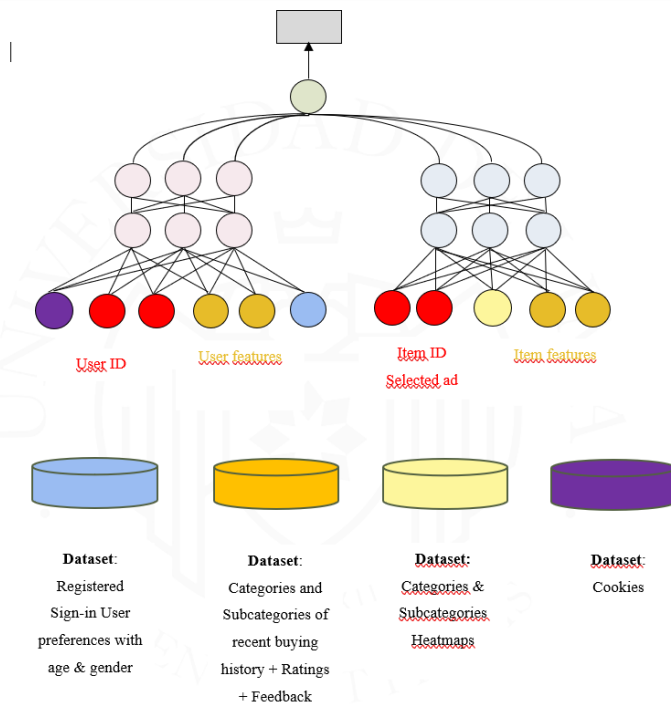


Figure 3. Recommendations model architecture based on Google Tensorflow Diagram.

The collection of the necessary information to feed the machine learning model could be performed at the following moments in the registration, account activation and at the publishing the advertisement processes. In the case of the User, when entering the Clic-App landing page, he/she should look for a registration option where he/she will be asked to fill in personal data such as: Full Name and Surname, Type and Number of Identification Document (ID Card, EC, Passport), Pseudonym (optional), Date of Birth, Cell Phone Number, Gender, Address (also with the option of marking it on the map), District of residence, City of Residence, E-mail, Password and confirmation of the same (considering that it must have at least 10 characters, combined with special characters and numbers). To feed back to the Machine Learning algorithm, the client will select 03 professions of interest for which you would like recommendations from Clic (Psychology, Medicine, Dentistry, Veterinary, Graphic Design, Communication, Law, Accounting, among others) and select 03 topics of interest related to the chosen professions. E.g.: In case of selecting Law, you could select Criminal Law, Family Law, Labor Law, Corporate Law, Commercial Law, Consumer Protection, etc.).

In the case of Professionals, you should enter the Clic-App landing page, look for the registration option and choose the option to register as a Professional and fill out the personal data section such as: Full Name and Surname, Type and Number of Identification Document (DNI, CE, Passport), Pseudonym (optional), Date of Birth, Cellular Number, Gender, Address (you will also have the option to mark it on the map), District of residence, City of Residence, E-mail, Bank where the money will be received and number of the bank account, Password and confirmation of this (considering it must have at least 10 characters, combined with special characters and numbers), Higher Education attended, College Degree and number (if applicable), College Degree and number (if applicable), Purser's Certificate of Education (if applicable). Password and confirmation of this (considering that it must have at least 10 characters, combined with special characters and numbers), Higher Education, Tuition and number (if applicable). Additionally, upload an image of the identity document described and Curriculum Vitae (Optional). When continuing to fill in the data, select, to feed back the algorithm, the areas of specialty in which you have experience/knowledge according to the higher education chosen. E.g.: In case of indicating that you studied Law, you could select specialty in Criminal Law, Family Law, Labor Law, Corporate Law, Commercial Law, Consumer Protection, etc.

Finally, information is collected from the publications during the process of publication of the advertisement when the professional enters the Clic platform through his/her account indicating his/her email and password, clicks on "Publish your advertisement" and fills in the required information, which can be: "About Me" section, CV upload, Upload of complementary documents (work certificates, letters of recommendation, among others), Profession, Specialties, Introductory video, tags for the profile, Choice of Avatar or photo upload, Upload of Banner (Photo), Reference Link (connect with LinkedIn or other

similar page according to the category it belongs to), Schedule Configuration/Connect with Hubspot, Type of attention: Virtual or face-to-face, Session price and estimate duration.

5. Results and discussion

5.1 Numerical results

After carrying out the surveys to both professionals and clients, the results obtained are presented. With respect to the intentionality of the professionals to use the application, the results were favorable. We have considered the ranges according to response. From 1 to 3 with respect to the registration of the application as a "No", with 7.14%. From 4 to 6 we considered it as "No decision", with 25% and from 7 and above we considered it as "Yes", with 67.86% according to Figure 4.

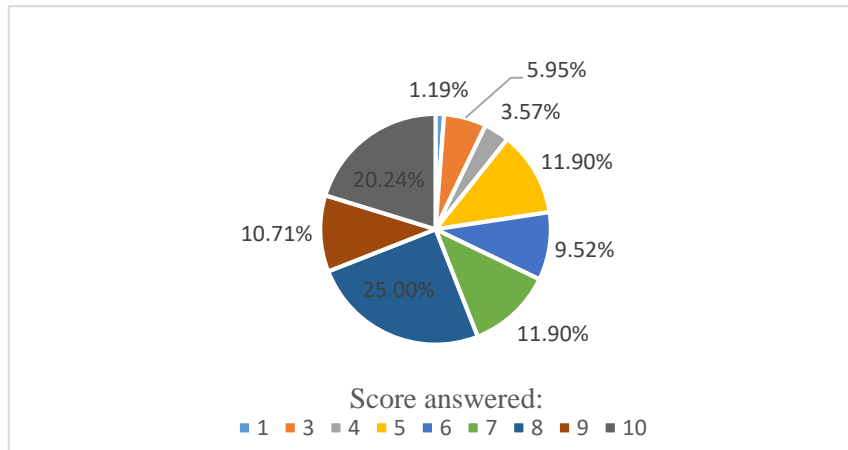


Figure 4. Platform-registration user interest.

Likewise, for the professionals, information was requested on the probability of monthly purchase to maintain their publication by marking options from 1 to 10. The following results were obtained: They marked option 1, 9.52%, option 2, 1.19%, option 3, 10.71%, option 4, 8.33%, option 5, 15.48%, option 6, 9.52%, option 7, 14.29%, option 8, 14.29%, option 9, 5.95% and option 10, 10.71%. The average probability of monthly payment of the professionals is calculated considering the sum of the pesos from those who checked option 6 onwards, obtaining the figure of 54.76%.

96 surveys were collected from which the regularity with which they usually access the services of professionals (psychologists, lawyers, veterinarians, doctors, among others) during the year, reflected in Figure 5.

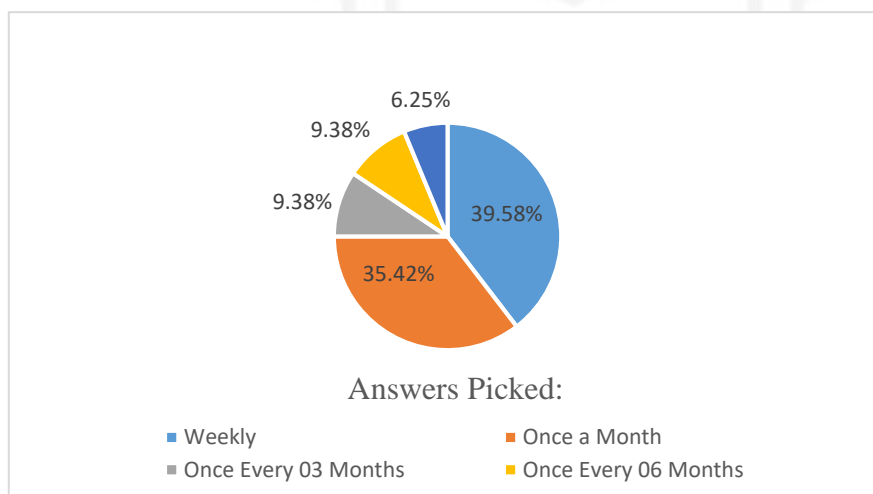


Figure 5. How regularly does a User usually contacts a Professional.

With the information collected, it is possible to know how many times services are used on an annual basis for the respondents as shown below on Table 1.

Table 1. Annual contact ratio for Services by Users.

Table 1 : Annual contact for Services by Users. Contact Regularity	Quantity	Annual Multiplier	Quantity of Annual Services	Contact Regularity Percentage	Annual Contacts for 96 persons
Weekly	38	52	1976	39.58%	782.17
Once a Month	34	12	408	35.42%	144.50
Once Every 03 Months	9	4	36	9.38%	3.38
Once Every 06 Months	9	2	18	9.38%	1.69
Annually	6	1	6	6.25%	0.38
Total			2444	100%	932.10

After performing the calculations, we have an approximate figure of 932 annual services requested by 96 people, so we can infer that a person could request, per year, 9.71 services. The results were favorable about the intentionality of the clients to use the application. We have considered the ranges according to the response. From 1 to 3 interest to register on of the application as a "No", with 6.25%, from 4 to 6 we consider it as "Undecided", with 23.96%, and from 7 and above we consider it as a "Yes", with 69.79% all showed on Figure 6.

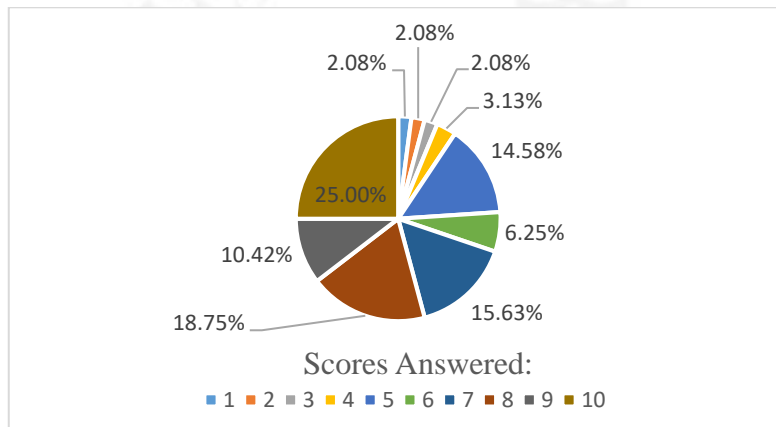


Figure 6. User interest on using a Platform to contact Professionals.

5.2 Graphical results

A review of the necessary business costs was made, detailing the aspects that we consider to be able to start the service in the first 05 years in relation to demand and growth of this, price of the service, i.e., commission per scheduled session and the cost of making the publication by the professional. Likewise, we have also considered the costs of the technological infrastructure, Google Firebase, e-mail, services necessary for the incorporation of the company such as legal services, accounting, physical infrastructure, and workers' salaries. The following operating cash flows were obtained: For years 0, 1, 2, 2, 3, 4 and 5 of the projects, the amounts in Peruvian currency were -43 639, -137 126, 35341, 220,360 436,808 and 635 882 respectively, as well as an NPV of S/.788,459 and an IRR of 82%.

After performing the economic flows related to the demand, price and costs of the service that can be offered with Clic, the following is the risk tornado graph of the project on Figure 7.

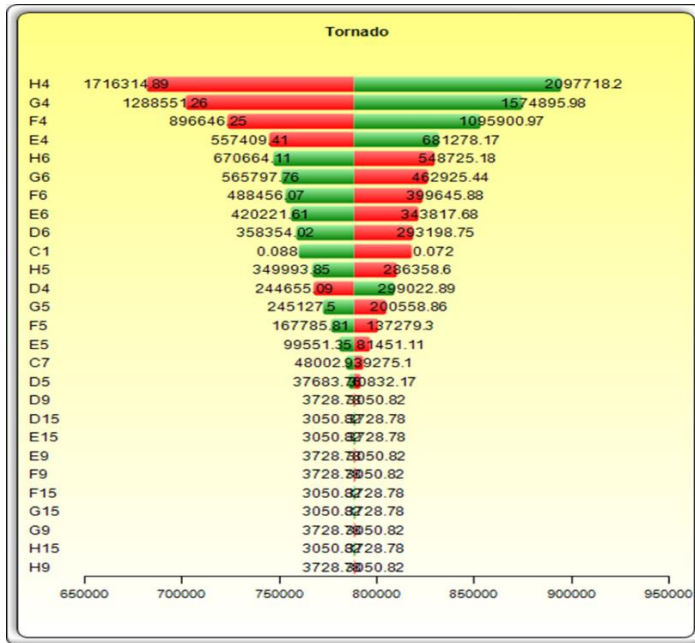


Figure 7. Risk Simulator tornado for the project.

5.3 Proposed improvements

In obtaining the classification for the various classes in the dataset, it is observed that the random forest method presents a better performance. The model designed using Orange software is shown in Figure 8. The model and data can be obtained from <https://bit.ly/3M3ow1L>.

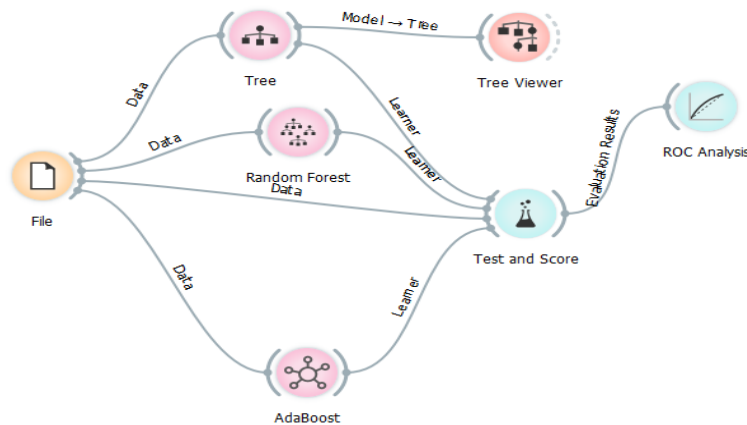


Figure 8. The training model.

5.4 Validation

Figure 10 shows the area under the curve (AUC) of the classification of the various types of service. This figure presents the classification of the accounting models and shows a good level of classification by the accuracy value of 90%.

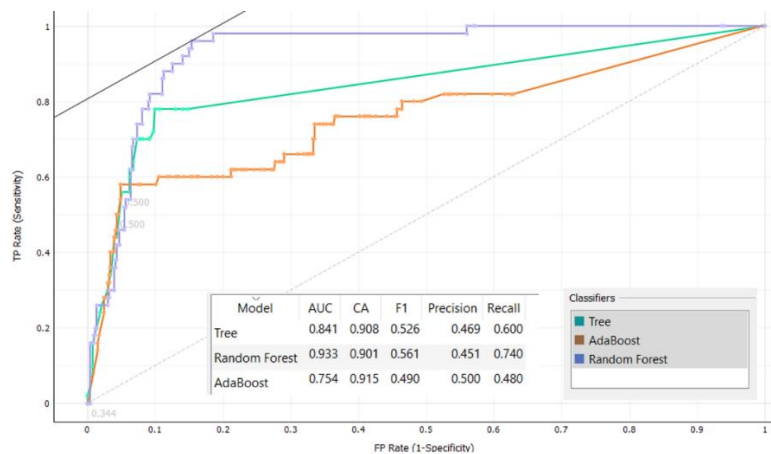


Figure 10. Classification of the Accounting models

6. Conclusion

After the investigations carried out, it can be concluded that the technology is available to perform the service sought by Clic for both Professionals and User using applications such as Google Firebase as the core of the service. It is also evident that there is labor in the market (professionals), who would use the service to attract customers in a faster and digital way by publishing the ad, as well as there is a market for such professionals who would register and allow a percentage commission for the execution of such service.

As there is no holistic and popularized service like Clic's currently in the peruvian market, continuous flexibility and specialization would be done to the marketplace as it increases in demand and market share and new jobs could be considered for the company, even an exit or the acquisition of other outsourced services, etc.

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● **Biographies**

Renato Alejandro Manrique Acha holds a bachelor's in industrial engineering at Universidad de Lima with a diploma on Business Analytics and Information Management at PUCP Centrum Católica and currently studying a Master in Fintech at Eada Business School Barcelona. Have worked last five years in on-demand services apps, fintech, ecommerce in companies such as Glovo, Entrepreneurial Finance Lab, Mercado Pago, and Mercado Libre.

Roger Elías Lescano Vargas holds a bachelor's in the industrial engineering program at the Universidad de Lima with specialty in Quality Systems and a master's in integrated management from CEREM International Business School. Integrated management systems such as those related to ISO 9001 and 27001 are of special interest to him and are topics to which he has devoted his working life.

José Antonio Taquía is a Doctoral Researcher from Universidad Nacional Mayor de San Marcos and holds a Msc. degree in Industrial Engineering from University of Lima. He is a member of the School of Engineering and Architecture teaching courses on quantitative methods, predictive analytics, and research methodology. In the private sector he was part of several implementations of technical projects including roles as an expert user and in the leading deployment side. He worked as a senior corporate demand planner with emphasis on the statistical field for a multinational Peruvian company in the beauty and personal care industry with operations in Europe and Latin America. Mr. Taquía has a strong background in supply chain analytics and operations modeling applied at different sectors of the industry. He is also a member of the Scientific Research Institute at the Universidad de Lima being part of the exponential technology and circular economy groups. His main research interests are on statistical learning, predictive analytics, and industry 4.0.

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