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Information System for Price Comparison and Prescription Reading using Automation Technologies and Digitalization of Texts for Pharmacies in Peru

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***Abstract*— The Peruvian population has problems with access to free medicines, as this leads to go to private pharmacies affecting the economy, since many of the prices of medicines are not accessible to the budget of the population, this leads to another problem which is the abandonment of treatment. Therefore, a technological solution is proposed that integrates web scraping and OCR (Optical Character Recognition) technology for the extraction of information from pharmacies with web pages, for the comparison of drug prices. The solution also scans prescriptions for a fast and accurate search. The solution aims to facilitate the drug search by saving time and money, as they will be able to visualize the compared prices and purchase the drug at a lower cost. The solution has been validated on 20 prescriptions, which has led to a positive result, with a prescription scanning accuracy of 90.5%. Likewise, with the solution a search can be performed in a time of 30.87 seconds and thus also obtain an economic saving of 8.16 soles in contrast to other pharmacies.**

Keywords—web scraping, medicines, OCR, comparison, prices

I. Introduction

In the Peruvian population, in [1]. Patients Peruvians who are treated in public health centers face difficulties with the availability of medicines, which results in the acquisition of supplies at high prices, affecting the economy as well as their quality of life. According to studies conducted by Ipsos on behalf of the National Association of Pharmacy Chains (ANACAB), pharmacies in Peru offer low prices (53%). However, price perception is high, as patients pay for medicines instead of receiving them for free. In addition, one out of every two patients (79.5%) do not receive medicines in health centers, which leads to looking in private pharmacies, in case you have the financial means. Otherwise, they may abandon treatment or purchase illegal or expired medications.

Access to medicines quickly and efficiently at a timely time can be decisive in regaining health or even saving lives. It is known that access to medicines in Peru is complicated in several sectors of the population. According to the National Household Survey on Living Conditions (ENAHO), 21.8% of Peruvians do not use all health services due to the economy and there is a high probability that they will not be able to get the medicines prescribed by doctors. Globally, the price of medicines is a critical aspect in the State's health institutions, as it must be prioritized to improve distribution and ensure that a larger sector of the population can have access to quality medicines. Likewise, the population belonging to the poor sector (39.9%) cannot obtain the medicines for the adequate treatment to cure the disease or stop the symptoms. The extreme poor (13.7%) are the population that spends the most on health and medicines, which accounts for 60% of their expenditure [2].

In Peru, safe and efficient brand-name medicines can be obtained at lower prices in pharmacies and pharmacies by researching at the drug price observatory of the General Directorate of Medicines, Supplies and Drugs (DIGEMID), which belongs to the Ministry of Health (MINSA). This Observatory of Prices of Pharmaceutical Products (OPPF) reveals the prices of the products offered by different establishments, allowing comparisons from the minimum to the maximum price. However, many citizens are unaware of this platform, making it difficult to acquire basic and essential medicines at affordable prices [3].

Our research proposes a solution to address the problem of searching for medicines and comparing prices, as well as locating nearby pharmacies. This solution also allows you to compare prices by scanning a prescription if it is readable and in image format (jpg or png). So far, our results show an accuracy of 90.5%, with an average scanning time of 30.87 seconds per prescription, and a possible economic saving of 8.16 soles with the proposed solution.

II. Context

A. Web Scraping

Web scraping is a technique used to convert unstructured data from the web into structured data that can be stored and analyzed in a database. This technique makes it possible to retrieve large amounts of data in a short time, offering significant advantages in a world where data is constantly changing. It works by extracting information from websites using software that simulates human browsing in different web browsers such as Mozilla Firefox and Internet Explorer. Web scraping finds applications in various fields of computing, including Business Intelligence, Artificial Intelligence, Data Science, Big Data, Cloud Computing, and Cybersecurity [4].

B. Web Crawling

Web crawling is a technique that involves selecting a URL from a list in each crawl cycle, retrieving the page corresponding to that address using HTTP, parsing it, and extracting the URL and relevant information. Unvisited URLs are added to lists called borders. It is a primary source of information retrieval on the web and is used to periodically

update and maintain databases by search engines and various users to meet their needs [5].

C. OCR

OCR (Optical Character Recognition) is a specialized software that identifies the text contained in an image and converts it into a sequence of characters that can be edited in word processing programs. To extract text from a scanned image or document, you need an OCR program capable of recognizing and converting the text into a string of characters in ASCII or Unicode format. This feature allows you to copy the text into an editing program, saving time by avoiding manual typing [6].

D. Generic Drugs

According to the authors, access to medicines has become a global challenge for the healthcare system, as it has a significant influence on household economic expenditures. In accordance with this problem, the World Health Organization (WHO) has urged governments to establish policies aimed at the sensible use of medicines and the promotion of generic drugs. The usefulness of generic drugs could generate savings in the personal expenses of consumers and result in a more efficient administration of expenses for insurers and health systems, which would become a strategy to control costs [7].

III. Main Contribution

Fig. 1 shows the relationship and operation of the technologies that will be used to develop the system.

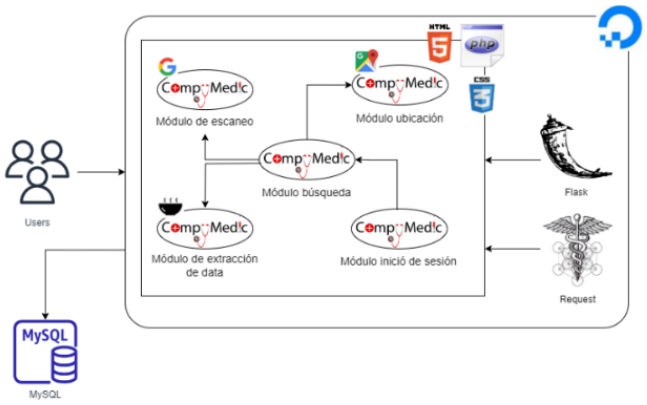

Fig. 1. Solution integration.

For the correct operation of the solution, the use of various technologies, such as OCR, web scraping and georeferencing, has been foreseen. The process of operation of these technologies in relation to the proposal will be described in detail below. This proposal aims at searching and comparing drug prices, as well as visualizing the location of pharmacies. The system has been organized into modules, which will be explained in detail below.

A. Scanning Module

This module uses Pytesseract v0.3.10, is an OCR tool for Python, and requires at least Python version 3.7 and the Apache Software License 2.0 for implementation. Its goal is to extract the names of the drugs from the loaded prescriptions, which must have legible and understandable handwriting so that the technology can process it. The tool extracts the raw text of the recipe, allowing you to consult and obtain answers from a database that is based on a previously defined glossary.

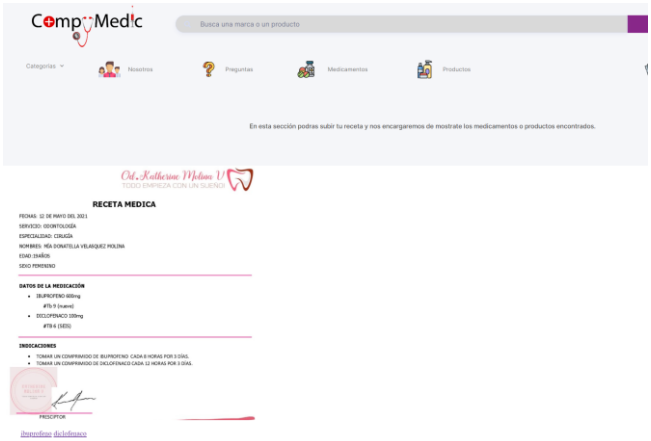

Fig. 1. Prescription scanning module.

B. Location Module

The location module uses the Google Maps Geocoding API, compatible with Python 3.5 and above. It aims to show nearby pharmacy locations that offer the medicine you are looking for. This technology determines the physical location of the venues using previously extracted coordinates. The results are presented on a map that shows the exact location based on the user's location. When a location is requested to be displayed, communication is established with the API to connect to the database of the locations and geolocate them. Pharmacy parameters, such as address or place description, are passed to geolocate, and the API returns the corresponding geographic coordinates.

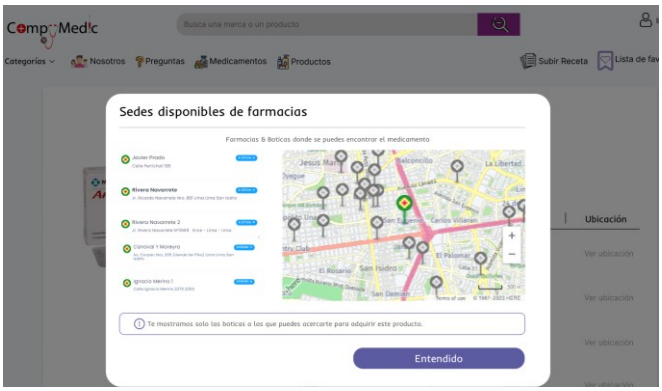

Fig. 2. Location module.

C. Extraction Module

The data extraction module uses the BeautifulSoup 4 library and is implemented in Python 3. Its objective is to extract the necessary data to display to the user from websites such as Inkafarma, Mifarma, Boticas and Salud, among others. The extracted data includes the image, product name, price, and composition, all of which are stored in a MySQL database. In addition, a scheduled job has been incorporated to keep the data up to date, which will run every midnight in our solution.

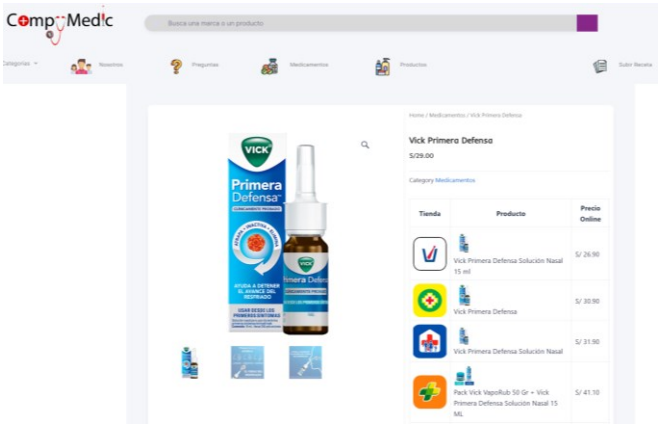

Fig. 3. Extraction module.

Finally, the system has a login software to ensure and manage security, privacy, and customization of the user experience. On the other hand, the software is built by the programming language PHP 7.3, Python 3, HTML5 and CSS3 as it allows and supports large amounts of data and with all the information obtained will deliver a view of information to the user detailing everything about the drug and pharmacies.

IV. Related Word

Web scraping research has become a crucial topic for data extraction, as it determines the accuracy and excellence of the result you are going to have. In this section, we will mention research related to the use of techniques like ours. This research mentions proposals for the improvement of data extraction in different industries.

From another perspective of the other research on indicators of improvement that can be linked to solutions that are related to extraction. Reference [8] propose to acquire Thai herbal knowledge recorded in the Thai language system on the internet through web scraping. This solution used a functional programming language for the extraction and manipulation of Thai Herbal Medicine (THM) data that is available on the internet. The authors in [9] use a Scrapy and Kibana interface for extracting data from an online clothing retail store. In less than 24 hours, this solution collected information from 24,000 garments, where they are characteristics of the garments. Reference [10] provide a systematic measurement analysis of structures and trends in the drug market. The data collection was carried out through web scraping, this tool allowed the automated extraction of "AlphaBay". Finally, the author in [11] proposes a method of investigating food prices. This method uses web scraping to collect custom data in real-time, where it overcomes the limitations of the food price data sources they currently use.

Reference [12] it addresses urban tourism in today's cities, focusing on the environmental factors that influence the choice of tourist accommodation according to location. The author proposes a three-phase approach: first, he uses the automated data collection technique to identify the availability and location of tourist accommodations through web scraping and geospatial mapping. It then collects property location ratings from post-purchase reviews from customers on Booking.com, using the Octoparse tool for web scraping. The technological approach allows users to create web crawlers for dynamic website data collection. The extraction of data is carried out in different categories of accommodations through several steps, such as entering web pages. select accommodation types, collect names and locations, and select global rankings. In addition, in the field of urban design, they use network connectivity as an indicator of accessibility, considering the number of interactions in a specific region. They also employ measures of global and local integration of the main streets leading to accommodations, as indicators of network centrality, both at the city and neighborhood level. For our research, we applied these measures and indicators to contribute to geolocation in pharmacies.

Reference [13] it addresses the growing disparity in the adoption of digital technology between urban and rural businesses. The authors used web scraping to collect information from industrial companies, including zip codes and website addresses. This technique made it possible to verify the status of the websites, the operation, the latest update, and the presence of references on social networks. They propose using web data to determine the proportion of companies with websites as an indicator of digitization, which increased by 30.2%. This novel approach helped to measure digitalization, particularly in craft companies in Germany, using a web scraping algorithm. In conclusion, we argue that web scraping is a promising tool for future research on digitization from a spatial perspective. In addition, they highlight its effectiveness in collecting information from different pharmacies and comparing products. It is recommended to promote websites through digital channels such as social media to increase their visibility and reach a wider audience.

Reference [14] they address the problem on the housing supply side where sellers expect to recover the price of their homes, in contrast to official statistics based on transaction prices. The data is retrieved through daily web scraping of the three major UK real estate websites Zoopla, Rightmove and OnTheMarket. Through these websites, an average of more than 1,500,000 real estate listings are collected every day. The authors mention that, for each listing, information was collected describing in detail the home, the type of transaction, the price, and its location at a very granular level. By web scraping the major real estate websites in the UK with these daily indicators that monitor the supply side of the housing market in real time. By monitoring the supply side of the real estate market, the price variation of goods and services is defined, as this indicator stands at 4.1% according to research. In conclusion, the comparison of our data extracted from the web and the list of drug prices will help the comparison of the different products and drugs at the commercial level of the most recognized pharmacies in Peru.

Reference [15] the research focuses on the use of state-of-the-art Google Vision OCR. In addition to extracting medication names, it collects other prescription information, helping to create a digital health record. The methodology is effective for approximately 95,000 drug SKUs. Custom methods were developed for handwritten and printed recipes, with a mechanism for self-detecting the type of recipe. The effectiveness of the methodology was demonstrated on a large corpus of more than 115,000 prescriptions. In addition, 75% of the requests that enter the system were randomly applied, which means that this percentage is assisted by data science suggestions, while the remaining 25% is not assisted at all. This division makes it possible to measure the effectiveness of the assisted automated system against the control set to evaluate the performance of the model. As a result, the authors were able to significantly reduce time, saving more than 2,100

man-hours per year. In conclusion, OCR was applied in our project, as it will facilitate the detection of drug names by uploading the prescription to the web system and making it less time waste searching for a drug or product.

Reference [16] the authors propose a system based on computer vision to acquire data and images related to patients' clinical information, capturing information from clinical monitors in real time in the operating room. They use an OCR algorithm in a Unity app on mobile devices to extract and transmit data to another system, allowing for correction of outliers. During surgical interventions, they omit 0.42% of the values and misinterpret 0.89%. The experiments show an accuracy of 85.613% in extracting information in real-time.

Reference [17] a free mobile app called "Carrot Rewards" is proposed to send educational messages about the flu vaccine and promote its uptake. The campaign is divided into two parts: an educational questionnaire on the importance of the vaccine and awareness at flu clinics, and the use of geolocation-based push notifications to encourage users to interact with pharmacists about the vaccine when they are near a sponsored pharmacy. The authors demonstrate that this methodology can facilitate access to influenza vaccine using geolocation. This research provides valuable insights for our solution by informing users about the location of pharmacies closest to their current location.

V. EXPERIMENTS

In this section we will discuss the experiments of our project. In addition, everything necessary to carry out the experiments and discuss the results will be described.

A. Experimental Protocol

We present an experimental study in the search for medicines in pharmacies, using collected data. The experiments will be carried out in the implemented solution, which is deployed on a Digital Ocean virtual machine, which has 4 GB, 2 CPU, 80 GB (SSD disk).

The variables for this research to solve the problem are time, accuracy, and economic savings. In (1), the time from the start of the solution's operation until the name of the prescription drug is displayed was calculated.

$$T = T_{cm} + T_{bm} + T_{er} \quad (1)$$

T: Total Time

T_{cm} : Medication Purchase Time

T_{bm} : Medication Search Time

T_{er} : Recipe Scan Time

The precision is the same as in Ref. [9], Sbb= FBFB+TB+TW; where FB (false white CtP), FB (false black CtP), TB (True black CtP) and TW (true white CtP). Which is going to be tested by comparing the result with the real recipes that are read. In our solution, the accuracy will be calculated with (2).

$$P_{re} = \frac{T_{me}}{T_{mr}} \times 100 \quad (2)$$

P_{re}: Accuracy Percentage

T_{me}: Total Medications Scanned

T_{mr}: Total Prescription Drugs

Finally, the savings variable will be calculated with (3), which can be measured with the comparison of medicines, finding the cheapest medicine of all Peruvian pharmacies.

$$Savings = P_{pharmacy} - P_{solution} \quad (3)$$

Savings: Purchase Savings Amount

$P_{pharmacy}$: Total price at the physical pharmacy

$P_{solution}$: Total price with the solution

On the other hand, to test, the following scenarios were defined, 10 original prescriptions were uploaded, in which 5 are digitally and 5 handwritten the original prescriptions were obtained from the medical center between January and October 2023. Also, the recipes that were prepared for this experiment were designed considering some examples. These tickets have been uploaded to the solution to obtain the names of the drugs and then visualize the price comparison. For each of the uploaded ballots, time, accuracy, and economic savings can be calculated.

Likewise, the test scenario was defined for the economic savings variable, 3 medicines will be sought, since it is the average of the number of medicines of all the scanned prescriptions, which will show the prices that were extracted from Peruvian pharmacies. Where the lower price will be able to compare it with the price of the same medicine by searching in the same pharmacy in person. For each of the medications, the difference of what you are saving will be calculated. We visited 6 of the busiest pharmacies and they have websites.

B. Results

The average time that has been calculated using the solution to look up the medicine by scanning the prescription is 30.87 seconds. However, for the traditional search, when a person goes to a pharmacy to find out the price and subsequently the acquisition of medicine, it takes an average of 10 minutes.

On the other hand, the accuracy of the scanning of medical prescriptions has been calculated, the accuracy indicates the number of words that are recognized and extracted. For these uploaded recipes, the OCR accuracy of our solution is 90.5%, as shown in Table I.

TABLE I. DATA SAMPLE

SOLUCIÓN								
		Recetas	Cantidad de Medicamentos	Promedio de cantidad de medicamentos	Tiempo (seg)	Promedio del tiempo (seg)	Precisión (%)	Promedio de la precisión (%)
Originales	Digitales	Receta 1	3	3.3	20.50	30.87	100	90.5
		Receta 2	1		31.52		100	
		Receta 3	2		44.58		100	
		Receta 4	4		22.34		100	
		Receta 5	4		35.21		100	
	Manuscritas	Receta 6	3		20.56		67	
		Receta 7	5		32.44		80	
		Receta 8	4		40.00		75	
		Receta 9	1		32.23		100	
		Receta 10	2		33.50		50	
Preparadas	Digitales	Receta 11	6		21.15		100	
		Receta 12	5		27.59		100	
		Receta 13	3		30.23		100	
		Receta 14	1		34.46		100	
		Receta 15	4		41.35		100	
	Manuscritas	Receta 16	1		37.56		100	
		Receta 17	5		24.23		80	
		Receta 18	4		34.20		75	
		Receta 19	2		23.55		100	
		Receta 20	6		30.12		83	

The savings indicator was calculated with the sample of the price comparison in our solution. We searched for 3 of the most common prescription medications. Then, in Fig. 5, the scanned recipe will be shown.

RECETA MEDICA

FECHAS: 12 DE MAYO DEL 2023

ESPECIALIDAD: CIRUGÍA

NOMBRES: TEOFILA FLORES CISNEROS

EDAD: 50AÑOS

SEXO: FEMENINO

DATOS DE LA MEDICACIÓN

- BISOLVON 120 ml
- ASPIRINA 500 mg
- APRONAX 275 mg

INDICACIONES

- TOMAR 5ML DEL JARABE ORAL CADA 8 HORAS POR 3 DÍAS
- TOMAR UN COMPRIMIDO DE ASPIRINA CADA 12 HORAS POR 2 DÍAS
- TOMAR UN COMPRIMIDO DE APRONAX CADA 12 HORAS POR 3 DÍAS

PRESCIPTOR

FIRMA Y SELLO

bisolvon apronax aspirina

Fig. 5. Prescription.

After extracting the words from the digital prescription, the prices of the medicines were compared to calculate the economic savings indicator in each of the pharmacies mentioned. It was found that the lowest total price of the recipe was 31.20 soles and the highest was 39.30 soles. However, when comparing the prices with our solution, the total cost of the prescription is 31.14 soles, which represents a saving of more than 8.16 soles compared to the pharmacy, pharmacy, and health, as shown in Table II.

TABLE II. PRICE DIFFERENCE DATA

Medicamentos	CompyMedic	Inkafarma	Mifarma	Farmacia Universal	Boticas Perú	Boticas y Salud	Boticas Hogar y Salud
Bisolvon	17.40	17.40	17.50	21.50	17.90	22.50	18.00
Aspirina	3.14	3.10	3.24	4.00	3.40	3.20	3.20
Apronax	10.60	10.70	10.60	12.72	12.20	13.60	12.40
Precio Total	**31.14**	**31.20**	**31.34**	**38.22**	**33.50**	**39.30**	**33.60**
Ahorro		**0.06**	**0.14**	**7.08**	**2.36**	**8.16**	**2.46**

In Fig. 6 shows the comparison of the Bisolvon drug that was scanned from the digital prescription, the prices extracted coincide with the prices of those that were found out from the pharmacies.

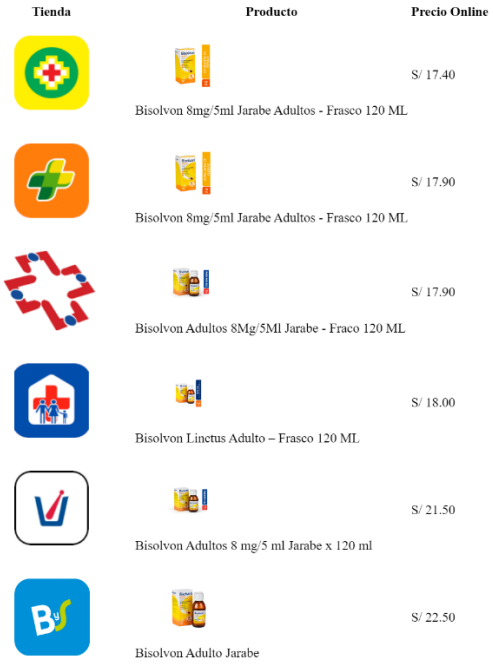

Fig. 4. Comparison of Bisolvon Drug.

In Fig. 7 shows the comparison of the drug Aspirin that was scanned from the digital prescription, as can be seen the prices extracted coincide with the prices of those that were found out from the pharmacies, as shown in Table II.

Fig. 5. Comparison of Aspirin Drug.

In Fig. 8 shows the comparison of the Apronax drug that was scanned from the digital prescription, as can be seen the prices extracted coincide with the prices of those found out from the pharmacies, as shown in Table II.

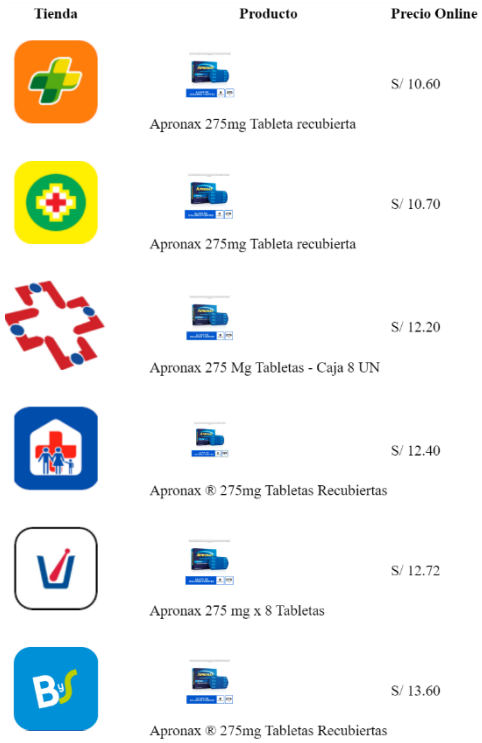

Fig. 6. Apronax Drug Comparison.

The proposed solution managed to significantly reduce the time spent searching for medications with various prescriptions, with an average of 30.87 seconds and a prescription extraction accuracy of 90.5%. This accuracy is

4.89% higher than the proposal of the Ref. [16] proposal. These results indicate that our solution can scan prescriptions more efficiently, resulting in potential time savings in searching for medications. These achievements were achieved thanks to the collection of data using web scraping technology.

VI. Conclusions

Thanks to Google's OCR technology and the incorporation of digital prescriptions, our solution has been able to achieve 90.5% accuracy regarding scanned medical prescriptions. On the other hand, web scraping components have made it possible to reduce the time to 30.87 seconds in users' search for medicines. Likewise, with the comparison of the solution, there is a possible economic saving of 8.16 soles with respect to the pharmacies mentioned.

During the development, two main challenges were assumed, such as the time it takes to know the price of a medicine by going to pharmacies for the calculation of the economic savings indicator. The second challenge would be for the solution to bear the burden of the different medical prescriptions using OCR technology. Likewise, with the help of the extraction of web scraping, which obtained the largest amount of information about the medicines from the different pharmacies, this process could be carried out from start to finish.

To continue our research is to continue testing the solution in other scenarios to find new data and thus demonstrate an improvement in time, accuracy, and economic savings. This demonstrates improved results for higher throughput of web scraping extractions and OCR readings of prescriptions.

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