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Use of robotized process automation for research management and evaluation

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ABSTRACT

Universities, called entities with the responsibility of training new professionals and contributing to continuous knowledge for human development through research, seek to increase their scientific production and climb positions in research rankings. In this sense, research management is necessary and knowing which information and communications technology tools help in this task is a great help. The main objective of this work is to identify the information and communications technology tools that help to perform a good research management and implement a system based on robotized process automation to generate a scientific information system for the University of Sciences and Humanities, for this research work was used the cascade methodology which provided several advantages and support for the structure and development of the system, for the process of the system was used the UiPath tool which is considered the best process automation tool. As a result of this research work, a system was obtained that drastically reduces the data collection time to evaluate the scientific production of researchers, thus allowing a better research management.

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1. INTRODUCTION

Research is essential for any country, as it helps the development of nations [1], [2]. In Peru, as of 2013, research began to be given greater importance, empowering the National Council for Science, Technology, and Technological Innovation (CONCYTEC for its acronym in Spanish). The budget was increased to finance research projects and have repatriation programs for scientists [3]. Likewise, with the new University Law 30220 [4], universities must meet basic quality conditions to obtain a license that allows them to continue operating. One of these basic conditions is related to research. In this context, universities, which are not only called to train new professionals but also to contribute to human knowledge through research, seek to increase their scientific production and climb positions in the research rankings [5]. In this sense, in research management, it is necessary to know what information and communication technology (ICT) tools help in this task, and it is of great help. Robotic process automation (RPA) can help in the task of managing and evaluating research activities in an institution, and a country [6]. Faced with this context, the present work presents a proposal for using ICT and RPA tools that can help conduct good research management and evaluation.The importance of this proposal lies mainly in the fact that for a good performance in research, it is necessary to

increase the number of researchers or increase resources and carry out good management of the research, so that said increase in resources ends. In good results, the research carried out contributes to the university in the management of the research effectively and efficiently using the ICT tools.

Google Site is an online application developed to generate a website or an intranet more simply as if it were the edition of a document. This application allows users to meet in a single place and quickly, provides varied information [7], includes videos, calendars, attachments, presentations, spreadsheets and texts. Its main objective is to create a platform that allows information to be distributed quickly to be shared or viewed with a small team of people or with a large group, or with everyone. So it is very viable in the creation of employee pages, projects, and intranets. Guiding a large group of people to collaborate and share files. The RPA is a software technology that develops bots by performing transactional tasks in any IT application. Every RPA application has as its structure a digital input of structured data and a process logic based on rules, conditions, loops, among other activities. The development possibilities of RPA are endless as it can tackle any sequence of tasks. Users can also create bots by observing the digital actions of humans [8]. Robotic process automation software can interact with any application or system in the same way that people do. However, the difference with people is that RPA bots can operate 24 hours a day, non-stop, much faster and with 100% reliability and accuracy. UiPath is an RPA-based tool that develops activities based on desktop and Windows automation. Its purpose is to automate repetitive tasks, eliminating human intervention.

In addition to providing a unique value to all sectors of activities where the fact develops, it eliminates manual labour that has no added value and increases user productivity at high speed. When a company implements it in its activities, this application helps to automate and rapidly scale many of them without the need to use additional resources. UiPath is thus an optimal software for companies that do not want to invest in infrastructure or hardware and do not have dedicated resources to establish an automation infrastructure. This tool has different components that help its flexibility of use and problem-solving. For this research, the Uipath Studio tool [9] was used. This tool is the visual editor of UiPath, which provides the functionality of the building and designing the dashboard where the software robots will work.It also has a versatility that works with the drag and drop method, generating orders and directing the bots during automation. In addition to robotising processes, thanks to the main functionalities of UiPath Studio, it also allows unique and complex workflows to be developed through its interface. It gives designers the facility to incorporate custom VB.Net, Python, JavaScript, AutoHotkey and Java directly into the workflow. They also contain a vault that stores work, which one share with other team members. On the other hand, this tool carries out a mapping of the processes, simplifying the automation of the processes, allowing the analysis of automated activities through the execution of visual processes, giving greater control over the inputs and outputs of these sequences.

This research focuses on the use of the automation of robotic processes for the management and evaluation of research to streamline or optimize the information gathering processes of repetitive activities. According to some authors, [10], today's business and data collection activities require the use of robotic automation processes known as RPA. For this reason, the present author developed a research aimed at improving the ITEMMASTER data maintenance process to show the potential benefits that the implementation of RPA contains. In this way, it proposes the implementation of RPA under a framework oriented to the master data management process, making clear the enormous benefits that an organization can obtain under automation with Software robots.Likewise, the authors of [11] state that thanks to the contribution of the RPA and its benefits, it has been widely adopted in various industries in different areas, supporting the repetitive processes that are managed in these entities. It comprehensively covers all areas, as is the case with auditing. For this reason, the author proposes an RPA framework that manages to free auditors from performing repetitive and very low-judgment work and allow their focus on tasks that need their professional support. This research work is focused under its methodology based on two stages with sub-processes, as the first stage contains "The framework" focused on the selection of the procedure, modification of the procedure, implementation, evaluation and operation.

In contrast, there is "The evaluation and the pilot project" in the second stage, containing the same sub-processes. As a result of this research, it can be seen that the application of RPA technology can become a way to improve the quality of processes and reduce hours to 10 to 20 % that are spent in repetitive work. However, these have a significant limitation: this technology can only perform routine tasks and act under decision-making based on explicit rules, which can be adapted to procedures requiring structured or professional analysis instructions. On the other hand, the author of [12] points out that the automation of routine and frequently repetitive processes frees up human resources and reduces costs. The article developed by this author

is reflected in determining and showing the advantages and/or benefits of RPA technology in Public administration oriented to commercial, administrative processes, using its methodology based on analysis, process selection, development, implementation for this research and scaling. Thus becoming a methodology that takes into account the peculiarities of the government, processes of the case study of this research, thus generating results that meet the requirements, improving and reducing resources through robotization business processes. Similarly, the author of [13] points out that the best way to end tedious tasks is by using or working with robotic process automation. To do this, in his research, he focuses on showing the benefits and effectiveness of RPA in repetitive activities, using its own and simple methodology based on the design, implementation and tests or tests before the use of RPA, leaving to see that under a study, the use of this technology generates 100 % satisfaction with tedious jobs. However, if people carry them out, this satisfaction decreases drastically, falling between 5 % and 10 %. This study has the results that based on the data collected and tests implemented, RPA technology is too practical to complete redundant tasks but are more accurate in their development than a job done by one person. However, in the same way as the previous authors, the present author points out that RPA still needs to improve when faced with more complex tasks. In addition, the author [8] of states that the automation of robotic processes is a very advanced technology that establishes intelligent software robots that can imitate the interactions of people with business processes or activities, thus being an efficient method where software robots interact through the graphical interface with the user. Likewise, this indicates a new analysis method for RPA processes, comparing it with the traditional model through several fields.

In the research work, the cascade methodology was applied [14]. The cascade methodology is a linear process that divides the activities into successive development phases; these phases are executed only once. Each result of an ace becomes a hypothesis for the beginning of the next phase. This methodology is especially used for software development [15]-[17]. The objective of the research is to carry out adequate research management through automation and ICT. This work will allow optimizing resources such as cost and time in the university. The scope of the research is only to automate its well-defined processes, and then through the waterfall methodology, all the stages can be developed to reach the goal set. This article continues as follows: Section 2 presents a review of the literature necessary to know the research of other authors related to the work. Section 3 shows the methodology followed for the implementation of the RPA. Section 4 presents the results and discussion, Finally Section 5 shows and conclusions.

2. METHOD

The cascade methodology is divided into 5 phases (see Figure 1). The first one is analysis; it consists of the planning and the specification of the requirements. The second phase is the design. The third phase is the implementation; this consists of programming and unit testing. Another phase is the verification, where the validation of all the requirements is checked. Finally, there is maintenance, a final review in case an error is found, or a requirement is missing.

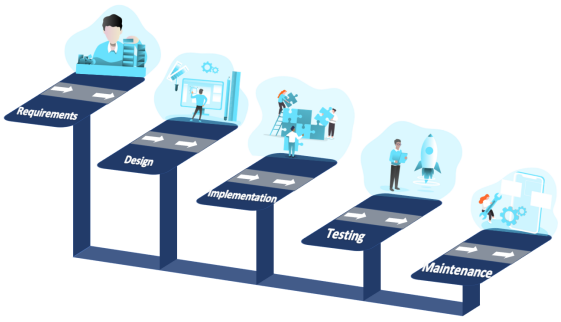


Figure 1. Phases of the cascade method

2.1. Analysis

2.1.1. System general requirements

In Table 1 one can se the system requirements. The first column shows the automated system. it explains all its functionalities. Also in the second column. it focuses on the requirements of the web system. In both cases it is explained in detail.

Table 1. Functional requirements

Automation system	Web system
- The automation system must be able to extract data on the characteristics of the authors on their development from scientific articles and The system must read the search data with which it will interact in the search for information. - When extracting the data, the system must obtain them in an orderly manner and place them depending on the corresponding researcher.	- The system must be easy to understand and use and The web system must be secure. - Only personnel from the research areas should have access to the web system. - The web system must be organized and divided into three different research areas. - The web system must have a space where one provides data on development projects.

2.1.2. Previous process (AS IS)

In Figure 2 shows a flow digaram. This process analysis is based on a traditional way of collecting information if RPA is not implemented, as shown in Figure 2(a). It is based on the collection of information in a complex way in the face of repetitive and overwhelming activity. This procedure begins with the collection of the names of the researchers from the three research areas. These primary data are placed in Excel, where they will be separated by three sheets and the researcher's name depending on his research area. The next step is to search for articles that each researcher has developed; these searches are carried out within a repository or a previously selected database. When the search has been carried out, the information obtained is collected and placed in Excel, repeating this entire step for the number of researchers. After this, the data obtained is uploaded into the web system developed in Google Site. Carrying out this type of process in a regular way takes much time and causes stress on the worker.

2.1.3. Current process (TO BE)

Analysis based on the performance of information collection together with the implementation and management of RPA technology, as seen in Figure 2(b). Regarding comparison with the process shown in Figure 3, here it can be seen that the work is streamlined and optimized. In addition, here, one only has to do the construction of the algorithm and prepare an Excel with the names of the researchers so that the automation system reads the name of the researcher. Once the researcher's name is obtained, it will be placed within the repository or database and will perform the search, collecting the selected data within the algorithm immediately and placing it within Excel. This procedure does it in minutes, and if one wants to update the data, it will be done quickly without having to do everything from scratch. Where it would have to do in the zero process is in the process shown in AS-IS. On the other hand, in the analysis part, an equation for the final study was also determined through metrics on the evaluation of researchers. This equation is based on their progress in research work. The proposal is to separate by ranges of execution date and collection before the compilation of the automation system [18]. If this were the first time the automation system was run, the current date would be the range. On Scopus, documents, citations and h-index will be evaluated. For ResearchGate, the evaluation will be taken on publications, reads, citations as shown in (1) to (3).

$$Scopus = \frac{Documents}{20} + \frac{Citations}{10} + (h - index) \tag{1}$$

$$ResearchGate = \frac{Publications}{20} + \frac{Reads}{1000} + \frac{Citations}{10} \tag{2}$$

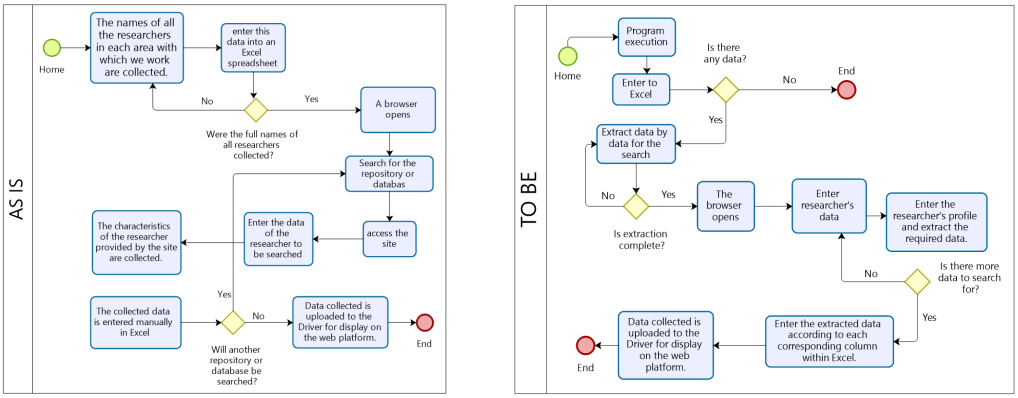
$$FinalEquation = \frac{Scopus + ResearchGate}{2} \tag{3}$$

Regarding the (3), it is by which the evaluation metrics will be carried out for the researchers of the different research areas.

2.1.4. Automation development

Based on the ideal form for the development of the web system under the cascading methodology from start to finish as shown in the Figure 3(a). For the construction of the automation system, it was necessary to establish the requirements that the RPA software would have to cover. After this step, the search and comparison of different RPA software were carried out, thus selecting UiPath. UiPath was recognized as an RPA leader

by Forrester wave: robotic process automation, Q1 2021, with the highest possible score in the strategy and market Presence categories and the highest position of all vendors. The RPA construction process was under constant testing until all the requirements were obtained without any error; a detailed investigation of the RPA tool and its elements was carried out [19].

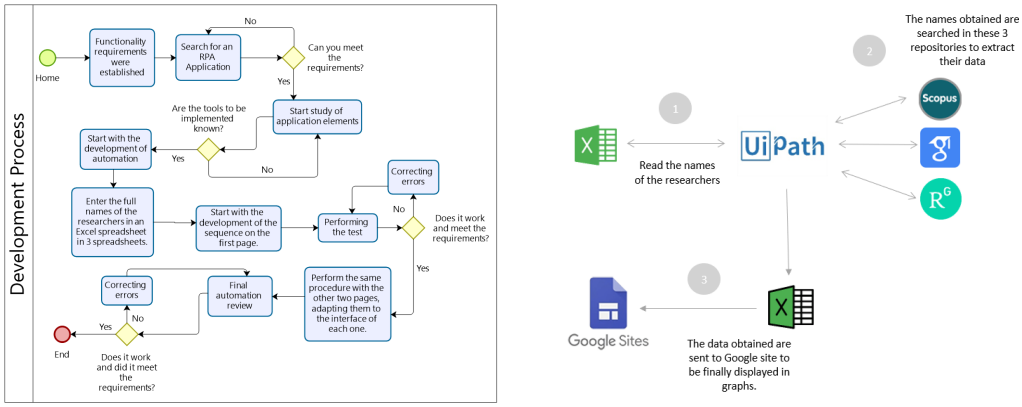


(a) (b)

Figure 2. Flow diagram (a) AS IS and (b) TO BE

2.2. Design

The design that will be presented below is based on the functionality level of the system before the interaction with the automation as shown in the Figure 3(b). As a first instance, one wanted to carry out the design at a general level about the implementation and structure of automation in the face of RPA technology, using an Excel that works with the Uipath application. Where the application reads the names of the researchers, after that, the application writes the researcher's name in the repositories, returning the selected data to be obtained. Finally, these are automatically placed in Excel and uploaded to Google Site [20]-[22].



(a) (b)

Figure 3. Design (a) automation development and (b) structure design of robotic process automation

2.3. Verification

For this verification, the selection of functional and non-functional requirements will be taken and tested to meet each (see Table 2). The functional requirements allow to know how the system under study requires for the operation in the optimal way. Likewise, the non-functional requirements allow to have in detail the capabilities that are required in the system, among others.

Table 2. Non-functional requirements assessment

Non-functional requirements	System assessment
The automation system must be efficient, optimize time and be easy to use. The automation system must store the data extracted to an Excel sheet.The automation system must be divided depending on the repository or database with which it will interact.	The automation system perfectly meets the primary needs that are required.The system optimizes and reduces time to 91.01%, which took 155 min to do in 9 min. The system is easy to understand and execute and can be compiled by anyone else in the organization. The system manages to store the data it extracts to a specific Excel file.The automation process is divided into three parts depending on the repositories used.

2.4. Maintenance

Feedback must be carried out from start to finish to improve the procedure. But in this case, it has been determined that it has been fulfilled exactly as required according to the needs raised. No modification will be made to the process automation system in the analysis process since it compiles and generates benefits in different aspects through its optimization [23]. Thanks to the feedback it was possible to make the identification.

3. RESULTS AND DISCUSSION

3.1. Prototypes

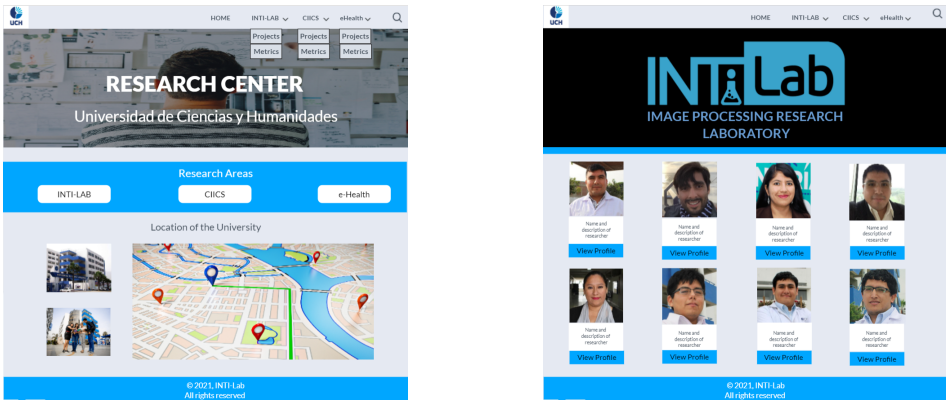
The design presented in Figure 4 is based on the structure of the web system. The prototype in Figure 4(a) is based on the presentation of the first page of the web system, where the structure that contains the primary information of the entity is detailed, in this case of the Universidad de Ciencias y Humanidades, in the navigation bar, there are four entrances, 3 of those entrances are detachable, which direct to Figure 4(b) (projects by area) and Figure 5(a) (evaluation metrics by area). There are also three buttons with the name of each research area of the entity. These buttons direct to see the researchers in each area, as shown in Figure 5(b).

In the prototype of Figure 4(b), the basic information of the researchers was placed. A list of researchers is observed according to the area selected from the first prototype. On this page, the user can enter the profile of each researcher to obtain more detailed information. Upon entering, the profile of the researcher selected within prototype 2 of Figure 4(b) is observed. Likewise, a space was located for information at the professional level of the researcher. On the other hand, three buttons were located which will allow access to the size of the researcher's articles, the project that is in progress and finally, the study metrics regarding the characteristics of the researcher's articles.

Figure 5 presents the scientific production design of prototype 3 and prototype 4. In the prototype of Figure 5(a), a graphic box was placed. Here the reference is made to the data obtained from the three repositories. These data were collected by the RPA system, each with its different criteria for the articles developed by the researcher. The example shown is based on the number of articles, the cumulative citations of all articles and the number of indexed times. Likewise, when entering the prototype in Figure 4(b), when accessing the profile of each researcher, there is a button to enter a template that contains a button that gives access to another screen to observe in detail what is being developed in the current project of the researcher. On the other hand, there is also a space that will contain the primary information of the project.

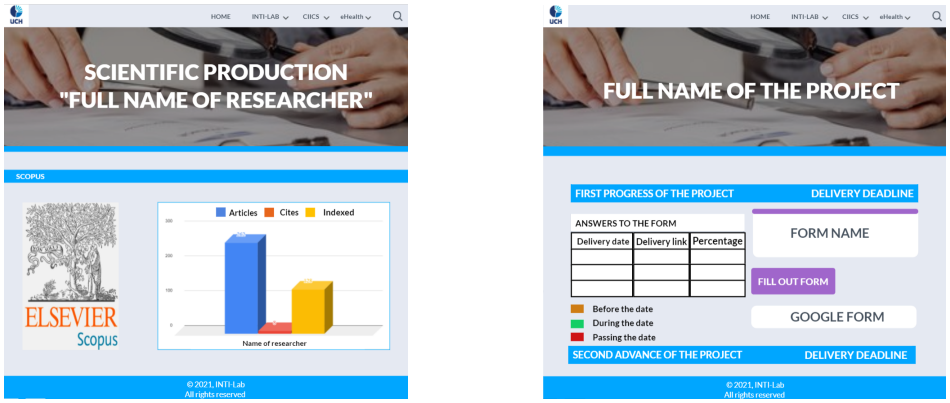
In the prototype of Figure 5(b), one will find detailed data about the researcher's selected current project. Also, this is separated by deliveries; according to the selected date, one has to upload the document through the google form. In addition, according to the date, it was uploaded, it is evaluated in 3 colours, if it was sent ahead of time, during the time or after the established time. All this together with the percentage of the delivery progress and the link of the uploaded document. On the other hand, one can also access general projects by area from the drop-down menu as shown in Figure 4(a), allowing one to know the general data of the project being inspected; these displayed projects are separated by years according to their completion.

Figure 6 presents the metrics of prototype 5 and prototype 6. In the prototype of Figure 6(a), the matrices are shown according to the data collected and uploaded by the RPA system. These data are oriented on two of the three repositories used for the web system, which are Scopus and ResearchGate, having as y-axis the quantities of the characteristics and as x-axis the dates in which the RPA system was run. In the prototype of Figure 6(b), the evaluation matrices are shown at the area level selected to inspect or review. The evaluated data is information collected by the RPA system, having as its y-axis the quantities of the characteristics and as x-axis the dates the RPA system was run.



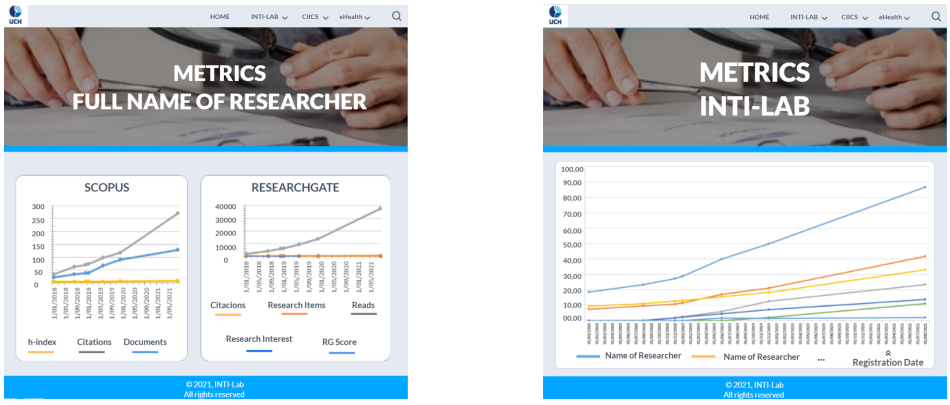
(a) (b)

Figure 4. Reserach design (a) prototype 1 and (b) prototype 2



(a) (b)

Figure 5. Design scientific production (a) prototype 3 and (b) prototype 4



(a) (b)

Figure 6. Metrics (a) prototype 5 and (b) prototype 6

3.2. Optimization

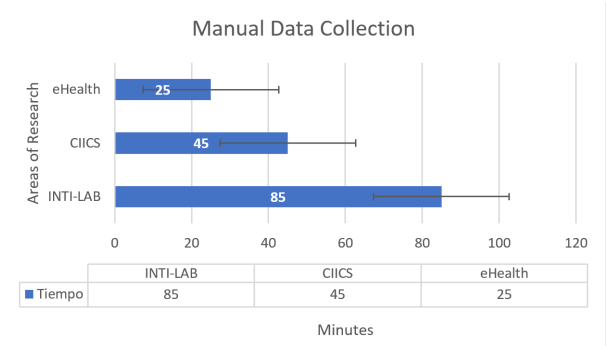
The implementation of the RPA on the data collection process to aid information management resulted in the RPA providing a positive incremental effect for the benefit of operations. Likewise, it generates cost reduction, speed of delivery, greater precision and satisfaction in the work environment by freeing itself from tedious and repetitive activities, achieving advantages and information gathering facilities. The best thing

about using RPA is troubleshooting and improving processes through accurate and practical analysis. On the other hand, it is understood that RPA technology still needs to be further developed to cover beyond repetitive processes. It is recommended to analyze the processes to be automated and determine if the automation of robotic processes can cover these. The last result obtained was that the automation of robotic processes is beginning to change the essence of the work it self [24]. Not only by providing an accessible way for business processes to become more digital and by transforming the human experience of work and setting the stage for growth and change, thus defining a new era through RPA.

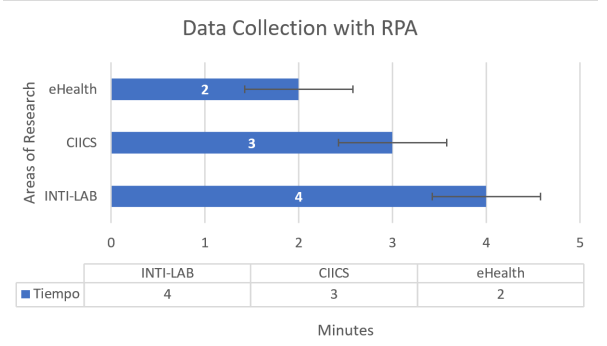
In Figure 7(a), the minutes it takes to collect data manually per area was established as the x-axis, while the names of each research area were placed on the y-axis. According to the data in the figure shown, manual data collection usually takes a different value per area due to the number of researchers working in each one of them. On the other hand, this manual task takes too long and causes displeasure in workers when collecting data as it is a repetitive task.

Concerning Figure 7(b), the minutes it takes to collect data per area using RPA technology was established as the x-axis, and the names of the research area were placed as the y-axis. It is also determined that by implementing RPA technology, the minutes of the collection work duration decreases abysmally. It is causing excellent optimization.

Finally, according to Figure 8(a), the data collection methods proposed above were established as the x-axis, while the number of minutes it takes each to finish the data collection process was set as the y-axis. If we compare the duration of both collection methods, the difference is significant. With the implementation of RPA technology, time is reduced to 91.01%. Likewise, the time in percentage executed is 8.99%.



(a)



(b)

Figure 7. Optimization (a) manual data collection and (b) collection method comparison

3.3. Metrics

The results of the metrics were obtained through (1) to (3). As a first step, the data collection of the two repositories that will be used to evaluate the metrics was carried out, in this case, Scopus and ResearchGate, being evaluated by compiling the robotic automation system. For the samples presented in Table 3, we worked with the data of 7 researchers.

On the information collected in Table 3, the graph in Figure 8(b) was executed in order to help identify the advances that the researcher had during the different dates regarding the Scopus repository, in the same way, one worked with the ResearchGate repository [25]. On the collection of information from the Scopus repository, it was reflected by date, being step one to achieve the evaluation matrices, as the x-axis, the execution date of the RPA system was placed as the y-axis the result of (3) was located, which allows one to see the researcher's progress up to that date. In the same way, one worked with the ResearchGate repository.

Table 3. Documentation with citations in and h index Scopus

Date	Documents	Citations	h-index
9/01/2018	21	33	4
31/08/2018	33	63	5
24/12/2018	38	70	5
28/01/2019	39	73	5
24/06/2019	67	98	5
13/12/2019	91	118	6
30/08/2021	128	271	8

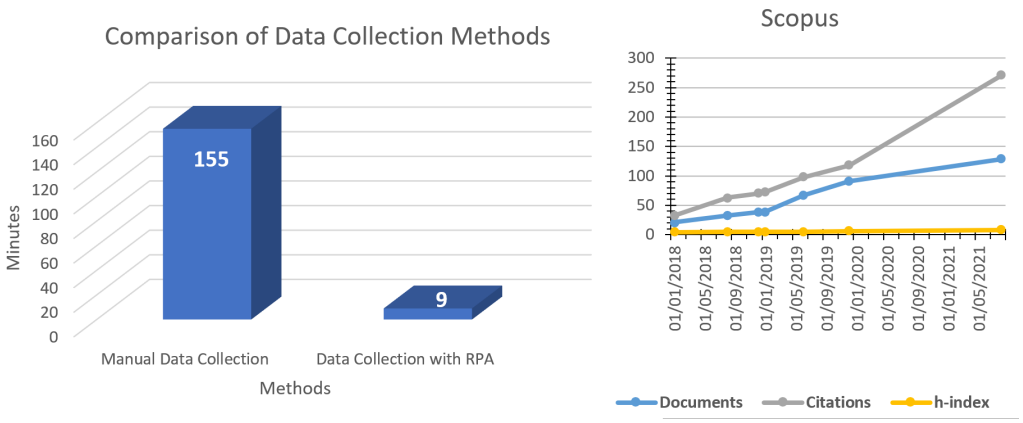


Figure 8. Optimization and evaluation (a) data collection using RPA and (b) Scopus evaluation

4. CONCLUSIONS

Finally, it was possible to design and implement an RPA system that provides different optimization benefits of repetitive work under data collection processes to help information management. This provides cost reduction, delivery speed, greater precision and satisfaction in the work environment. On the other hand, the Cascade methodology is one of the most appropriate for the administration and advancement of this type of system. In the same way, the research work should be seen as the beginning of new work methods optimized under RPA technology due to the fact that this type of technological tools can increase in their provided benefits. In addition, to generate greater scope for optimization in the face of new jobs or complex activities that can be improved with the implementation of a system or process with RPA. The limitation found in the research was space, since there was no face-to-face meeting due to the pandemic; it was only virtual. It is suggested as future work to continue researching with other technologies such as expert systems and machine learning.

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