Implementation of a web application to optimize the financial management of an automotive company using Extreme Programming

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Abstract

The need for companies to have systems that can automate the different processes that are carried out is increasingly high, even more so, from the COVID-19 pandemic that evidenced great automation shortcomings in a large part of the commercial sector. The implementation of a web application focused on automating financial processes in the automotive company R.A.L.E will allow payments, collections, order requests and control of the different administrative and operational processes to be carried out in a controlled and efficient manner. For the development of the application, the XP methodology is used, Power Designer for data modeling, Laravel as a development framework and MySQL as the database engine. To evaluate the response time in the different processes, the ISO/IEC 25010 standard was applied, taking time for both the current process and the automated process. The results show that payment, collections and orders processes significantly decreased execution times. In general terms, based on terms of performance efficiency, the web application is rated as VERY GOOD, resulting in a weighted rating of 75% which is the result of the temporary behavior and use of system resources.

Keywords: Web application, Financial management, XP methodology, E-commerce.
1. Introduction

Over the years the advancement of technology has become the center of attention, due to many aspects that allow the advancement in studies of several areas not only of computer science, this has allowed to automate much of the activities that a person can perform. It is not feasible that in the XXI century businesses are constituted on paper, it is necessary, therefore, to think, organize and build digitally to create agile, scalable solutions with the capacity to grow (Tembelo, 2020). One of the largest areas and that today is of utmost importance, is E-commerce, which has grown considerably due to the pandemic which affected all types of business, which forced the world to take a leap of era, entering completely in the era of technology and not partially as years ago, Because they have been adapting to the demand caused by the large number of services in the present. (Kamlesh, 2005: p.4). The world of E-commerce offers us today many alternatives to implement and create a web application, before it was a complex and expensive process that required great programming knowledge in JavaScript, PHP, HTML, but numerous tools have emerged that allow us to easily create an online store. (Marroquin, 2012: p.30).

Currently, a large number of companies dedicated to the trade, in this case to the trade of automotive spare parts, sell their products in person, offering their service in a personalized way. It should be noted that there are companies that work virtually, but the vast majority of consumers before the pandemic, caused by COVID-19, did not see the need to use technology to make a purchase. The pandemic caused a change in the way people acquire different products and services, currently more businesses have a presence on the Internet with the aim of serving customers who prefer to make purchases virtually, massify the service by correctly interpreting the data and minimize the losses caused during confinement (Duque, 2022). Large companies in the financial sector, for example, handle a large amount of customer data, this increases the possibility that using this information correctly, their different products and services can be positioned better (Romero et al., 2021). Starting from a study or size or the management and business logic of a commercial company, it is considered to develop a web application with the aim of being able to automate and optimize payments, collections and order requests of the company and in this way, to be able to offer a much more personalized service with customers and meeting their needs quickly and efficiently. Inventory management has been defined based on the stock and fertilizer that the company has, under the concepts of E-commerce and cloud computing that allows applications to be built with a low investment cost, great reliability, flexible expansion and on-demand services (Chen & Metawa, 2020). It is important to indicate that web applications currently allow to improve the management that is carried out within companies, considering that a very thorough internal control must be carried out.
since it is of utmost importance for companies to ensure the reliability of financial processes against fraud and to guarantee operational efficiency through the control of human and material resources that are established (Álvarez et al., 2020), in addition, web applications favorably improve the management of the different financial processes within the company, payments, collections, orders or credits can be implemented to guarantee shorter execution times and maximize the number of attentions made to customers (Gutarra, 2021). In terms of the project, for the collection of requirements, a traceability of requirements was implemented, which was a matrix where each of them was detailed.

The BPMN standard or also called Notation for Business Process Management, is a language of process diagrams in which an image is detailed with the stages that a business must have during its process from start to finish. (Floku, 2018). That is why this standard was implemented to develop the inventory management of the company and through this to be able to verify and control the amount of products that are owned, thanks to this you can have a clearer point of how it works. (MEANA, 2017: p.4). Regarding the web application, it was carried out in Laravel using the PHP programming language, applying the XP methodology which is an agile methodology, with the aim of looking for small or medium work teams, in environments of imprecise or changing requirements. (Molina, Cevallos and Dávila, 2018: p.117). This has allowed to optimize the processes of payments, collections and purchase requests applying the ISO/IEC 25010 standard which indicates the quality model focused on efficiency, establishing a system for the evaluation of the quality of the product when evaluating the properties of the software product. (ISO/IEC, 2021), considering therefore that the quality of a product or service is always hand in hand with the processes followed by the entity, that is, a process management is the way to organize and manage a business to meet goals that are required by senior management (López et al., 2020).

2. Methodological Framework
The type of application research is used, because it is focused on the development of a web application, through technological tools that allow the management of payments, collections and order requests from an automotive spare parts company, based on existing or original knowledge. A web application receives this name for the reason that it is executed on the internet, in other words, all the data and information sent are stored and governed under a process on the web (García, 2010), so they do not need to be installed on a computer, rather they can be used on any machine with an internet connection. Being a web application all people with internet access will be able to interact with it efficiently, allowing purchases within the platform. The customer will be able to find information about the products, thus allowing the desired
order to be placed and the administrator, customers and seller will be able to interact in an intuitive and friendly way with the web application allowing purchases to be made within the platform in such a way that the company can receive order requests immediately and therefore dispatch each order in a much faster time compared to the current business model.

There are several agile methodologies, among the most used are Scrum, Kanban and XP, responsible for managing software development as determined by the Agile manifesto, all three consider important aspects such as people and communication, functional software, cooperation with the client and reaction to change (Saleh, 2019), however, XP is a programming methodology that also allows to develop applications in a short time guaranteeing a joint creation process that allows to identify failures in previous stages (Astucuri, 2021), and always seeking customer satisfaction, better software quality and efficient project management, it is important to note that it is ideal for working in small teams. It is a dynamic software development model, i.e. the continuous discussion and integration of new features and ideas is the cornerstone of this model (Shrivastava et al., 2021). To its efficiency is added the process of testing and planning of the project, thanks to its small error rate since it facilitates the changes that are made, due to the organized programming that allows when developing the application. In addition, this methodology greatly encourages communication between the client and the developer, something that has been key to this project. During the development of the project, the application of XP allows to perform various tests, saving development costs and time. One of the most important points to consider for the development of a web application is the organization, something that the XP methodology helps considerably, because it allows a highly organized programming facilitating future changes and adding to the fact that the client has control over the priorities to be considered (Molina, Cevallos and Dávila, 2018: p.117)

Performance efficiency assessment

This section addresses the process carried out to evaluate the efficiency based on the performance of the web application under the ISO 25010 standard, where the response time of the processes of payments, collections and order requests and the use of these resources will be taken as indicators.

For the comparative study, response times will be taken which will be taken by stopwatch where the current process can be analyzed with respect to the automated process when using the implemented application. To verify whether the times obtained have a normal distribution or not, the Shapiro-Wilk Test will be used because a total of 25 times will be taken for each process, and thus be able to test the
hypothesis through the parametric test called Student’s T. For this, two statistical software, Software R and MiniTab, will be used.

Population and sample

We work with a non-probabilistic sampling by judgment for the reason that for this study it has been based solely on our own knowledge and credibility, that is, all those who have been considered suitable for the research study have been chosen.

A total of 10 employees work in the company, which are detailed below:

• In the warehouse area there are three employees, these are responsible for inventory control and dispatch of products based on the order received.

• In the typing area there are three workers, who are responsible for receiving orders from sellers and preparing the corresponding invoice manually.

• For the sales area, the company works with three salespeople, who receive orders from customers of various companies and send the order to the warehouse department.

• The company has an administrator who is the manager of the company which is in the administration area.

This system manages the 4 areas mentioned: warehouse, typing, sales and administration, because it is focused on the optimization of payments, collections and order requests, through the management of the inventory that the company has, with a total of 10 workers.

Methodology for determining performance efficiency.

This section presents the indicators to measure the performance efficiency of the web application, through the use of cards that allow assessing each sub efficiency feature.

Table 1. Performance efficiency variable.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance efficiency</td>
<td>Temporal behavior</td>
<td>It is the ability of software to be effectively modified based on user needs.</td>
</tr>
<tr>
<td></td>
<td>Resource utilization</td>
<td></td>
</tr>
</tbody>
</table>

Development of the Web Application using XP methodology (eXtreme Programming).

Exploration phase

This phase aims to have an approach with the client to obtain information on the requirements of the system, in this way it has been allowed to carry out a preliminary study of the system, technical, economic and operational feasibility, in turn the analysis and management of risks. In order to publicize the people involved in the
development of the web application in Table 2, each of the corresponding roles is detailed.

**Table 2. Personnel involved**

<table>
<thead>
<tr>
<th>Role</th>
<th>Person</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>Ruben Loaiza</td>
<td><a href="mailto:klirinrube17090@hotmail.com">klirinrube17090@hotmail.com</a></td>
</tr>
<tr>
<td>Programmer</td>
<td>Rafael Loaiza</td>
<td><a href="mailto:rafael.loaiza@espoch.edu.ec">rafael.loaiza@espoch.edu.ec</a></td>
</tr>
<tr>
<td>Project follower</td>
<td>Mr. Miguel Ángel Duque</td>
<td><a href="mailto:miguel.duque@espoch.edu.ec">miguel.duque@espoch.edu.ec</a></td>
</tr>
</tbody>
</table>

Risk analysis and management

In order to identify the risks that can be made when developing the web application, actions were established to reduce the impact of risk, for which it begins with the identification, prioritization analysis and finally with the risk sheet. Having had several meetings with the manager of the company Rubén Loaiza, 5 possible ones have been raised:

- Poor collection of functional requirements information
- Lack of time-bound planning for functional requirements.
- Poor database design.
- Incompatibility of technologies.
- Damage to computer equipment used by the developer.

For each of these risks, their impact was analyzed, being able to be low, moderate or high and thus detail the degree of exposure that can be caused in the web application. Table 3 shows the priority of the risks, based on the classification of exposure levels, the values that allow cataloguing each of the impact risks were considered: high (red), medium (yellow), low (green).

**Table 3. Determination of risk priority.**

<table>
<thead>
<tr>
<th>Identification</th>
<th>Description</th>
<th>Exposition</th>
<th>Value</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>Poor collection of functional requirements information</td>
<td>Casualty</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>R2</td>
<td>Lack of time-bound planning for functional requirements</td>
<td>Casualty</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>R3</td>
<td>Poor database design</td>
<td>Media</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>R4</td>
<td>Incompatibility of technologies</td>
<td>Loud</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>R5</td>
<td>Damage to computer equipment used by the developer.</td>
<td>Loud</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

Conceptualization of the system

This section is made with the purpose of allowing the client to have a greater visualization of the operation of the system, for which the diagram of use cases has been made which is indicated in Figure 1.
Inventory Control Process

The inventory control process has several phases, which are: registering a category, an inventory, registering products, and after having carried out these activities, the products are filtered based on a quantity to later generate an inventory report as can be seen in Figure 2.
Figure 2. Automated process through the use of the BPMN standard for inventory control.

Planning phase

The activities that are part of the planning were carried out. This phase aims to estimate the effort required to develop metaphors and user stories, this helped to give the respective compliance to the planning practice for each established iteration.

The estimation of points was made through the use of the Planning Poker technique, which was adopted by the XP methodology for the calculation of necessary effort through a list of metaphors and established user stories. For this, the mechanism that was used lies in the number of points that would be thought prudent when finishing some functionality. This technique has as its starting point the choice of the smallest user story to which 1 default point of estimated value is assigned. Table 4 shows the example estimate considered.

Table 4. Point estimation of application metaphors

<table>
<thead>
<tr>
<th>No.</th>
<th>METAPHOR</th>
<th>ESTIMATE</th>
<th>PRIORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS_01</td>
<td>Analysis of functional and non-functional requirements</td>
<td>5</td>
<td>LOUD</td>
</tr>
<tr>
<td>MS_02</td>
<td>System architecture analysis</td>
<td>5</td>
<td>LOUD</td>
</tr>
<tr>
<td>MS_03</td>
<td>User interface analysis</td>
<td>5</td>
<td>LOUD</td>
</tr>
<tr>
<td>MS_04</td>
<td>Define the encoding standard.</td>
<td>3</td>
<td>LOUD</td>
</tr>
<tr>
<td>MS_05</td>
<td>Database analysis and design</td>
<td>5</td>
<td>LOUD</td>
</tr>
<tr>
<td>MS_06</td>
<td>User interface integration</td>
<td>5</td>
<td>LOUD</td>
</tr>
<tr>
<td>MS_07</td>
<td>Data validation</td>
<td>3</td>
<td>LOUD</td>
</tr>
<tr>
<td>MS_08</td>
<td>Document curricular integration work.</td>
<td>5</td>
<td>LOUD</td>
</tr>
</tbody>
</table>
As a developer, I need to put the app into pre-production so I can evaluate user interaction.

Design Phase

This phase includes the coding standard, system architecture, user interface which will be implemented in the software product, also, the respective analysis of the database design is carried out which will be used in the application, these activities are called system metaphors which serve to document functionalities required by the developer to execute the project.

Encoding standard

Snake case is a notation which combines words using an underscore and lowercase as a nexus. This type of convention is used in variable names and functions of ancient language particularly associated with C. Like the CamelCase there are varieties, for example, all uppercase letters are called SCREAMING_SNAKE_CASE which used in the definition of constants. (Vega, 2018)

System architecture

For the implementation of web applications it is necessary to use different technologies which are essential to verify the quality of a software product. For this, an MVC architecture (model, view, controller) has been implemented, which has been designed with the aim of reducing the programming effort necessary when implementing synchronized systems and multiple data. (Fernandez, 2012)

Interface design

The design of interfaces has been carried out with the aim of generating a prototype which indicates how the information is organized and distributed in the user interface, through the Balsamiq tool which has allowed to develop a low-level, understandable and friendly prototype, Figure 3 shows the prototype of the home screen of the web application.

Figure 3. Prototype of the main screen
Database design

Based on the requirements obtained by the manager of "AUTOMOTRIZ R.A.L.E", entities, attributes, relationships and cardinalities have been created. For this, the ANSI technique has been used to obtain the physical model in which it has been made in the Power Designer case tool and through this to be able to implement the database in MySQL as a database manager, obtained a total of 11 entities with their respective attributes.

Data dictionary

A data dictionary as its name indicates is a set of data that have specific characteristics of the metadata which will be used within the web application in which it is included: the name and description of the file, field name, description, data type and size, NULL permission and the respective allowed values.

Coding Phase

The architecture in n layers determined the separation that exists between the Frontend and the Backend, where the logical business layer and the respective data access were created. The database is hosted on MySQL. Once the database storage was configured, Visual Studio Code was used to manage the encoding, for which the command was necessary: composer create-project laravel/laravel shopcar, which when executed creates an application with everything necessary to work with Laravel packages, later the server or Backend was generated.

A versioning manager such as GitHub was necessary, which was used for the main reason of maintaining adequate control of the work done, through a backup in this repository. The indispensable thing was the necessary creation for the connections of the web application with the database, to this also, two services of sum import such as Cloudinary were used to store the images and PayPal for the corresponding proofs of the online payment.

The file structure of the web application in question of the Backend consists of the following:

- Config: This folder contains the files necessary for the database connection, the ports, as well as the access keys to the image and online payment services.

- Controllers: Contains the business logic where the methods are located so that they can be consumed.

- Middlewares: Contain the files that are necessary for authentication and error handling.

- Models: The files concerning the collections are located in such a way that the data can be accessed.
- Routes: It is integrated in a general way with the routes of the services.
- Utils: It is made up of utilities necessary for functionalities such as search, filtering, pagination.

Testing phase

The tests are a fundamental basis when using the XP methodology, so they should always be taken into account, because they are essential to improve the quality of the software by reducing the errors detected, as well as to avoid failures once the web application is put into production. The acceptance tests were carried out to validate the functionalities and it is worth mentioning that these were reviewed by the client of the project.

Completion phase

The user manual was also made as a deliverable, so it was also necessary to describe in a technical way each the tasks performed in the web application, so that any end user can have knowledge to access each of the functionalities developed. Once the development of the web application was completed, the respective deployment was made in a free hosting service, which was chosen by the company, it is worth mentioning that the company did not have a hosting to be used in software technologies.

3. Results

This chapter shows the results obtained by concluding the development of the web application. Where the efficiency in terms of performance was measured based on ISO 25010, where the temporal behavior is evaluated based on the response times obtained with the use of the web application and without it, and also, the use of resources such as RAM and CPU. The present analysis was carried out in order to determine if the web application positively alters the response time when carrying out the process of payments, collections and order requests with respect to the current process handled by the company.

3.1 Criteria for assessing efficiency

To assess the performance efficiency of this project, through ISO 25010, the evaluation criteria for performance efficiency shown in Table 5 were established.
Table 5. Performance efficiency evaluation criteria.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Subcaracterísticas</th>
<th>Indicators</th>
<th>Purpose</th>
<th>Type of Analysis</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Temporal behavior</td>
<td>Response time</td>
<td>Measure the time at the time of the generation of the process of payments, collections and order request.</td>
<td>Inferential and descriptive</td>
<td>Compare times, before vs after.</td>
</tr>
<tr>
<td>Resource</td>
<td>CPU usage</td>
<td>Measure CPU usage when performing an action using software</td>
<td>Descriptive</td>
<td>Study each case by performing actions in the system that allow to enhance the use of system resources</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RAM usage</td>
<td>Measure RAM usage</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.2 Descriptive analysis of response times

Below are the quantitative descriptive results that have been obtained during the payment process. Table 6 shows the maximum and minimum times of the current process and the optimized process in seconds, as well as its standard deviation and mean.

Table 6. Quantitative descriptive results of the payment process.

<table>
<thead>
<tr>
<th>Type of weather</th>
<th>Maximum time (seconds)</th>
<th>Minimum time (seconds)</th>
<th>Standard deviation (seconds)</th>
<th>Average (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>1696</td>
<td>362</td>
<td>361.6</td>
<td>865.5</td>
</tr>
<tr>
<td>Automated</td>
<td>531</td>
<td>143</td>
<td>117.8</td>
<td>293.9</td>
</tr>
</tbody>
</table>

Now the quantitative descriptive results that have been obtained during the collection process are shown. In Table 7 you can visualize the maximum and minimum times of the current process and the optimized process in seconds, in addition to its standard deviation and mean.
Table 7. Quantitative descriptive results of the collection process.

<table>
<thead>
<tr>
<th>Type of weather</th>
<th>Maximum time (seconds)</th>
<th>Minimum time (seconds)</th>
<th>Standard deviation (seconds)</th>
<th>Average (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>911</td>
<td>405</td>
<td>122.1</td>
<td>583.6</td>
</tr>
<tr>
<td>Automated</td>
<td>441</td>
<td>171</td>
<td>68.22</td>
<td>265.7</td>
</tr>
</tbody>
</table>

Table 8 shows the quantitative descriptive results that have been obtained during the purchase request process, you can visualize the maximum and minimum times of the current process and the optimized process in seconds, in addition to its.

Table 8. Quantitative descriptive results of the order requisition process.

<table>
<thead>
<tr>
<th>Type of weather</th>
<th>Maximum time (seconds)</th>
<th>Minimum time (seconds)</th>
<th>Standard deviation (seconds)</th>
<th>Average (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>1802</td>
<td>402</td>
<td>397.3</td>
<td>1038</td>
</tr>
<tr>
<td>Automated</td>
<td>726</td>
<td>198</td>
<td>160.0</td>
<td>364.6</td>
</tr>
</tbody>
</table>

Normality analysis of response times

For the respective analysis based on the response times that have been obtained, it is necessary to apply inferential analysis techniques. Taking into account that the amount of data collected is less than 50, it has been decided to use the Shapiro-Wilk test in order to determine whether the set of automated times and current processes in both requirements has a normal distribution or not. Based on the result, it may be decided whether to apply the corresponding test to test the hypothesis raised.

Hypothesis statement.

Null hypothesis (A) = The times obtained have normal distribution.

Alternative hypothesis (B) = The times obtained do not have normal distribution.

Level of significance

For the respective level of significance in the present analysis, a value of 0.05 was considered, which ensures a confidence level of 95%, thanks to the fact that a minimum margin of error is handled.

Statistical test

The number of data taken was small (less than 50), so the Shapiro-Wilk test was used, which through the application of a normality test was analyzed based on the data collected on the response times of both the current process and the automated process of payment processes. Collections and order requests.
Performing the Shapiro-Wilk test of both the current process and the automated process, allowed to verify that the data obtained are distributed in a normal way thanks to the p-value obtained in each of the three processes studied. Table 9 indicates whether the data obtained have a normal distribution or not. The following are the respective normality analyses for the three processes:

**Table 9. Normality test results.**

<table>
<thead>
<tr>
<th>CURRENT PROCESS TIME</th>
<th>AUTOMATED PROCESS TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carry out the order request process.</strong></td>
<td><strong>Perform the collection process</strong></td>
</tr>
<tr>
<td></td>
<td>0.2679&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>HA is not rejected. The data follow a normal distribution.</td>
</tr>
<tr>
<td><strong>Make the payment process</strong></td>
<td>0.2037&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>HA is not rejected. The data follow a normal distribution.</td>
</tr>
</tbody>
</table>

In the processes of collections, payments and order requests respectively, the data of the current and automated process has been taken, which have a normal distribution and have paired samples, so we proceeded to analyze the difference between the means by paired Student's T.

**Inferential analysis of payment process response times.**

For the respective inferential analysis of the payment process, the statistical software Software R was used, where the Student's T test was applied. The process followed is detailed below.

**Hypothesis statement**

For the following hypothesis statement, the following variables have been defined: TPO= Average time for the automated process and TPA= Average time for the current process.

**Null hypothesis (A) = TPO = TPA**

**Alternative hypothesis (B) = TPO ≠ TPA**

**Level of significance**
For the respective level of significance in the present analysis, a value of 0.05 was considered, which ensures a confidence level of 95%, thanks to the fact that a minimum margin of error is handled.

Statistical test

For the respective statistical test, as two paired samples were taken, it was decided to use a student’s t test, because it was found that the data are normal, as the number of data is less than 50, so a test was performed before and after.

In Table 10 you can visualize the data that have been obtained for decision making regarding the analysis of the payment process.

Table 10. Results for the decision – Analysis when performing the payment process.

<table>
<thead>
<tr>
<th>RESULTS – PERFORM THE PAYMENT PROCESS.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparison of values.</strong></td>
<td><strong>Decision.</strong></td>
</tr>
<tr>
<td>T-value: 11.56 &gt; -2.06</td>
<td>The null hypothesis is rejected and the alternative is accepted.</td>
</tr>
<tr>
<td>P-value: 2.69e-11 &lt; 0.05</td>
<td>The null hypothesis is rejected and the alternative is accepted.</td>
</tr>
</tbody>
</table>

Taking into account that the value t (11.56) is greater than the critical value -2.06, it is proposed that the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted, which means that the automated processing time is different from the time of the current process, when executing the payment process with a significance level of 0.05. So that through Figure 4 you can see a clear difference of 571.6 seconds between the current process vs. the automated process of the order request process, which concludes that the application reduces 49.3% of time.

Figure 4. Average payment processing times.
Inferential analysis of response times in the collection process.

For the respective inferential analysis of the collection process, the statistical software Software R was used, where the Student's T test was applied. The process followed is detailed below.

Hypothesis statement

For the following hypothesis statement, the following variables have been defined: TPO= Average time for the automated process and TPA= Average time for the current process.

Null hypothesis (A) = TPO = TPA

Alternative hypothesis (B) = TPO ≠ TPA

Level of significance

For the respective level of significance in the present analysis, a value of 0.05 was considered, which ensures a confidence level of 95%, thanks to the fact that a minimum margin of error is handled.

Statistical test

For the respective statistical test, being two paired samples, it was decided to use a student's t test, because it was found that the data are normal, being a number of data less than 50, for which a pretest and post test was performed.

In Table 11 you can visualize the data that have been obtained for decision making regarding the analysis of the collection process.

Table 11. Results for the decision – Analysis when performing the collection process.

<table>
<thead>
<tr>
<th>Comparison of values.</th>
<th>Decision.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-value: 23.546 &gt; -2.06</td>
<td>The null hypothesis is rejected and the alternative is accepted.</td>
</tr>
<tr>
<td>P-value: 2.2e-16 &lt; 0.05</td>
<td>The null hypothesis is rejected and the alternative is accepted.</td>
</tr>
</tbody>
</table>

Taking into account that the value t (23.546) is greater than the critical value of -2.06, it is proposed that the null hypothesis is rejected and the alternative hypothesis is accepted, which means that the automated processing time is different from the time of the current process, when executing the collection process with a significance level of 0.05. So that through Figure 5 you can see a clear difference of 317.9 seconds between the current process vs. the automated process of the order
request process, which concludes that the application reduces 37.44% of time.

Figure 5. Average of the times of the collection process.

Inferential analysis of the response times of the order requisition process

Finally, for the inferential analysis of the order request process, the statistical software R was used, where the Student’s T test was applied. The process followed is detailed below.

Hypothesis statement

For the following hypothesis statement, the following variables have been defined: TPO= Average time for the automated process and TPA= Average time for the current process.

Null hypothesis (A) = TPO = TPA

Alternative hypothesis (B) = TPO ≠ TPA

Level of significance

For the respective level of significance in the present analysis, a value of 0.05 was considered, which ensures a confidence level of 95%, thanks to the fact that a minimum margin of error is handled.

Statistical test

For the respective statistical test, being two paired samples, it was decided to use a student’s t test, because it was found that the data are normal, being a number of data less than 50, for which a pretest and post test was performed.
In Table 12 you can visualize the data that have been obtained for decision making regarding the analysis of the purchase request process.

Table 12. Results for the decision – Analysis when performing the order request process.

<table>
<thead>
<tr>
<th>RESULTS WHEN PERFORMING THE ORDER REQUISITION PROCESS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison of values.</td>
<td>Decision.</td>
</tr>
<tr>
<td>T-value: 13.29 &gt; -2.06</td>
<td></td>
</tr>
<tr>
<td>P-value: 1.45e-12 &lt; 0.05</td>
<td></td>
</tr>
</tbody>
</table>

Taking into account that the value t (13.29) is greater than the critical value located in the left tail with a value of -2.06, it is proposed that the null hypothesis is rejected and the alternative hypothesis is accepted, which means that the automated processing time is different from the time of the current process when executing the order request process with a significance level of 0.05. So that through Figure 6 you can see a clear difference of 673.4 seconds between the current process vs. the automated process of the order request process, which concludes that the application reduces 35.48% of time.

Figure 6. Average of the times of the order request process.

Interpretation of results

This section assesses the measurements that have been made in order to verify if the application meets the objective set in terms of performance efficiency, which have been evaluated by the ISO/IEC 25010 standard.
In order to evaluate the response time, it is indicated by Table 13 where the assessment of response times is established.

**Table 13. Assessment of response time.**

<table>
<thead>
<tr>
<th>Time taken</th>
<th>Qualification</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 3.5 minutes</td>
<td>100%</td>
<td>Excellent</td>
</tr>
<tr>
<td>3.6 – 7.1 minutes</td>
<td>75%</td>
<td>Very good</td>
</tr>
<tr>
<td>7.2 – 10.7 minutes</td>
<td>50%</td>
<td>Well</td>
</tr>
<tr>
<td>10.8 – 14.3 minutes</td>
<td>25%</td>
<td>Regular</td>
</tr>
<tr>
<td>14.4 or greater is minutes</td>
<td>0%</td>
<td>A little</td>
</tr>
</tbody>
</table>

Source: (Gómez, 2019)

In order to make a correct evaluation, the proposed indicators were used, it is necessary to mention that it is necessary to transform the time obtained from minutes into seconds. Table 14 indicates the average of the times taken from the web application when making the payment, collection and order request process.

**Table 14. Results of the average response time for the evaluation.**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Time (seconds)</th>
<th>Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payments</td>
<td>293.9</td>
<td>4.89</td>
</tr>
<tr>
<td>Collections</td>
<td>265.7</td>
<td>4.42</td>
</tr>
<tr>
<td>Order Request</td>
<td>364.6</td>
<td>6.07</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>308.06</td>
<td>5.13</td>
</tr>
</tbody>
</table>

It is observed in the table above that the average time of the different values previously calculated generate a value of 5.13 minutes equivalent to 308.06 seconds. Once this value was achieved, Table 13 was reviewed, where it can be seen that the response time obtained is located in a range of 3.6 – 7.1 minutes, so it is concluded that the response time of the web application obtains a rating of 75% that is interpreted as VERY GOOD.

**4. Conclusions**

- With the realization of the web application it is evident that the financial processes of the company have become more efficient, achieving a more efficient control of the processes of payments, collections and orders, improving the response time to provide a higher level of efficiency to customers and making the company more competitive.
- The web application is programmed in PHP, has allowed to optimize the process of payments, collections and order requests for the company AUTOMOTRIZ R.A.L.E located in Quito-Ecuador, with an efficiency level of 75%, this being a quality characteristic based on the ISO/IEC 25010 standard, and the efficiency value obtained was the result of the weighted value obtained based on the measurement of times and resources of the respective processes of payments, collections and order requests.

- The automated payment process allows a time saving of 571.6 seconds, which represents a time reduction of 49.3%. As for the collection process, it allows a saving of 317.9 seconds which represents a 37.44% of time saved. And finally, the order request process allows a saving of 673.4 seconds, which has a 35.48% time saving, which is represented as a VERY GOOD improvement based on the results obtained in the three processes analyzed.

- The requirements traceability matrix was used as a technique, because it allowed detailing each requirement requested by the manager of the company, allowing adequate control and monitoring of them.

Bibliography


