

Technology transfer in inventory and order management in automotive parts stores

Transferencia de tecnología en la gestión de inventarios y pedidos en refaccionarias automotrices

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Classification:

Area: Engineering
Field: Engineering
Discipline: Systems engineer
Subdiscipline: Information systems

<https://doi.org/10.35429/JAC.2025.9.23.1.1.9>

History of the article:

Received: September 15, 2025
Accepted: December 30, 2025



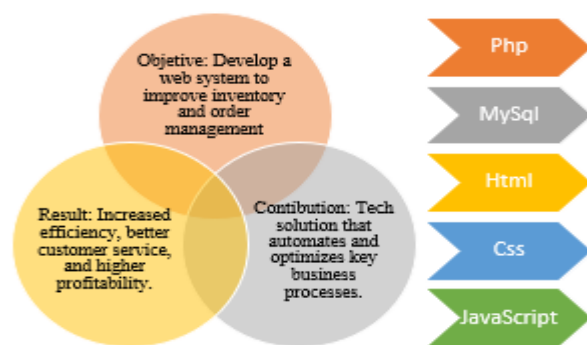
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Abstract

Currently, the business “MELQUIAS AUTOMOTRIZ,” located in Salamanca, Gto., is facing serious operational difficulties due to poor inventory control and errors in order management, despite having a digital system in place. The lack of accurate records leads to mistakes when fulfilling orders, resulting in financial losses and customer dissatisfaction. To address this issue, the development of a web-based system for inventory control and order management is proposed. This system will allow for the registration of incoming and outgoing products, efficient order handling, and the generation of detailed reports on sales, suppliers, and customers. The proposed solution aims to improve inventory accuracy, customer service, and overall business profitability. This research seeks to demonstrate that the adoption of appropriate technologies can positively transform the operations of automotive parts businesses.

Resumen

Actualmente, el negocio “MELQUIAS AUTOMOTRIZ”, ubicado en Salamanca, Gto., enfrenta serias dificultades operativas debido a un deficiente control de inventarios y errores en la gestión de pedidos, a pesar de contar con un sistema digital. La falta de registros precisos ocasiona errores al surtir pedidos, generando pérdidas económicas e insatisfacción en los clientes. Ante esta situación, se propone desarrollar un sistema web para el control de inventarios y administración de pedidos, que permita registrar entradas y salidas, gestionar pedidos eficientemente y generar reportes de ventas, proveedores y clientes. Esta solución mejorará la precisión del inventario, la atención al cliente y la rentabilidad del negocio. La investigación busca demostrar que la implementación de tecnologías adecuadas puede transformar de manera positiva la operación de refaccionarias automotrices.



Php, MySql, Administration, Software



Php, MySql, Administración, Software

Area: Development of strategic leading-edge technologies and open innovation for social transformation

Citation: Sánchez-Luna, Antonio, Rodríguez-Campos, Juan Carlos and Rico-Chagollán Mariana. [2025]. Technology transfer in inventory and order management in automotive parts stores. Journal Applied Computing. 9[23]1-9: e5923109.



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Introduction

This project addresses the main problems faced by the spare parts store, such as uncontrolled inventory, inefficient order management, and frequent delivery errors. Through the implementation of a web-based inventory control and order management system, the aim is to improve the company's operational efficiency, optimise inventory management, and reduce delivery times. It also seeks to provide a solution that improves the customer experience, consolidates the spare parts store's competitiveness, and provides a solid foundation for its future growth.

Software

Instructions [computer programs] that, when executed, provide the desired features, function, and performance; data structures that allow programs to manipulate information appropriately; descriptive information in both paper and virtual forms that describe the operation and use of the programs.

JavaScript

JavaScript [JS] is a lightweight, interpreted, or just-in-time compiled programming language with first-class functions. Although it is best known as a scripting language for web pages, and is used in many non-browser environments, such as Node.js, Apache CouchDB, and Adobe Acrobat, JavaScript is a prototype-based, multi-paradigm, single-threaded, dynamic programming language with support for object-oriented, imperative, and declarative programming.

Programming language

A programming language is a formal language that provides a set of instructions that allow a programmer to write sequences of commands and algorithms to control the physical and logical behaviour of a computer in order to produce various types of data. This set of commands and data written in a programming language is known as a programme.

Database

A database is a set of data belonging to the same context and stored systematically for later use.

Visual Studio Code

Visual Studio Code is a distribution of the Code - OSS repository with specific Microsoft customisations released under a traditional Microsoft product licence. It combines the simplicity of a code editor with what developers need for their basic edit-compile-debug cycle. It provides comprehensive code editing, navigation and comprehension support along with lightweight debugging, a rich extensibility model and lightweight integration with existing tools. There is no cost to access its features.

HTML 5

This is the markup language we use to structure and give meaning to our web content, for example, by defining paragraphs, headings and data tables, or inserting images and videos into the page. [[Mdn Web Doc, Network, 2005](#)].
CSS

This is a style rule language that we use to apply style to our HTML content, for example, setting background colours and font types, and distributing our content across multiple columns.

Life Cycle

The software life cycle consists of the set of stages that precede and follow programming. Software engineering methods and techniques fall within the framework defined by the software life cycle and, more specifically, by the different stages that can be distinguished.

Web Browser

A [computer program](#) that allows users to access the [web pages](#) they want, provided they know the [URL](#) address where they are located [e.g. [www.google.com](#)] or click on a [hyperlink](#) that leads to that page.

Jquery

A fast and concise JavaScript library that simplifies HTML document, event handling, animation, and AJAX interactions for web development.

Server

Definition Server [software]: A software-based server is a programme that provides a special service that other programmes called clients can use locally or over a network. The type of service depends on the type of server software. The basis of communication is the client-server model, and service-specific transmission protocols come into play when it comes to data exchange. .

MySQL

This is the name of a system that allows for the management of [databases](#). It is the most widely used option for web-based applications. [Pérez Porto, 2019].

PhpMyAdmin

This is a tool written in PHP with the intention of managing MySQL administration through web pages, using the Internet. It is available under the GPL [General Public Licence] and in more than 50 languages. This project has been in existence since 1998.

Xampp

XAMPP is the most popular PHP development environment. XAMPP is a completely free and easy-to-install Apache distribution that contains MariaDB, PHP, and Perl. The XAMPP installation package has been designed to be incredibly easy to install and use.

Methodology

In this project, the waterfall life cycle was used because it is suitable for the development of the web platform in the degree awarding processes. It provides a clear and sequential structure that facilitates project planning and management.

Each phase, from requirements analysis, design, implementation, testing, to maintenance, is completed before moving on to the next, minimising the possibility of unforeseen changes and allowing for better risk management.

Box 1

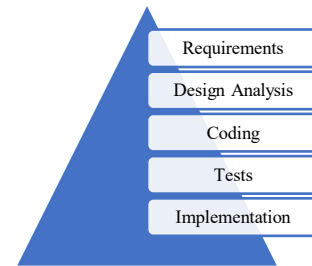


Figure 1
Cascading Life Cycle

Source: Own elaboration

Figure 1 shows the iterative cycle methodology especially useful in projects where the feedback obtained in each phase should improve the previous one.

Therefore, by choosing the iterative cycle, we proceed to show the activities in the table below for the definition of the processes and their stages. This structured methodology ensures that each phase is completed before moving on to the next, allowing for an orderly and controlled development of the project. As shown in Table 1.

Box 2

Table 1

Activity and stages of the cycle.

Stage	Objective	Procedure
Planning and Analysis	Identify needs, define objectives and scope.	Analysis of current problems. - Compilation of requirements.
Design	Establish the structure and detailed design of the system.	Interface design with HTML5, CSS3 and Template
Development	Build the system according to the requirements and design.	Programming of the graphic interface.
Testing	Validate operation and detect errors.	- Unit testing and integration.
Implementation	Deploy the system and train users.	Data migration from the previous system.
Maintenance	Ensure continuous operation and future enhancements.	Corrective maintenance.
Evaluation	Measure impact and collect feedback.	Operational efficiency analysis.

Source: Own elaboration

Analysis

1. Planning and Analysis Phase.

Objective: Define system objectives, business requirements, and project scope.

- Problem Analysis: Evaluate the current problems of the spare parts store, such as lack of inventory control and inefficient order management.
- Definition of Requirements: Identify customer needs and the functional and non-functional requirements of the system.
- Project Scope: Establish the scope of the system based on the Frontend, Processes and Backend layers, ensuring that the system is scalable and modular.
- Project Planning: Develop timelines, necessary resources, and deliverables for each phase of the project.

2. Design Phase

Objective: Establish the system architecture and detailed design of its components.

- System Architecture: The modular structure of the system is defined, clearly separating the three layers [Frontend, Processes, and Backend], which allows the system to maintain its independence and flexibility.
- User Interface Design [Frontend]: Using HTML5, CSS3, and the Celestial Template, an attractive and functional visual interface is created.
- Database Design [Backend]: The data model is created in MySQL 10, ensuring that the database is scalable and efficient.
- Functionality Specification: The interactions between the layers, data flow and system features are specified, using PHP 8.3, JavaScript ECM6 and jQuery to process and manage the information.

3. Development Phase

Objective: To build and programme the system in accordance with the previously defined requirements and design.

- Frontend Development: The user interface is built with HTML5, CSS3 and Template Celestial, ensuring that the user experience is intuitive and efficient.

- Process Logic Development: The interaction layer between the frontend and backend is implemented, using JavaScript ECM6 and jQuery for dynamic interactions and PHP for data processing logic.
- Backend Development: The server and database are configured using PHP 8.3 and MySQL 10, establishing the functionalities to manage inventory, orders, and customers efficiently.

4. Testing Phase

Objective: To verify that the system works correctly and meets the specified requirements.

- Unit Testing: Tests are performed on individual components of the system to ensure that each part functions as expected [frontend, processes, and backend].
- Integration Testing: The interaction between the different layers of the system is verified, ensuring that data flows correctly between the frontend, backend, and database.
- User Testing: Usability and user experience tests are performed to ensure that the interface is intuitive and easy to navigate.
- Security Testing: Tests are performed to identify potential vulnerabilities in the system, with a special emphasis on protecting customer data and transactions.

5. Implementation Phase

Objective: Deploy the system in the production environment and make it available to end users.

- System Deployment: The system is installed on the production servers, configuring the databases and ensuring that all components are correctly integrated.
- User Training: Parts store staff are trained in the use of the new system, including inventory management, ordering, and reporting.
- Data Migration: If necessary, data is migrated from the old system to the new one, ensuring that no important information is lost.

6. Maintenance Phase

Objective: To ensure the continuous operation of the system and adapt it to future needs.

Corrective Maintenance: Errors that may arise during the use of the system are managed and corrected.

Evolutionary Maintenance: New functionalities and improvements are implemented in the system according to business needs and user suggestions.

- **Technology Updates:** Underlying technologies [PHP, MySQL, etc.] are updated to keep the system secure, efficient, and compatible with new versions.

7. Evaluation Phase

Objective: To evaluate the system's performance and its impact on the auto parts store.

- **Performance Evaluation:** The impact of the system on the spare parts shop's operational efficiency is measured, including accuracy in inventory control, reduction of ordering errors, and increased customer satisfaction.
- **User Feedback:** Feedback is collected from employees and customers to identify potential areas for improvement and optimisation.

Conclusion

The project life cycle follows a structured and modular approach that allows for efficient and scalable development of the inventory control and order management system. Each phase is geared towards ensuring the quality of the system and its suitability for the business needs, allowing the spare parts store to improve its operations, increase customer satisfaction, and optimise its sales and inventory management processes.

The life cycle that best suits the development of a web-based inventory control and order management system is the Waterfall Life Cycle or the Iterative and Incremental Life Cycle. Both approaches are commonly used for software projects and have features that can be tailored to the needs of this type of system.

Box 3

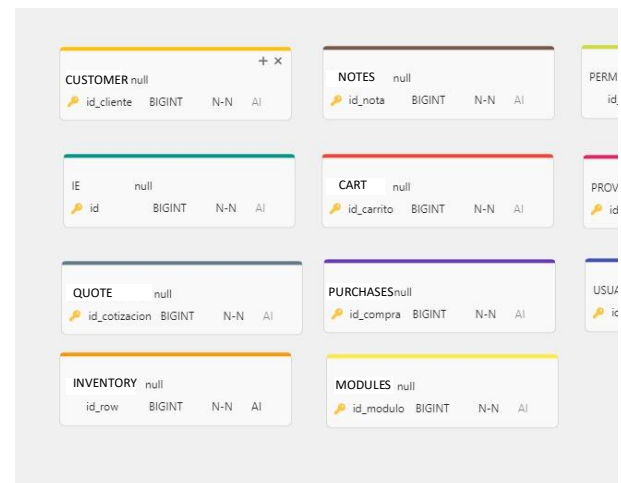


Figure 2

Database design

Source: Own elaboration

Figure 2 shows the final structure of the database, which was designed to ensure efficient data management, facilitate future extensions and improve the overall performance of the system.

Box 4

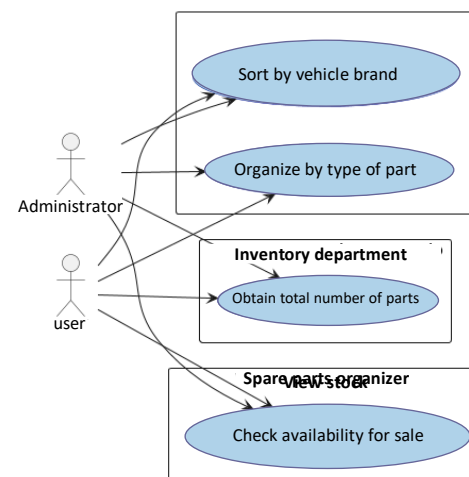


Figure 3

General system use case diagram

Source: Own elaboration

The use case diagram in figure 3 describes the functionalities for organising and sorting spare parts in the system. Both the administrator and the user can perform four main actions: organise parts by part type, sort parts by vehicle make, obtain the total parts in inventory, and check parts availability for sale. This allows for efficient inventory management and facilitates decision making on parts available for sale.

This system is designed to manage different processes related to the administration of sales, vehicles, inventory, parts, customers and suppliers. It has two types of users: the common user and the administrator. The common user can generate invoices, register sales, check stock, update inventory, consult vehicle data and generate reports.

The administrator has full access to the system, including the ability to register and query vehicles, parts and customers, as well as manage suppliers, register purchases and also generate reports. Thanks to this structure, the system allows the centralisation and efficient organisation of the organisation's key operations, providing comprehensive control and facilitating decision making.

Box 5

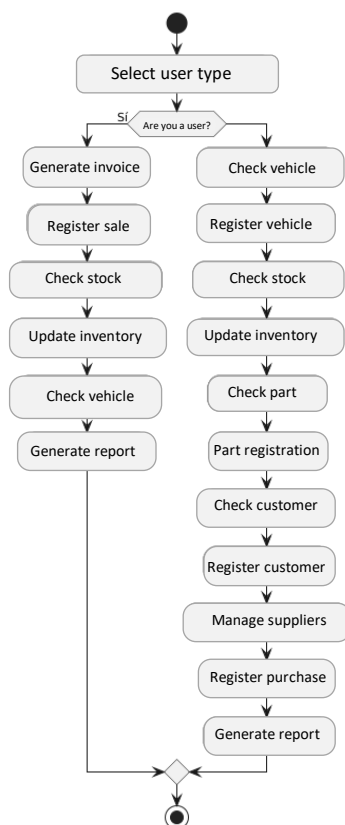


Figure 4

Coding [Backend]

Source: Own elaboration

Figure 4 describes the business process of the system that manages sales, inventory, and purchases, differentiating the workflow according to user type.

It begins with the selection of the user type, which branches the process into two main paths:

1. A flow for sales/billing users [Generate Invoice, Record Sale, Update Inventory, Generate Report].
2. A more comprehensive flow for inventory/purchasing management users [Consult/Register Vehicles and Parts, Manage Suppliers, Register Purchase, Update Inventory, Generate Report].

Results

Design User control

The user section, shown in Figure 5, is essential for system administration. In this section, you can manage user changes to access the system, as well as grant the necessary permissions to interact with and manipulate it as required. To perform these actions, the system only requests three pieces of information: name, user, and profile.

Box 6

Name	User	Profile
DEVELOPER	acv	Administrator
toño	toño	Administrator

Figure 5

User Administrator

Input control and output control

This section of the system allows for the efficient management of related operations, providing an intuitive interface for monitoring, recording and updating related information. From here, users can make necessary adjustments, verify details of specific purchases and ensure that data is correctly synchronised with the rest of the system, thus facilitating a comprehensive and accurate control of receipts.

Box 7

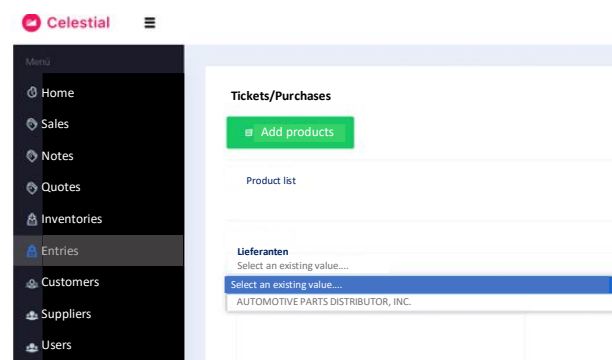
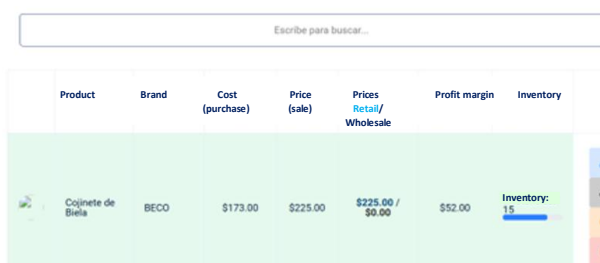


Figure 6

Inputs and Outputs [Administrator role]

Box 8


Product	Brand	Cost (purchase)	Price (sale)	Prices Retail/ Wholesale	Profit margin	Inventory
Cojinete de Biela	BECO	\$173.00	\$225.00	\$225.00 / \$0.00	\$52.00	Inventory: 15

Figure 7

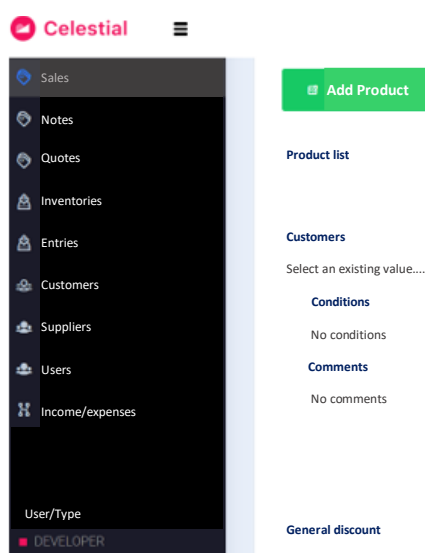
Inventory Control

Source: Own elaboration

In figure 7, inventory control allows to manage and update the inventory in an efficient way by feeding the product catalogue. To add new products, simply click on the "Add new" option. In this section, it is required to enter relevant product information, such as name, brand, product type, cost price and selling price, this process in a visual way, making it easy to understand.

Sales control

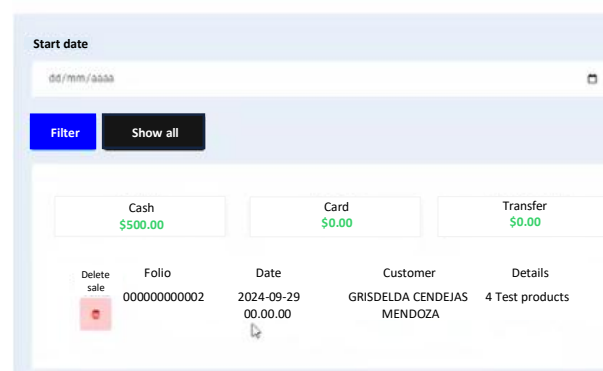
The "Sales" section, shown in figure 8, facilitates the direct generation of a new sale. When interacting with this section and using the corresponding button, the inventory is displayed along with visual controls in colours that highlight relevant information. These indicators provide key data that help to make quick and accurate decisions, optimising the sales process and improving the user experience.

Box 9**Figure 8**

Sales control

Source: Own elaboration

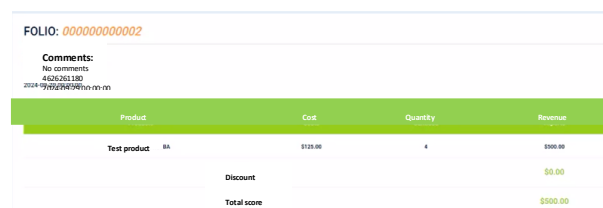
Figure 9 shows how the customer data, the type and conditions of payment, as well as the discount rates and the date on which the transaction took place are displayed.

Box 10**Figure 9**

Note management

Source: Own elaboration

Finally, in figure 10 we can see how the sales note has been generated, where several sections and sections that were previously fed at the time of being with the customer during the sales process appear. And this generates at the end, the note that will be delivered to the client.

Box 11


Product	Cost	Quantity	Revenue
Test product BA	\$125.00	4	\$500.00
Discount			\$0.00
Total score			\$500.00

Figure 10

Note Generation

*Source: Own elaboration***Data Analysis****Social Impact**

The implementation of the inventory control and order management system will have a positive impact on the customer experience, as it will ensure the availability of spare parts when needed, reducing dissatisfaction and strengthening confidence in the company. In addition, the staff at 'MELQUIAS AUTOMOTRIZ' will benefit from a reduction in workload by minimising errors in inventory control and orders.

The digitisation of the process will also encourage the development of new technological skills among employees, which will increase their efficiency within the company and provide them with tools that can improve their performance and employability in the future.

Economic Impact

The project will improve the profitability of the business by reducing economic losses resulting from errors in inventory management. More efficient administration will prevent unnecessary purchases or shortages of key products, optimising operating costs. In addition, better order management will increase customer satisfaction, which can translate into greater loyalty and sales growth. The ability to generate detailed reports on suppliers and customers will identify opportunities for improvement in business relationships, optimising supply and reducing additional costs.

Scientific Impact

From a scientific perspective, this project will contribute to the study and development of best practices in inventory management within small and medium-sized enterprises in the automotive sector. The collection and analysis of data on sales, orders, and customer management will generate valuable information for future research on business digitisation. In addition, the experience gained in implementing the system can serve as a reference for studies focused on process optimisation and the application of new technologies to improve operational efficiency in similar businesses.

Technological Impact

The proposed system will drive digital transformation in the company by integrating advanced tools for inventory and order management. The use of a web platform will allow real-time access to information, improving decision-making and streamlining administrative processes. In the long term, this system will be able to evolve with the incorporation of emerging technologies such as artificial intelligence or the Internet of Things [IoT], which will facilitate even more efficient and automated business management.

Conclusions

In conclusion, the problems identified in this study show that the 'MELQUIAS AUTOMOTRIZ' auto parts store faces serious operational challenges due to a lack of efficient inventory control and inadequate order management. These deficiencies have a negative impact on both customer satisfaction and the profitability and competitiveness of the business.

The research focused on developing a proposal based on a web-based system for inventory and order management, with the aim of optimising operations and solving the problems detected. Critical issues such as inaccurate stock records, errors in order fulfilment and the lack of tools to efficiently manage sales were addressed. In addition, specific solutions were proposed, such as automated merchandise control, the generation of detailed reports, and the agile issuance of quotes and payment notes, successfully addressing key areas of opportunity.

In summary, this study demonstrates that the implementation of appropriate technologies, such as a web-based inventory and order control system, can significantly transform the operations of an automotive parts store. This not only increases operational efficiency and facilitates decision-making, but also improves the customer experience and strengthens the company's competitive position. With this solution, 'MELQUIAS AUTOMOTRIZ' has the capacity to grow sustainably, face the challenges of today's market, and ensure high-quality service for its customers.

Declarations

Conflict of interest

The authors declare that they have no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Contribution of the authors

Sánchez-Luna, Antonio, I contributed to the collection of system analyses, project ideas, and communication between the client and the developer.

Article

Rodríguez-Campos, Juan Carlos: I contributed to the development of the project, data analysis, and interface relationship.

Rico-Chagollán, Mariana: I contributed to the review of the project in the final tests.

Availability of data and materials

Further information on the availability of data or programming methodology during this study is available from the author.

Funding

This research was not funded by any grant or other external support.

Acknowledgements

I would like to thank TecNM campus ITESI for giving me the opportunity to publish the research and studies carried out within the institution.

Abbreviations

CouchDB	Cluster Of Unreliable Commodity Hardware
AJAX	Asynchronous JavaScript and XML
CSS	Cascading Style Sheets
HTML	HyperText Markup Language
ITESI	Tecnológico Superior de Irapuato
JSON	JavaScript Object Notation
MySQL	My Structured Query Language
PHP	Hypertext Preprocessor
SQL	Structured Query Language
TecNM	Tecnológico Nacional de México
X [de	Cross-platform [Multiplataforma:
XAMPP]	Windows, Linux, macOS]
A [de	Apache [Servidor web]
XAMPP]	
M [de	MySQL o MariaDB [Base de
XAMPP]	datos]
P [1° P de	PHP [Lenguaje de programación
XAMPP]	del lado del servidor]
P [2° P de	Perl [Otro lenguaje de
XAMPP]	programación]

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