Design of AliGEST computer application for food management in the nickel industry

Diseño de la aplicación informática AliGEST para la gestión de alimentación en la industria del níquel

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Abstract: A web-based software application was developed to manage food information in Cuban nickel industry. For its implementation, open-source technological tools such as ExtJS, PHP, Javascript, HTML, and MySQL database engine were selected, along with the XP methodology. Upon analyzing the results obtained with the system development, after testing and user evaluations, it is considered that the system will favor the planning of adequate and personalized menus, in addition to allowing the monitoring of food consumption, controlling nutrition levels, and adapting diets according to individual needs, providing tangible benefits for workers in the nickel sector.

Key words: food management, computer program, application software

Resumen: Se desarrolló una aplicación informática basada en la web para gestionar la información de la alimentación en la industria cubana del níquel. Para su implementación se seleccionaron herramientas tecnológicas de código abierto como ExtJS, PHP, Javascript, HTML y el motor de datos MySQL, junto con la metodología XP. Al analizar los resultados obtenido con el desarrollo del sistema, luego de las pruebas y valoraciones de usuarios, se considera que el sistema favorecerá la planificación de menús adecuados y personalizados, además de permitir monitorear el consumo de alimentos, controlar los niveles de nutrición y adaptar las dietas según las necesidades individuales, brindando beneficios tangibles para los trabajadores del sector niquelífero. Palabras clave: gestión alimentaria, programa informático, software de aplicación.

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Introduction

Food management plays a fundamental role in employee well-being and performance. Working in the nickel industry involves considerable physical effort and a demanding work environment, which underscores the importance of a balanced and nutritious diet to maintain workers' energy, health, and efficiency. To guarantee the productivity and well-being of those who work in this industry, an effective information management system related to the food service provided to them is required.

According to Caicedo, Chuquimarca & Velásquez (2019), the final product of a food service system is the provision of food that adjusts to the needs and desires of the target users. Statistics show that the organizations prefering this type of service are oil, mining, education, and health industries (Cruz y Muñoz, 2019).

Companies that offer food services must comply with food quality and safety standards and regulations. These patterns aim to guide and encourage the production, processing, and consumption of safe food (Cruz y Muñoz, 2019). In Cuba, a set of provisions aimed at regulating mass catering, food handling, cleaning, and storage are implemented, based on Cuban Standards 453, 455 (Oficina Nacional de Normalización, 2006) and 488 (Oficina Nacional de Normalización, 2009).

When analyzing this service in the nickel industry, problems in information management with a direct impact on decision-making were identified. An absence of data on food production costs, problems to adjust to specific dietary instructions, a lack of synchronization between menu planning and product availability in warehouses, as well as the non-existence of reliable statistical reports were detected.

Several computer applications are related to food management, some examples are ERP Libra, SoftExpert, and myGestion. These are exclusive systems that, despite covering all food service phases, involve a high acquisition cost, deployment, and professional training for software handling; therefore, their investment is only justified for companies in developed countries.

In Cuba, there are applications linked to food management, such as BiomaSoft, a computer system for monitoring and evaluating food and energy production proposed by Quevedo and Suárez (2015); PEEM, an application for elaborating and evaluating hospital menus (González & Canetti, 2009); and Ceres+ tool, an automated system for

evaluating food consumption (Rodríguez y Mustelier, 2013). These applications are designed for specific client needs, lacking a generic vision that allows their adaptation to the analyzed business process.

For this reason, this study presents the de development of the web-based computer application AliGEST to manage information on food services in the nickel industry.

Accessibility, flexibility, and security are web systems key factors (Salas, 2022). These programs are accessible through a browser via the internet. Unlike desktop programs, web applications allow users the access, from any device, without the need to download and install them.

Materials and methods

To implement the application, open-source tools were selected, thus, it is in line with the Cuban policy of free software development and ensures features that meet the needs of the business in question.

-Hypertext Pre-Processor (PHP): A server-side interpreted language, used in web development for its ease of use and learning. It is intuitive and especially compatible with JavaScript functions (Saavedra, 2020). It adapts to the dynamic development of web applications, using tools that improve software development productivity (Valarezo, 2018; Bautista-Villegas, 2022). Its use facilitates requirement analysis and logical database modeling, allowing the fast development of web applications (Vidal *et al*., 2017; Peña *et al.*, 2023).

-JavaScript: A high-level, client-side programming language that runs on all browsers and is platform-independent. Its rapid evolution and integration with CSS3 and HTML5 have boosted the creation of advanced and attractive websites (Gascón, 2017). In addition to browsers, it is used in databases like MongoDB and CouchDB, and in desktop platforms and servers with Node.js (Haverbeke, 2018).

-ExtJS: An advanced JavaScript framework for cross-platform applications quick development. It stands out due to its modern appearance and flexible architecture, allowing the construction of complex applications with predefined components (Dzhangarov, Pakhaev & Potapova, 2021; Sencha, 2021). It offers pre-integrated user interfaces and optimized components for data visualization in multiple browsers. Ext JS

facilitates the creation of single-page web applications (SPA) that interact dynamically with browser, updating the content without reloading the entire page (Faghfourmaghrebi, 2019).

-MySQL: A database management system (DBMS) popular for its simplicity, performance, and user-friendliness. It is ideal for commercial and entertainment applications (Cornejo, 2022). Its GPL license offers stability and rapid development. It is considered the most reliable open-source database (Oracle Corporation, 2019).

-Apache: An open-source, cross-platform, and free web server, widely used for its stability, performance, and flexibility (Regueira *et al*., 2020). It supports various programming languages and is capable of handling high traffic. Its modular architecture, concurrent connections management, and features like proxy server and support for virtual hosts (Palma, 2020) contribute to its popularity.

Software Development Methodology

Software development methodologies are a set of procedures, techniques, and aids for documentation that guide the entire development process. They are used to develop software products. Methodologies detail the information that must be produced upon completing an activity. They also indicate the information required to initiate each activity. For the development and implementation of the proposed web application, the Xtreme Programming (XP) methodology was chosen.

Extreme Programming (XP) is an agile framework. It is based on incremental development, customer participation, a focus on people, and change acceptance (Saavedra, 2020). Its process includes exploration, planning, iterations, production, maintenance, and closure. XP promotes practices such as incremental planning, small releases, simple design, refactoring, pair programming, and continuous integration. Rahman *et al*. (2020) highlight its adaptability over predictability by connecting waterfall and iterative practices.

Different information gathering techniques were used for the system requirements bidding. In-depth interviews were conducted with the client to expand the initial knowledge. Business documentation was also studied. Furthermore, direct observation of food service management process was carried out in different areas: production, warehouses, pre-dispatch area, and dining halls. Workshops were held between the

development team and the client. The information obtained was qualitatively analyzed. Content analysis was used to identify relevant themes and patterns.

Stages of XP Methodology

Stage 1. Planning

The XP methodology imposes, as part of its application, the determination of those individuals who will have a direct relationship with the system. In this case, the following ones were identified: Administrator, Industrial Processes Technologist, Quality Specialist, Unit Head, and Standardization Specialist, totaling five main positions.

Backlog

The Backlog consists of a prioritized list that defines the work to be done in the project (Beck, 2003). This list may grow and be modified as more knowledge is gained about the product and the customer, with the restriction that it can only be changed between iterations (Beck, 2003). For the proposed system, 12 functionalities were identified (Table 1).

Table 1. System Backlog

Functionalities	General Description of Functionalities
1. Manage users	Includes functional requirements that guarantee entering, deleting, modifying, and listing users
2. Manage LDAP authentication	Includes functional requirements that guarantee entering, deleting, modifying, and listing users
3. Manage clients	Includes functional requirements that guarantee entering, deleting, modifying, and listing clients
4. Manage technical card	Encompasses functional requirements that guarantee entering, deleting, modifying, and listing technical cards
5. Manage dishes	Encompasses functional requirements that guarantee entering, deleting, modifying, and listing dishes
6. Manage type of dish	Encompasses functional requirements that guarantee entering, deleting, modifying, and listing dish types.
7. Manage services	Encompasses functional requirements that guarantee entering, deleting, modifying, and listing services.

Functionalities	General Description of Functionalities
8. Manage dining halls	Encompasses functional requirements that guarantee entering, deleting, modifying, and listing dining halls.
9. Manage ingredients	Gathers functional requirements that guarantee entering, deleting, modifying, and listing ingredients.
10. Manage warehouse	Gathers functional requirements that guarantee entering, deleting, modifying, and listing warehouses.
11. Manage unit	Groups functional requirements that guarantee entering, deleting, modifying, and listing units
12. Manage reports	Groups functional requirements that generate different statistical reports
13. General browser	Consists of requirements that guarantee searching in the system by different criteria

System Characteristics

The system´s characteristics are properties that make the product attractive, fast, or reliable. Non-functional requirements are fundamental to the product's success. Six necessary characteristics for the system development were identified:

- Usability requirements: Ensures the website is easy to use and satisfies user needs intuitively.

-Design and implementation constraints: Establishes limits and guidelines for the website's design and development, ensuring coherence and quality in implementation.

-Security requirements: Establishes measures to protect information and guarantee the privacy of data stored on the website.

-Software requirements: Specifies the software tools and technologies necessary for the website´s optimal development and functioning.

-Hardware requirements: Defines the technical resources and equipment necessary to guarantee the website's proper functioning.

-Maintenance and support requirements: Establish the updating, error correction, and technical assistance needs to keep the website operational and in optimal conditions.

Based on the elements making the Backlog up, the system characteristics, and other elements collected in the interviews, a questionnaire was developed to be applied to the end-users and other personnel selected to participate in the Testing stage included in the XP methodology.

User Stories (US), an XP technique to specify requirements, fulfill the same purpose as use cases (Beck, 2003). They describe the system's needs from the customer's perspective. They are dynamic and flexible and can be modified or replaced. Table 2 shows an example of the 13 US created.

Table 2. User Story: Manage Dish

User Story	
Number: US 5	User Story Name: To Manage Dishes
User: admin_genex	Assigned Iteration: 1
Business Priority: High	Estimated Points: 0.4
Development Risk: Low	
Description: System administrators need to be able to manage dishes to register their information. Hence, the system must allow the creation, modification, removal, searching, and listing of dishes, as well as assigning them to each of the services prepared.	

Iterations Plan

The plan specifically defines how many iterations are required to complete the project. Based on this, a plan of five iterations was defined. This plan contemplates a total duration of 12.1 weeks for implementation.

Stage 2. Design

Class-Responsibility-Collaboration Cards

A template was used for CRC cards (Class, Responsibilities and Collaboration). These cards, as an alternative to UML diagrams, facilitate communication, document results, and allow the programmer to focus on object-oriented development (Beck, 2003). The cards represent objects, with the class, responsibilities, and collaborators. For the project, 12 CRC cards were developed (Table 3).

Table 3. CRC Card Technical Card

Service	
Description: class responsible for managing the data of the technical cards associated with the dishes	
Attributes	
Name	Description
idTechnicalCard	Integer data type (represents a unique auto-increment identifier to enter a technical card in the database)
codeTechnicalCard	String data type (represents the identifying initials of the technical card)
description	String data type (represents a description of the technical card)
Dish name	String data type (used to describe the name of the dish prepared according to that technical card)
ingredients	String data type (used to describe the name of the dish prepared according to that technical card)
grammage	Integer data type (to represent a numerical value corresponding to the amount of grams of an ingredient for the dish)
Responsibilities	
Name	Collaborator
eliminateTechnicalCard ()	TechnicalCard
insertTechnicalCard ()	Plate
modifyTechnicalCard ()	Plate
searchTechnicalCard ()	TechnicalCard
listTechnicalCard ()	TechnicalCard

Data Model

A data model, according to (Gómez, 2013) based on (Celma, Casamayor & Mota, 2003), structures information, representing its static and dynamic properties. The model type chosen was the relational, resulting in a normalized database. At the client's request, instead of the diagram, the composition of the database is described: 17 tables, including 8 strong entities, 2 weak entities, 5 security tables, and 2 generated by many-to-many relationships.

Stage 3. Coding

In XP, each US is generally divided into engineering tasks or programming tasks. These are created to obtain better planning of the story; they are aimed to fulfill the basic

functionalities that will form the general functionalities of each story later. As part of the system development, the implementation of 69 engineering tasks resulting from the analysis of the different US was carried out.

Model-View-Controller Pattern

In software design, architectural patterns offer solutions to design problems. The Model-View-Controller (MVC) pattern stands out for separating business logic from presentation, facilitating maintenance and reuse by decoupling the model view (Faghfourmaghrebi, 2019). Due to its characteristics and benefits, this pattern was chosen for the development of AliGEST.

In the implementation with ExtJS, data models, views, and controllers were defined. Work was done with data binding and routes for navigation, allowing URLs mapping to specific actions and managing the application state.

Results and Discussion

The main results obtained with the development of this research are associated with the creation of AliGEST, an Information System to Manage FS (Food Service) in Cuban nickel industry. Through this web application, it is possible to manage FS in an organized, planned, and controlled manner, providing strategic information about this service to the entity's managers and specialists.

The system is structured into four modules:

1. Administration: A series of users, roles, and permissions are specified here, where each has specified levels of access and information visibility. They will only be able to see and execute the documents for which they were given permission, thus guaranteeing the security and integrity of data within the system.

2. Codifiers: consist of a set of input forms to collect the system's primary data such as dishes, dish types, ingredients, services, menu type, ration type, dining halls, units, companies, warehouses, and diners.

3. Reception: this is the most complex module as it aims to handle technical cards, preparation of food service and its distribution, as well as consultation and interaction with the warehouse management system.

4. Reports: Automated reports are implemented, where information is retrieved, evaluated, and presented to users in a simplified and dynamic manner.

These elements allow the application to provide reliable data that support adequate process control and decision-making regarding food services.

AliGEST evidences easy of use and understanding of the system by users. It has a simple user interface, with fresh and friendly colors (Figure 1).

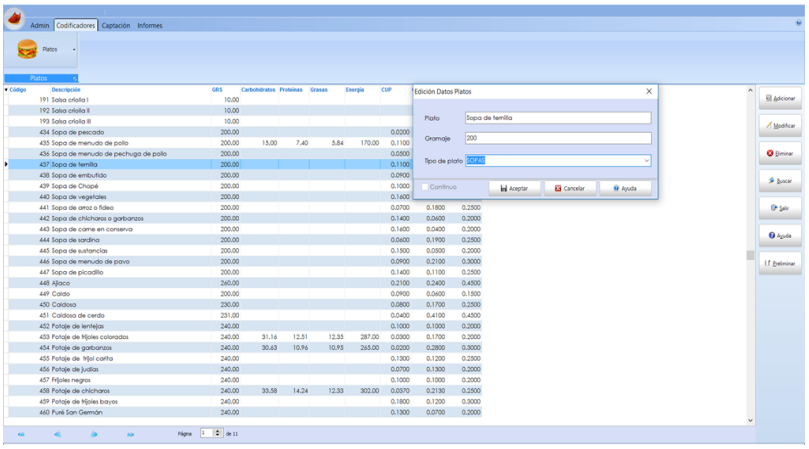

Figure 1. AliGEST codifiers interface.

Other AliGEST benefits are:

· Issuance of statistical reports based on reliable mathematical-computational processing.

· Possibility to control client information, based on daily food services, in correspondence with their service requests.

· Immediate access and consultation of dish technical sheets, in case any type of product verification is necessary.

· The system contributes to improving work in the kitchen, as it safely provides the list of dishes to be prepared, as well as the raw materials to be used for their preparation.

· Coding, grouping, and specification of food properties and characteristics.

· Coding and calibration of dishes, indicating the ingredients each one contains and the necessary quantities per portion, as well as the nutrients total caloric value.

· Control of food production costs.

· Possibility to consult dietary instructions for workers with health history.

· Consulting the system for product availability in the warehouse ensures that menus are prepared in line with available ingredients.

The developed application presents innovative characteristics for Cuba´s nickel industry. Complying with government policies, it is based on free software technologies. Furthermore, this tool automates a process traditionally performed manually through Excel spreadsheets. This offers significant benefits:
-Reliable and centralized information management, from product extraction to service provision
-Precise calculations
-Remote access to data with adequate security levels
-Strict compliance with food safety standards
-Integration with purchasing and warehouse computer systems
-Summarized and exact information to facilitate decision-making based on reliable data

These elements will improve process efficiency, allow customer satisfaction through a more rapid service, and provide essential information to make accurate decisions.

Testing

In the XP Methodology, testing is fundamental. It allows for continuous code verification. Constant testing improves software quality and provides greater security in the development.

In this project, three types of tests were performed.

Unit tests: To ensure AliGEST's quality and functioning, unit tests were implemented via GitHub Actions. This tool compiled the code after each "push" to a repository branch, verifying quality, deployment, and integration. Each new module undergoes cross-review, where team members evaluate the code with options such as "approved", "request change", or "comment". These tests are effective to identify and correct errors in the code.

Integration tests: The designed integration tests allowed verifying the joining of components in three stages: Front-End, Back-End, and final adjustments based on feedback. A development branch (develop) was used for integration and a main branch (master) for the official version.

Usability tests: The application's usability tests were conducted in two stages with real users to evaluate its functioning.

Stage 1: The administrator deployed the application on the server to verify login and registration of authorized users.

Stage 2: Personnel related to the application tested its use, including access, login, and information adding.

After each group tested the application autonomously, a questionnaire was applied to them. The tests were conducted without any guides to evaluate the application's user-friendliness and interactivity at different user levels of computer knowledge. In essence, the goal was to ensure that the application was intuitive and easy to use for all users, without the need for manuals.

Acceptance tests: A survey was conducted with 15 key users (planners, specialists, technologists, heads) to evaluate AliGEST. The survey evaluated five main functionalities, with the options "it worked", "it partially worked", and "it did not work". The results, with over 83% of approval, indicated a satisfactory evaluation. Positive comments were obtained and no critical errors were found, although suggestions for future versions were considered. Figure 2 shows a graph obtained from the survey results.

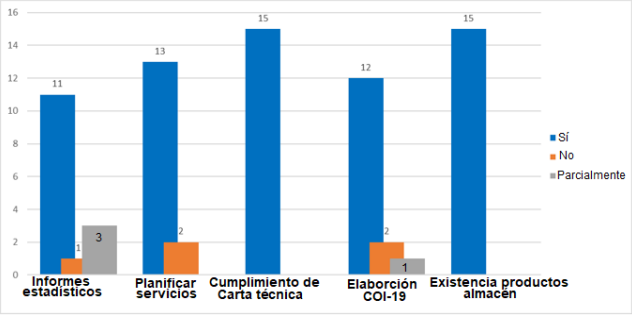

Figure 2. Survey processing result graph.

The testing process, with its variety of approaches, culminates with the acceptance tests. By validating the requirements fulfillment from the end-user's perspective, they stand as the definitive success criterion. By passing these tests satisfactorily, it is confirmed that the software functions as designed and satisfies the client's needs and expectations. Thus, the testing process guarantees product quality.

Conclusions

The design and development of AliGEST, a web application for the organization, planning, and control of food services in the nickel industry in Cuba, were presented. Open-source technologies and the agile XP methodology were used. The development process was characterized by iterations, constant communication and feedback. The tests performed demonstrated that the system functions correctly, is easy to use, and shows acceptance by users.

AliGEST will improve food service information management in the nickel sector, making it more efficient and secure. The findings suggest that the use of open-source technologies and agile methodologies are valuable for the development of computer systems in this industry. Nevertheless, it is recognized that the results may be specific to the context of nickel in Cuba, therefore, future studies are recommended to explore its application in other mining industries in the country.

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