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VETERINARY CLINICAL MANAGEMENT IN THE DIGITAL ERA: DESIGN, IMPLEMENTATION, AND EVALUATION OF A RESPONSIVE WEB SYSTEM TO OPTIMIZE SERVICES IN SMALL-SCALE CLINICS (EXFOVET, ECUADOR)

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ABSTRACT

This article describes the design, implementation, and evaluation of a responsive web system aimed at optimizing clinical management in the Exfovet veterinary clinic, Ecuador. The primary objective was to transform traditional administrative and clinical processes, which were characterized by inefficiencies, duplication, and information loss, through a digital solution tailored for small clinics. An applied methodology was adopted, utilizing an Agile XP approach (eXtreme Programming) combined with participatory tools. This involved veterinary staff, the administrator, and clients in the requirements gathering and iterative system validation processes. Methods included structured observation, SWOT analysis, interviews, and satisfaction surveys. The designed system integrates functionalities such as online scheduling, clinical history management, inventory administration, and direct communication between users and veterinarians, featuring responsive interfaces adaptable to any device. The functional evaluation, supported by integration testing and a user survey, evidenced a significant reduction in errors, improved access and traceability of clinical data, optimization of time, and an increase in user satisfaction and trust levels. These results align with recent scientific literature, indicating that digitalization in veterinary clinics enhances

operational efficiency and service quality. In conclusion, the experience at Exfovet demonstrates the viability and replicability of responsive web systems in small clinics, highlighting the importance of continuous training and technical support for a sustainable transition toward digital veterinary management.

KEYWORDS: Digital Clinical Management, Responsive Web System, Veterinary Clinic.

1. INTRODUCTION

Digital transformation is revolutionizing the veterinary sector, generating profound changes in the way clinical services are administered and patient information is managed. Small-scale veterinary centers, such as Exfovet in Ecuador, face significant challenges regarding service organization, efficiency, and quality due to the predominance of manual processes for clinical record keeping, appointment scheduling, and inventory control. The integration of digital technologies in veterinary services improves the precision, speed, and quality of care, providing advantages in decision-making and client satisfaction. (1)

Several recent studies indicate that the digitalization of veterinary clinics allows for the optimization of workflows, the reduction of the administrative burden, the minimization of errors, the facilitation of information access, and improved communication between professionals and pet owners. (2, 3)

The value of digitalization for diagnosis, clinical planning, and follow-up, as well as for the implementation of big data systems and intelligent data processing oriented toward precision veterinary medicine, is increasingly recognized. (4) Furthermore, the adoption of responsive web systems provides accessible access from any device, offering flexibility and efficiency to both clinical teams and clients.

In the specific case of Exfovet, the lack of IT solutions to manage critical processes such as appointment scheduling, post-consultation follow-up, and supply administration has resulted in time wastage, record duplication, and difficulty in providing high-quality services. International experience suggests that introducing user-centered digital tools facilitates functional integration between different areas of the clinic, enables the automation of reports and controls, and improves overall patient satisfaction. (5)

This research addresses the development and implementation of a responsive web system to optimize clinical management at Exfovet, evaluating its impact on operational efficiency, data traceability, and user experience (UX). The methodological and technological approach is based on the use of agile frameworks and user-centered design (UCD) techniques, which aligns with international trends in the digitalization of veterinary clinics. This contribution seeks to demonstrate how digital transformation can become a driver of change for small clinics, promoting best practices and new quality standards in veterinary services.

2. METHODOLOGY

This research was developed with an applied and descriptive focus, aimed at solving real-world problems in the clinical management of the Exfovet veterinary clinic, located in the El Triunfo canton, Guayas province, Ecuador. A qualitative methodology was employed, supported by direct observation and collaborative work with the main stakeholders: the veterinary doctor and the administrator. (6)

The design selected the Extreme Programming (XP) methodology, recognized for its adaptability and short iterative cycles, which promotes constant feedback from the end-user and continuous improvement of the developed product. (7, 8, 9)

2.1. Population And Sample

The population consisted of the two main members of the Exfovet team: the veterinary doctor responsible for clinical care (Dr. Edison Franco) and the administrator in charge of management and sales. Additionally, for the user evaluation phase, a sample of 30 frequent clients was included, who were administered a satisfaction survey following system implementation. (6)

2.2. Data Collection Instruments and Techniques

Observation Log: Used to record initial administrative processes, technological resources, and procedures.

Semi-structured Interviews: Conducted with the veterinary doctor to identify the clinic's needs, difficulties, and workflows.

SWOT Analysis (Situational Analysis): Employed to detect strengths, weaknesses, opportunities, and threats in the existing management.

User Stories: Used to define the system's requirements and functionalities.

Satisfaction Survey: A questionnaire applied after implementation to assess improvements in efficiency and service quality.

This combination of techniques is recommended by recent studies for the development of IT solutions in the veterinary field, as it facilitates the identification of real-world problems and allows for the design of user-adjusted interfaces. (10, 11, 12)

2.3. Project Procedures and Phases

Initial Diagnosis: Observation and interviews to map the flow of care, clinical history recording, and supply administration.

System Modeling and Design: Development of

use cases, Data Flow Diagrams (DFD), class diagrams, and database structure; prototyping and interface design using responsive design principles.

Iterative Development: Coding using PHP, MySQL, JavaScript, Bootstrap, and Slim Framework under the XP methodology; each module was validated through delivery certificates and adjusted based on feedback. (6)

Implementation and Training: System installation, user training, delivery of technical and user manuals.

Functional and Satisfaction Evaluation: Integration and functionality tests (see Annex 21), and application of the satisfaction survey to clients and the administrator. This user-centered and iterative approach aligns with international recommendations for animal health technologies. (13, 14, 15)

2.4. Documentation

Exhaustive documentation was generated, including a data dictionary, UML diagrams, a technical manual, a user manual, and a project schedule, providing support for replication and future improvements.

2.5. Considerations For Replicability

The use of participatory techniques, detailed documentation, and the XP methodology facilitates replication in other small-scale veterinary clinics. International publications highlight this approach as key for sustainability and innovation in clinical digitalization (16, 17).

3. RESULTS

The implementation of the responsive web system at the Exfovet veterinary clinic led to measurable improvements in clinical management, patient follow- up, and administrative processes. The results are presented in three subsections: initial diagnostic findings, system performance, and user- perceived impact.

3.1. Initial Diagnostic Findings

The baseline diagnosis, based on structured observation and interviews, revealed a predominantly manual management model with significant limitations in information handling and process control. As shown in Table 1 (Observation Log), the clinic had basic computer equipment and internet access but relied on paper notebooks for appointment scheduling, clinical histories, and inventory records, which increased the risk of information loss and duplication. No digital tool was used for systematic follow- up of patients, and appointment control was incomplete, since many clients arrived without prior scheduling.

Table 1: Observation Log.

Evaluation Indicators	Yes	No	Observation
Does the veterinary clinic possess technological equipment?	X		It has a computer.
Does it use any office automation tool or system to record processes?		x	It does not record processes; some services are registered manually in notebooks or sheets.
Does it have an internet connection?	X		Yes, it has internet service from Satelital.Net.
Does it maintain a control of scheduled client appointments?	X		Appointments are controlled manually on paper, but most clients arrive sporadically without a prior appointment.
Does it keep a record of clinical history in any technological tool?		x	Clinical history records are kept in physical documents.
Does it use any office automation tool to record inventory?		x	Inventory is recorded in a notebook.
Does it perform any follow-up after clinical care for patients?	X		Follow-up is done by scheduling another appointment for control.
Is it necessary to implement a system that allows managing services, clinical care follow-up, and online appointment scheduling?	X		A system is important to help them better manage these processes and services.

Source: Own Elaboration.

The SWOT situational analysis (Table 2) confirmed that, despite having trained staff and minimum technological infrastructure, Exfovet faced weaknesses such as time loss due to manual procedures, limited digital skills of the administrator, and lack of online communication channels. Opportunities were identified in cost reduction, faster information retrieval, and improved client communication if a digital system were implemented, while potential threats related to system errors, cyberattacks, and data security highlighted the need for appropriate technical support and protection measures. Overall, the diagnostic phase justified the development of a web- based solution to strengthen service management, clinical follow- up, and online appointment scheduling.

Table 2: SWOT Situational Analysis.

Internal factors / External factors	Strengths – S Has computer equipment to implement the system. Veterinarian with knowledge of veterinary systems. Personnel trained in veterinary care. Has employees available for the job.	Weaknesses – W Administrator has limited knowledge in system usage. Time loss due to manual processes. Lack of online communication.
Opportunities – O Cost reduction. Immediate information retrieval. Improved client communication. Satisfied clients. Improved quality of services. Improved operational efficiency.	S-O Strategies (Strength-Opportunity) Integrate updated computer equipment for system management. Encourage system usage for service provision.	W-O Strategies (Weakness-Opportunity) Conduct training for personnel in charge of system administration. Incentivize the use of the virtual channel for clinical follow-up.
Threats – T Error in design or programming. Cyberattacks or viruses. Data theft. Host or domain failure. Internet failure.	S-T Strategies (Strength-Threat) Maintain contact with the developer to resolve errors. Have antivirus software on the equipment where the system will be implemented. Constant communication regarding new updates.	W-T Strategies (Weakness-Threat) Review the functional model of the system according to needs. Incentivize the use of the user and technical manual for system administrators.

Source: Own Elaboration.

3.2. System Performance and Functional Validation

After implementation, the system's performance was assessed through functionality and integration tests for the main modules (users, pets, appointments, clinical records, and inventory). Table 3 (Functionality Tests) summarizes representative test cases, including login, registration of administrators and clients, pet registration, and appointment management, all of which met the expected outcomes with successful execution and no critical incidents reported.

The consistent "OK" status across the tested scenarios indicates that the system correctly handled data entry, modification, deletion, and retrieval operations required for routine clinical and administrative workflows. (17, 18, 19)

Table 3: Functionality Tests.

Test Case	Test Description	Input Data	Expected Output	OK?	Observation
Login	Verifies the login page with valid credentials.	User and password are entered.	Correct entry into the system.	Yes	None
Register a new user (admin)	Manage admin and verify correct functioning of view, modify, and delete buttons.	Enter personal information: ID number, date of birth, names, surnames, cell phone, email, and gender.	Success, the user has been saved correctly.	Yes	None
Register a new user (client)	Manage clients and verify correct functioning of view, modify, and delete buttons.	Enter personal information: ID number, date of birth, names, surnames, cell phone, email, and gender.	Success, the client has been saved correctly.	Yes	None
Register new pets	Manage pets and verify correct functioning of view, modify, and delete buttons.	Enter information such as: Name, date of birth, weight, gender, client, category (canine, feline), breed, and photograph.	Success, the pet has been saved correctly.	Yes	None
Appointment Management	Verify correct functioning of view, modify, and delete buttons when scheduling an appointment.	Enter appointment reason, select client, pet, appointment date, service, veterinarian, and time.	Success, the appointment has been generated correctly.	Yes	None

Source: Own Elaboration.

These results confirm that the responsive web system operated reliably under the intended use conditions, supporting secure access, role- based management, and accurate recording of clinical information and services. The successful validation of core functionalities provided a robust foundation for the subsequent assessment of its impact on daily practice.

3.3. User Impact and Satisfaction

The impact of the system on service quality and efficiency was evaluated through a satisfaction survey administered to 30 frequent clients and the clinic administrator after a period of use.

The results (Figure 1) showed high levels of satisfaction regarding ease of appointment scheduling, clarity of information provided, and perceived improvements in service organization and follow- up. Most respondents agreed that the new system facilitated communication with the clinic, reduced waiting times, and improved the overall experience when accessing veterinary services (20, 21).

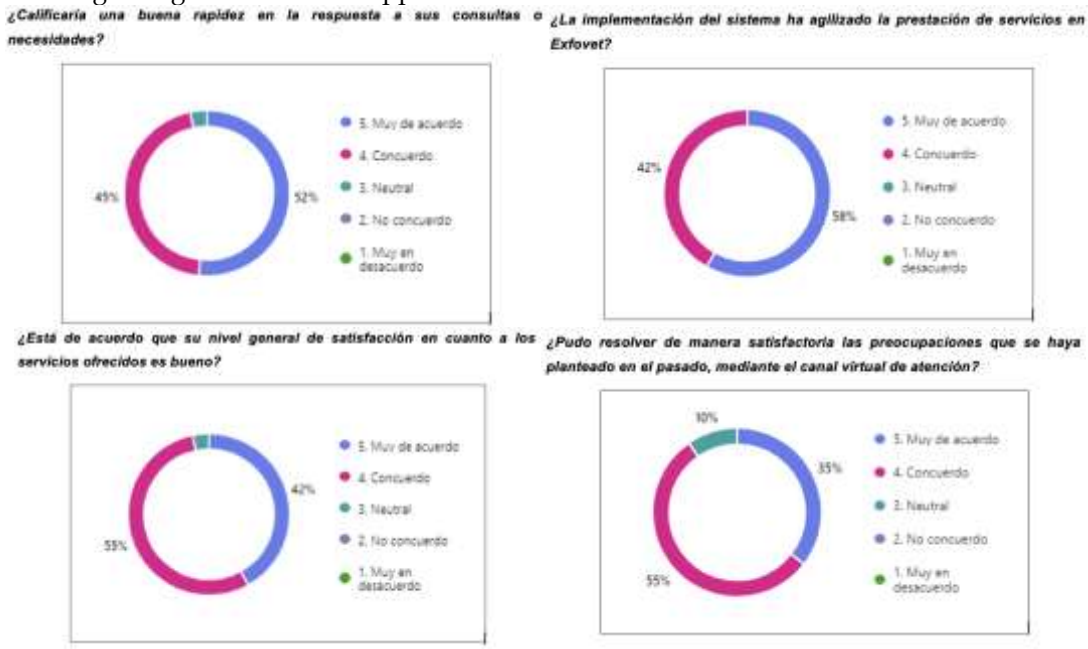

Figure 1: Satisfaction Survey Results.
Source: Own Elaboration.

From the administrator's perspective, the system contributed to a noticeable reduction in time and errors in clinical and administrative management, particularly in the registration and retrieval of clinical histories and the control of products in inventory.

The ability to generate updated information quickly and to maintain a clear record of appointments and services enhanced transparency and process traceability. In summary, the main achievements observed were reduction of time and errors, improved access and quality of service, increased satisfaction and trust among users, and more efficient inventory and online appointment management. These findings are consistent with international reports indicating that the adoption of web- based systems in veterinary clinics improves operational efficiency, quality of care, and user experience. (22, 23, 24)

4. DISCUSSION

The adoption of a responsive web system at Exfovet marked a positive transformation in clinical and administrative management, enabling the optimization of processes, the enhancement of user experience, and the elevation of care quality, in line with advancements highlighted by international literature. Recent studies demonstrate that veterinary web applications contribute to reducing service times, facilitating access to information, and mitigating errors resulting from manual records, in addition to strengthening data management and file organization.

The iterative validation technique employed during the development allowed for the continuous adjustment of the solution to the real needs of the clinical and administrative team, achieving high levels of satisfaction among end-users, including both clinic staff and clients. This aligns with current research that underscores the importance of user-centered design (UCD) focused on ease of adoption, multi-platform accessibility, and information transparency in animal health. (1)

However, digitalization presents challenges such as the digital divide, the learning curve for new systems, and the need for constant training to ensure effective and sustainable appropriation. (13) The experience at Exfovet reveals that technical support and comprehensive documentation are crucial determinants for the success of technological

migration.

It is important to note that automation does not replace the clinical work of the veterinary professional, but rather enhances efficiency, precision, and security in management, allowing for personalized services and continuous follow-up of animal health. The literature suggests complementing technological innovation with training and professional updating strategies, integrating the entire clinic team into the transformation process. (17)

Finally, the replicability of the methodological and technical model used at Exfovet opens new avenues for the modernization of small-scale veterinary clinics, facilitating access to digital services, the integration of artificial intelligence (AI), and the strengthening of clinical management in Latin America.

5. CONCLUSIONS

The implementation of the responsive web system at the Exfovet veterinary clinic proved to be an effective solution for modernizing clinical, administrative, and customer service management, optimizing critical processes such as appointment scheduling, clinical history management, and inventory control. The results revealed a significant reduction in time and errors, an improvement in information transparency, and greater satisfaction for both staff and clients, thereby validating the benefits identified in the scientific literature.

The agile and user-centered approach allowed the technological solution to be adapted to the real context needs, facilitating the adoption and appropriation of the system by the clinical and administrative team. These findings confirm that digitalization, when accompanied by training and technical support, constitutes an effective driver for continuous improvement, traceable management, and the professionalization of veterinary services.

The study provides evidence that the implemented model is replicable in other small-scale clinics, constituting a methodological and technical basis for the deployment of new digital applications in veterinary management in the region. It is recommended that future implementations strengthen training and support strategies to overcome technological barriers and enhance the positive impact of digital transformation in Latin American veterinary medicine.

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