QhaliKiosk: Design and Implementation of a Multilingual Health Kiosk for Automated Triage in Peri-Urban Communities in Peru

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***Abstract*—Timely and standardized triage at the first level of care remains challenging in peri-urban Peru, where processes are largely manual, device readings are transcribed by hand, and language and access barriers persist. The general problem is the operational strain and variability that manual triage imposes on already limited staff, resulting in a specific technological challenge: "In Peru, triage in healthcare services continues to be a manual, fragmented process, dependent on staff availability, with biomedical devices operating in isolation and without automated integration into digital systems". We propose QhaliKiosk, a bilingual (Spanish–Quechua) self-service health kiosk that automates the acquisition of SpO_2, heart rate, respiratory rate, temperature, and blood pressure, links each encounter to the national ID (DNI) to build a longitudinal preclinical record that can be uploaded to the cloud. The design targets less than 180 s end-to-end per user and a prototype that adheres to ergonomics, accessibility, and electrical safety requirements. Our methodology combines *GAITS* and *VDI 2206* to ensure traceability from need to validation: (1) discovery and context; (2) requirements and guidelines; (3) conceptual design (black box, function structure, block diagram); (4) alternatives and selection (morphological and decision matrices); (5) system prototyping (hardware–software–UI integration); and (6) verification, calibration, and field validation. The paper details the architecture, design trade-offs, and planned evaluation against technical and usability KPIs, positioning QhaliKiosk as a pragmatic pathway to scalable, equitable triage automation in resource-constrained settings.**

***Keywords*—automated triage, health kiosk, biomedical instrumentation, electronic health records interoperability, multilingual user interface (Spanish–Quechua)**

I. Introduction

Strengthening first-contact care in low- and middle-income countries requires streamlining triage and vital-sign acquisition, which in many settings remain manual and staff-dependent. Globally, approximately 24% of the rural population—nearly two billion people—lacks adequate access to primary care; at the same time, a shortage of 18 million health workers by 2030 is projected, a gap associated with congested emergency departments and worse clinical outcomes. Consequently, overcrowding has been linked to a 50% increase in 10-day mortality following emergency visits [1], [2].

In Peru, disparities are particularly stark. Only 3% of the rural population reports adequate access to medical services versus 83% in urban areas [3]. According to the 2022 ENAHO survey, 7 in 10 people who needed care did not obtain it—most often due to delays (35%) and distance (13%) [4]. The Andean highlands concentrate 35.7% of reported health problems; in rural and peri-urban zones, 59.9% of those reporting illness lack formal preventive education, which further limits help-seeking [5]. Preventive culture is low: only 30% of Peruvians pursue preventive checkups, and just 52% use the formal health system; 8% cite lack of money, 17% facility remoteness, and 23% poor perceived quality as reasons for not seeking care—contributing to an estimated 20 million-person care gap [6].

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Peruvian triage is regulated by NTS 042, which defines triage as a clinical process based on vital signs (blood pressure, heart rate, respiratory rate, oxygen saturation, and temperature), level of consciousness, and chief complaint. Patients are prioritized into five urgency levels under national and international guidance [7], [8]. Time is critical: international references (ACEM/ESI) indicate that triage should take 2–5 minutes, with observed medians 2–3 minutes in routine practice; maintaining this short interval preserves patient flow and reduces bottlenecks in vital-sign assessment [9].

Despite this guidance, implementation remains largely manual and heterogeneous across the country. Vital-sign devices (BP monitors, oximeters, thermometers) typically operate in isolation, and results are hand-entered into information systems [10]. Recent digitalization efforts created the SIHCE—an electronic health record platform for primary care that includes a dedicated triage module and interoperability with SIS, RENIEC, and HISMINSA, including digital signature as a regulatory requirement [11], being a national interoperability milestone validated by MINSA/PAHO in 2025 [12]. However, routine triage still lacks automated capture from biomedical devices or self-service kiosks feeding data directly into clinical workflows [10]–[12].

Internationally, health kiosks have matured as self-service solutions that measure vital signs, store results in the cloud/EHR, and often enable teleconsultation. Evidence in emergency and primary care shows reduced waiting times, improved accessibility, and continuity of care with digital check-in and triage [13], [14]. In rural contexts, hybrid programs such as Ontario's Virtual Triage and Assessment Centre (VTAC) report high patient satisfaction (86%) while improving coordination with clinicians [15].

Therefore, our preliminary state-of-the-art analysis confirms these benefits but also surfaces limitations that are decisive for Peru's peri-urban and rural settings [16]–[25]. First, manual processes persist locally, over-burdening staff and introducing variability; automation would standardize criteria and reduce workload. Second, devices are not integrated, with hand transcription delaying data availability; an automatic information flow to SIHCE is needed. Third, patient re-evaluation depends on remaining physically at facilities; reminder technologies could enable remote follow-up. Fourth, geographical, cultural, and linguistic barriers constrain access—few solutions provide multilingual interfaces suited to low literacy, including Quechua. Finally, data protection protocols specific to automated triage are still immature [state-of-the-art limitations]. Collectively, these gaps define the technological problem that motivates our work: "In Peru, triage in healthcare services continues to be a manual, fragmented process, dependent on staff availability, with biomedical devices operating in isolation and without automated integration into digital systems".

In response, this paper presents QhaliKiosk, a bilingual (Spanish–Quechua) self-service health kiosk designed to automate triage by standardizing the measurement of essential vital signs (SpO_2, heart rate, respiratory rate, temperature, and blood pressure) and by linking each use to a national ID (DNI) to construct a longitudinal preclinical record. Results are synchronized via connectivity to cloud services; locally, the design targets < 180 s per user end-to-end, aligned to ergonomics, accessibility, maintainability, and safety (Peruvian and International Norms) [10]–[12].

Beyond describing the solution, the methodology (a combination of GAITS and VDI 2206) is explained, ensuring end-to-end traceability from stakeholder needs and national regulations to conceptual design, alternative evaluation, system prototyping, and verification in context. This combination is particularly apt for public-sector constraints of Peru, where interoperability and bilingual, low-literacy UX are not desirable features, but determinants of equitable access.

II. Methodology

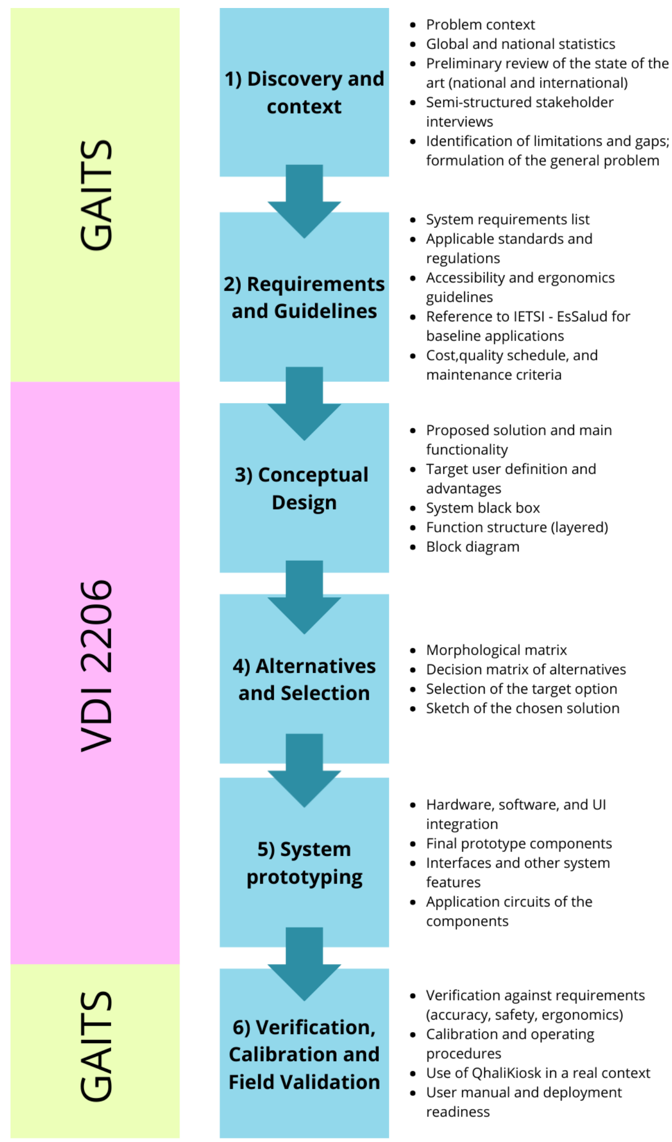

Fig. 1. QhaliKiosk methodology mapped to GAITS and VDI 2206. Labels indicate the framework owning each stage. Bullets are high-level and aligned with the development of the project.

A. Discovery and Context (GAITS)

In this initial stage, the general problem was identified by analyzing the current triage processes in Peru and their associated limitations. Global and national statistics were reviewed in order to contextualize the magnitude of the challenge, while a preliminary state-of-the-art survey highlighted existing technological approaches, both nationally and internationally. Semi-structured interviews with healthcare professionals and potential users were conducted to identify barriers such as language, accessibility, and the lack of digital integration. From this information, key gaps were synthesized and the technological problem of fragmented and manual triage was formulated.

B. Requirements and Guidelines (GAITS)

Once the problem was established, a list of system requirements was developed. These included functional specifications (e.g., accuracy targets for physiological measurements and time per patient below 180 seconds), as well as non-functional requirements such as ergonomics, accessibility (multilingual interface), and maintainability. Applicable standards and regulations were also referenced, including IEC 60601-1 for electrical safety and IETSI–EsSalud guidelines for biomedical equipment [26]. These requirements serve as measurable criteria for subsequent verification.

C. Conceptual Design (VDI 2206)

The conceptual design defined the proposed solution — a bilingual health kiosk capable of automating vital sign acquisition and integrating with national health information systems. The design process included the elaboration of a black-box diagram, a layered function structure (energy supply, signal acquisition, control, user interface, and cloud connectivity), and a block diagram that describes the interaction between components. This stage also clarified the main functionality of QhaliKiosk and its expected advantages for peri-urban communities.

Fig. 2. Preliminary sketch of the QhaliKiosk solution proposal.

D. Alternatives and Selection (VDI 2206)

Several technical alternatives were generated through a morphological matrix, combining different sensor options, interaction modules, and communication schemes. A decision matrix was then applied to evaluate these alternatives under criteria such as cost, precision, availability in the local context, and user experience. Based on this structured evaluation, "Option 1" was selected as the most feasible solution, balancing affordability, availability of components, and ease of implementation. A sketch of the selected solution was prepared to support the transition into prototyping.

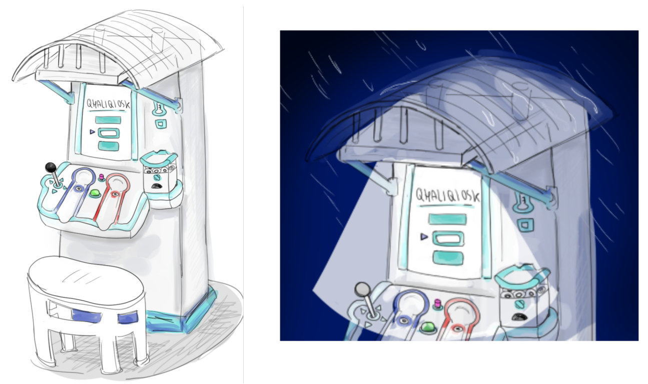

Fig. 3. QhaliKiosk sketches. Left, the complete prototype; right, how it works at night.

E. System Prototyping (VDI 2206)

In this stage, the selected alternative was materialized through the integration of hardware, software, and user interface modules. The final prototype components include the XSpace Bio development board, the AD8232 ECG module, the AFE4490 PPG/SpO_2 front-end, an infrared thermometer, joystick and arcade buttons for interaction, as well as a Raspberry Pi 5 with a monitor for graphical display. The system's graphical user interface was designed in both Spanish and Quechua, ensuring inclusivity. This phase also defined the circuits of application for each component and the initial operating procedures.

F. Verification, Calibration and Field Validation (GAITS)

The final stage involves verifying the system against the predefined requirements, focusing on accuracy, safety, and ergonomics. Calibration procedures for each sensor module are being defined to ensure consistency of measurements. Moreover, the kiosk is intended to be tested in a real context, where usability, adoption, and completion rates will be evaluated. The user manual and deployment guidelines were also prepared to facilitate future scaling. In practice, verification covers bench comparisons of SpO_2, heart rate, respiratory rate, temperature, and blood pressure against clinical reference devices, with acceptance thresholds derived from the requirement list. Furthermore, ergonomic verification includes interaction-height checks, reach and visibility assessments, and confirmation of contrast/readability targets on the bilingual UI. This stage closes the loop by linking the original requirements with measurable results obtained in both laboratory verification and pilot validation.

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