Sismorcego: Usability Evaluation of an Offline Mobile Application for Surveillance of Sylvatic Rabies in the Amazon

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Abstract. *The Amazon region faces severe logistical and climatic challenges that hinder the epidemiological surveillance of wild rabies. The traditional use of paper forms often results in delays in reporting and the loss of geographic tracking of outbreaks. This study presents Sismorcego, an offline-first mobile app developed to record and georeference bat attacks in areas without network connectivity. To assess the tool's practical feasibility, the System Usability Scale method was applied to 42 Community Health Agents. The app obtained an average score of 74.80, with heuristic highlights for Efficiency (73.21) and Satisfaction (75.79). Statistical validation using the Wilcoxon test ($p = 0.0006$) confirmed that the system's usability is significantly higher than the 68-point acceptability threshold. The results indicate that the transition to an offline digital solution is a viable strategy for overcoming geographic isolation, ensuring continuous and accurate monitoring of zoonoses in the Amazon.*

1. Introduction

The Amazon region presents a unique and challenging landscape for public health, defined not only by its continental dimensions but also by a logistical complexity that often makes it impossible to apply traditional models of care [Fausto et al. 2022]. The vast territorial expanse, dominated by dense forests and crisscrossed by a vast river basin, creates severe geographical barriers that drastically restrict the reach of public health surveillance teams [Franco et al. 2025]. Recently, drastic global climate variations have intensified these obstacles. Historic droughts and extreme floods drastically reshape rivers and landscapes, further isolating riverside and indigenous communities [Pantoja and Santos 2025]. In this context of environmental uncertainty, the health system's response time is severely compromised, leaving historically vulnerable populations unassisted in the face of epidemiological emergencies.

Given this reality, exacerbated by climate change, Rabies Lyssavirus (rabies) remains a zoonosis of extreme importance, continuing to be a public health priority due to its clinical severity and profound psychosocial impact on affected communities. Classified as an acute and progressive viral encephalitis, the disease has a case fatality rate of nearly 100% [Hemachudha et al. 2013]. Although it is a vaccine-preventable disease, its endemic persistence in Latin America highlights how fragile basic health coverage is at the frontiers between human expansion and nature [Furlan 2025]. The dynamics of virus transmission operate through distinct epidemiological cycles — urban and sylvatic — which require differentiated response strategies [Vargas et al. 2019]. With climate change and the expansion of agricultural frontiers, wildlife is forced to alter its routes in search of survival, which intensifies synanthropy and increases the likelihood of attacks in peridomestic areas [Carneiro et al. 2025]. In this scenario, the hematophagous bat *(Desmodus rotundus)* has established itself as the primary vector in the region [Da Rosa et al. 2006].

The major obstacle to addressing this problem from a humanitarian and public health perspective lies in the inefficiency of current reporting mechanisms. The detection of attacks depends on a painfully slow and fragmented flow of information [Catozo et al. 2025]. During periods of extreme weather events, the physical transport of paper forms to municipal offices becomes challenging [Lima et al. 2021]. Without a computerized system at the front lines, the problem goes far beyond bureaucracy, as the exact location of rabies outbreaks is lost. This spatial and epidemiological disorientation hinders the preventive mapping of risk areas and shelters, making surveillance rigid and reactive—a situation that often costs lives due to delays in administering rabies serum.

To aid in adapting to this new climatic and logistical reality, mobile health technologies (m-Health) emerge as essential tools for overcoming geographic isolation [Lambert et al. 2022]. The implementation of systems capable of operating offline allows field agents to record the exact geographic coordinates of bat sightings and roosts on-site, ensuring that disease tracking occurs even when communication networks fail. In response to these urgent needs, this study presents the "Sismorcego" app, designed to operate without connectivity and ensure the timely, georeferenced recording of attacks.

For technology to effectively fulfill its role, it must be adopted by healthcare workers. With this in mind, the present study recognizes that validating the proposed tool and its impact on the daily routines of healthcare workers — especially given the pressures of fieldwork exacerbated by weather conditions — is a fundamental step. To this end, a user experience evaluation was conducted using the System Usability Scale (SUS) [Brooke et al. 1996]. The method was chosen because it is a simple, quick ten-question questionnaire, has high scalability, and is widely accepted by the scientific community for objectively evaluating interactive systems. The aim is to highlight how human-centered design is vital for technological innovation to function in the daily practice of professionals.

In this context, this study aims to: (i) present the Sismorcego app as a digital solution designed to operate offline, automating the generation of notification forms and ensuring the georeferenced recording of bat attacks; (ii) evaluate the tool's usability and acceptance among health workers using the SUS method; and (iii) demonstrate how the use of human-centered mobile technologies can mitigate the impacts of climatic and logistical variations on the epidemiological surveillance of wild rabies in the Amazon. To further these discussions, the remainder of this article is organized into four sections. Section 2 presents the theoretical framework focused on climate challenges and usability concepts. Section 3 details the methodological approach and data collection. In Section 4, the data from the user evaluation are presented and discussed. Section 5 summarizes the final considerations of the study.

2. Related Work

The use of mobile technologies has been essential for improving the surveillance of tropical diseases and zoonoses, especially in settings with logistical constraints. A prominent example is the mobile app Calculator of Epidemiological Risk for Rural Properties and Establishments (CREPER, from brazilian portuguese: Calculadora de Risco Epidemiológico de Propriedades e Estabelecimentos Rurais, developed to support the Animal Health Protection Service of Maranhão in the collection and analysis of surveillance data [de Jesus Barros et al. 2025a]. This tool integrates criteria from various animal health programs, including the National Program for the Control of Rabies in Herbivores (PNCRH), enabling the standardized recording of rabies occurrence indicators on properties and in shelters of bat vectors [de Jesus Barros et al. 2025a]. The system's architecture enables *offline* operation, ensuring georeferencing and automatic calculation of the Risk Index (RI) even in rural areas without internet connectivity [de Jesus Barros et al. 2025a].

The effectiveness of CREPER was validated through usability tests conducted with professionals from the official veterinary service using the SUS [de Jesus Barros et al. 2025b]. The application obtained an average score of 92.19 on the SUS, being classified in the "Best Imaginable" category, which demonstrates high practical acceptability and an intuitive interface for the end user [de Jesus Barros et al. 2025b]. Field tests showed that process automation and the replacement of physical records with electronic ones drastically reduce data entry errors and the processing time for epidemiological information [de Jesus Barros et al. 2025b].

In the context of Visceral Leishmaniasis (VL), a major neglected tropical disease, a mobile app prototype structured from a One Health perspective was proposed to assist in the monitoring and control of the disease in humans, domestic animals, and wildlife [da Silva 2024]. The system is organized into different access profiles, allowing the community to request technical visits and receive health education, while surveillance agents can submit immediate notifications of suspected or confirmed cases [da Silva 2024]. This integration between the human, animal, and environmental spheres is considered essential for anticipating outbreaks and refining the data available for public health management [da Silva 2024].

The development of this prototype was based on the principles of User-Centered Design, using tools such as Figma[1] to ensure an optimized user interface (UI/UX) experience [da Silva 2024]. The prototyping methodology was divided into stages to create intelligent and intuitive interfaces that facilitate navigation and the entry of complex epidemiological data, such as canine clinical signs and wildlife movement history [da Silva 2024]. By prioritizing operational simplicity, the project aims to reduce the need for in-depth computer skills among field professionals, promoting more participatory and agile surveillance in the fight against wild rabies [da Silva 2024].

[1] figma.com

Following the same logic as these tools, it is clear that simply creating a system is not enough, as it must operate without an internet connection and be intuitive for health workers. Sismorcego was designed to meet these exact requirements for the control of wild rabies. Section 3 details the research methodology, from the coding of the prototype to user acceptance testing.

3. Methodology

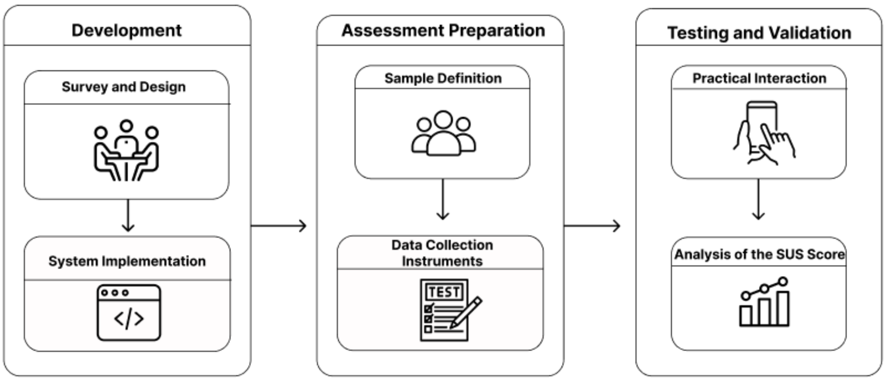

Figura 1. Overview of the methodological steps, illustrating the sequential flow of the methodology's subsections

The methodological strategy of this study was structured in three interdependent phases, with the aim of ensuring that technological development would accurately address the challenges of health surveillance in the Amazon region. As illustrated in the methodological flowchart in Figure 1, the process ranges from requirements gathering and user-centered design, through careful preparation of the sample, to the practical validation of the tool using the SUS method. This integrated approach allows not only for the creation of an offline-first solution, but also for the confirmation of its technical and operational acceptability by health workers in the field.

3.1. Development

Sismorcego was developed to address the severe logistical constraints of wild rabies surveillance in the Amazon, which has historically relied on paper forms and slow river travel. This analog workflow caused critical delays in reporting, loss of spatial traceability, and the inability to implement timely vaccination containment [Carvalho-Costa et al. 2012]. By replacing this process with agile, georeferenced records, the app is part of the project "Risk Analysis of Rabies in a Riverside Population Vulnerable to Bat Attacks in the Mãe Grande de Curuçá Environmental Reserve."

During the requirements gathering and design phase, the central premise was to accommodate the lack of telecommunications infrastructure typical of high-risk areas. We opted to use the React Native framework[2], which enabled the development of a cross-platform mobile app from a single codebase. The interface was designed to be utilitarian, translating the old physical notification forms into digital forms that consolidate information about the patient and the attacking animal, minimizing data entry errors and streamlining the field agent's work, as shown in Figures 2 and 3.

[2]https://reactnative.dev/

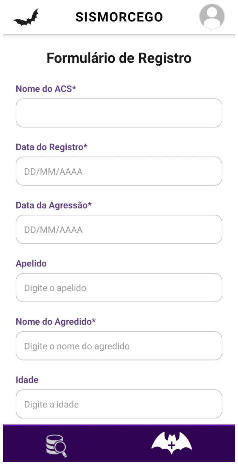

Figura 2. Registration Form Screen

Figura 3. Information Screen

During the system implementation phase, shown in Figure 1, the technical solution adopted to ensure functionality in the forest was an offline-first architecture. In practice, when a professional logs an incident, the app automatically captures the geographic coordinates via satellite and securely saves the record to the device's local database. Later, when the device detects an internet connection, a background service synchronizes the records with the cloud database, hosted on Firebase [3]. This mechanism ensures the integrity of data collected in isolated communities and feeds the web-based administrative dashboard, providing the metrics necessary for epidemiological management.

3.2. Preparation for the Evaluation

The user evaluation phase took place during the event "One Health Meeting in the Amazon" [4], held in the municipality of Curuçá, Pará. In addition to this event, samples were collected in the state of Roraima. The study sample was defined intentionally, focusing strictly on the tool's primary target audience: Community Health Agents. In total, 42 professionals working on the front lines of epidemiological surveillance participated in the study. The selection of this specific group was essential to ensure that the data collection reflected the perceptions, advantages, and challenges of those who would actually carry out the reporting routines in the field. Following this pilot phase, the agents were invited to record their impressions via a structured digital form on Google Forms consisting of 10 questions

Following this experimental phase, the agents were asked to record their impressions using a structured digital form in Google Forms consisting of 10 questions[5]. The data collection instrument followed the SUS methodology and consisted of ten statements alternating between positive and negative aspects of the system. To express their opinion, each professional used a five-point Likert scale, [Joshi et al. 2015]. In this format, the level of agreement ranged from 1, representing the option "Strongly Disagree," to 5, indicating "Strongly Agree," allowing for the capture of nuances in usability perception

[3] http://firebase.google.com/
[4] https://www.even3.com.br/encontro-uma-so-saude-na-amazonia-595675/
[5] http://docs.google.com/forms/

without causing significant cognitive fatigue among respondents.

The questionnaire was strategically structured to avoid response bias. To achieve this goal, odd-numbered questions present positive statements about the interface, while even-numbered questions present negative statements. This methodological alternation forces the professional to read and reflect on each item individually, inhibiting automatic or standardized responses. The ten statements, adapted to evaluate the app targeted by this study, are:

1. I would use the Sismorcego app frequently.
2. I found the app unnecessarily complex.
3. I found the app easy to use.
4. I think I would need help from someone with technical knowledge to use the app.
5. The app's features are well integrated.
6. I found the app to be very inconsistent.
7. I imagine most people would learn to use the app quickly.
8. I found the app very complicated to use.
9. I felt confident using the app.
10. I had to learn several things before I could use the app.

To calculate the scores, subtract 1 from the score given for positive items (odd-numbered) and subtract the selected score from 5 for negative items (even-numbered). The total sum of these ten questions is multiplied by 2.5, generating an absolute usability index ranging from 0 to 100 (not a percentage). Scores above 80.3 indicate excellence; scores between 68 and 80.3 suggest satisfactory acceptance; and scores below 68 point to interface deficiencies that require revision [Bangor et al. 2009].

In addition to overall acceptability, the questionnaire responses allow for a segmented analysis by correlating the ten items with Nielsen's usability heuristics [Nielsen 1995]. To evaluate the interaction of healthcare workers with Sismorcego, the statements were grouped into five dimensions: Efficiency, Ease of Learning, Memorability, Error Prevention, and Satisfaction. The calculation of these metrics uses the values standardized in the SUS stage (a scale of 0 to 4 points for variables Q_1 through Q_{10}). The scores for each group are summed, divided by the maximum score for the respective dimension, and multiplied by 100, generating a percentage index (0 to 100). The equations governing this calculation are presented below:

$$\text{Ease of Learning} = \frac{Q_3 + Q_4 + Q_7 + Q_{10}}{16} \times 100 \tag{1}$$

$$\text{Efficiency} = \frac{Q_5 + Q_6 + Q_8}{12} \times 100 \tag{2}$$

$$\text{Memorability} = Q_2 \times 25 \tag{3}$$

$$\text{Error Prevention} = Q_6 \times 25 \tag{4}$$

$$\text{Satisfaction} = \frac{Q_1 + Q_4 + Q_9}{12} \times 100 \tag{5}$$

The main advantage of applying these mathematical formulas is that they eliminate the need to have professionals complete a second exhaustive questionnaire in the field. All of the analytical mapping — which precisely links each question in the data collection instrument to its respective heuristic objective — can be viewed in a structured format in Table 1.

Tabela 1. Correlation between Nielsen's Usability Goals and SUS Questions.

Usability Goal	Correlated SUS Questions
Ease of Learning	Questions 3, 4, 7, and 10
Efficiency	Questions 5, 6, and 8
Memorability	Question 2
Error Prevention	Question 6
Satisfaction	Questions 1, 4, and 9

3.3. Testing and Validation

The Testing and Validation phase (Figure 1) began with Community Health Agents engaging in hands-on interaction with the Sismorcego prototype. Using preconfigured devices, participants simulated reports of attacks by blood-feeding bats. This process allowed us to evaluate the responsiveness of the interface and the system's offline-first architecture, encompassing form filling, geolocation capture, and local storage prior to cloud synchronization.

Once the free experimentation phase with the smartphones was completed, individual perceptions were recorded, and the responses submitted via the form were exported in spreadsheet format to populate the research database.

The computational processing and analysis of the SUS Score were performed in Python [6], using the Google Colab cloud platform [7]. The coding environment was structured to automatically clean the Likert scale data and apply the mathematical equations for normalizing the responses. The script was responsible for calculating not only the overall system acceptability score but also for extracting the scores related to the five Nielsen usability heuristics investigated in the study. Finally, the validation methodology stipulated the use of hypothesis testing to verify the scientific rigor of the findings.

4. Results

The results showed how the Sismorcego interface was adopted by professionals during the tests, highlighting the system's performance across various usability metrics. The following discussion details the tool's level of acceptability, its performance as assessed by Nielsen's heuristics, and the statistical robustness of the findings through hypothesis testing.

[6]https://www.python.org/
[7]https://colab.research.google.com/

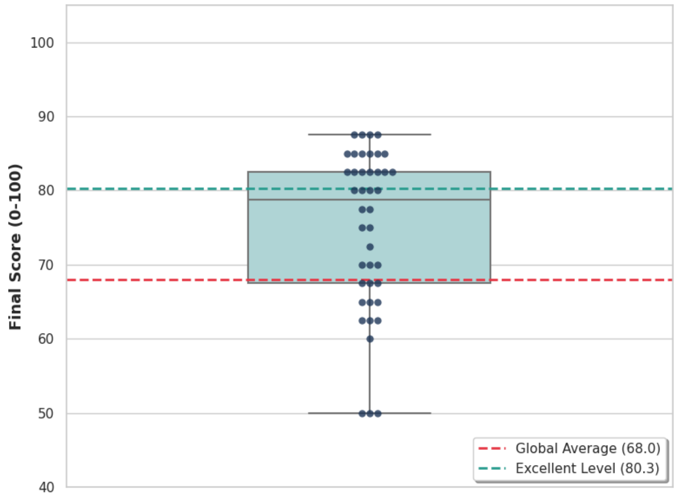

Figura 4. Distribution of SUS scores for the proposed application.

The evaluation of the Sismorcego application interface revealed positive acceptance ratings from the tested users. The system achieved an average SUS Score of 74.80, placing it well above the threshold of 68.0 points, which is considered the global average for acceptance in the Human Computer Interaction literature. The detailed behavior of this metric can be viewed in the boxplot, Figure 4, which illustrates the central distribution of the data. The median of the sample was 78.75 points, with the entire interquartile range (the box plot) positioned above the 68.0 point cutoff, a benchmark established in the literature to attest to the viability of an interface.

The breakdown of the dispersion, shown by the individual markers (swarmplot), confirms the high level of acceptance. A dense cluster of users who rated the tool in the excellence range is observed, exceeding the threshold of 80.3 points. Although there are outliers in the lower portion of the graph (with minimum scores hovering around the 50-point mark), it is imperative to note that there were no records in the critical rejection ranges (below 25). For a system focused on public health surveillance, which inevitably deals with technical terms from epidemiology, this consistency in the distribution proves that the information architecture was designed to be accessible.

The transition from absolute scores to a qualitative rating scale confirms the interface's effectiveness, as illustrated in Figure 5. The graphical analysis shows that the largest portion of evaluators, representing 40.5% of the sample, rated the experience with Sismorcego as "Excellent." Adding to this group the 28.6% who rated the app as "Good," it is evident that approximately 69% of users found the navigation highly satisfactory and free of hindering friction.

On the other hand, the segments corresponding to "Fair" (23.8%) and "Poor" (7.1%) represent the scenarios where users encountered the most friction. In the technological context of the Amazon region, external factors such as health workers' prior digital fluency and the novelty of the tool may directly influence this perception. However, the significantly low rejection rate ("Poor") (less than 8%) is a strong indication that the app is ready for field deployment, requiring only occasional tutorials to mitigate the difficulties faced by the minority who rated it as fair.

The heuristic usability profile of Sismorcego, derived from the decomposition of

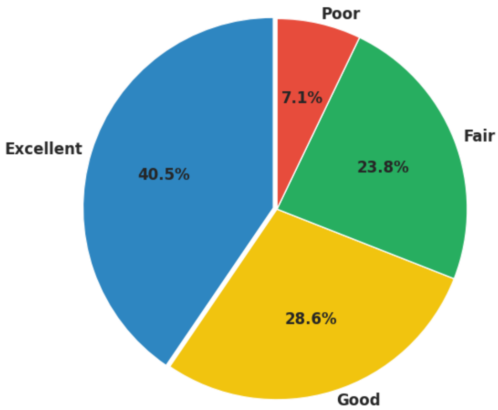

Figura 5. Proportion of responses from raters categorized by classifications of the Scale SUS.

SUS metrics, reveals balanced and consistent performance across all analyzed dimensions. As illustrated in Figure 6, the system exceeded the 68 point acceptability benchmark on all five axes, forming a concentric polygon that indicates maturity in interface design. The highest scores were observed in Satisfaction (75.79) and Efficiency (73.21), suggesting that the application's architecture not only appeals to the end user but also enables the rapid execution of tasks a critical requirement for epidemiological surveillance tools operating in field settings.

Figura 6. Illustration of the heuristic usability profile in relation to the usability principles evaluated

From the perspective of Nielsen's Heuristics, the closeness of the Learnability (72.47) and Memorability (71.43) scores points to an intuitive interface that facilitates the recognition of functions rather than requiring exhaustive memorization. On the other hand, the relative decline on the Error Prevention axis (69.05) reflects the technical nature of Sismorcego. In rabies monitoring systems, the implementation of rigorous validations and required fields is essential to mitigate the entry of inconsistent data.

Beyond the overall picture, the decomposition of the SUS score into five usability heuristics (Table 2) allowed for a granular diagnosis of the system's strengths and weaknesses. The "Satisfaction" criterion received the highest score (75.79; SD = 15.70), suggesting that the app's purpose rabies monitoring and prevention was well understood and well received by users. "Efficiency" also stood out (73.21; SD = 12.14), validating the premise that data entry in the field can be performed quickly, a fundamental requirement to avoid delaying the agents' operational work.

Usability Parameter	**Mean (Sismorcego)**	**Standard Deviation**
Overall SUS Score	74.80	10.87
Efficiency	73.21	12.14
Learnability	72.47	15.56
Memorability	71.43	16.17
Error Prevention	69.05	15.43
Satisfaction	75.79	15.70

Tabela 2. SUS Results and Inferred Heuristics for Sismorcego.

To ensure the scientific rigor of the findings, the scores obtained were subjected to statistical inference tests. Initially, the Shapiro-Wilk test [Hanusz et al. 2016] yielded a p-value of 0.0010 ($p < 0.05$), confirming that the data do not follow a normal distribution. This characteristic of the sample required the application of the non-parametric Wilcoxon Signed-Rank [Woolson 2007] test to compare Sismorcego's performance with the 68-point acceptability threshold, established in the literature as the minimum benchmark for usable interfaces.

The Wilcoxon test resulted in a p-value of 0.0006, demonstrating a statistically significant difference from the normative benchmark. This result mathematically proves that Sismorcego's usability is significantly superior to the established acceptability standard, validating the interface's effectiveness. Taken together, the heuristic scores and statistical validation indicate that Sismorcego is ready for real-world use. The data show that the tool not only fulfills its technical role but is also easy to operate in the daily routine of healthcare workers.

5. Conclusion

The implementation of this study validated the proposed objectives, thereby establishing Sismorcego as a strategic tool for public health in complex settings. Objective (i) was achieved through the development of a digital solution capable of operating offline, automating the generation of records and ensuring the georeferenced logging of bat attacks in remote areas. The usability assessment fulfilled objective (ii) by demonstrating, using the SUS method, that the tool has significant acceptance among health workers, with an average score of 74.80 and statistical validation via the Wilcoxon test ($p = 0.0006$). Regarding objective (iii), the study highlighted the potential of mobile technologies to mitigate logistical barriers in the region. The use of the app ensures that epidemiological surveillance is not interrupted by weather variations, allowing for the accurate and rapid mapping of rabies cases even in the most isolated communities.

Future work includes plans to expand Sismorcego's capabilities by implementing predictive analytics modules based on artificial intelligence, capable of cross-referencing outbreak data with seasonal variables to anticipate outbreaks. There are also plans to conduct long-term field studies with a larger team of professionals to measure the app's direct impact on reducing response times by health authorities. Furthermore, integrating the system with national health databases could automate the notification process, establishing the use of offline-first technologies as the standard for controlling zoonoses in hard-to-reach regions.

Further Relevant Informations

Ethics and Transparency: This research was approved by an ethics committee under CAAE: 95971026.7.0000.0018.

AI Usage: Artificial intelligence tools were used for textual revision and preliminary research of this study.

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