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Analysis Of The Location And Situation Of Medications In Health Posts

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Resumo:
The "Location and Situation Analysis of Medications in Health Posts" app was developed with the goal of optimizing the consultation and management of medications in healthcare units, using agile methodologies, specifically the Scrum framework. The system allows users to search for medications, view their availability at nearby health units, and receive notifications about shortages or the need for restocking. With the use of technologies such as Flutter, Node.js, and PostgreSQL, the app ensures a cross-platform experience and efficient inventory management. One of the significant outcomes achieved was the improvement in the logistics of medication distribution, with accurate restocking predictions, preventing shortages, and providing greater transparency for users and administrators. The system was designed to be intuitive, secure, and scalable, facilitating access to information and real-time decision-making.

Palavras-chaves: *APP, Medication Tracking, Geolocation, Inventory Management, Agile Methodology, Scrum, Flutter, Node.js, PostgreSQL, Unified Health System, Medication Shortages, Restocking Prediction, Transparency.*

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I. Introdução

The management of medications in healthcare units is a highly relevant topic within the context of the Unified Health System (SUS). The effective organization and distribution of medications, combined with transparency in the process, are essential to ensure that patients have access to the necessary treatment efficiently. The traceability of medications and inventory management are key aspects in preventing shortages, optimizing resources, and ensuring quality service to the population. With the advent of technologies that allow real-time monitoring, the potential to improve this management becomes increasingly feasible.

The importance of this topic becomes evident with the enactment of Law 11.903/2009, which establishes the National Medication Control System (SNCM), aimed at tracking products from production to delivery to patients. Medication traceability through technologies such as two-dimensional barcodes provides greater security for both patients and healthcare professionals. The system enhances control over production and distribution, offering a clearer and more precise view of medication availability, directly contributing to more efficient management and compliance with regulatory standards (EICKHOFF et al., 2012).

The implementation of tools that allow online consultation of medication availability, such as the one provided by the City of Manaus, also makes a significant contribution to this scenario. This type of technology not only provides transparency but also facilitates citizens' access to information about medications in healthcare units (CRF-RJ, 2014). The ability for users to see which units have the desired medication and the available stock promotes a quicker and more accurate service. The continuous improvement of these platforms, including features like mapping the nearest units to the user, further reinforces the importance of a more accessible and efficient medication management system.

The purpose of this study is to analyze the current situation of medication location and availability in healthcare units, with the aim of developing a system that integrates tracking technologies, enabling users to check, in real-time, which health posts have the required medications. The system should also alert the central office about product shortages and calculate stock forecasts, contributing to more accurate management and preventing shortages.

II. Referencial Bibliográfico

According to Carlessi et al. (2017), the effective management of medications in healthcare units involves a series of processes and practices aimed at ensuring the continuous and appropriate availability of essential drugs for the treatment of the population. In recent years, technological advancements have provided new ways to enhance the control and tracking of these products within the distribution chain (WHITEHEAD; SEATON, 2016). To better understand this context, five essential subtopics are presented below, addressing different aspects related to the location and status of medications in health centers, considering the laws, the technologies involved, and the transparency required in this process.

National Medication Control System (SNCM)

According to Galvão and Püschel (2012), the National Medication Control System was established by Law 11.903/2009 and aims to ensure the complete tracking of medications, from manufacturing to patient consumption. This system is of utmost importance for increasing patient safety, preventing the use of counterfeit or inappropriate medications, and ensuring compliance with regulatory standards. The traceability of medications is achieved through the capture and electronic transmission of data, using two-dimensional barcodes to facilitate tracking.

Impacts of Law 13.410/2016 on Medication Management

Law 13.410/2016, which amended Law 11.903/2009, established specific deadlines for the regulation of medication traceability in Brazil, with the final implementation deadline set for April 2022. This legislation has direct implications for strengthening the traceability of medications and enhancing the logistics and stock control, requiring healthcare units to provide greater accuracy in stock and distribution information.

Tracking and Inventory Monitoring Technology

The use of tracking technologies, such as two-dimensional barcodes and computerized systems, enables real-time monitoring of the quantity of medications available in healthcare units. The implementation of computerized systems for online consultation of medication availability, such as the one developed by the Prefecture of Manaus, is an example of how technology can contribute to more transparent and efficient management, as well as improve public access to information about stock levels (PINHEIRO; PEPE, 2011).

Transparency in Medication Management in the SUS

Transparency in medication management is an essential aspect to ensure that the population has access to accurate information about the availability of drugs in healthcare units. Law No. 8.080/1990, amended by Law No. 14.654 of 2023, requires the online disclosure of medication stocks in public pharmacies of the SUS (Unified Health System), providing greater clarity about the management of public resources and ensuring that citizens can check the availability of medications in the nearest units.

Challenges and Opportunities in the Implementation of Monitoring Systems

According to Roque et al. (2016), although technological advancements bring significant benefits to medication management, there are still considerable challenges in implementing these systems, such as the integration of different platforms, real-time information updates, and training of healthcare professionals. However, with the continuous evolution of technologies and the development of new resources, such as mapping the location of healthcare units and predicting medication shortages, new opportunities are being created to improve management, optimize resources, and enhance the quality of care (TIBES et al., 2014).

III. Materiais E Métodos

The methodology adopted for the development of the medication consultation application was based on agile methodologies, using the Scrum framework. This approach allowed for an iterative and incremental development process, providing continuous deliveries and the constant incorporation of feedback from users and stakeholders. The methodology was structured to ensure efficiency, flexibility, and quality in the development of the application, considering user needs and system complexity. Below, the main stages, technologies, and tools used in the development process are described.3.1 Framework Ágil - Scrum.

The development of the application followed the Scrum framework, which organizes the work into cycles called sprints (usually 2 to 4 weeks). Each sprint aimed to deliver specific system features, with a focus on continuous development and constant improvement. The main stages of each sprint include.

- Sprint Planning: Planning of activities and definition of features to be delivered.
- Daily Standups: Daily meetings to monitor progress and identify obstacles.
- Sprint Review: Presentation of completed features to stakeholders.
- Sprint Retrospective: Analysis of the previous sprint, identifying what worked well and what can be improved.

Development of the User Interface (UI).

The Human-Machine Interface (HMI) was developed with a focus on simplicity and usability, aiming to cater to users with varying levels of familiarity with technology. The HMI was designed to be intuitive, allowing users to quickly search for medications and view information about availability in healthcare units. The main screens and features include:

Home Screen: Search field for the user to enter the medication name.
Results Screen: Display of nearby healthcare units with medication availability.
Map Screen: Visualization of the nearest healthcare units using geolocation.
Alerts: Notifications about medication shortages and suggestions for alternatives.

Technologies Used

Programming Language and Framework: Dart with the Flutter framework was used, enabling cross-platform development (Android and iOS) from a single codebase, which reduced costs and development time.

Backend and Database: The backend architecture was built with Node.js and Express.js, allowing scalability and performance. The chosen database was PostgreSQL, a robust and reliable system for storing information about medications, healthcare units, and stock levels.

Geolocation and Mapping: For user location integration, the Google Geolocation API and Google Maps were used, allowing accurate display of the nearest healthcare units.

Security and Authentication: User authentication was performed using JWT (JSON Web Tokens), ensuring information security and user data privacy.3.4 Testes e Qualidade

Tests were conducted at each stage of development, following best practices for Unit Testing and Integration Testing. The team implemented a continuous process of Continuous Integration (CI) and Continuous Delivery (CD) to ensure that the code was constantly validated and reviewed. Additionally, usability tests were conducted to ensure a good user experience, and performance tests were carried out to ensure system stability under high traffic conditions.

Iteration and Deliveries

Based on the agile Scrum methodology, deliveries were made at the end of each sprint, with the product being improved at every cycle. The first version of the application focused on essential features, such as searching for medications and displaying healthcare units. In subsequent sprints, additional features were implemented, such as the alert system and medication shortage forecasting.

IV. Resultados

Scope

This article discusses the development of an application focused on medication consultation and management in healthcare units, with an emphasis on optimizing access to information and improving stock management efficiency. The solution was built using agile methodologies, applying the Scrum framework to ensure an iterative and flexible process. The application offers features such as medication search, real-time stock visibility, and geolocation of healthcare units, as well as technologies like Flutter, Node.js, and PostgreSQL to ensure performance and security. The system was designed to enhance transparency and resource management in the Unified Health System (SUS), promoting better control over medication availability and facilitating decision-making. Positive outcomes include improvements in restocking logistics and a reduction in supply failures, with a direct impact on the operational efficiency of healthcare units.

Functional Requirements

Functional requirements are crucial for the development of any system as they describe the specific functionalities that the system must perform to meet user needs (SCHOENTHALER; CUFFEE, 2013). In the context of the medication tracking and consultation system in healthcare units, the functional requirements are designed to ensure that the system can provide users with the necessary information efficiently, reliably, and clearly. Below, we present Table 1, which lists the main functional requirements for the system.

Table 1. Functional Requirements

ID	Functional Requirements	Contextualized Description
RF01	Medication Search	The system must allow users to search for medications by name, providing quick and easy access to data about availability in healthcare units. This requirement aims to increase the efficiency of service, enabling citizens to quickly find the medication they need.
RF02	Display of Stock Availability in Healthcare Units	After the search, the system must display the healthcare units that have the medication available, including the stock quantity. This feature aims to optimize the search process and prevent unnecessary travel for citizens.
RF03	Geolocation and	The system must allow users to view the nearest healthcare units on a map using

	Healthcare Unit Map	geolocation. This feature facilitates transportation logistics and enhances the user experience, ensuring quick access to healthcare facilities that have the medication in stock.
RF04	Medication Shortage Alerts	The system must send notifications to administrators and users when a medication is about to run out in healthcare units. This functionality helps anticipate medication shortages, preventing stockouts and ensuring that patients do not lack the necessary treatment.
RF05	Replenishment Need Forecasting	Based on consumption history and stock analysis, the system must predict when medication replenishment will be needed. This functionality contributes to more accurate management and better resource allocation, preventing unexpected medication shortages in healthcare units.
RF06	Healthcare Unit Consultation	The system must allow users to check the availability of medications by healthcare unit, based on location or unit name. This feature promotes transparency and efficiency in communication between healthcare units and the population.
RF07	Stock History Consultation	The system must provide information on the medication stock history, allowing for a more detailed tracking of the distribution and use of medications in healthcare units over time. This feature is essential for the continuous improvement of medication management.

Source: Own Authorship (2025)

Table 1 lists the main functional requirements that must be implemented in the medication tracking and consultation system in healthcare units. Each of these requirements has been developed to directly address the needs of users, promoting a more efficient and transparent management of medications in the Unified Health System (SUS).

Use Case Description

The use case of the system "Analysis of the Location and Status of Medications in Healthcare Units" describes the main interactions between users and the features available in the application. The system is designed to cater to different types of users, including patients, healthcare unit administrators, and health managers.

The primary functionality is to allow patients to quickly check the availability of medications at nearby healthcare units by searching for the medication by name. After the search, the user can view a list of healthcare units that have the medication in stock, along with the available quantity, and can use the map to locate these units with precise geolocation.

Healthcare unit administrators and health managers have access to additional features such as registering and updating medication stocks, managing alerts for medication shortages, and forecasting replenishment needs based on consumption history. Managers can approve medication restocking and monitor the distribution logistics. The system also generates automatic notifications for out-of-stock medications, ensuring a quick and efficient response.

This set of functionalities enables agile and accurate resource management, optimizing the medication tracking and distribution process across healthcare units.

Non-Functional Requirements

Non-functional requirements are characteristics that the system must exhibit to ensure its good performance, usability, security, and reliability. Unlike functional requirements, which describe what the system should do, non-functional requirements focus on how the system should behave during its use (MATHER et al., 2017). They are essential for quality and user experience, directly impacting the system's performance, security, and availability. Below, we present Table 2, which lists the non-functional requirements for the medication tracking and consultation system in healthcare units.

Table 2. Non-Functional Requirements

ID	Non-Functional Requirement	Contextualized Description
RNF01	Performance and Response Time	The system must be able to process medication inquiries and display results within 3 seconds. This requirement ensures that users do not experience significant delays while searching for information, promoting a fast and efficient user experience.
RNF02	Scalability	The system must be scalable to handle a large number of simultaneous users, ensuring that even during peak demand periods, such as the distribution of essential medications, it continues to function properly without performance degradation.
RNF03	Availability and Reliability	The system must have 99.9% availability, ensuring that users can access the platform for medication inquiries at any time, without frequent interruptions or failures. This is essential to maintaining service continuity and preventing issues that could hinder public assistance.
RNF04	Security	The system must ensure that all user and healthcare unit data is protected through encryption. Information security is crucial to safeguarding sensitive data, such as information about medications, stock levels, and user history, ensuring privacy and compliance with data protection laws (such as LGPD).
RNF05	Usability	The system interface must be simple and intuitive, allowing any user, regardless of their

		familiarity with technology, to use the platform efficiently. A clean design and easy navigation ensure that the system is accessible to as many people as possible, especially in public service contexts.
RNF06	Compatibility with Different Devices	The system must be compatible with different devices, such as smartphones, tablets, and desktops. The platform should ensure that users have a consistent and high-quality experience, regardless of the device they are using, catering to a wide range of users.
RNF07	Maintainability and Support	The system must be developed in a modular way, making maintenance and updates easier. Additionally, it should have efficient technical support to quickly resolve user issues or questions, ensuring that the system remains functional and up to date over time.

Source: Own Authorship (2025)

Business Rules

Business rules play a critical role in the operation of the medication tracking and consultation system within healthcare units, as they define how interactions between data, processes, and users should occur in alignment with the needs of the Unified Health System (SUS). These rules ensure that the system operates efficiently and consistently, ensuring that operations related to medication control, such as registration, stock updates, and replenishment forecasting, are organized and conducted within the established guidelines. Below are the key business rules that must be followed for the success of the system.

Registration of Medications

The system should allow the complete registration of medications, a procedure to be carried out by system administrators. When registering a medication, essential information such as name, description, dosage, category, supplier, and expiration date must be provided. The business rule here is to ensure that, before a medication is added to the system, all data is validated to prevent duplicate or inaccurate entries, which could impact the reliability of the information in the tracking process.

Stock Update

The update of medication stock in health units will be performed automatically by the system whenever a transaction occurs, such as the dispensing or replenishment of medications. This means that when a medication is taken or restocked, the system should record the change in stock levels in real time. This is crucial to ensure that the information about the availability of medications in health units is accurate and always up to date.

Medication Availability

The display of medication availability will be determined by the stock quantity in the health units. If the stock of a medication is greater than zero, it will be shown as available; otherwise, it will be displayed as "out of stock" or "unavailable." This rule ensures that the system always provides users with accurate information about what is actually available for use in the health units, preventing frustrations when trying to search for medications that are not accessible.

Scarcity Alert

The system must generate an automatic alert whenever the stock of a medication reaches a predefined minimum level. For example, if the stock of a medication falls below 10 units, the system will send an alert to both the health unit managers and the distribution center. This alert aims to prevent medication shortages and ensure that health units can request replenishments on time. The flexibility of the system will allow alerts to be configured according to the demand and criticality of each medication.

Medication Restocking Forecast

The medication replenishment forecast will be based on consumption history and usage trend analysis. This will allow the system to anticipate replenishment needs, considering factors such as seasonal demand peaks, vaccination campaigns, among others. The business rule here is to ensure that the system can accurately and efficiently calculate the necessary quantity to restock, avoiding both shortages and waste of medications.

Medication Transaction Recording

The system will record in detail each transaction related to medications, including dispensing, replenishment, and transfers between health units. Each record will contain information such as the transaction date, medication quantity, the involved health unit, the person responsible for the operation, and the specific medication. These records are essential to ensure complete traceability of medications, providing transparency and facilitating future audits.

Display of Healthcare Units and Located Stock

To facilitate access to medications, the system will display the health units closest to the user based on their geographic location. Additionally, it will be possible to check, in real-time, the quantity of medications available at each unit. This rule aims to provide an efficient and practical search experience for citizens, allowing them to quickly find the medications they need at nearby health units.

Limitation of Access to Sensitive Data

The security of users' and health units' information is a priority. Therefore, the business rule stipulates that only authorized users, such as administrators and health managers, will have full access to sensitive data, including stock details, financial transactions, and replenishments. Common users (such as patients) will only be able to access information regarding the availability of medications. This access limitation is crucial to protect personal data and maintain the privacy and security of sensitive information.

These business rules are essential to ensure the system operates smoothly, promoting transparency, efficiency, and reliability in medication management. They help align the system with the objectives of the SUS (Unified Health System), ensuring that the population has quick and fail-free access to the necessary medications, while health units can manage their stocks in an optimized and secure manner.

System Diagramming

Use Case

The Use Case Diagram is a fundamental graphical representation used to describe the interaction between different users and the system (MAMTA, 2014). In the context of the medication tracking system in healthcare units, this diagram illustrates the main functionalities offered by the system and the actors interacting with it, such as the user, administrator, and healthcare manager. Each actor has a specific set of actions, such as querying medications, viewing the availability of medications in healthcare units, registering and updating stocks, as well as managing alerts and approving replenishments.

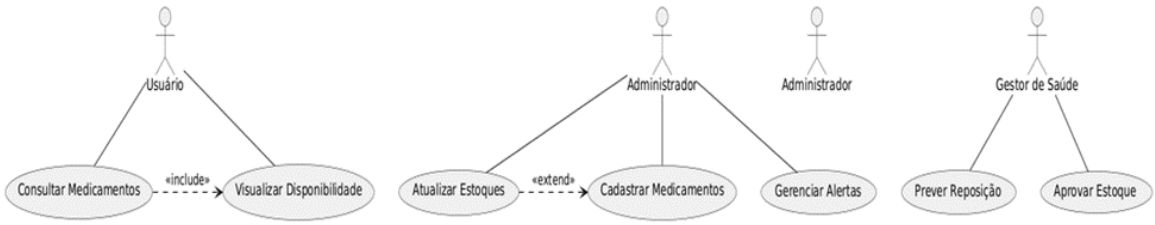

Figure 1. Use Case Diagram of the Proposed System
Source: Own Authorship (2025)

Figure 1 presents the crucial interactions between users and the system, focusing on the efficiency of the medication tracking and management process. The user can query medications and check their availability in health units, while the administrator is responsible for registering new medications, updating stocks, and managing alerts related to medication shortages. The health manager monitors the replenishment process, approving stock levels and forecasting the need for new supplies. This diagram facilitates the understanding of the system's operation and serves as the foundation for the development and implementation of its functionalities.

Class Diagram

The Class Diagram is a type of structural diagram that shows the classes of the system and their relationships. In the medication tracking system, the classes represent the main components of the system, such as Medication, HealthUnit, User, and HealthManager. Each class has attributes that store information about the objects, such as the medication name, stock quantity, and methods that perform actions on this data. This diagram is essential for understanding how the entities interact and how the system can be structured to meet the requirements of medication management and control.

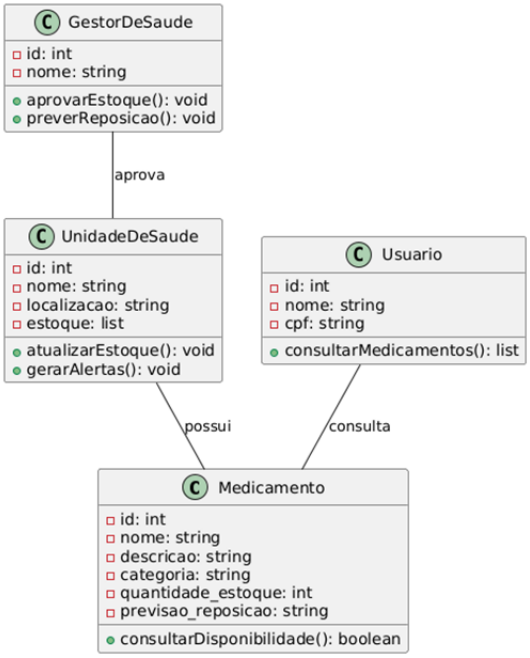

Figure 2: Class Diagram of the Proposed System
Source: Own Authorship (2025)

Figure 2 shows the Class Diagram of the medication tracking system. Each class in the diagram has attributes that represent the relevant information for the system and methods to interact with this data. For example, the Medication class stores information such as the name and quantity in stock, and it has the method checkAvailability(), which checks if the medication is available at the healthcare units. The HealthcareUnit is responsible for updating the stock levels and generating alerts when a medication is out of stock. The HealthcareManager, on the other hand, has the function of approving stock levels and forecasting replenishments. This diagram is crucial for the development of the system, as it defines the entities and the core logic of the medication management system.

System Implementation

Below are two simplified code examples in React Native for creating medication search and health unit details screens. These screens are designed for mobile devices and can be extended to include additional functionalities, such as database integration or geolocation.

Screen 01.
This screen allows the user to search for a specific medication and view its availability in healthcare units.

```
Welcome   consultMed.js
consultMed.js > ...
4   const ConsultaMedicamento = () => {
7
8     const consultar = () => {
9       const medicamentos = [
10        { nome: 'Paracetamol', unidade: 'UBS Centro', quantidade: 10 },
11        { nome: 'Dipirona', unidade: 'UBS Norte', quantidade: 5 },
12      ];
13      const med = medicamentos.find(m => m.nome.toLowerCase() === medicamento.toLowerCase());
14      setResultado(med ? `${med.nome} disponível na ${med.unidade} com ${med.quantidade} unidades.` : 'Medicamento não
15    };
16
17    return (
18      <View style={{ padding: 20 }}>
19        <TextInput
20          placeholder="Digite o medicamento"
21          value={medicamento}
22          onChangeText={setMedicamento}
23          style={{ borderBottomWidth: 1, marginBottom: 10 }}
24        />
25        <Button title="Consultar" onPress={consultar} />
26        {resultado && <Text>{resultado}</Text>}
27      </View>
28    );
29  };
30
```

Figure 3. Medication Search Screen Code
Source: Own Authorship (2025)

The code creates a medication search screen. The user enters the name of the medication, and upon clicking the "Consult" button, the system displays the health unit and the available quantity. If the medication is not found, a message is shown.

Screen 02:
The second screen displays information about health units, including a list of available medications.

```jsx
import React from 'react';
import { View, Text, Button } from 'react-native';

const UnidadeSaude = ({ unidade, medicamentos }) => {
  return (
    <View style={{ padding: 20 }}>
      <Text style={{ fontSize: 18, fontWeight: 'bold' }}>{unidade}</Text>
      {medicamentos.map((med, index) => (
        <Text key={index}>{med.nome} - {med.quantidade} unidades</Text>
      ))}
      <Button title="Ver mais detalhes" onPress={() => alert('Detalhes da unidade')} />
    </View>
  );
};

const App = () => {
  const unidade = 'UBS Centro';
  const medicamentos = [
    { nome: 'Paracetamol', quantidade: 10 },
    { nome: 'Dipirona', quantidade: 5 }
  ];

  return <UnidadeSaude unidade={unidade} medicamentos={medicamentos} />;
};

export default App;
```

Figure 4. Health Unit Details Code (React Native)
Source: Own Authorship (2025)

This screen displays information about the selected health unit and the medications it offers, along with their available quantities. The "View More Details" button simulates a redirection for additional information about the unit. The implementation is simplified to enhance understanding.

V. Conclusão

The "Analysis of Location and Status of Medications in Health Centers" application represents a significant innovation in the management and accessibility of medications within healthcare units, aligning technology with the needs for efficiency and transparency in the Brazilian Unified Health System (SUS). Using an agile development approach and the Scrum framework, the project was designed with a focus on the continuous delivery of features that serve both end users and healthcare unit administrators.

Through an iterative process, the application offers an intuitive and easy-to-navigate platform, allowing users to quickly search for medications and check their availability at nearby healthcare units without unnecessary travel. Additionally, features such as geolocation, shortage alerts, and stock replenishment forecasts play a crucial role in optimizing medication management, improving public access to treatments, and ensuring that healthcare centers can anticipate potential supply failures.

With a solid architecture and technologies like Flutter for cross-platform development and PostgreSQL for the database, the system ensures efficient and secure operation, capable of handling a large number of simultaneous users while guaranteeing data privacy. The use of JWT authentication and integration with geolocation APIs, such as Google Maps, allows the system not only to provide real-time information on medication availability but also to guide users accurately to the nearest healthcare unit.

By consolidating detailed information on stock levels and healthcare units, the application becomes a valuable tool for managers and administrators, offering real-time data for decision-making, such as medication replenishment and shortage prevention. Thus, the "Analysis of Location and Status of Medications in Health Centers" has a direct impact on improving medication management, promoting transparency, efficiency, and accessibility within the SUS.

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