Cidade Integra: A Digital Platform for Participatory Management of Urban Complaints

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Abstract. *The Cidade Integra project aims to make cities safer and cleaner through a digital platform for reporting and managing urban issues such as waste accumulation and street obstructions. It seeks to improve communication between citizens and authorities while enhancing transparency in public administration. Unlike geographically limited solutions, the project adopts a national approach focused on usability and continuous civic engagement. The platform enables users to track the status of reports, allowing authorities to respond efficiently, thus supporting administrative effectiveness and environmental sustainability. Developed with technologies such as React and Firebase, Cidade Integra fosters active citizenship, institutional trust, and innovation in urban governance. Moreover, the initiative aligns with the United Nations Sustainable Development Goals, particularly Goal 11, by contributing to the creation of inclusive, resilient, and sustainable cities, as outlined in the 2030 Agenda.*

Resumo. *O projeto Cidade Integra visa tornar as cidades mais seguras e limpas, por meio de uma plataforma digital para registro e gestão de denúncias urbanas, como acúmulo de lixo e obstruções viárias. A iniciativa busca aprimorar a comunicação entre cidadãos e autoridades, além de promover transparência na gestão pública. Diferente de soluções limitadas geograficamente, o projeto propõe uma abordagem nacional com foco em usabilidade e participação contínua. A plataforma permite que cidadãos acompanhem o status das ocorrências e que as autoridades respondam de forma ágil, contribuindo para a eficiência administrativa e a sustentabilidade ambiental. Desenvolvido com tecnologias como React e Firebase, o Cidade Integra promove cidadania ativa, confiança nas instituições e inovação na gestão urbana. Por fim, a proposta está em consonância com os Objetivos de Desenvolvimento Sustentável, especialmente o ODS 11, contribuindo para cidades inclusivas, resilientes e sustentáveis, conforme as metas da Agenda 2030 da Organização das Nações Unidas.*

1. Introduction

The increasing complexity of urban life has amplified the demand for innovative solutions aimed at promoting safer, cleaner, and healthier cities (Jacobi and Monteiro, 2006; Sommerville, 2011). In this context, the *Cidade Integra* project addresses a core challenge in contemporary urban governance: effectively mediating between the population and public authorities to identify and resolve infrastructure-related problems. To this end, the project involves the development of a digital platform that functions as an intermediary channel, allowing users to report and manage urban issues such as solid waste accumulation, water leaks, and fallen trees, among other recurring occurrences.

The initiative not only aims to optimize the maintenance of urban infrastructure but also seeks to foster citizen participation, community engagement, and transparency in public administration (Silva and Oliveira, 2019; Pereira and Teixeira, 2016). Its specific objectives include: facilitating communication between civil society and government institutions; promoting shared responsibility in addressing local problems; and cultivating a culture of active transparency in municipal management. By integrating with existing institutional systems (Alvares and Lima, 2020), the platform supports more strategic and effective public resource management, enabling quicker and better-aligned urban interventions based on the real needs of the population.

The project's impact extends across various social sectors. For citizens, the platform provides a tangible means to exercise their right to the city, thereby improving collective well-being and quality of life (Silva and Oliveira, 2019; Colab, n.d.). For public authorities, it offers a technological tool to enhance monitoring capabilities and responsiveness to urban demands, promoting greater efficiency and transparency (MySociety, n.d.). The initiative also welcomes participation from private companies—through partnerships to promote products and services—and from civil society organizations, which can use the platform to support their social missions.

From a legal and institutional perspective, *Cidade Integra* is grounded in key legislative frameworks that prioritize transparency and citizen participation, including the Access to Information Law (Law No. 12,527/2011) and the Transparency Law (Complementary Law No. 131/2009) (Pereira and Teixeira, 2016). These laws advocate for the use of digital technologies to expand social oversight and provide real-time access to public data (Silva and Oliveira, 2019).

Additionally, the project aligns with international guidelines that aim to modernize public administration and strengthen participatory democracy, such as those promoted by the Open Government Partnership (OGP). It also resonates with the concept of smart cities (Sommerville, 2011), where strategic use of information and communication technologies is key to building efficient and inclusive urban governance. Case studies like the 311 apps in the United States, Colab.re in Brazil (Colab, n.d.), and FixMyStreet in the United Kingdom (MySociety, n.d.) demonstrate the technical and social feasibility of digital platforms focused on collaborative urban management.

Lastly, the *Cidade Integra* project is aligned with the Sustainable Development Goals (SDGs), particularly SDG 11, which aims to make cities and human settlements inclusive, safe, resilient, and sustainable (United Nations, n.d.). By promoting participatory management practices and leveraging technology as a transformative tool,

the project contributes directly to the achievement of the targets outlined in the United Nations 2030 Agenda.

2. Related Work

Over the past few decades, a variety of technological initiatives have emerged with the goal of bridging the gap between citizens and public administration, while also improving urban infrastructure through social participation. These initiatives align with the principles of smart cities, participatory governance, and sustainable urban development (Sommerville, 2011; Silva and Oliveira, 2019).

One pioneering initiative on the international stage is the FixMyStreet platform, developed in the United Kingdom to allow citizens to report urban issues such as potholes, broken streetlights, and illegal waste disposal. This tool features a simple interface, available both on the web and as a mobile application, and supports geolocation and image uploads. Reports are sent directly to the responsible local authorities, enhancing transparency and public visibility of demands (MySociety, n.d.). However, its effectiveness relies on voluntary cooperation from local governments, which can hinder issue resolution in certain regions. Moreover, the platform faces limitations such as the absence of impact metrics, lack of feedback mechanisms for users, and poor integration with existing public administration systems.

In Brazil, the Colab platform stands out by expanding its functionality beyond urban issue reporting to include the evaluation of public services and participation in public consultations. Colab employs technologies similar to FixMyStreet—such as geolocation, image uploads, and a mobile-friendly interface—but innovates by offering control panels for public managers, enabling real-time data analysis (Colab, n.d.). Nonetheless, its usage is limited to partner municipalities, which restricts its geographical reach. Additionally, the resolution of reports still depends on the administrative capacity of local governments, which can result in user frustration and disengagement.

Another noteworthy case is the Traffy Fondue platform, implemented in Thailand. It stands out for its intensive use of emerging technologies, including artificial intelligence and big data analytics, to automatically prioritize and respond to reports (NSTDA, 2022). Initially designed for the city of Bangkok, the platform has achieved high user satisfaction and has significantly improved public resource optimization. Despite its technological advancements, the platform still faces challenges related to its replicability in less urbanized regions and its dependence on advanced digital infrastructure (Silva and Oliveira, 2019).

Although these platforms contribute meaningfully to digital citizenship and collaborative urban governance, critical gaps remain. Key challenges include: low interoperability with public systems; inconsistent responsiveness from responsible authorities; digital exclusion of certain population segments; the absence of standardized impact indicators; and difficulty maintaining long-term civic engagement (Pereira and Teixeira, 2016; Alvares and Lima, 2020).

In light of these limitations, the *Cidade Integra* project proposes an incremental and evidence-based approach centered on the implementation of public dashboards with

performance and engagement indicators, administrative panels for public managers, and a structured list of urban reports. From its inception, the project has prioritized data transparency, public accountability, and ease of information access—aiming to meet demands for responsive governance and informed citizen participation. Although still in early development, the initiative is distinguished by its focus on open visualization of urban management data, laying the foundation for future functionalities such as public system integration, digital inclusion strategies, and predictive technology adoption. In doing so, *Cidade Integra* seeks to address the deficiencies of earlier platforms, while remaining aligned with the principles of smart cities, urban sustainability, and shared accountability between state and society.

3. Methodology

To ensure scalability, security, and efficiency in the platform's development, modern web technologies were employed. React was used for front-end development, offering a component-based architecture and optimized performance (Gutierrez and Kauffman, 2018). TailwindCSS enabled consistent and responsive interface styling. On the back end, Firebase was chosen for its seamless integration and comprehensive support for services such as Firestore (a NoSQL database) and Firebase Authentication (for user management) (Chen, 2020). Project management was supported by Notion for documentation and organization, and GitHub Projects for task tracking via Kanban boards. This technological ecosystem enabled an agile and adaptable development process that met the project's evolving needs.

The *Cidade Integra* platform followed an agile development life cycle, specifically a Scrum-based approach adapted to an academic context. This iterative and incremental methodology facilitated frequent deliveries and continuous validation, and was structured into three main phases: planning, design, and development. To ensure an efficient workflow, functional roles were clearly defined. The Product Owner was responsible for requirement definition and backlog prioritization, while the Scrum Master facilitated meetings, removed obstacles, and monitored progress. Technical team members were assigned tasks based on their areas of expertise, which optimized workload distribution and promoted collaboration.

Project management was conducted through monthly sprints, with regular planning, review, and alignment meetings. Notion served as the centralized hub for organizing backlogs, timelines, and documentation, while GitHub Projects was used to manage task progress through a Kanban system with stages such as "To Do," "In Progress," and "Done." This integration provided a comprehensive view of development progress, improved traceability, and enhanced process control.

During the planning phase, both functional and non-functional requirements were analyzed, ensuring alignment with user needs and with the targets of Sustainable Development Goal 11 (United Nations, n.d.). The definition of a minimum viable product (MVP) helped prioritize essential features and establish success criteria. Strategic decisions were also made regarding the technology stack, which consisted of React and TailwindCSS for the front end and Firebase for the back end (Chen, 2020; Alvares and Lima, 2020).

In the design phase, the user experience was improved through the creation of low- and high-fidelity prototypes using Figma, which were iteratively refined based on heuristic evaluations and user feedback.

Once the prototypes were validated, the development phase began with incremental implementation through monthly sprints. Each new feature was developed, tested, and validated before being integrated into the system.

The quality and reliability of the platform were ensured through multiple validation strategies to guarantee that the system met all established requirements. The team adopted guidelines from the PMBOK® Guide (Project Management Institute, 2021) to define success criteria and assess platform effectiveness, focusing on usability, functionality, and transparency.

To evaluate usability, a heuristic evaluation was conducted based on Jakob Nielsen's principles (Nielsen, 1994), which guided improvements to the interface and user experience. Additionally, multi-layer testing was performed for technical and operational validation:

- **Black-box testing**: Assessed functional behavior by analyzing user interactions and system responses to ensure compliance with defined requirements.
- **White-box testing**: Verified internal logic and algorithm behavior, including exception handling, data processing, and Firestore structuring.
- **Gray-box testing**: Evaluated integration between front-end and back-end components, particularly Firebase Authentication and Firestore, to ensure consistent and stable communication between modules.

This structured testing approach supported continuous improvement, rapid iterations, and validated deliveries, ensuring the platform fully adhered to its defined quality standards.

4. Results and Discussions

4.1. Partial and Final Results Obtained

During the development process, high-fidelity prototypes were created using the Figma tool to test and validate the navigation flow of the user interface. These prototypes included visual elements such as color palettes, icons, text, and images, offering a preview of the expected final interface behavior (Garrett, 2011).

Based on usability testing, improvements were made to page layouts, navigation buttons, and form structures. These adjustments were guided by principles of usability, visibility, and informational consistency (Preece, Rogers, and Sharp, 2013).

The currently developed functional product includes:

- A complete authentication system, including login, registration, password recovery, and Google authentication, implemented via Firebase Authentication;
- A NoSQL database (Firebase Firestore) for storing and managing submitted reports;

- An access control system based on user permission levels (unauthenticated visitor, standard user, and administrator).

These features are already integrated and fully functional, representing the minimum viable product (MVP) of the platform.

4.2. Interaction Flow Between the User and the Application Services

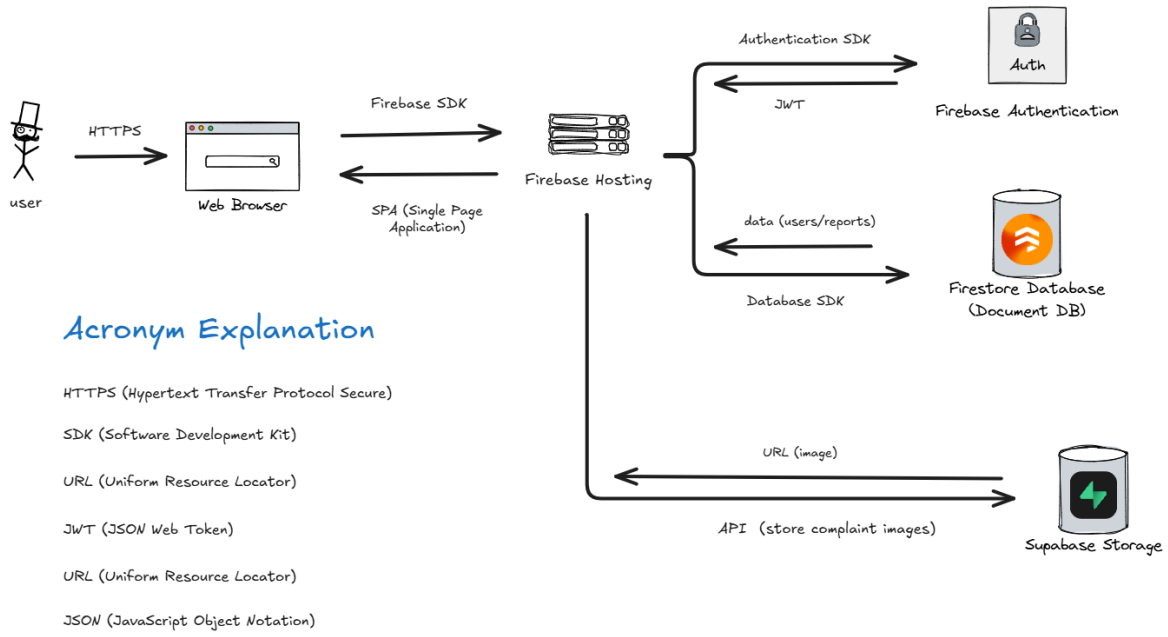

Figure 1. Deployment Diagram *(Excalidraw, 2023)*[2]

The interaction flow between users and application services was designed to ensure security, scalability, and a seamless user experience. When a user accesses the application through a web browser, the initial connection is established via HTTPS (Hypertext Transfer Protocol Secure), and the application files—built as a Single Page Application (SPA)—are served through Firebase Hosting. Once loaded, the application communicates with other platform services using the Firebase SDK (Software Development Kit) (Chen, 2020).

During the authentication process, Firebase Authentication is triggered via the Authentication SDK, which validates user credentials (via email/password or federated login). Upon successful authentication, a JWT (JSON Web Token) is issued to represent the user session. This token is used in subsequent operations to authorize access to restricted resources.

[2] Diagram created using Excalidraw – Virtual whiteboard for sketching hand-drawn like diagrams. Available at: excalidraw.com

Report data operations (insertion, retrieval, and updates) are conducted using Firebase Firestore, a document-oriented NoSQL database. The data is structured in collections (e.g., users and reports) using the JSON (JavaScript Object Notation) format (JSON, n.d.).

If a report includes an image, the file is uploaded via a request to the Supabase Storage API, an external service used to efficiently store media assets. After the upload, the API returns a public URL referencing the image, which is then linked within the corresponding report document in Firestore.

This integration—spanning authentication, data persistence, and media storage—reflects a distributed, secure, and modular architecture, aligned with current best practices in modern web development and cloud-based application design.

4.3. Use Case Modeling

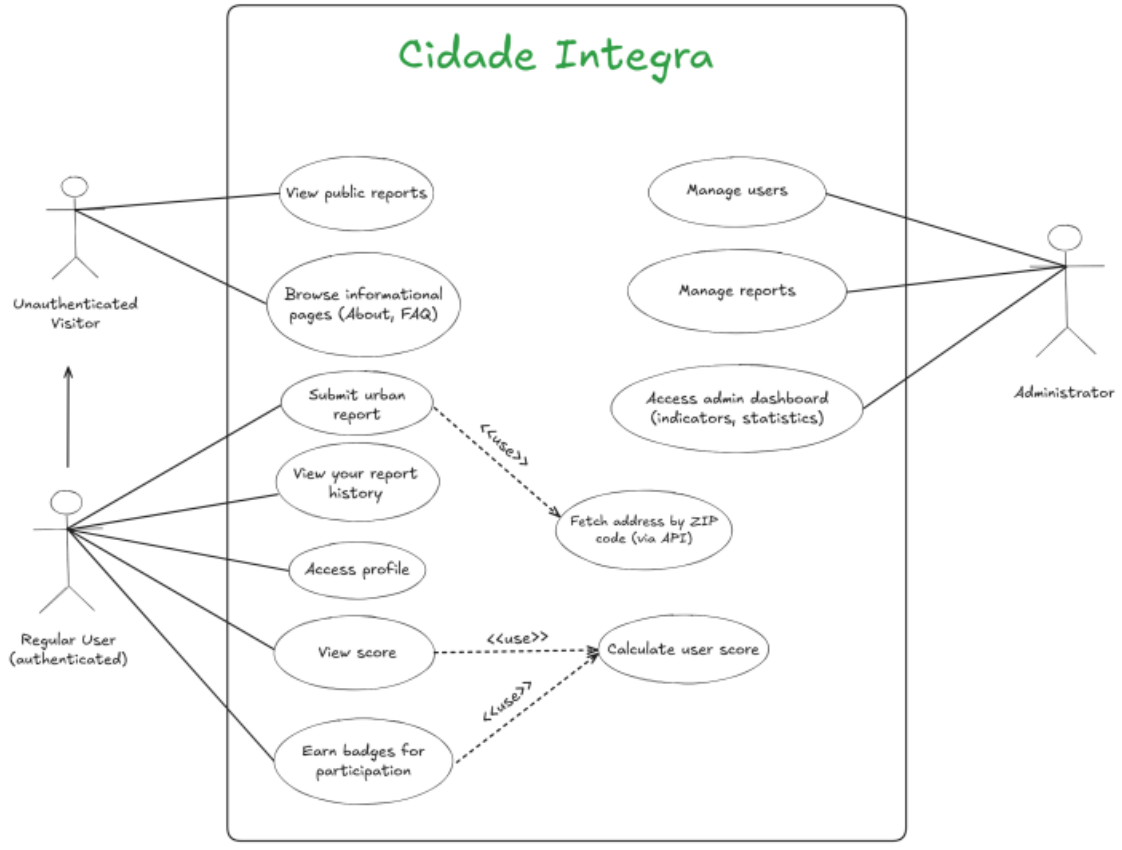

Figure 2. Use Case Diagram *(Excalidraw, 2023)*[3]

[3] Diagram created using Excalidraw – Virtual whiteboard for sketching hand-drawn like diagrams. Available at: excalidraw.com

To visually represent the platform's essential functionalities and their interactions with different user types, a use case diagram was developed following Unified Modeling Language (UML) principles. This modeling process enabled the identification of the system's main actors and their corresponding operations, including automated internal processes (Sommerville, 2011).

Three primary actors were defined: **Unauthenticated Visitor**, **Regular User (authenticated)**, and **Administrator**.

The Unauthenticated Visitor has limited access, being allowed only to view public reports and browse institutional pages such as "About" and "Frequently Asked Questions."

The Regular User has full access to civic participation features. In addition to all permissions available to visitors, this user can submit new reports, view personal report history, access their profile, check their engagement score in the ranking, and earn participation badges based on platform activity.

The Administrator possesses extended privileges and full access to the system's administrative interface. They are responsible for managing registered users, moderating submitted reports (including archiving or deleting), and accessing dashboards with community engagement and platform performance metrics.

In addition to these roles, the system performs various automated operations via internal services. These include ZIP code-based address lookup through external APIs, dynamic user ranking calculations based on predefined scoring rules, and automatic badge assignment.

This modeling process contributed significantly to aligning the functional requirements with system development, enabling modular organization and clarifying user role responsibilities.

4.4. User Validation and Feedback

To assess the platform's functionality, usability, and navigational clarity, tests were conducted with users across diverse age groups and varying levels of digital literacy. Qualitative validation involved direct observation of participants interacting with the platform, followed by the collection of suggestions and feedback.

Several areas for improvement were identified, including: excess information in the "Help" section; unbalanced use of images on the homepage; and unclear terminology—such as the recommendation to change "Register" to "Sign Up."

Further adjustments were made to form elements, including field reorganization, refinement of required input fields, and the addition of contextual help messages. Incorporating this user feedback led to a more cohesive, accessible, and user-centered platform version (Garrett, 2011).

4.5. Limitations and Challenges

Throughout the project, two major technical challenges emerged. The first involved selecting the most appropriate database technology for the project's scope. After practical testing and technical analysis, Firebase Firestore was chosen due to its scalability, native integration with the Google ecosystem, and relatively low learning curve—making it suitable for rapid prototyping and validation (Alvares and Lima, 2020).

The second challenge pertained to image storage. Due to limitations in Firebase Storage's free tier, alternative storage solutions were explored. Options evaluated included Vercel Blob, Cloudinary, ImageKit.io, and Supabase Storage. Supabase was ultimately selected based on its generous free tier, low latency, support for WebP format, and easy integration with Firestore through public URLs, which eliminated the need for additional authentication. This decision was driven by cost-effectiveness, performance, and compatibility with the platform's front-end-first architecture (Sommerville, 2011).

A more comprehensive comparative study is currently underway to evaluate long-term scalability and the viability of these storage solutions under high-demand scenarios.

4.6. Planned Improvements and Future Perspectives

Ongoing development plans include both structural and functional enhancements, such as:

- Converting authentication pages (Login, Sign Up, Password Recovery) into modal interfaces to improve user experience (Garrett, 2011);
- Developing a commenting system for reports to encourage interaction between users and administrators;
- Integrating an interactive map displaying the geolocation of submitted reports;
- Implementing accessibility features, including screen reader support, adjustable contrast, and keyboard navigation, in accordance with WCAG 2.1 guidelines (W3C, 2018) and NBR 17060:2022 (ABNT, 2022);
- Exploring the use of artificial intelligence for automated report triage and response suggestions.

The prioritization of these features will depend on available resources and will be guided by agile and user-centered design principles (Beck et al., 2001).

5. Final Remarks

Team Learnings During Development: During the development of the *Cidade Integra* project, the team consolidated both technical and interpersonal skills, contributing significantly to their growth as developers and as members of a multidisciplinary team.

From a technical standpoint, the team deepened its expertise in technologies such as React (Gutierrez and Kauffman, 2018) for interface development, and Firebase (Chen, 2020) for authentication, hosting, and real-time database management. The use of GitHub for version control was enhanced through collaborative practices such as pull requests and code reviews. Figma played a central role in user-centered interface design and prototyping.

On the interpersonal side, the team cultivated a culture of collaboration and empathy, marked by strong collective commitment. Regular meetings, active listening, and mutual support were key to maintaining consistent progress. The use of the SMART methodology (Specific, Measurable, Achievable, Relevant, and Time-bound) was instrumental in setting clear goals and distributing tasks evenly, fostering autonomy and cohesion among team members (Sommerville, 2011).

Project Impact Potential: *Cidade Integra* demonstrates significant potential for social, environmental, and technological impact. Socially, it serves as a tool for promoting active citizenship by involving residents directly in the identification of urban issues (Silva and Oliveira, 2019). Transparent handling of complaints fosters public trust in institutions (Pereira and Teixeira, 2016).

From an environmental perspective, the platform facilitates rapid response to issues such as improper waste disposal or faulty public lighting, reducing negative impacts on public health and the environment (Jacobi and Monteiro, 2006). Technologically, the use of modern frameworks such as React and Firebase ensures high performance, security, and scalability. Project management was organized using Notion, and interface design emphasized accessibility and usability via Figma.

The adoption of software engineering best practices and UX/UI principles, combined with the SMART methodology, contributes to the solution's replicability in different urban contexts.

Next Steps for Platform Development: Despite its advanced functional stage, the platform still requires technical improvements to enhance scalability—particularly for deployment in large urban centers. Viable solutions include adopting a microservices architecture, implementing load balancing, and integrating with municipal APIs (Villamarin-Salomon and Sekar, 2010).

Automated data collection and performance monitoring will also be key for continuous improvement. Establishing partnerships with public agencies will enable integration with existing urban management systems, increasing the platform's institutional and social impact.

Final Considerations: The *Cidade Integra* project has proven the feasibility of a digital platform capable of transforming the relationship between citizens and public authorities. By promoting administrative efficiency, social inclusion, and environmental sustainability, the initiative demonstrates how civic technology can drive innovation in public management. The technical and interpersonal skills acquired throughout the project have contributed to the team's professional maturity and their ability to work effectively in multidisciplinary and collaborative environments.

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