



FIELD SAMPLE TRACEABILITY SYSTEM USING QR CODES AND THE GOOGLE SHEETS PLATFORM

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Abstract:

Efficient traceability of field samples is a critical requirement in laboratory workflows, particularly in institutions that process large numbers of geological, environmental, and industrial samples. Conventional procedures based on handwritten labels, manual spreadsheet entry, and phone-based coordination are often slow, error-prone, and difficult to monitor in real time. This paper presents the design and implementation of a low-cost field sample traceability system utilizing QR codes, Google Sheets, Google Apps Script, and shortcut-based mobile clients on Android and iPhone devices. The proposed solution enables unique sample identification, rapid status updates through QR scanning, and centralized monitoring of sample movement from field collection to laboratory processing. The system was designed so that personnel can mark samples as sent, received, in progress, or completed without directly editing the spreadsheet. Instead, mobile devices invoke a web endpoint implemented in Google Apps Script, which updates the corresponding spreadsheet record and returns a confirmation message to the operator. The proposed architecture improves sample visibility, reduces manual data entry, minimizes duplicate or inconsistent status records, and provides a practical implementation path without the need for a custom native mobile application. The paper argues that accessible cloud tools and lightweight mobile automation can provide an effective and scalable platform for sample traceability in laboratory environments with limited development resources.

Keywords:

Sample Traceability, QR Codes, Google Sheets, Google Apps Script, Mobile Automation.

INTRODUCTION

Reliable identification and monitoring of field samples are essential parts of laboratory and research operations. In institutions that handle geological, mining, metallurgical, environmental, or material samples, each specimen must remain clearly connected to its origin, interval, requested analysis, and processing status throughout the entire workflow. If this information chain is interrupted, the consequences may include sample confusion, reporting delays, inconsistent metadata, and reduced confidence in laboratory outputs [1], [2].

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In many laboratories, sample handling still depends on handwritten labels, manually prepared spreadsheets, and informal communication between field teams and laboratory personnel. Although such procedures may function in low-volume environments, they become inefficient when the number of samples increases and when multiple actors participate in collection, transport, reception, analysis, and reporting. Manual operations performed between collection and publication are well known sources of avoidable errors in field and laboratory data chains [3].

Studies have shown that QR-code-based labelling solutions can significantly reduce handling time and improve storage rationalization [4], while proper barcode placement ensures fast and reliable scanning in operational environments [5].

Recent advances in cloud platforms, scripting environments, and mobile automation tools make it possible to construct lightweight traceability systems without the cost and complexity of full-scale enterprise software. QR codes provide machine-readable identifiers, Google Sheets can act as a centralized cloud database, and Google Apps Script can publish a script as a web app through doGet(e) or doPost(e) handlers that receive request parameters and modify spreadsheet data. In parallel, Apple Shortcuts supports API requests through the Get Contents of URL action, while HTTP Shortcuts on Android is designed to trigger HTTP requests from home-screen shortcuts and widgets. Mobile automation tools such as iOS Shortcuts have been successfully implemented in academic settings to replace custom-built mobile solutions, while studies have shown that preprogrammed mobile shortcuts can significantly reduce the complexity of field data entry and standardized reporting workflows. [6]

The aim of this paper is to present the low-cost design and implementation of a field sample traceability system utilizing QR codes and the Google Sheets platform. The system was developed for a practical workflow in which a unique sample identifier is encoded into a QR label, scanned through a mobile shortcut, and synchronized with a cloud spreadsheet that records status transitions and timestamps. The paper focuses on architecture, implementation logic, mobile integration, practical benefits, and current limitations. The only cost in this low-cost system is the purchase of the thermal printer (Brother QL-810W or any other thermal printer), which prints QR code labels on the field to be applied to the samples.

This work makes four main contributions: it proposes a practical QR-based traceability model for field and laboratory samples, demonstrates a low-cost tracking system using Google Sheets and Google Apps Script, introduces a mobile interaction layer via shortcut-based clients on Android and iPhone, and shows how lightweight validation reduces duplicate updates and improves reliability.

2. RELATED WORK, RESEARCH METHOD AND IMPLEMENTATION APPROACH

Traceability in scientific and laboratory workflows refers to the ability to identify and follow a sample throughout its lifecycle. Prior studies show that QR-code-based approaches can improve tracking, data accessibility, and workflow transparency, especially in environments where fast scanning and mobile access are important [2].

Although laboratory information systems can provide broader process control, their deployment is often demanding for smaller institutions. For that reason, lightweight solutions based on cloud platforms and low-code tools are attractive when the goal is to solve a specific operational problem with lower cost and complexity [7]. Recent implementations have shown that cloud-based applications using Google Sheets can successfully integrate data search functionalities and leverage Google's reliable uptime for ease of deployment. Studies have also demonstrated that QR code tracking systems can address traceability challenges in academic settings by making design, fabrication, and quality control data accessible across multiple institutions [8].

This work implements a prototype integrating Google Sheets, QR labels, Apps Script web endpoint, and smartphone shortcuts for reliable identification and status tracking without direct mobile spreadsheet editing.

The script receives sample identifiers, validates requests, updates rows, adds timestamps, and confirms operations. The operational model uses four core states—Sent, Received, In Progress, Completed—with duplicate protection to prevent overwrites, providing a practical traceability framework simpler than full-scale enterprise systems.



Uzorak ID	Projekt	Substancija	Oid (bg)	Oid (bor)	Datum	Analiza	Status	Datum slanja (BG)	Datum prijema (BOR)	Nepoznata	QR (BG)	QR (BOR)
Metro-BP1-03-0-12.0	Metro	BP1	33	32	24.02.2020	GEOMHANKA	ZAVRSENO	24.02.2020	25.02.2020		[QR Code]	[QR Code]
Metro-BP1-03-0-26.0	Metro	BP1	33	34	24.02.2020	GEOMHANKA	ZAVRSENO	24.02.2020	25.02.2020		[QR Code]	[QR Code]
Metro-BP1-03-0-22.0	Metro	BP1	33	32	25.02.2020	GEOMHANKA	URADU	25.02.2020	26.02.2020		[QR Code]	[QR Code]
Metro-BP1-03-0-11.0	Metro	BP1	33	32	25.02.2020	GEOMHANKA	URADU	25.02.2020	26.02.2020		[QR Code]	[QR Code]
Metro-BP1-03-0-15.0	Metro	BP1	33	32	25.02.2020	GEOMHANKA	URADU	25.02.2020	26.02.2020		[QR Code]	[QR Code]
Metro-BP1-03-0-10.0	Metro	BP1	33	32	25.02.2020	GEOMHANKA	URADU	25.02.2020	26.02.2020		[QR Code]	[QR Code]
Metro-BP1-03-0-18.0	Metro	BP1	33	32	25.02.2020	GEOMHANKA	URADU	25.02.2020	26.02.2020		[QR Code]	[QR Code]
Metro-BP1-03-0-7.0	Metro	BP1	33	32	25.02.2020	GEOMHANKA	POSILAO	25.02.2020	26.02.2020		[QR Code]	[QR Code]

Figure 2. Google sheets

Because the response is displayed immediately on the mobile device, the operator can confirm whether the update succeeded, whether the state was already assigned, or whether the sample ID was not found.

3.3.ANDROID AND IPHONE IMPLEMENTATION FOR QR-BASED SAMPLE STATUS UPDATES

The proposed mobile implementation enables laboratory staff to update sample statuses directly from Android and iPhone devices by sending HTTP GET requests to a deployed Google Apps Script Web App. In both cases, the mobile phone serves as a lightweight client, while the central processing logic remains in the backend. This approach supports a practical traceability workflow in which each scanned sample can be immediately marked with the appropriate lifecycle status, without manually editing the spreadsheet.

On Android devices, the system is implemented using the HTTP Request Shortcuts application, while QR code scanning is performed through the Binary Eye scanner. HTTP Request Shortcuts is suitable for this purpose because it allows predefined HTTP requests to be launched directly from shortcuts or widgets on the home screen, while also supporting dynamic variables. This is important because the request structure remains the same for all samples, and only the sample identifier changes during execution.

A separate Android shortcut is created for each main laboratory action: Beograd – Poslato, Bor – Primljeno, Bor – Uradu, and Bor – Završeno. Each shortcut uses the same request structure: the HTTP method is

GET, the base URL is the deployed Google Apps Script /exec endpoint, and the two query parameters are mode and id. The mode value is fixed for each shortcut and defines the status transition (bg, bor, uradu, završeno), while the id value is dynamic and contains the sample identifier. A typical request has the form: .../exec?mode=bg&id=[SampleID]. This unified structure simplifies both maintenance and everyday use.

The sample ID can be entered manually or captured by scanning the QR code, but QR-based input is preferable because it is faster and reduces typing errors. Ideally, the QR code contains only the exact sample identifier, which is then inserted directly into the request. Once configured, the shortcuts can be pinned to the Android home screen, allowing the operator to complete the update in only three steps: tap the shortcut, scan the QR code, and wait for the confirmation message returned by the Web App. The response informs the user whether the update was successful, already recorded, or unsuccessful because the sample was not found. This makes the Android workflow efficient and operationally suitable for routine laboratory use.

On iPhone devices, the same logic is implemented using the built-in Apple Shortcuts application. In this version, the shortcut collects the sample ID at runtime, constructs the request URL, sends the HTTP GET request, and displays the response. A typical iPhone shortcut contains four steps: Ask for Input, URL construction, Get Contents of URL, and Show Result. This allows one reusable shortcut structure to be applied repeatedly, with only the entered sample identifier changing from one execution to another.



As on Android, one iPhone shortcut is created for each sample status. The shortcut sends a request to the same backend endpoint, using the same parameter structure: mode defines the status, while id carries the sample identifier. For example, the “Sent” action uses a request of the form `.../exec?mode=bg&id=[SampleID]`. In this way, the iPhone implementation mirrors the Android solution and preserves a consistent communication model with the Google Apps Script backend.

In practical use, the operator simply launches the corresponding shortcut, provides or scans the sample ID, and waits for the returned confirmation. The result immediately shows whether the record has been successfully updated. Therefore, both Android and iPhone implementations provide a simple and effective mobile interface for QR-based sample traceability, while keeping the core business logic centralized in Google Sheets and Google Apps Script. This design improves speed, reduces manual errors, and supports a clear digital trace of each status transition in the laboratory workflow.

3.4. WORKFLOW LOGIC

The proposed workflow connects field sampling, label generation, transport, laboratory reception, analysis, and final completion within a single traceability framework. It combines one initial manual data-entry step in the field with later mobile status updates performed by scanning QR codes. In this way, the system joins spreadsheet-based record creation, on-site thermal label printing, and smartphone-based tracking.

The workflow starts in the field, where sampling personnel use a laptop with internet access and a Brother QL-810W thermal printer. For each sample, the operator enters the key data into Google Sheets, such as the borehole designation, depth interval, and sampling date. This is the only full manual input step, used to create the digital record, generate the unique sample identifier, and produce the corresponding QR code.

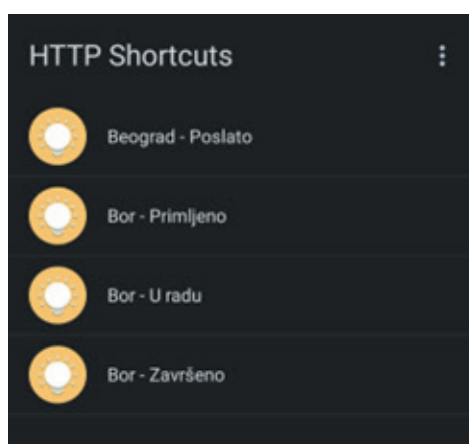


Figure 3. Android HTTP Request Shortcuts

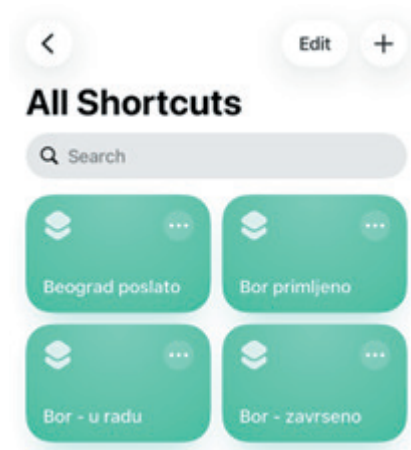


Figure 4. Apple Shortcuts

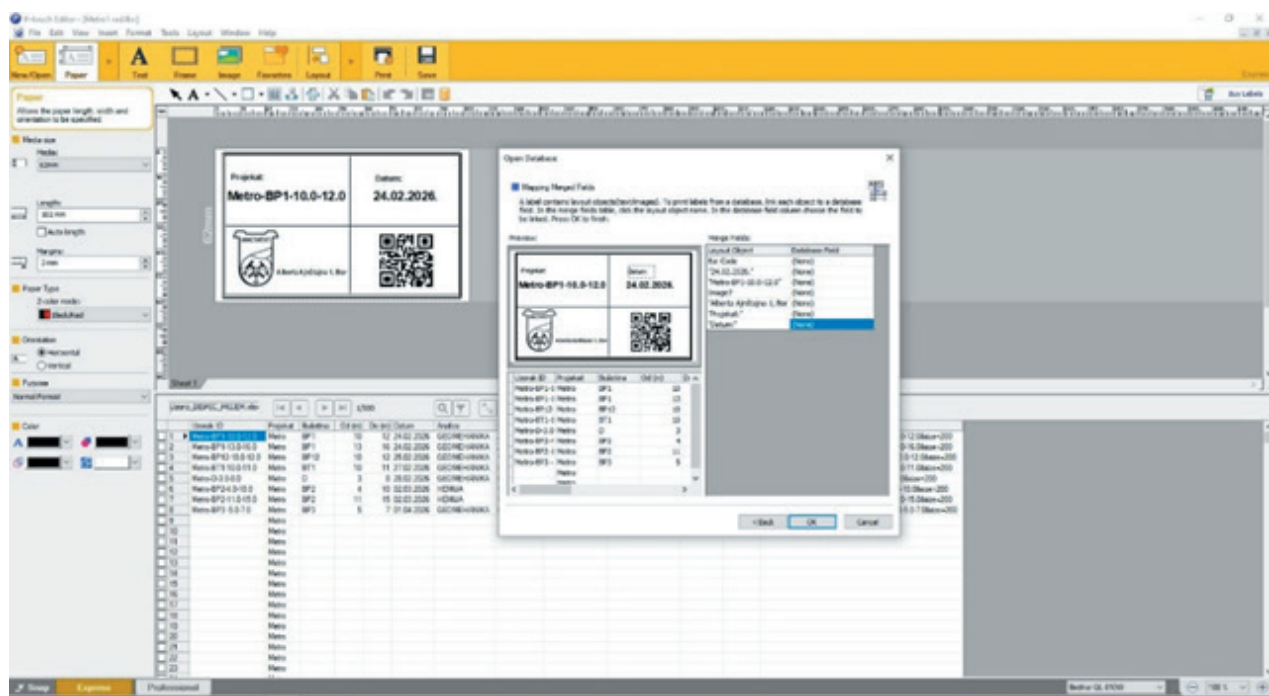


Figure 5. Import of spreadsheet data into P-touch Editor



Figure 6. Printed sample label with QR code

After that, the spreadsheet is imported into P-touch Editor, where the label layout is defined and printed on the Brother thermal printer. The printed label is then attached directly to the sample, creating a permanent connection between the physical specimen and its digital record. From this point onward, all later updates are performed on a mobile phone through shortcut applications, without re-entering sample data.

When the sample is sent, received, processed, and completed, the operator simply selects the appropriate shortcut on the mobile phone and scans the same QR code. Each scan updates the matching Google Sheets record and changes the status accordingly. In this way, the system replaces handwritten notes and delayed reporting with immediate, structured, and centralized tracking, improving traceability and transparency throughout the sample lifecycle.

4. CONCLUSION

This paper presented a practical field sample traceability system based on QR codes, Google Sheets, Google Apps Script, and shortcut-based mobile clients on Android and iPhone devices. The proposed solution addresses the need for simple, reliable, and low-cost monitoring of samples during transport and laboratory processing. By combining machine-readable identification with centralized cloud-based status control, the system reduces manual entry, improves consistency, and provides better visibility of sample movement across operational stages.

An important contribution of the proposed approach is that it can be implemented without a dedicated server, custom mobile application, or expensive enterprise infrastructure.



Instead, it relies on widely available and familiar technologies such as spreadsheets, smartphone cameras, and mobile automation tools, which makes deployment faster and more accessible for institutions with limited technical resources. In addition, centralized and immediate status updates improve operational transparency, reduce uncertainty between field and laboratory personnel, and lower the probability of human error during repeated handling events.

The study also indicates that this architecture is particularly suitable for sample-driven environments such as mining, geology, metallurgy and environmental monitoring, where the number of workflow transitions is limited but traceability requirements are high. Research in field data collection has demonstrated that combining mobile applications with barcode scanning can ensure reliable data tracking from field collection to laboratory storage, a principle that the proposed system extends through its automated synchronization capabilities. [9]

Overall, the results show that accessible digital tools can be organized into an effective traceability platform that significantly improves transparency, coordination, and data integrity in sample handling workflows. Future work should include broader validation in real operating conditions with larger numbers of samples and users, as well as further development toward offline synchronization, automated reporting, dashboard visualization, printer integration, and tighter connection with laboratory information systems. Such improvements would strengthen the practical value of the system and support its wider adoption in scientific and industrial practice.

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