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Usability Evaluation of a Blockchain-IoT Platform for Traceability in the Cyprus Cereal Supply Chain

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Introduction

Cereals are fundammental to global food systems, supporting food security, rural livelihoods, and agri-food value chains. However, cereal supply chains are increasingly vulnerable to climate change, water scarcity, armed conflicts, market volatility, and import dependence, highlighting the need for transparent and resilient traceability systems.

Traceability enables product and process information to be tracked throughout the supply chain, supporting food safety, quality assurance, transparency, and informed decision-making. In cereal systems, this extends from genetic material and cultivation practices to processing, storage, transportation, and distribution. Conventional approaches, however, often rely on fragmented databases and paper-based records, limiting interoperability and timely information exchange. Blockchain offers a promising alternative by enabling secure, tamper-resistant, and verifiable information sharing among supply-chain actors. Combined with Internet of Things (IoT) technologies, it can integrate real-time agronomic and environmental data into traceability records, strengthening provenance verification, quality assurance, risk assessment, and decision-making. However, successful blockchain–IoT implementation depends not only on technological performance but also on usability, effective data management, and alignment with stakeholder needs.

TraCEREAL was developed as a proof-of-concept blockchain–IoT platform for end-to-end traceability across the Cypriot cereal supply chain (Figure 1).

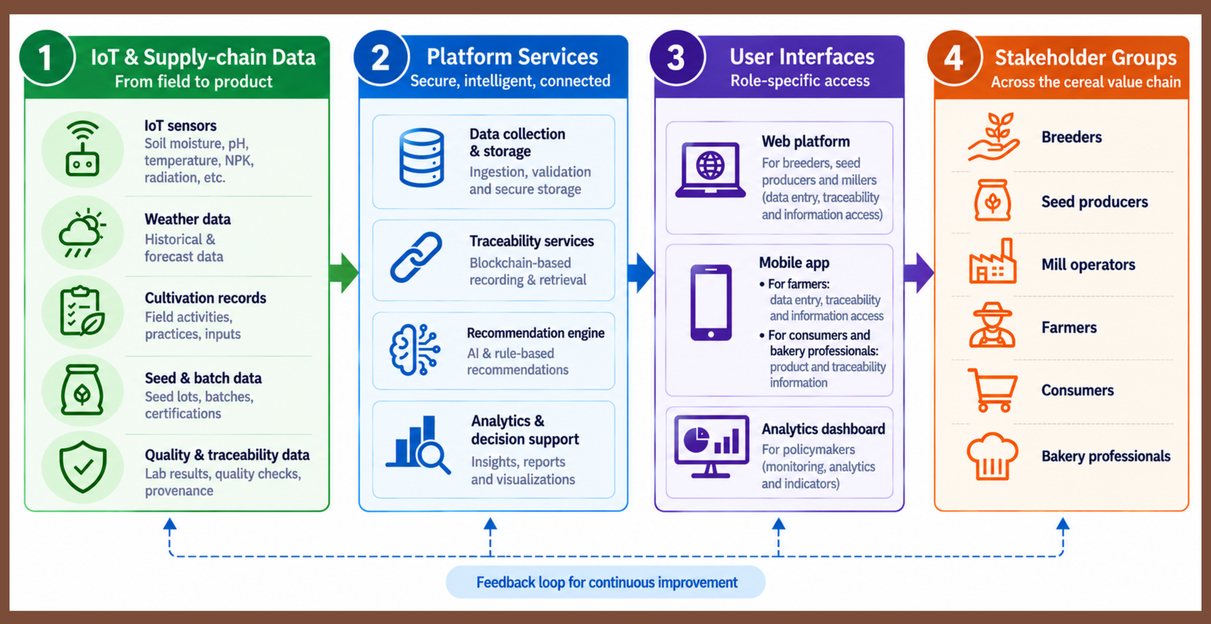


Figure 1. TraCEREAL data flow

The present study focuses on the practical usability evaluation of the platform through a structured, scenario-based user-testing exercise involving 117 stakeholders, including breeders, seed producers, farmers, mill operators, bakery professionals, consumers, and policymakers.

Methodology

Six stakeholder-specific scenarios comprising tasks tailored to each user group were developed. Following task completion, participants evaluated the platform using three complementary usability instruments. Overall usability was assessed using the two-item, seven-point Usability Metric for User Experience–Lite (UMUX-Lite), with scores transformed to a standardized 0–100 scale [1]. Task-level ease was measured immediately after each task using the Single Ease Question (SEQ), a seven-point scale ranging from “Very Difficult” to “Very Easy” [2]. Finally, recommendation intention was assessed using the Net Promoter Score (NPS), rated from 0 to 10. Respondents were classified as promoters (9–10), passives (7–8), or detractors (0–6), with NPS calculated as the percentage of promoters minus the percentage of detractors [3] (Reichheld, 2003).

Results

A total of 117 participants were recruited across all stakeholder groups (mean age = 46.05 years; 57.2% male, 42.8% female).

Overall results indicated high perceived usability, task ease, and recommendation intention (Table 1). The aggregate NPS was +55.6, with 60.7% promoters, 34.2% passives, and 5.1% detractors. Usability was strongly associated with task ease ($\rho = .68$, $p < .001$) and moderately associated with recommendation intention ($\rho = .47$, $p < .001$); task ease was also associated with recommendation intention ($\rho = .49$, $p < .001$). The UMUX-Lite items showed moderate correlation ($r = .44$; standardized $\alpha = .61$), suggesting some caution when interpreting the composite score.

Table 1. Overall participant-level outcomes (n=117)

Measure	Mean	SD	Median	95% CI for mean	Minimum–Maximum
UMUX-Lite	88.65	10.91	91.57	86.65–90.65	58.33–100.00
SEQ	6.40	0.76	7.00	6.26–6.54	3.00–7.00
NPS	8.76	1.31	9.00	8.52–9.00	4.00–10.00

Task-completion times varied across stakeholder groups, averaging 4.0 min for the breeder, 5.0 min for seed producers, 8.0 min for farmers and mill operators, and 1.3 min for end-users (bakery professionals and consumers). Overall, these results indicate efficient completion of the assigned tasks across stakeholder groups.

Conclusion

These findings provide empirical evidence from a multi-stakeholder evaluation of a blockchain–IoT traceability platform spanning the seed-to-shelf value chain. Methodologically, they demonstrate the value of combining scenario-based testing with complementary measures of usability, task ease, and recommendation intention for evaluating socio-technical traceability systems under realistic conditions. Several stakeholder groups were represented by very small samples; therefore, the corresponding results should be treated as indicative rather than generalizable. Future research should extend the evaluation to larger and more diverse stakeholder populations incorporating task-based assessments and longitudinal studies to gain deeper insights into the adoption and practical implementation of blockchain-IoT based traceability in cereal supply chains.

References

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