Catalyst Final Report
Integrating AI and Blockchain: Developing AI Standards for Cardano

UnboundedMarket Team

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Contents

1 Introduction

This report serves as the close-out report and final deliverable for our Project Catalyst Fund 12 project, *Integrating AI and Blockchain: Developing AI Standards for Cardano*.

2 Project Overview (Name, Link, ID, Dates)

All relevant project details, including the name, link, number, manager, and start & completion dates, are given in table 1.

Item	**Details**
Project Name	Integrating AI and Blockchain: Developing AI Standards for Cardano
IdeaScale URL	https://projectcatalyst.io/funds/12/cardano-open-developers/integrating-ai-and-blockchain-developing-ai-standards-for-cardano
Project Number	1200134
Project Manager	UnboundedMarket
Project Dates	Start: Aug 12, 2024 — Completion: Oct 27, 2025

Table 1: Project overview

3 KPIs

3.1 Challenge KPIs & How We Addressed Them

- **KPI: Provide practical tools and knowledge for Cardano builders.**
  How we addressed it: When creating the Catalyst proposal we identified four pillars important for AI growth on Cardano: API, Certification, Benchmarking, and Consensus. We have created a lot of theoretical research on the four pillars and we released an open-source toolbox that follows these ideas. The repository includes runnable examples and a simple Quick Start so teams can integrate AI with Cardano without building core primitives from scratch.

- **KPI: Build trust through transparency and verifiability.**
  How we addressed it: All research papers, code, and CLI tools are public under an MIT license. Model cards use a clear schema and can be minted as NFTs via a blockchain connector, and benchmark results can be stored along the same path. This makes model details and scores auditable over time.

- **KPI: Make a complex system easy to use.**
  How we addressed it: We provide a REST API with clean endpoints, auto-generated OpenAPI docs, and example clients, plus CLIs for certification, benchmarking, and consensus. The examples demonstrate end-to-end flows, so developers can run the system with a few commands and focus on their own applications.

- **KPI: Create high-quality research.**
  All our research papers follow the guidelines of internationally renowned conferences, and we use verifiable, trustworthy sources to support our data and findings.

3.2 Project KPIs & How We Addressed Them

- **KPI: Publish the research and specifications for the four pillars.**
  How we addressed it: We produced three papers: the Research Proposal (Milestone 1), the API/Certification/Benchmarking report (Milestone 2), and the AI Consensus report (Milestone 3). These documents define the standards and guide the reference implementation.

- **KPI: Deliver a working REST API with core routes.**
  How we addressed it: The API server exposes Administration routes (register, revoke, update), Inference routes (single, batch, consensus), and a health endpoint. OpenAPI docs are generated automatically, enabling quick integration and testing.

- **KPI: Enable certification and benchmarking with on-chain traceability.**
  How we addressed it: The certification module defines fixed and optional model-card fields and validates them. A blockchain connector (mock in development) records model cards and benchmark results to create an auditable history.

- **KPI: Provide a consensus engine for multiple output types.**
  How we addressed it: The consensus module supports discrete outputs (weighted voting), text (distillation/reranking), vision (latent feature fusion), and audio (spectro-temporal fusion). Model weights come from certification status and benchmark scores, with utilities for Byzantine penalties.

3.3 Key Achievements (Collaboration & Engagement)

- **Community Collaboration:** Engaged with the Cardano community through open discussions, and updates shared on GitHub, X (Twitter) and of course through Project Catalyst. This created transparency and encouraged participation from developers and researchers.

- **Open-Source Contribution:** Published all source code, research papers, and documentation publicly under the MIT License, allowing others to contribute, reuse, and build upon the project's foundation.

- **Knowledge Sharing:** Provided clear documentation, tutorials, and runnable examples that demonstrate how to use the API, certification, benchmarking, and consensus tools. This supports adoption within the Cardano ecosystem.
- **Academic and Technical Collaboration:** The team combined expertise in AI, blockchain, and systems engineering to co-author technical reports and implement a working prototype that can serve as a reference standard for development on Cardano.

3.4 Key Learnings

- **Standardization is essential:** Integrating AI with blockchain requires clear and shared standards. Defining consistent APIs, certification formats, and benchmarking methods helps developers to save time and development effort. In addition, the overall code-quality and development speed increases.
- **Transparency builds trust:** Open documentation and verifiable, on-chain data are key to user and developer confidence. Public research and code reviews strengthened the credibility of the framework.
- **Modularity supports growth:** Designing each component (API, Certification, Benchmarking, Consensus) as an independent module made the system easier to test, extend, and adapt for future Cardano applications.
- **Complex systems need simple interfaces:** Abstracting technical processes into clear routes, CLI commands, and examples are important for developer adoption.

3.5 Next Steps

Please note: We are defining next steps for the project that are outside the scope of the funded project in Project Catalyst.

- **Cardano integration:** Connect the current mock blockchain connector to the Cardano mainnet to enable live certification, benchmarking, and consensus verification on-chain.
- **Scalability testing:** Conduct larger-scale simulations to measure performance, fault tolerance, and efficiency as the number of models and users grows.
- **Ecosystem collaboration:** Partner with other Cardano projects and research groups to validate and extend the framework for real-world AI applications.
- **Continuous improvement:** Maintain and expand the open-source repository with additional examples, improved documentation, and updated tools based on community feedback.

4 Milestone Summaries

4.1 First Milestone Summary

The first milestone established the conceptual foundation of the project. The research proposal defined the motivation, scope, and objectives for integrating Artificial Intelligence (AI) with the Cardano blockchain. It introduced the four foundational pillars **API**, **Certification**, **Benchmarking**, and **Consensus Mechanisms** and outlined their individual requirements and interdependencies. The document discussed challenges such as interoperability, verifiability, and scalability, and provided a roadmap for subsequent milestones.

4.2 Second Milestone Summary

The second milestone expanded upon the initial proposal by presenting detailed theoretical foundations for the first three pillars: the **API framework**, the **Certification Procedure**, and the **Benchmarking Procedure**. Each section built upon the defined requirements, introducing practical approaches and technical design principles for implementing these standards. The report provided comparative analysis with existing AI and blockchain integration methods, highlighting how standardized APIs and certification can promote transparency and interoperability.

4.3 Third Milestone Summary

The third milestone focused on the development of a theoretical framework for the **AI Consensus Mechanism**. This report extended the previous milestones by introducing methods for achieving consensus across multiple AI models using blockchain principles. It included sections on related work, technical background, and detailed methodology, covering ensemble learning, Byzantine fault tolerance, and modality-specific aggregation strategies for text, vision, and audio models. The report concluded with a critical discussion of challenges and future directions for implementation. The full paper and supplementary material were made publicly available on GitHub and announced to the community via X.

4.4 Final Milestone

The final milestone brought together all research outputs into a functional open-source reference implementation. A fully documented **MVP toolbox** was released on GitHub, including source code, CLI tools, API documentation, and runnable examples for all four pillars. The milestone also delivered the **Final Close-Out Report** and **Close-Out Video**, summarizing the outcomes. A public announcement was made on X to

introduce the AI standards to the Cardano community and a feedback form was shared. We integrated the collected feedback into our Github repository.

4.5 Addressing Community Feedback

Following the public release of the MVP Toolbox, we collected structured feedback from the Cardano community via a public form. Overall satisfaction was high, with the majority of respondents reporting they were *very satisfied* and expressing concrete interest in using multiple components of the toolbox in future projects, in particular the API framework and model certification tooling (Figure 1).

Despite the positive reception, the feedback highlighted two critical blockers for real-world adoption (Figure 2). Multiple users explicitly requested clarity on licensing and commercial usability, noting the absence of a license file as a reason to pause or abandon integration. In addition, users pointed out that the repository structure made it harder than necessary to locate generated reports.

We addressed both issues directly:

- A clear open-source license file was added to the repository, explicitly defining permitted usage, including commercial use, thereby removing legal ambiguity for downstream developers.[1]
- The repository structure was refactored by consolidating generated reports into a dedicated directory, significantly improving navigability and usability.[2]

These changes were implemented immediately after feedback collection and are now part of the main branch, ensuring the MVP Toolbox is both legally unambiguous and easier to integrate in practice.

5 Links to Relevant Sources

- IdeaScale/Fund page: https://projectcatalyst.io/funds/12/cardano-open-developers/integrating-ai-and-blockchain-developing-ai-standards-for-cardano
- GitHub Repository with MVP Toolbox and Reports: https://github.com/unboundedmarket/ai-standards/

[1] https://github.com/unboundedmarket/ai-standards/commit/bbfafdadb306f64d784c934512fb00d780c2279b

[2] https://github.com/unboundedmarket/ai-standards/commit/543a2032c7e31b63c476144542a104238c0df1f0

- Research Proposal: https://drive.google.com/file/d/1X1ImtPnbw3URHp_ZFobESpx-pW4gx2Qo/view?usp=sharing
- Research Report on Standards for API, Certification and Benchmarking: https://drive.google.com/file/d/1SskowgIo8PG5IFIsQu6dyOLpRcR1m8DY/view?usp=sharing
- Research Report on Consensus Mechanism: https://drive.google.com/file/d/1eA2NGHqK1Sjfu5mGFAPA5m4gMXb2dlDu/view?usp=sharing
- Community Announcements:
  - https://x.com/unboundedmarket/status/1869394071753498687
  - https://x.com/unboundedmarket/status/1891496342389739949
  - https://x.com/unboundedmarket/status/1982937295436066832
- Feedback Form: https://t.co/6NUlMjopkS
- Close-out Video Link: https://youtu.be/ufjS-IC3JI8

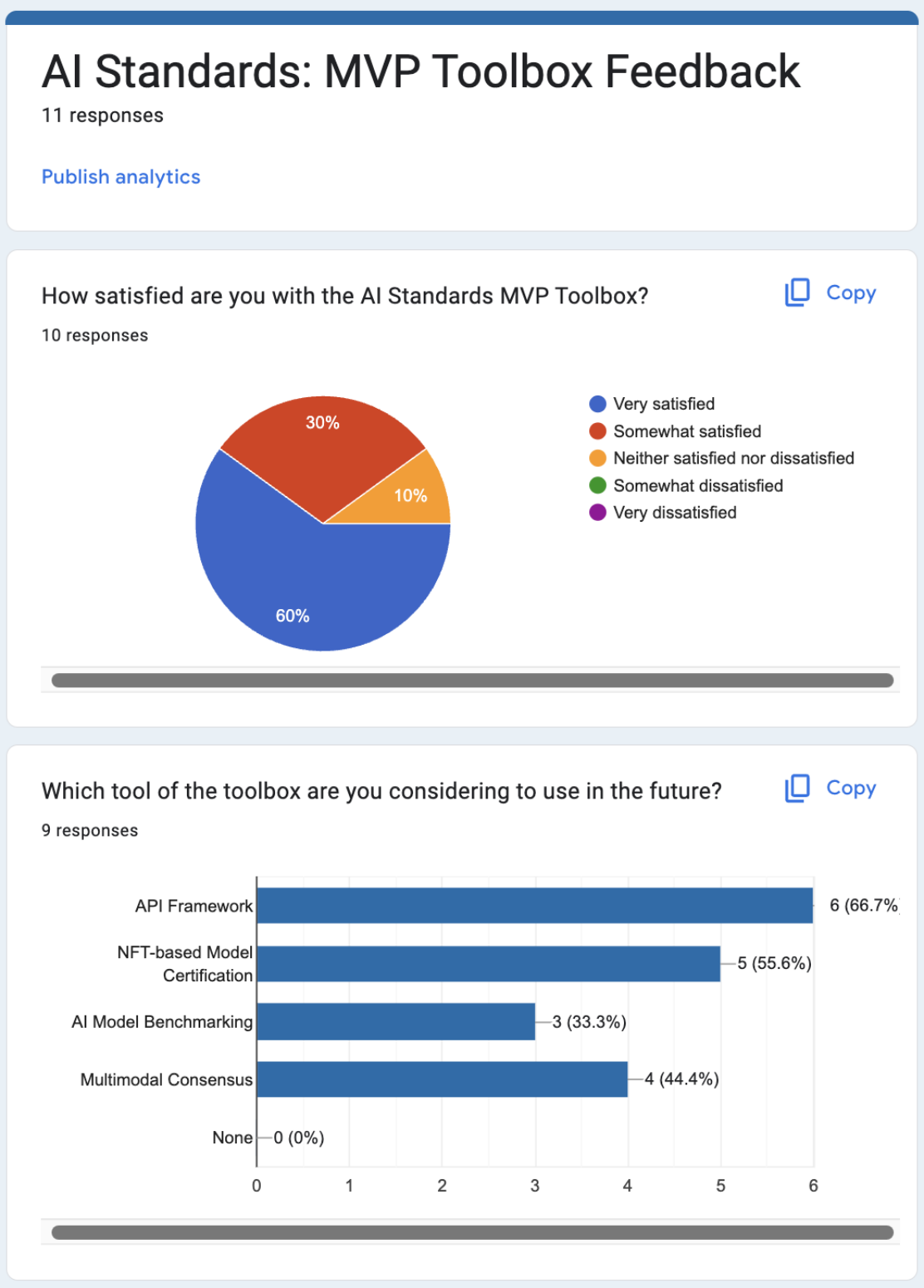

Figure 1: Summary of user satisfaction and intended future use of MVP Toolbox components.

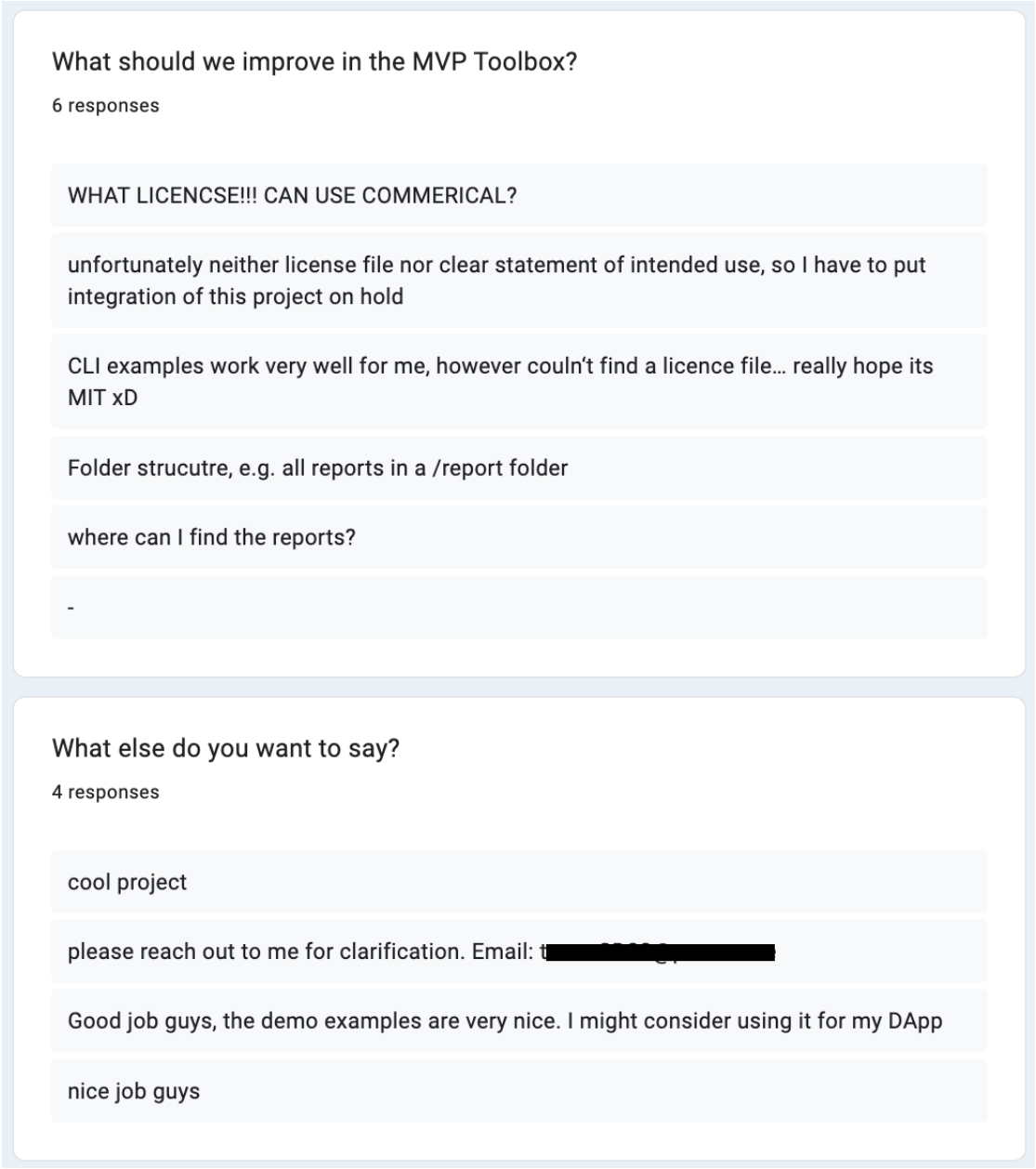

Figure 2: Qualitative feedback highlighting requested improvements to the MVP Toolbox.