Carnegie Mellon University in Qatar

67-404 Blockchain Applications – Fall 2025

Project Proposal

Athar (آثار): Blockchain for Cultural Heritage Preservation

Group Name: Athar

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Instructor

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1. Concept 1-Pager (Problem & Motivation)

Problem

Across the Arabian Gulf, tangible cultural artifacts such as Sadu woven textiles face growing risks of authenticity loss and misattribution. Physical degradation, machine-made reproductions, and the lack of trusted provenance records make it increasingly difficult to verify origin or attribute credit to artisans. Existing archives are fragmented and controlled by single institutions, which limits transparency, auditability, and public trust. In Qatar, there is limited shared digital infrastructure to safeguard these artifacts, putting their accurate preservation and cultural memory at risk.

Users & Stakeholders

- Creators (Artisans): register their works, prove authenticity, gain recognition, and control licensing.
- Validators (Museums, Heritage Guilds): co-sign authenticity to ensure cultural integrity.
- Curators/Licensees: require legitimate, transparent provenance to display or reuse artifacts.
- Public/Researchers: benefit from transparent, verifiable cultural records for education and preservation.

Target Outcomes

- A tamper-evident provenance registry for tangible Sadu artifacts using an EVM testnet.
- Multi-attester verification model (e.g., artisan + institution) to reduce single-oracle risk.
- IPFS integration for decentralized storage of media and metadata.
- A simple non-exclusive licensing flow with transparent royalty splits and revocation events.
- A pilot collection of 10–20 artifacts, with metrics on gas, latency, and usability.

Proposed Solution

Athar leverages EVM smart contracts and IPFS to build a shared, tamper-evident provenance layer for tangible cultural heritage. Each artifact is registered as an ERC-721 token with its IPFS content hash stored on-chain. Institutional validators co-sign authenticity through multi-attester verification, with revoke and dispute events to ensure transparency. Licensing terms are managed through a second contract, enabling non-exclusive licenses with capped royalty splits. This solution ensures provenance is public, auditable, and resilient, bridging traditional craftsmanship with blockchain infrastructure to preserve cultural authenticity.

Scope & Feasibility

The MVP focuses on two smart contracts (Registry and License) deployed on EVM Sepolia, with off-chain media references. By limiting scope to 10–20 artifacts and clearly defining roles (creator, validator, curator), the project remains feasible within the semester timeline while demonstrating decentralization fit, measurable performance, and usability flow.

2. WhyChain Canvas (Athar)

Element	Description
Problem	Tangible heritage artifacts lack trusted provenance; archives are centralized and opaque.
Actors / Users	Creators: Artisans, Validators: Museums / Guilds, Curators: License holder,s Public: Viewers and researchers
Why Blockchain	Provides tamper-evident records and shared authenticity without central control. Smart contracts enable multi-attester verification and transparent licensing.
On-Chain Components	ERC-721 tokens per artifact; creator/validator roles; attest/revoke/license events; royalty cap.
Off-Chain Components	IPFS or equivalent for media and metadata JSON to avoid storage bloat.
Trust & Feasibility	Multi-attester model reduces single-oracle risk; feasible on EVM Sepolia with test keys; no real funds or personal data.

3. Trust Boundaries

Artisans, institutions, and the public do not fully trust each other's records. Blockchain serves as a neutral, auditable ledger for provenance and licensing events, reducing central authority and enforcing transparency through public attestations.

4. On-Chain vs Off-Chain Split

On-Chain (EVM Sepolia)	Off-Chain (IPFS or Equivalent)
ERC-721 token ID per artifact	Media files (images, scans, metadata JSON)
Creator & Validator roles	Detailed metadata and archival content
Content hash or URL reference	Long-term storage
Events: Register, Attest, Revoke, LicenseGrant, LicenseRevoke	–
Licensing terms & royalty splits	–

5. Threats & Mitigations

Threat	Mitigation
Fraudulent artifact claims	Require ≥ 2 validator attestations; revoke/dispute events
Single-validator abuse	Multi-attester model
Storage bloat	Keep media off-chain; store hashes only on-chain
Royalty manipulation / reentrancy	Use pull-payment pattern; cap royalties
Key loss / misuse	Role separation; simulated validator keys for demo

6. Alternatives Considered

- Centralized database: Simple, but single point of control and no shared trust.
- Single-oracle verification: Reduces friction but creates dependency on one validator.
- Multi-attester model on EVM with off-chain media: Balances decentralization, auditability, and feasibility for a Sadu pilot.

7. Success Criteria

- 3-5 tangible Sadu artifacts registered in Sepolia.
- ≥ 2 validator attestations per artifact.
- Register → Verify → License flows fully functional.
- Gas and latency metrics collected (3 runs).
- ≥ 3 usability testers successfully complete core flows.
- Revocation and dispute events are visible and functional on-chain.

8. Chain & Tech Stack

- Blockchain: EVM Sepolia Testnet
- Contracts: AtharRegistry (ERC-721) + AtharLicense (non-exclusive licensing)
- Storage: Off-chain (IPFS or equivalent), on-chain hashes
- Tools: Foundry or Hardhat, OpenZeppelin libraries, Next.js + wagmi + viem for frontend
- The frontend will allow users to connect their wallets, register/view artifacts, and trigger validator attestations or license grants through a simple UI

8. Team Charter

8.1 Team Roles and Responsibilities

Salwa Al-Kuwari: Project Manager & UX/Research Lead

- Coordinates sprint timeline and task assignments.
- Leads concept development, literature review, and documentation.
- Oversees WhyChain Canvas, usability testing, and sprint reports.

Ghalya Al-Eshaq: Smart Contracts Lead

- Designs and implements AtharRegistry (ERC-721) and AtharLicense contracts.
- Handles deployment to Sepolia and unit testing.
- Ensures gas-use tracking and basic security checks.

Hind Almuraikhi: Frontend Developer & Integration Engineer

- Builds the frontend for artifact registration and verification.
- Connects wallet interactions and on-chain calls.
- Tests user flows for readability and responsiveness.

Alfajer Al-Rasheed: QA Engineer & Metrics Analyst

- Leads testing and debugging across smart contracts and UI.
- Collects gas, latency, and usability metrics.
- Documents threat model, alternatives, and success criteria.

8.2 Working Norms & Meeting Cadence

- The team meets once per week on Thursdays at 10:00 AM for sprint progress, planning, and task allocation.
- Members post asynchronous progress or blockers in the WhatsApp group before each meeting.
- Decisions are made by majority vote
- Messages or task updates should be acknowledged within 12 hours.

8.3 Working Norms & Meeting Cadence

A feature or task is marked Done when:

- Code or documentation compiles and passes relevant tests.
- Work is reviewed by at least one teammate.
- Contract is deployed and verified on Sepolia (for dev tasks).
- Documentation and sprint notes are updated.

8.3 Conflict Resolution

- Attempt to resolve issues privately between affected members.
- If unresolved, discuss as a group during the next weekly meeting.
- Persistent issues → report to TA or instructor for mediation.

8.5 Collaboration Standards & Accountability

- All members attend the Thursday meeting unless excused 12 hours in advance.
- Each member contributes code, documentation, or research weekly.
- Pull requests and document edits require peer review before merging or submission.
- Repeated missed deadlines or non-participation are documented and reported after two weeks.

9. Literature Scan

1. **"Blockchain and NFTs in the Cultural Heritage Domain: A Review of Current Research Topics"**
   This paper reviews studies from 2017 to 2022 on how blockchain has been used in cultural heritage. It focuses on applications such as provenance tracking, authenticity, and digital archiving. The authors also point out issues like scalability and storage limitations that affect current systems (Stublić, Bilogrivić, & Zlodi, 2023).

2. **"Blockchain in Cultural Heritage: Insights from Literature Review" (MDPI / Sustainability)**
   Vacchio and Bifulco (2022) identify three main use cases of blockchain in heritage: provenance and authenticity, tokenization and fractional ownership, and rights management. They emphasize that blockchain can re-establish transparency and verifiability in cultural assets but that institutional adoption is still limited.

3. **"HeriLedger – A New Generation of Blockchains for Cultural Heritage"**
   Trček (2022) introduces *HeriLedger*, a blockchain designed specifically for heritage preservation. It focuses on energy efficiency and easier integration with IoT and mobile systems, addressing the technical limitations of general-purpose blockchains when used for cultural preservation.

4. **"Digitalization of Cultural Heritage Through Blockchain"**
   Ilmi et al. (2025) discuss blockchain's role in supporting the digital tourism industry by improving data integrity, authenticity, and sharing across cultural institutions. They note that while blockchain helps manage assets and copyrights, many institutions still face challenges with interoperability and adoption.

9. Literature Scan

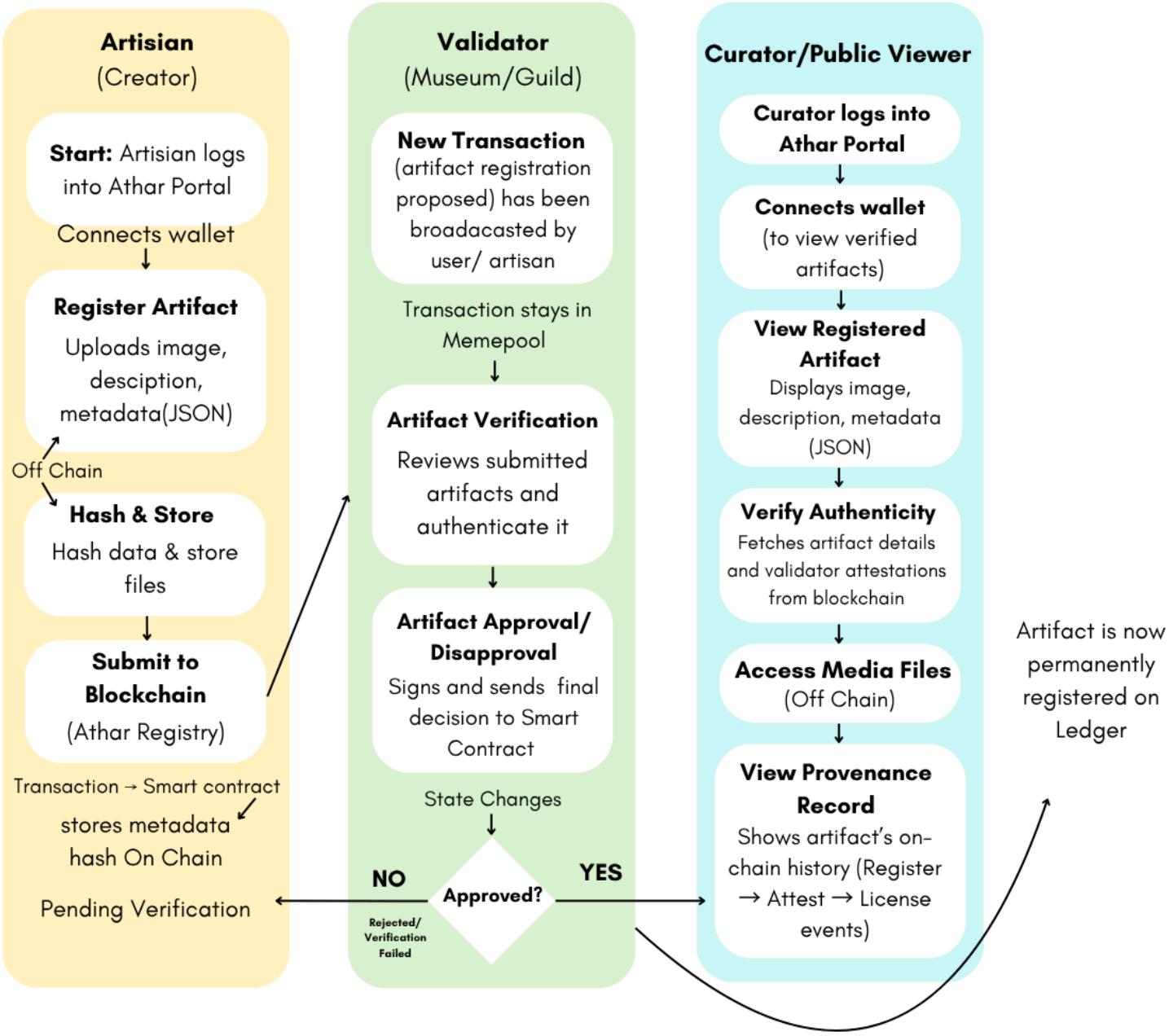
5. **“Cultural heritage preservation by using blockchain technologies”**
   In another work, Trček (2022) presents a blockchain-based architecture for preserving cultural heritage data. The study highlights how distributed ledgers can protect data integrity and ensure long-term access while balancing sustainability and archival reliability.

6. **“Strategizing blockchain adoption in public cultural services”**
   Rubino, Agostino, and Spallazzo (2025) examine how public cultural institutions approach blockchain adoption. They find that while blockchain improves transparency and accountability, implementation is still at an early stage and depends on clear governance strategies and policy support.

Synthesis & Gap:

Across the reviewed studies, blockchain is consistently seen as a tool that can improve how cultural heritage is documented and verified. Most research agrees that it strengthens authenticity, provenance, and transparency, but the actual systems are still experimental and often tested in controlled or institutional settings. A common limitation is that many projects depend on one organization or validator, which reduces decentralization and community participation. There is also very little work focused on local or Gulf-based heritage use cases. Athar builds on these ideas by focusing on a smaller, practical pilot for tangible Sadu artifacts. It introduces a multi-attester model and a simple licensing process to show how blockchain can be applied in a realistic, community-centered way within Qatar’s cultural context.

10 Lo-fi UX/ User Flow



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