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CHESS

Towards Developing a Blockchain Selection Toolkit for Smart Cities

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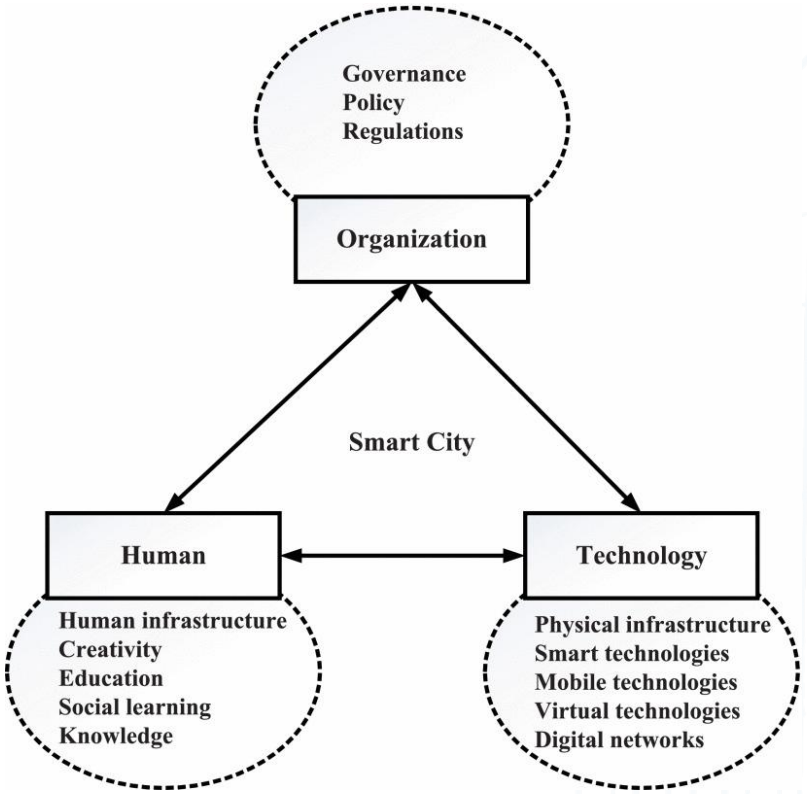
Smart Cities



- Institutional Infrastructure
- Physical Infrastructure
- Social Infrastructure
- Economic Infrastructure

Problem Statement

- Rapid smart city growth creates challenges in resource management & data security.
- Real-world risks: e.g., 2021 Colonial pipeline ransomware, 2023 Lisbon smart meter data breach.
- Research gaps: Lack of cross-domain integration (tech + urban planning).

Contribution

Design and implement a blockchain selection toolkit tailored for smart city contexts.

Based on multi-criteria decision analysis, enables policymakers and system designers to match blockchain solutions with project-specific requirements, bridging the gap between theory and practice.

Research Questions

1. What are the existing blockchain-based applications in smart city domains?
2. How are different blockchain solutions being compared in smart city infrastructure?
3. How can we build a tool to optimize the selection of blockchain technology for smart cities?

Systematic Literature Review

Research question ‘What are the existing blockchain-based applications in smart city domains?’ and ‘How are different blockchain solutions being compared in smart city infrastructure?’ are answered in SLR.

Public Blockchain: Kratos in Education

Purpose:

Secure, transparent educational data management using blockchain.

Blockchain platforms:

Stellar + Ethereum

Smart contracts:

Define and enforce data access rules between schools and edtech providers.

Architecture:

Combines blockchain + InterPlanetary File System + PostgreSQL

Private Blockchain: NAPR Land Registry

Purpose: Secure and transparent land title registration.

Platform: Private blockchain built on Exonum framework.

Consensus: PBFT-like mechanism

Performance: High throughput (up to 5,000 TPS).

Public trust: Reduces fraud and improves efficiency.

Future plans: Smart contracts for leasing & mortgage automation.

Consortium Blockchain: Brooklyn Microgrid

Purpose: Enable decentralized P2P energy trading.

Platform: Consortium blockchain using Tendermint consensus

Smart contracts: Automate energy trade and payment

Efficiency: Low energy cost, low latency, high throughput; Proof-of-Identity used

Privacy: Encrypted, permissioned, and supports anonymous transactions

Challenges of Blockchain Integration in Smart Cities

Security & Privacy

- Public blockchains reveal user data
- Solutions: Temp addresses, zero-knowledge proofs, encryption
- Trade-off: More privacy = Higher latency

Latency & Throughput

- Slow processing & network delays
- Forking causes chain inconsistencies
- Solutions: Nearest-neighbor, acknowledgment-based forks

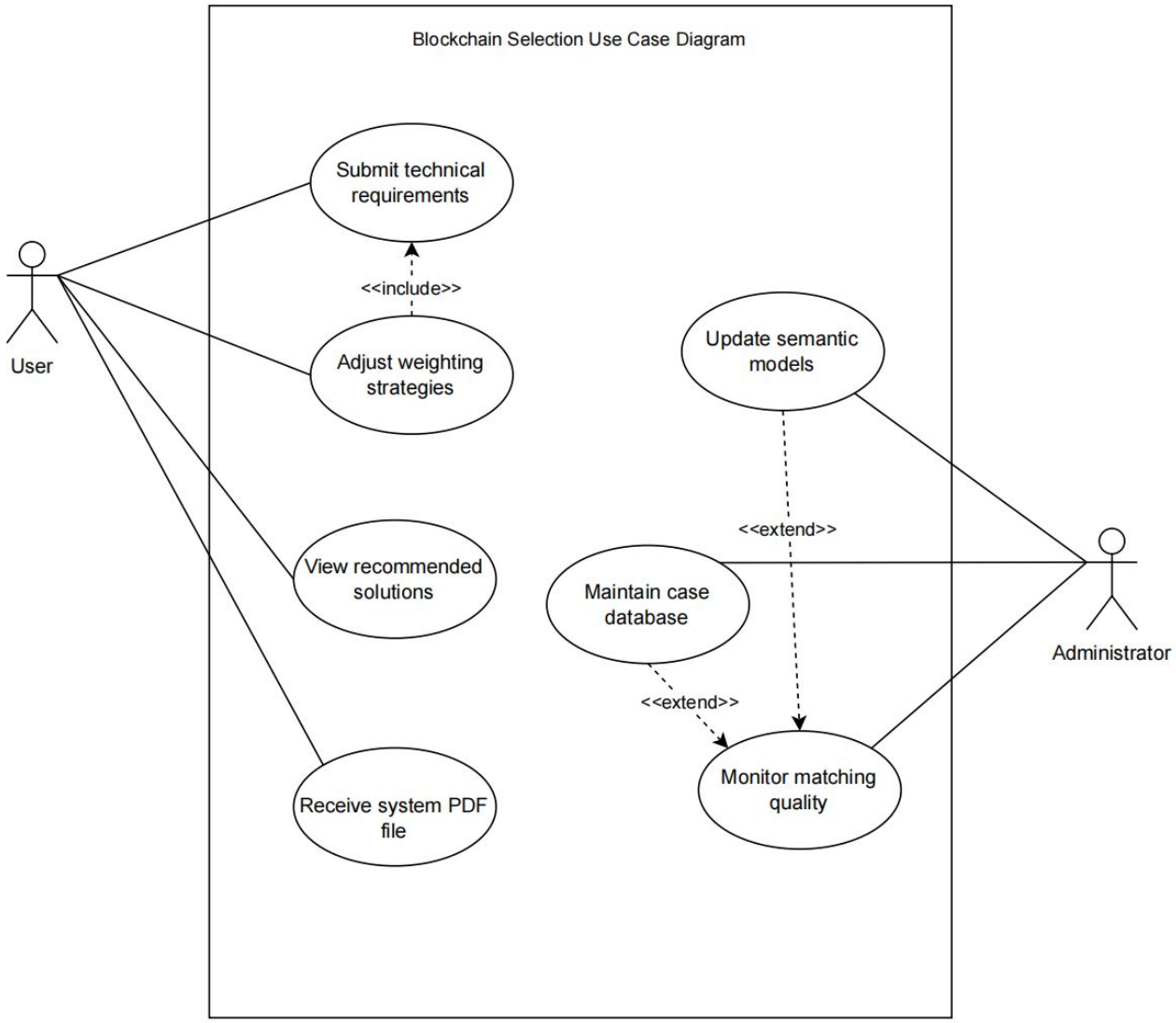
Energy Efficiency

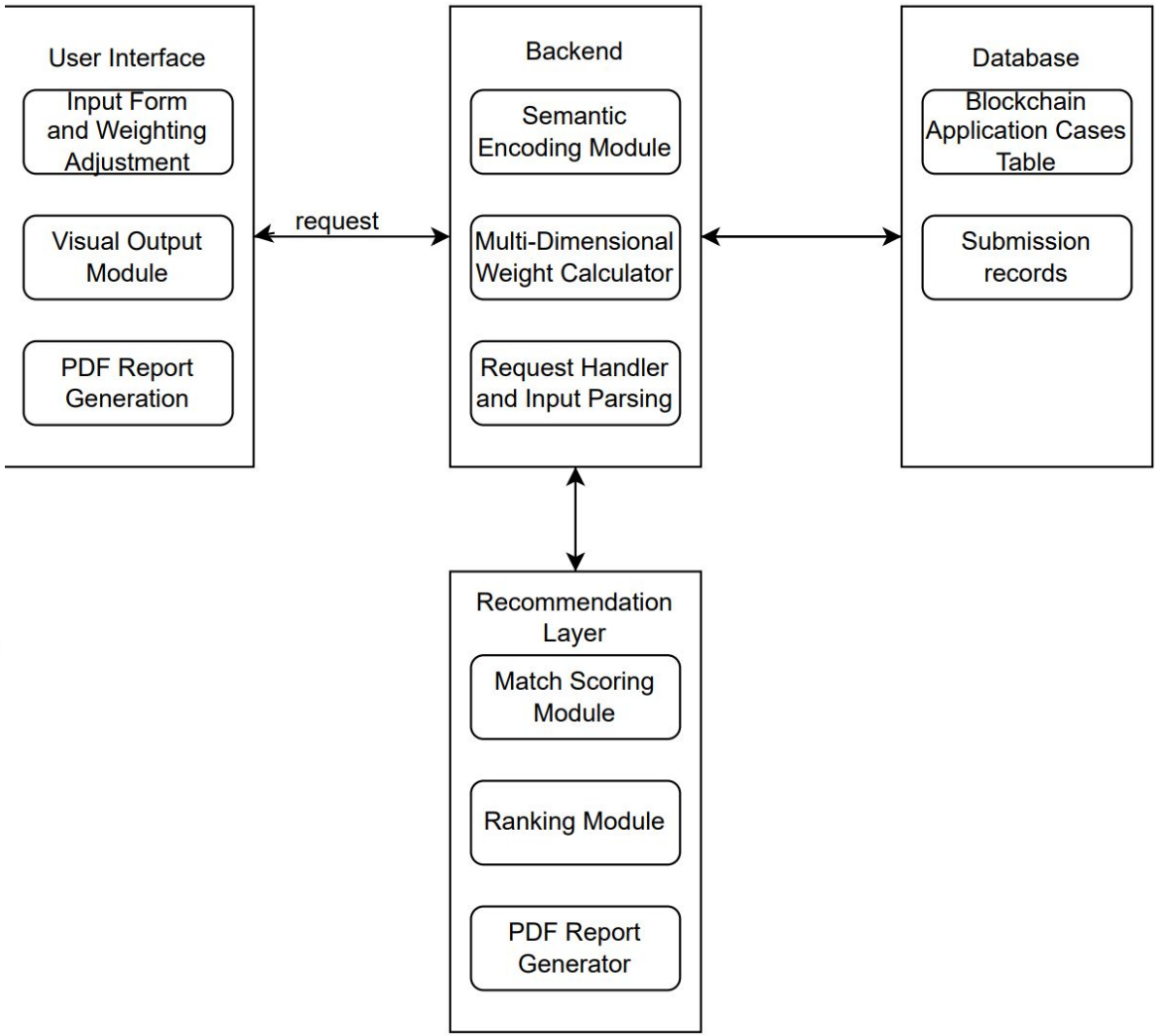
- PoW consumes too much energy
- Alternatives: PoS, DPoS, BFT algorithms
- Emerging: Proof of Trust (early stage)

Toolkit Design & Implementation

Answer research question 3: How can we build a tool to optimize the selection of blockchain technology for smart cities?

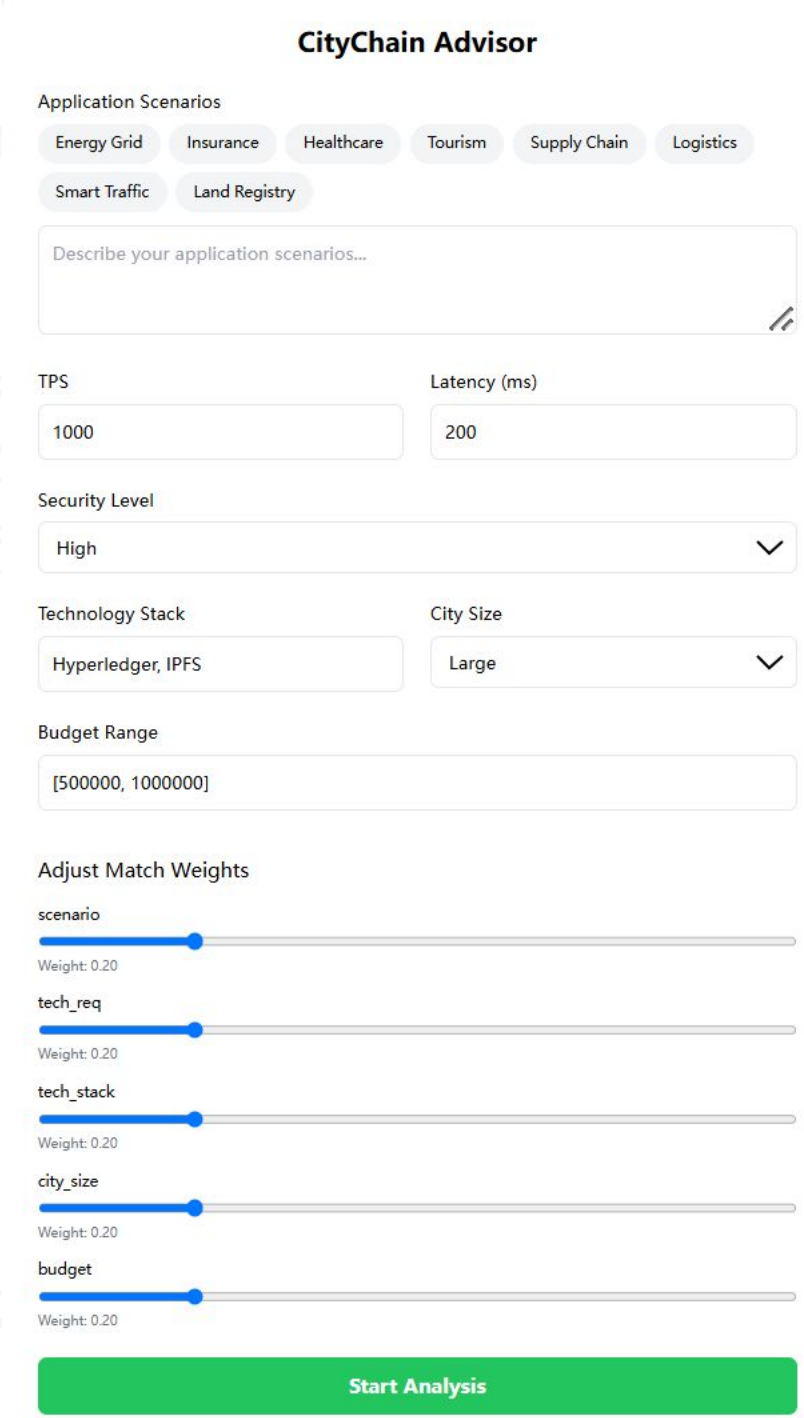
System Design





Implementation

- Built with FastAPI for multi-step decision logic
- NLP module encodes user input into semantic vectors
- Multi-dimensional fuzzy logic handles numeric and qualitative data
- Jaccard distance enables partial and vague input matching
- Ranked results based on similarity scores
- Generates PDF report with explanation of recommendations



Evaluation: Small-Scale Energy Grid

User input:

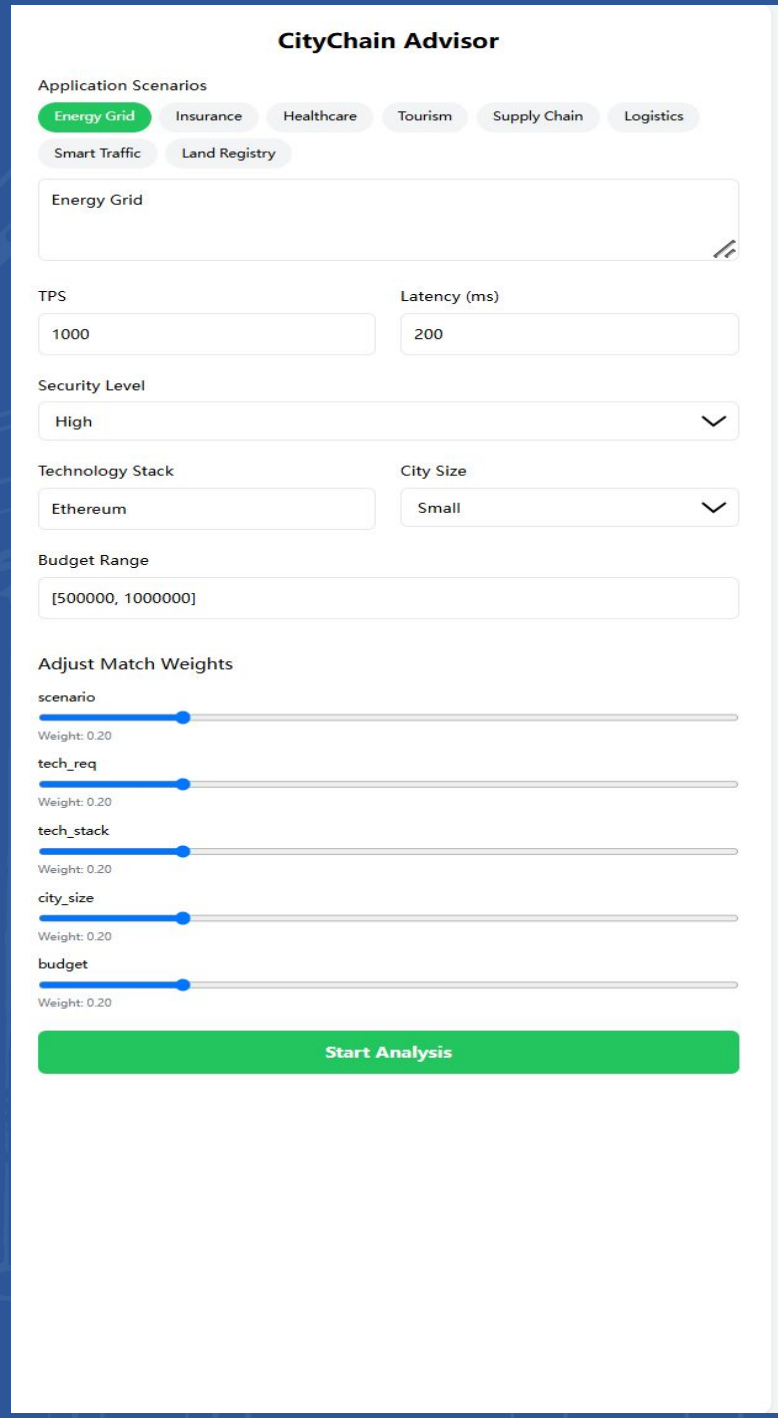
1000 TPS and 200ms latency

High security

Ethereum

Small city size

Budget from $500,000 to $1 million



Evaluation: Large-Scale Supply Chain

User input:

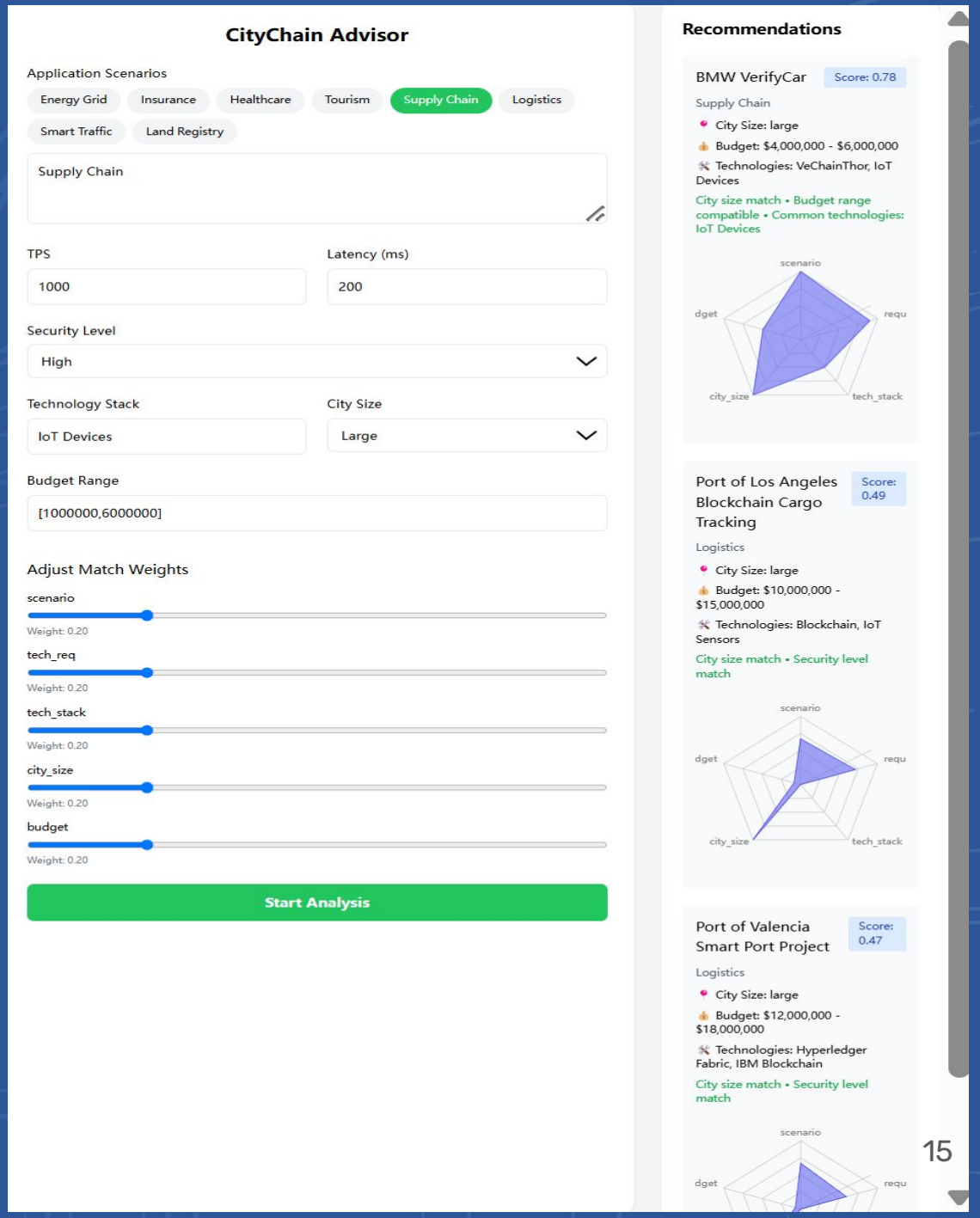
1000 TPS and 200ms latency

High security

IoT Devices

Large city size

Budget from $ 1 million to $ 6 million



Evaluation: Secure Healthcare

User input:

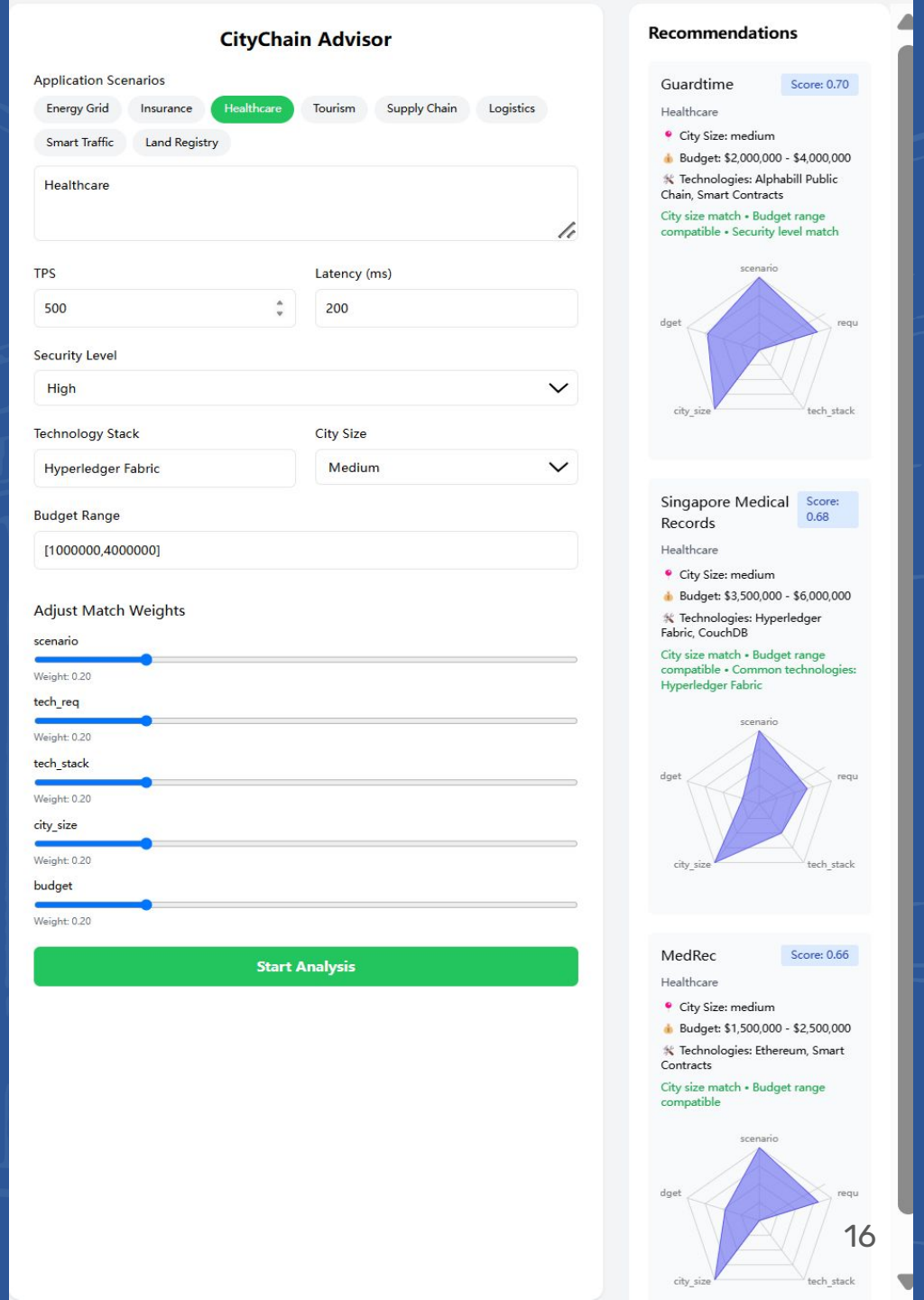
500 TPS and 200ms latency

High security

Hyperledger Fabric

Medium city size

Budget from $ 1 million to $4million



Conclusion

- Design and implement a blockchain selection toolkit for smart city contexts
- A comprehensive and up-to-date systematic survey of blockchain applications in smart cities

Limitations

- Limited case coverage (to expand case diversity)
- Policy compliance not yet quantitatively assessed

Thanks!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