A Comparison of Backend Architectures: Modular Monoliths, Microservices, and Serverless Design Patterns for Mobile Applications

This independent research study aims to provide a comparative analysis of the three backend architectural patterns, modular monoliths, microservices, and serverless, by implementing identical functionality for a campus sustainability mobile application. The research will generate an evidence-based report providing guidance on architecture selection, migration strategies, and performance tradeoffs between the three.

Research Objectives:

1. Implement the same backend services (potentially including user management, sustainability data, location services, analytics, or others) across all three architectures.

2. Document practical migration pathways and hybrid development strategies

3. Collect quantitative data on performance, scalability, and other crucial factors between architectures.

4. Analyze qualitative factors, including ease of development, operational complexity, debugging, and other relevant aspects.

5. Provide a decision framework for architecture selection based on project schema, requirements, and constraints.

Methodology:

This project has five phases:

1. Create a foundation with literature review, feature design, architecture diagrams, and metric designation.

2. Implement 2-3 backend services as modular monoliths with strict boundaries, a shared database, and tests.

3. Extract 2-3 modules into independent microservices with separate deployments and databases, and implement API gateways and service communication

4. Migrate 1-2 services to serverless functions, implement using event-driven architecture, and measure auto-scaling and cold start characteristics for later analysis.

5. Perform systemic performance testing across all implementations with identical workloads, collect quantitative metrics, including but not limited to response times, resources, costs, and qualitative assessments based on development experience and other factors.

Expected Outcomes:

Deliverables include three fully functional backend implementations of 1-2 services, each accompanied by comprehensive tests, quantitative performance and cost data, migration plans, pathway documentation, and a final report that synthesizes architectural decision frameworks based on both quantitative and qualitative findings. The comparative analysis conducted under

controlled conditions of a Mobile App provides practical guidance beyond theory, making it valuable for decision-making in real-world projects and software engineering education.

Research Ethics:

All services and testing will use synthetic data only; No real user information will be collected for this research. Cloud resources will be monitored, and appropriate auto-scaling limits will be enforced. Load testing will only be conducted on internal systems. All code will be original work with proper attribution, and documentation will highlight research methods for full transparency and reproducibility.

Evaluation Criteria

1. Technical quality: implementations of all three architectures contain clean code and comprehensive testing

2. Research rigor: systematic comparison with both quantitative and qualitative analysis, which is synthesized into decision frameworks

3. Educational value: Clear documentation of findings, acknowledgement of project interactions between scope, limitations, practical recommendations, and architectural diagrams, and how they can be transformed for suitable educational use in a broader context.