

ABSTRAK

Transformasi digital pendidikan mendorong penggunaan *Learning Management System (LMS)* sebagai infrastruktur utama pembelajaran dan evaluasi daring. *Moodle* merupakan *LMS* yang banyak digunakan, namun arsitektur monolitiknya menghadapi tantangan saat menerima beban pengguna tinggi, khususnya pada jalur *submit quiz*. Penelitian ini mengusulkan arsitektur *hybrid Microservice* menggunakan *Node.js Grading Service*, yaitu lapisan perantara ringan pada jalur request menuju *endpoint processattempt.php* tanpa mengubah kode inti *Moodle*. Layanan ini menampung *request submit quiz* ke dalam *in-memory queue*, lalu meneruskannya bertahap ke *Moodle* melalui *worker pool* yang dapat dikonfigurasi, sehingga lonjakan *request* dapat diatur alirannya sebelum mencapai sistem utama. Pendekatan ini diposisikan sebagai jalan tengah antara optimasi infrastruktur dan migrasi penuh ke *Microservice*, dan diimplementasikan sebagai *refactoring* parsial menggunakan arsitektur *Hybrid Microservice* dengan pola *Outpost*. Metode yang digunakan adalah *Design Science Research (DSR)*. Pengujian menggunakan *Grafana k6*, membandingkan arsitektur monolitik *baseline* dan *Hybrid* pada beban 50 hingga 300 *virtual users*, dengan metrik *p95 response time*, *error rate*, *throughput*, *CPU utilization*, dan *Process attempt duration*. Hasil penelitian menunjukkan *Node.js Grading Service* berhasil diterapkan sebagai artefak *queue-based load leveling*. Kedua arsitektur mempertahankan *error rate* 0,00% hingga 150 VU, tetapi *p95 response time* melewati *Threshold* sejak 50 VU dan mulai *overload* pada 200 VU ke atas. Arsitektur Hybrid menunjukkan perbaikan terbatas, seperti penurunan *p95 response time* pada 100 VU, namun belum konsisten pada seluruh level beban. Dengan demikian, solusi yang diusulkan layak sebagai *proof-of-concept* pengaturan aliran *request submit quiz Moodle*, tetapi belum cukup meningkatkan performa *Moodle* secara signifikan selama komponen inti, basis data, dan sumber daya host masih digunakan bersama.

Kata Kunci: *Hybrid Microservice, Load testing, Moodle, Node.js, Queue-based load leveling.*

ABSTRACT

Digital transformation has encouraged the use of Learning Management Systems (LMS) for online learning and assessment. Moodle is a widely used LMS, but its monolithic architecture faces challenges under high user load, particularly on the quiz submission path. This study proposes a Node.js Grading Service as the proposed solution: a lightweight intermediary layer inserted into the request path toward `processattempt.php` without modifying Moodle's core code. The service holds quiz submission requests in an in-memory queue, then forwards them gradually to Moodle through a configurable worker pool, regulating request spikes before reaching the main system. The approach is positioned as a middle ground between infrastructure optimization and full migration to Microservice, implemented as a partial refactoring using a Hybrid Microservice architecture with the Outpost pattern. The method used is Design Science Research (DSR). Testing used Grafana k6, comparing monolithic baseline and Hybrid architectures under loads of 50–300 virtual users, with metrics of p95 response time, error rate, throughput, CPU utilization, and Process attempt duration. Results show the Grading Service was successfully implemented as a queue-based load leveling artefact. Both architectures maintained 0.00% error rate up to 150 VU, but response time exceeded the Threshold from 50 VU, overloading from 200 VU onward. The Hybrid architecture showed limited improvements, such as lower response time at 100 VU, but not consistently across load levels. The solution is thus feasible as a proof-of-concept for regulating request flow, but not yet sufficient to improve Moodle's performance while core system, database, and host resources remain shared.

Keywords: Hybrid Microservice, Load testing, Moodle, Node.js, Queue-based load leveling.