

ABSTRAK

Fasilitas *Booster* Mawar yang dikelola oleh PT Tirta Asasta Depok merupakan stasiun pompa pendorong distribusi air bersih untuk menjaga tekanan dan pasokan air bagi pelanggan di wilayah Depok 1 dan Depok Utara, namun operasionalnya masih bergantung pada sistem kendali manual dan jarak pompa yang jauh dari pusat pemantauan sehingga rawan *human error* dan sulit diawasi secara *real-time*. Penelitian ini merancang dan mengimplementasikan sistem otomasi pompa distribusi air menggunakan *Programmable Logic Controller* (PLC) Schneider M221 dengan logika kendali yang disusun melalui metode *State Diagram* berbasis *Finite State Machine* (FSM) tipe *Moore Machine*. Diagram keadaan diuraikan menjadi persamaan Aljabar Boolean untuk variabel bantu dan variabel keluaran, kemudian ditranslasikan ke dalam *Ladder Diagram* guna mengatur operasi tunggal, rotasi otomatis setiap 6 jam, serta mode *cascade* dua pompa saat terjadi beban puncak. Sistem dilengkapi *Human Machine Interface* (HMI) berbasis SCADA FUXA yang terhubung dengan PLC melalui protokol komunikasi Modbus TCP/IP untuk visualisasi data tekanan, status pompa, dan kendali jarak jauh. Hasil pengujian menunjukkan bahwa akuisisi data sensor *pressure transmitter* memiliki tingkat akurasi tinggi dengan *error* 0% pada rentang 0-5 bar, logika *State Diagram* mampu mengeksekusi seluruh transisi status (S0 - S4) secara deterministik tanpa konflik logika, serta komunikasi Modbus TCP berjalan stabil dengan latensi rata-rata 2,8 ms dan *packet loss* 0% untuk fungsi monitoring. Namun, fungsi kendali jarak jauh (*remote control*) dari SCADA mengalami kegagalan penulisan data (*TransactionTimedOutError*) akibat pembatasan hak akses (*security privilege*) pada *firmware* PLC, sehingga SCADA FUXA saat ini hanya berfungsi sebagai terminal pemantauan pasif (*read-only*). Penelitian ini menyimpulkan bahwa metode *State Diagram* efektif menghasilkan logika kendali pompa yang terstruktur dan andal, sementara integrasi SCADA FUXA memerlukan penyesuaian konfigurasi keamanan PLC agar fungsi kendali jarak jauh dapat direalisasikan secara penuh.

Kata Kunci: Otomasi Pompa, PLC Schneider M221, *State Diagram*, FSM *Moore Machine*, SCADA FUXA, Modbus TCP/IP

ABSTRACT

The Mawar Booster Facility, managed by PT Tirta Asasta Depok, is a distribution water booster pump station designed to maintain water pressure and supply for customers in the Depok 1 and Depok Utara areas. However, its operation still relies on a manual control system and the pumps are located far from the monitoring center, making it susceptible to human error and difficult to monitor in real time. This study designs and implements an automated distribution pump system using a Schneider M221 Programmable Logic Controller (PLC) with control logic structured via the State Diagram method based on a Moore-type Finite State Machine (FSM). The state diagram is reduced into Boolean Algebra equations for auxiliary and output variables, which are then translated into a Ladder Diagram to manage single-pump operation, automatic 6-hour rotation, and two-pump cascade mode during peak demand. The system is equipped with a FUXA SCADA-based Human Machine Interface (HMI) connected to the PLC via the Modbus TCP/IP communication protocol for pressure data visualization, pump status monitoring, and remote control. Test results demonstrate that the pressure transmitter sensor data acquisition achieves high accuracy with 0% error within the 0–5 bar range. Furthermore, the State Diagram logic successfully executes all state transitions (S0–S4) deterministically without logical conflicts, and Modbus TCP communication operates stably with an average latency of 2.8 ms and 0% packet loss for monitoring functions. However, the remote control function from SCADA experienced write data failure (TransactionTimedOutError) due to security privilege restrictions on the PLC firmware; thus, FUXA SCADA currently functions solely as a passive (read-only) monitoring terminal. This study concludes that the State Diagram method effectively produces structured and reliable pump control logic, while full realization of SCADA FUXA remote control integration requires adjustment of the PLC security configurations.

Keywords: Pump Automation, Schneider M221 PLC, State Diagram, Moore State Machine, FUXA SCADA, Modbus TCP/IP