BAB V
KESIMPULAN DAN SARAN

V.1 Kesimpulan

Berdasarkan hasil penelitian dan pembahasan yang telah diuraikan, dapat ditarik kesimpulan sebagai berikut.

1. Karakteristik spasial jaringan rute eksisting BST Kota Surakarta menunjukkan pola yang terkonsentrasi di koridor utama kota dengan tingkat redundansi layanan yang tinggi. K3 memiliki panjang rute 18,552 km dengan cakupan populasi 120.849 jiwa dan aksesibilitas fasilitas 121 unit, namun nilai *overlap* mencapai 9,563 km² atau 96,34% dari total area layanannya mengindikasikan bahwa hampir seluruh area layanan K3 sudah dilayani koridor lain. K4 memiliki panjang rute 21,155 km dengan cakupan populasi 86.858 jiwa dan aksesibilitas fasilitas 72 unit, dengan nilai *overlap* 6,147 km² atau 66,55% dari total area layanannya. Kondisi ini diperkuat oleh *load factor* K3 dan K4 yang masing-masing tercatat 0,4921 dan 0,3637 pada Juni 2025 keduanya jauh di bawah standar minimum 0,70.
2. Pembobotan kriteria spasial menggunakan AHP menghasilkan bobot W = (0,0750; 0,4072; 0,4394; 0,0784) untuk kriteria C1 hingga C4 dengan nilai *Consistency Ratio* sebesar 0,0048 yang jauh di bawah ambang batas 0,10. Dominasi bobot pada C3 aksesibilitas fasilitas (0,4394) dan C2 cakupan populasi (0,4072) mencerminkan bahwa para ahli transportasi Kota Surakarta memprioritaskan peningkatan jangkauan layanan kepada masyarakat dibanding minimalisasi jarak dan pengurangan *overlap*. Evaluasi kinerja rute eksisting menggunakan *Weighted Sum Model* (WSM) dengan bobot AHP yang sama menghasilkan skor K3 = 0,9720 dan K4 = 0,6983, yang menjadi *baseline* perbandingan terhadap rute optimal.
3. Algoritma ACO dengan parameter optimal S5 (α=1,0, β=3,5, ρ=0,15) berhasil menghasilkan rute optimal K3 dan K4 yang menunjukkan peningkatan kinerja dibanding rute eksisting. K3 Berangkat meningkat dari fitness 0,4643 menjadi 0,5381 (+15,9%) melalui penambahan 5 halte baru dari K12, K3 Pulang meningkat dari 0,4519 menjadi 0,4960 (+9,8%) melalui penambahan 1 halte baru dari K2, dan K4 meningkat dari 0,4262 menjadi 0,5252 (+23,2%) melalui penambahan 1 halte baru dari K7. Secara spasial,

rute optimal K3 meningkatkan cakupan populasi sebesar +6,1% dan aksesibilitas fasilitas sebesar +7,4%, sedangkan rute optimal K4 berhasil mengurangi overlap sebesar -1,5% meskipun cakupan populasi dan fasilitas sedikit menurun akibat karakteristik geografis koridor. Evaluasi WSM mengkonfirmasi peningkatan tersebut; skor rute optimal K3 meningkat menjadi 1,0213 (+5,07%) sedangkan K4 mengalami penurunan marginal menjadi 0,6942 (-0,59%).

V.2 Saran

Berdasarkan hasil penelitian ini, beberapa saran dirumuskan sebagai berikut.

1. Hasil optimasi rute ini perlu dikomunikasikan kepada Dinas Perhubungan Kota Surakarta, PT Bengawan Solo Trans, dan PT Transportasi Global Mandiri sebagai bahan pertimbangan dalam evaluasi jaringan BST, mengingat peningkatan cakupan layanan yang dihasilkan berpotensi mendorong peningkatan penumpang secara bertahap.
2. Peningkatan *load factor* BST tidak dapat dicapai hanya melalui optimasi rute, sehingga perlu diimbangi dengan strategi peningkatan permintaan seperti integrasi moda, penguatan sistem informasi penumpang, dan kebijakan pembatasan kendaraan pribadi di kawasan yang dilayani BST.
3. Implementasi rute optimal K3 Berangkat perlu mempertimbangkan secara cermat catatan teknis dari validator ahli, yaitu: (1) segmen Jalan Saman Hudi (halte id=5, 6, 7, 8) dengan lebar jalan 6,8–7 meter yang tergolong sempit untuk operasional bus sedang BST, dan (2) halte id=15 yang tidak sesuai dengan konsep directness rute dan tidak tersedia ruang U-turn yang memadai. Untuk rute optimal K3 Pulang dan K4, perlu dilakukan kajian ulang terhadap segmen-segmen yang belum sepenuhnya memenuhi konsep directness sebelum diimplementasikan secara operasional.
4. Penelitian lanjutan disarankan mengintegrasikan parameter teknis operasional yang lebih komprehensif dalam fungsi optimasi, mencakup indeks *directness* rute, lebar dan kapasitas infrastruktur jalan, serta kemampuan manuver kendaraan sebagai *constraint* tambahan, sehingga rute yang dihasilkan tidak hanya optimal secara multi-kriteria spasial tetapi

juga layak secara teknis untuk diimplementasikan langsung oleh operator BST.

5. Penelitian lanjutan disarankan menggunakan data perjalanan aktual penumpang BST sebagai pengganti pendekatan cakupan spasial populasi, sehingga fungsi tujuan optimasi dapat lebih akurat mencerminkan pola pergerakan nyata pengguna.
6. Pengembangan model optimasi pada penelitian selanjutnya dapat mempertimbangkan optimasi jaringan BST secara keseluruhan (seluruh 10 koridor) secara simultan, bukan per koridor secara independen, agar solusi yang dihasilkan optimal secara jaringan dan mempertimbangkan interaksi antar koridor melalui perubahan pola overlap dan cakupan layanan.
7. Pengembangan model optimasi pada penelitian selanjutnya dapat mempertimbangkan penggunaan varian ACO lainnya seperti *Max-Min Ant System* (MMAS), *Ant Colony System* (ACS), atau *Rank-Based Ant System* (RAS) yang memiliki mekanisme eksplorasi dan eksploitasi berbeda dibanding *Ant System* (AS) yang digunakan dalam penelitian ini, sehingga dapat dibandingkan kualitas solusi dan efisiensi komputasinya dalam konteks optimasi rute angkutan umum.

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