BAB V
KESIMPULAN DAN SARAN

A. Kesimpulan

Berdasarkan hasil implementasi, pengujian, dan pembahasan yang telah diuraikan pada BAB IV, dapat ditarik beberapa kesimpulan sebagai berikut:

1. Arsitektur *Hybrid Retrieval-Augmented Generation* (RAG) yang mengombinasikan pencarian vektor semantik *TiDB Serverless*, pencarian leksikal BM25, *Reciprocal Rank Fusion* (RRF), dan jalur *Fast Path* SQL berhasil dikembangkan dan diintegrasikan ke dalam platform website Auto2000 Rantauprapat (toyota-rantauprapat.vercel.app) sebagai pengganti metode *static prompt-based knowledge injection*, sesuai dengan tujuan penelitian pertama.
2. Hasil evaluasi DeepEval terhadap 25 skenario kasus uji menunjukkan skor rata-rata keseluruhan sebesar 0,8679 (86,79%), dengan skor *Faithfulness* sebesar 1,00 pada seluruh skenario, yang mengindikasikan bahwa sistem yang dikembangkan cukup efektif dan akurat dalam merespons *input* bahasa alami pengguna, serta menunjukkan risiko halusinasi informasi yang rendah pada skenario yang diuji, sesuai dengan tujuan penelitian kedua.
3. Pengujian *Black Box* terhadap 31 skenario fungsional, terdiri atas 18 skenario modul konsumen dan 13 skenario modul admin, menghasilkan *pass rate* 100%, yang menunjukkan bahwa seluruh fitur sistem berfungsi sesuai dengan spesifikasi rancangan pada kedua sisi antarmuka.
4. Evaluasi *System Usability Scale* (SUS) terhadap 15 responden menghasilkan skor rata-rata 85,67 yang berada pada kategori *Excellent*/*Grade* A, berada di atas ambang batas standar industri sebesar 68, sehingga mengindikasikan tingkat penerimaan yang baik terhadap kemudahan penggunaan sistem oleh responden yang terlibat dalam pengujian.
5. Penelitian ini juga menemukan sejumlah keterbatasan, yaitu *trade-off* antara granularitas *chunking* dokumen dengan kelengkapan konteks jawaban yang memengaruhi skor *Contextual Relevancy*, serta keterbatasan mekanisme

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retrieval dalam menjaring seluruh entitas pada kueri kategori luas dan dokumen kebijakan lintas produk, yang menjadi dasar bagi saran pengembangan lebih lanjut.

6. Secara keseluruhan, penelitian ini berhasil menjawab rumusan masalah yang diajukan, yaitu mengembangkan asisten digital pada website Auto2000 Rantauprapat dari metode *static prompt-based knowledge injection* menjadi sistem berbasis arsitektur *Hybrid* RAG melalui penerapan mekanisme retrieval hibrida yang mampu menghasilkan rekomendasi mobil Toyota yang faktual dan menekan tingkat halusinasi informasi, sehingga sistem ini menunjukkan potensi untuk dikembangkan lebih lanjut sebagai alat bantu konsultasi produk di lingkungan Auto2000 Rantauprapat.

B. Saran

Berdasarkan kesimpulan serta keterbatasan yang ditemukan selama penelitian sebagaimana diuraikan pada sub-bab Pembahasan, berikut disampaikan beberapa saran untuk pengembangan lebih lanjut:

1. Bagi Auto2000 Rantauprapat

   Perusahaan disarankan untuk melakukan peningkatan dari Gemini API *Free Tier* ke tingkat layanan berbayar (*Paid Tier*) sebelum sistem diimplementasikan pada skenario produksi dengan volume pengguna bersamaan (*concurrent users*) yang tinggi. Pembaruan data basis pengetahuan (*knowledge base*), khususnya harga *On The Road* (OTR) dan spesifikasi kendaraan, perlu dilakukan secara berkala mengikuti siklus pembaruan resmi dari Toyota untuk menjaga akurasi rekomendasi. Selain itu, perusahaan dapat mengintegrasikan fitur simulasi kredit secara langsung di dalam antarmuka obrolan (*chatbot*). Fitur ini akan membantu calon pelanggan menghitung estimasi uang muka (*down payment*) dan angsuran bulanan secara mandiri dan interaktif, sehingga mempercepat proses pengambilan keputusan pembelian.

2. Bagi Peneliti Selanjutnya

   Penelitian selanjutnya disarankan untuk melakukan pengujian beban (*load testing*) guna mengukur ketahanan sistem pada skenario multi-

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pengguna (*multi-user*) secara bersamaan, mengingat penelitian ini masih dibatasi pada skenario pengguna tunggal. Perluasan cakupan *knowledge base* untuk mencakup data mobil bekas, analisis depresiasi nilai jual, maupun fitur transaksional seperti simulasi kredit *real-time* juga dapat menjadi arah pengembangan berikutnya. Dari sisi teknis, eksplorasi strategi *chunking* atau model *embedding* alternatif disarankan untuk meningkatkan skor *Contextual Recall* yang belum optimal pada beberapa skenario uji. Selanjutnya, evaluasi *usability* disarankan melibatkan responden dari kalangan calon konsumen langsung, guna memperkuat validitas eksternal dari hasil pengukuran *System Usability Scale* yang telah diperoleh. Terakhir, dari sisi metode evaluasi, penelitian selanjutnya disarankan untuk mengombinasikan metrik berbasis DeepEval dengan pendekatan evaluasi tambahan misalnya penilaian berbasis rubrik manual (*human judgment*) atau metrik klasifikasi khusus (*precision/recall* terhadap kueri *out-of-scope*) guna menghasilkan penilaian yang lebih representatif terhadap kualitas penolakan kueri di luar cakupan (*negative rejection*) pada penelitian RAG serupa di masa mendatang.

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