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ASKIGNITE: AI-POWERED SMART GIS AGENT

PROJECT TEAM

Land Transport Authority

Eddie Lim
Matthew Ong
Ming Le Soh
Yanzhang Shi
Gerald Tan

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Geographic Information Systems (GIS) technology is vital for LTA's mission of connecting people and places. LTA frequently needs to answer critical "Where?" questions (e.g., "Where are potholes requiring rectification?" or "Where are pedestrian bridges needing lift retrofitting?"). These directly impacts public service delivery and the commuter experience.

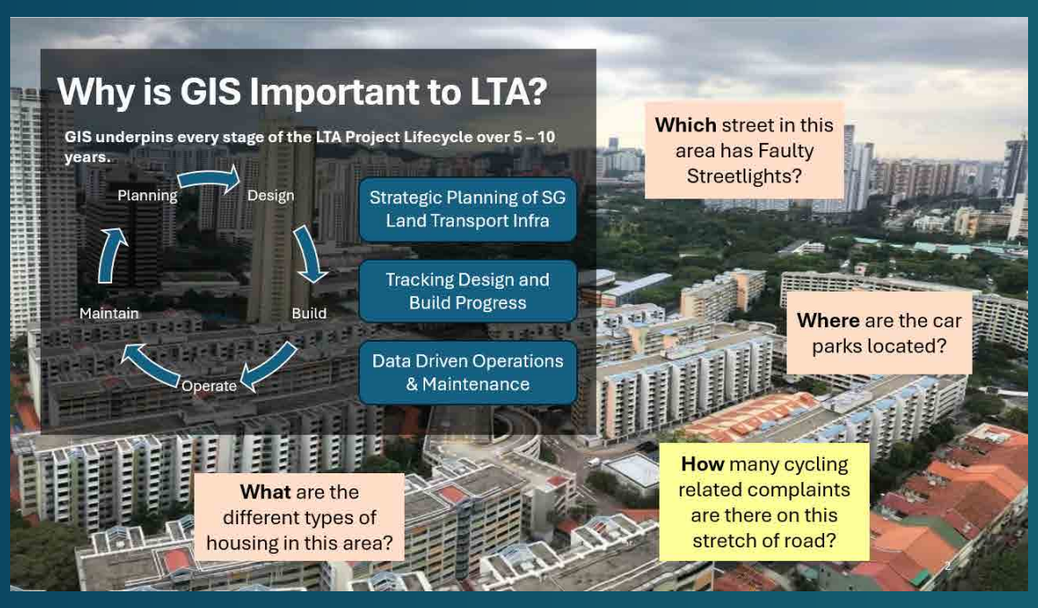

Figure 1: Importance of GIS technology in LTA

Figure 2: Key domains in LTA

<u>The Challenge:</u>

While the questions are simple, obtaining answers presents pain points. The complexity of GIS tools and the specialised knowledge needed to perform overlaying and spatial analysis creates a barrier for many staff, hindering quick access to these crucial answers and insights.

<u>GIS Impact on LTA: GIS profoundly transforms LTA's work. It empowers:</u>

- Strategic Planning & Development: Optimizing routes and infrastructure placement.
- Efficient Operations & Maintenance: Managing assets like roads and signals, and responding to incidents effectively.
- Enhanced Commuter Experience: Ensuring safety, accessibility, and better travel information.
- Data-Driven Decisions: Providing the spatial intelligence for better policy and resource allocation.

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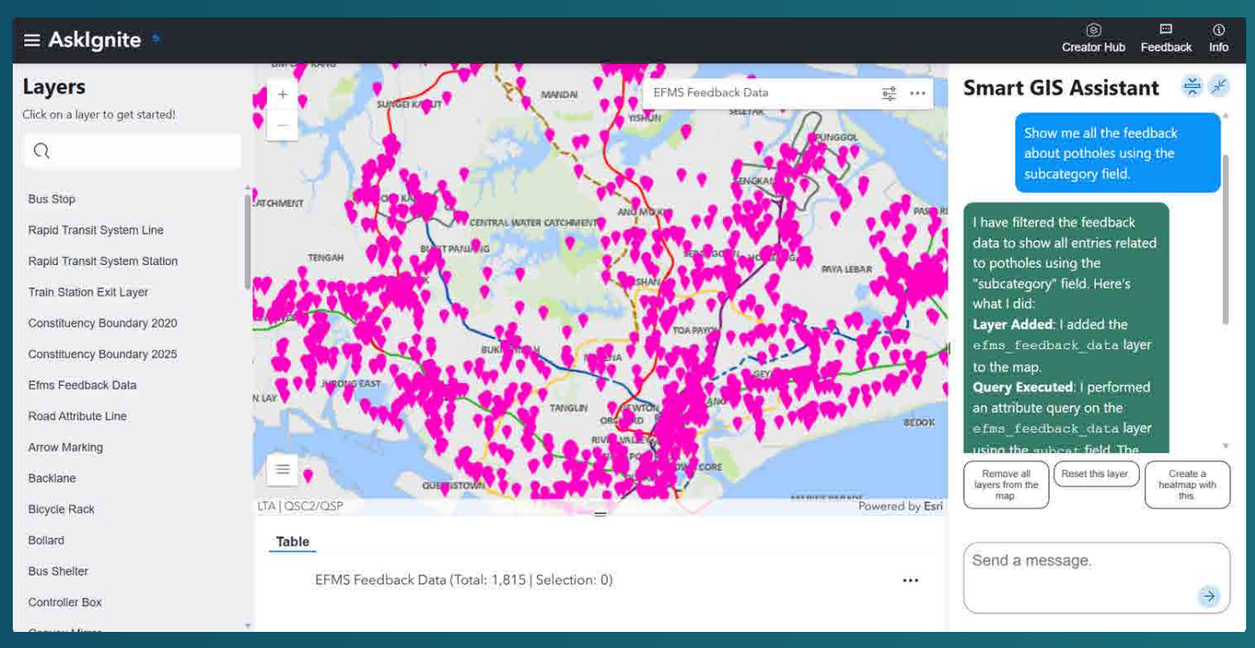

Figure 3: AskIgnite, AI-powered GIS Chatbot Interface

AskIgnite, our AI-powered GIS Chatbot aims to lower the barriers of entry to GIS and make it a ubiquitous tool that any officer can use just by talking to a chatbot in natural language. Interacting with a chatbot to perform GIS-related queries is much easier than navigating the steep learning curve of mastering GIS and its complex tools and terminologies. AskIgnite thus simplifies the process, making GIS accessible to everyone without the need for extensive training and allows us to find answers to improve public service delivery, work efficiency, better work experience, and encourage digitalisation.

This project was entirely developed in-house with two Software Engineers, a Cloud Engineer and an IT System Analyst. All have worked on this initiative on a part-time basis over the course of 1 year.

The operational expenditure (OPEX) for this application comes to only S$1,300 ($1000 USD) per month. This cost covers both cloud hosting as well as Large Language Model (LLM) utilisation.

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Using this application also reduces the need for Desktop Clients such as ArcGIS Pro and its related licensing costs of S$2,000 per license. Based on the 1,000 active GIS users on our Ignite platform, this works out to a potential cost saving of S$2 million.

Need:
LTA relies on Geographic Information Systems (GIS) to answer critical questions that impact customer service, and AskIgnite, our AI-powered GIS Chatbot, simplifies the process by allowing users to perform GIS-related queries through natural language interactions, making GIS accessible to everyone without extensive training.

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EXTENT OF INNOVATIVENESS

The team was exploring how we can leverage the advent of Generative AI in the realm of GIS. By integrating Generative AI, it provides a new, simplified and easy interface to using GIS. By lowering the barrier to entry to using the power of GIS, we have seen a raise in user interest in implementing GIS in their work.

Demand for this project is evident as seen from the proactive engagement from Planning, TRO, IDE, RCID and several other departments who are eager to understand its implementation and potential benefits. This unsolicited interest from a substantial portion of our potential user base highlights the unmet need this initiative addresses and supports the necessity of the proposed increment.

Traditionally, using GIS (e.g., ArcGIS Pro) demanded specialized knowledge. Users needed to learn technical skills for spatial and attribute queries, data manipulation, and visualization, creating a significant barrier for non-experts.

Our initiative leverages Generative AI to bridge this gap. Users can now perform key GIS tasks using natural language commands, eliminating the need for extensive GIS software training.

(1) **Current Capabilities: The system currently translates plain language requests into:**

- Spatial queries (e.g., "find features within this area")
- Attribute queries (e.g., "show all sites with 'X' characteristic")
- Heatmap visualizations

(2) **Benefit: This significantly lowers the entry barrier for these common GIS tasks, allowing more users to derive insights from spatial data quickly.**

The idea emerged as Generative AI's capabilities in understanding language and intent became apparent. We recognized an opportunity to apply this to simplify GIS, starting with core functionalities like querying and basic visualization, which are common pain points for new users.

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Previously, the main obstacle blocking such an initiative was the lack of powerful language interpretation technology. Previous AI and Natural Language Processing (NLP) tools lacked the accuracy to reliably interpret natural language and translate it into complex GIS operations, even for foundational tasks like those currently supported. The recent advancements in Generative AI have made this direct, intuitive interaction feasible for the first time.

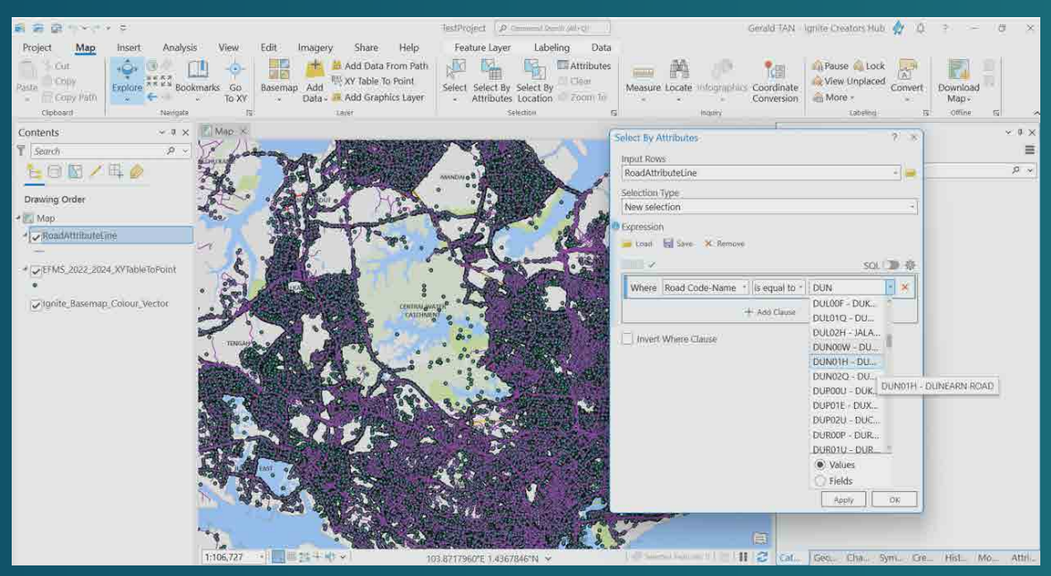

Figure 4: Complex user interface in ArcGIS Pro

Generative AI powered chatbots are ubiquitous today with the ability to synthesise information and generate answers mostly in a textual format. AskIgnite is a pioneering and groundbreaking innovation and takes this multiple steps further. It is not only able to provide GIS knowledge and technical assistance through text, but it is also able to perform spatially enabled actions, e.g. filtering through geospatial data attributes, spatial information, or temporal (time-related) data fields. This powerful capability is especially multiplied when it finds relationships across multiple data layers instead of in isolation.

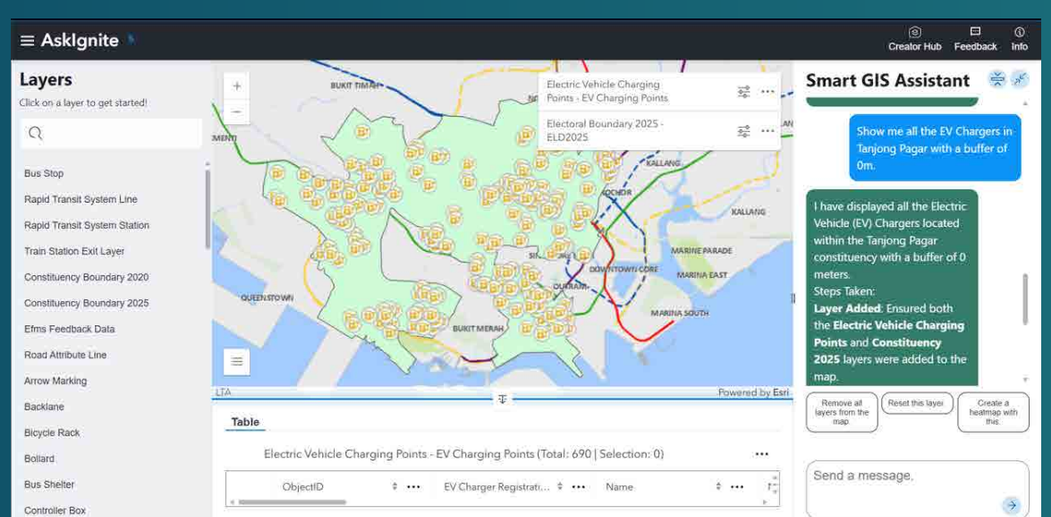

Figure 5: Finding all the EV Chargers in Tanjong Pagar GRC using the 2025 Electoral Boundary

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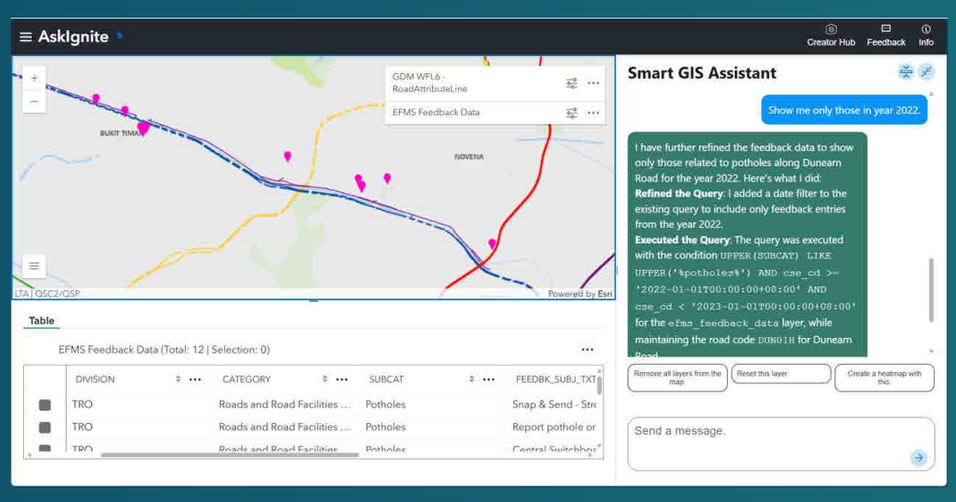

Figure 6: Finding feedback about Potholes along Dunearn Road in the year 2022.

AskIgnite can support various ongoing LTA operations in the real-world such as finding out where are the:

(1) Electric Vehicle Chargers are in any given Constituency

(2) Pothole related feedback along a given road across any given time period

(3) Hotspots related to Illegal Parking Feedback

(4) The Bus Stops, Bicycle Racks and Cycling Paths within 200m of an MRT Station for last mile connectivity.

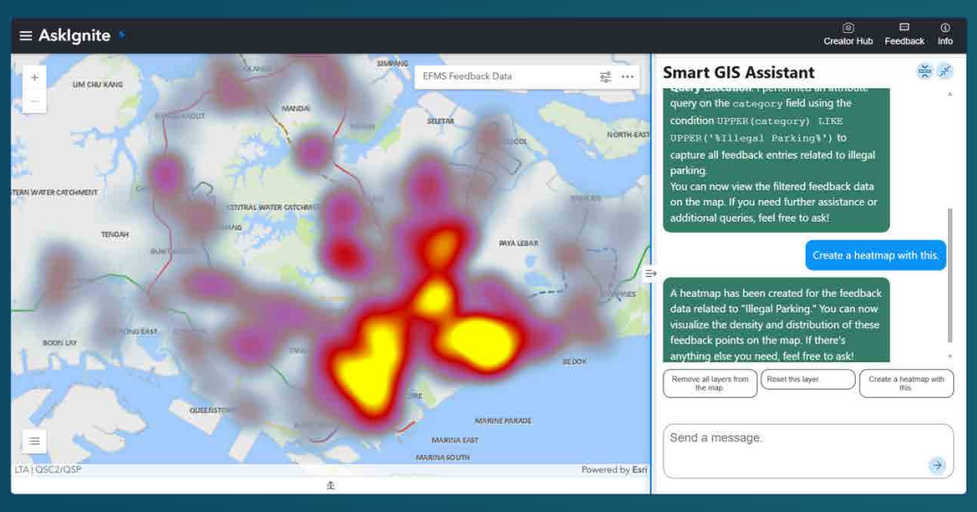

Figure 7: Generating a Heatmap for Hotspots related to Illegal Parking Feedback

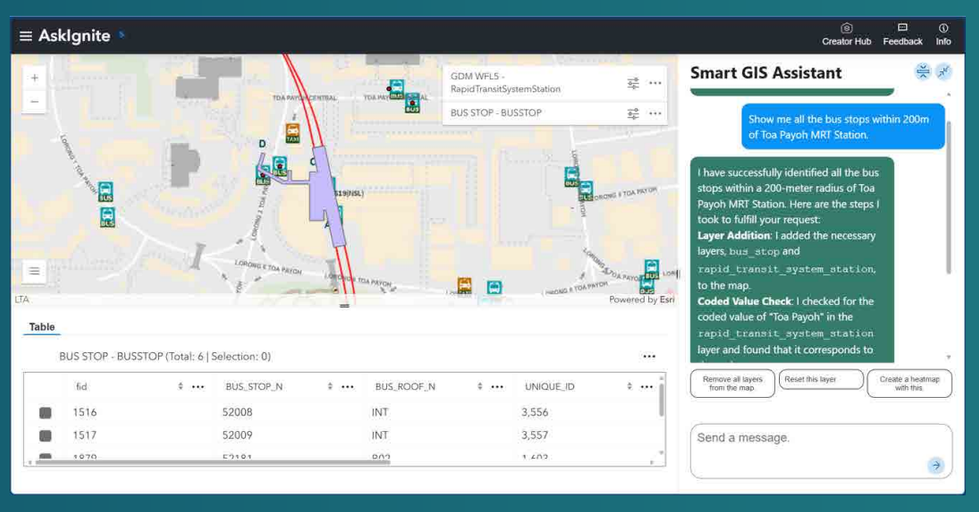

Figure 8: Bus Stops within 200m of Toa Payoh MRT

To date, there has not been a more comprehensive and fully-fledged GIS chatbot product deployed at a large scale to serve more than 7000 staff in the public and commercial domain.

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EXTENT OF INNOVATIVENESS

The initial development of the project was challenging as it was difficult to train a LLM to discern intents and perform actions on behalf of a user, particularly GIS related actions that are returned to a user in the form of data on a map. There were few successful case studies and examples in the industry and even little to none pertaining to GIS. There were also issues regarding these LLMs only being hosted overseas and restrictions on the sensitivity of data sent to it.

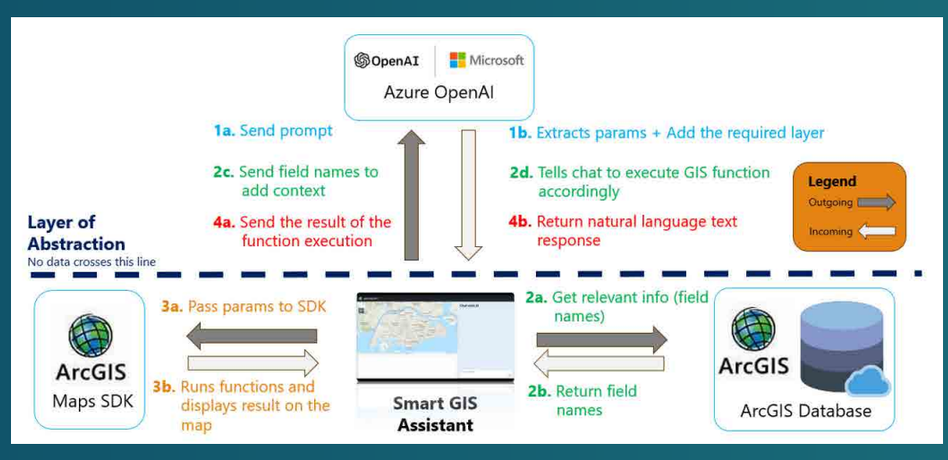

Figure 9: High Level Architecture Diagram

After trying many different architectural iterations and solutions, the team successfully architected a way to support two-way communication between an overseas-based LLM to generate the GIS content and related query parameters, and a locally hosted GIS Engine that can execute those actions and return the result on a map. This solution was carefully designed to be able to overcome data sensitivity issues by ensuring that the data always resides locally and any confidential information will not be sent to the LLM. The team also custom-built the GIS engine and all related capabilities such as: Single Layer and Multi-Layer Queries across attributes, spatial relationships, temporal relationships and also even visualisation features such as heatmapping.

Innovation Highlights:

The GIS chatbot AskIgnite is a pioneering innovation that not only provides GIS knowledge and technical assistance through text but also performs spatially enabled actions, such as filtering geospatial data by attributes, spatial information, or temporal data fields, and finding relationships across multiple data layers, making it the most comprehensive GIS chatbot deployed at a large scale.

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IMPACT AND VALUE-CREATION

LTA is currently trying to increase the exposure of GIS due to its potential to enhance data-driven decision-making in transport planning, optimize resource allocation for infrastructure projects, and improve operational efficiencies across various transit services. AskIgnite significantly contributes to this cause due to its ability to democratize access to GIS tools by lowering the technical skill barrier, enabling a wider range of LTA officers to directly perform spatial analyses and generate insights without extensive training, thereby fostering broader adoption and utilisation of geospatial data in their daily work.

AskIgnite has been deployed into production as a Beta release in March of 2025 and is made available to more than 7000 staff in LTA to use. It is positioned as a No-Code tool to harness the power of GIS from novices to more experienced GIS users. The application democratises 67 geospatial layers for all LTA staff to use to generate insights for any of their use cases. These 67 geospatial layers are home to data that is cross-cutting through the Rail, Roads, Bus, Enforcement and even Community Engagement domains of work.

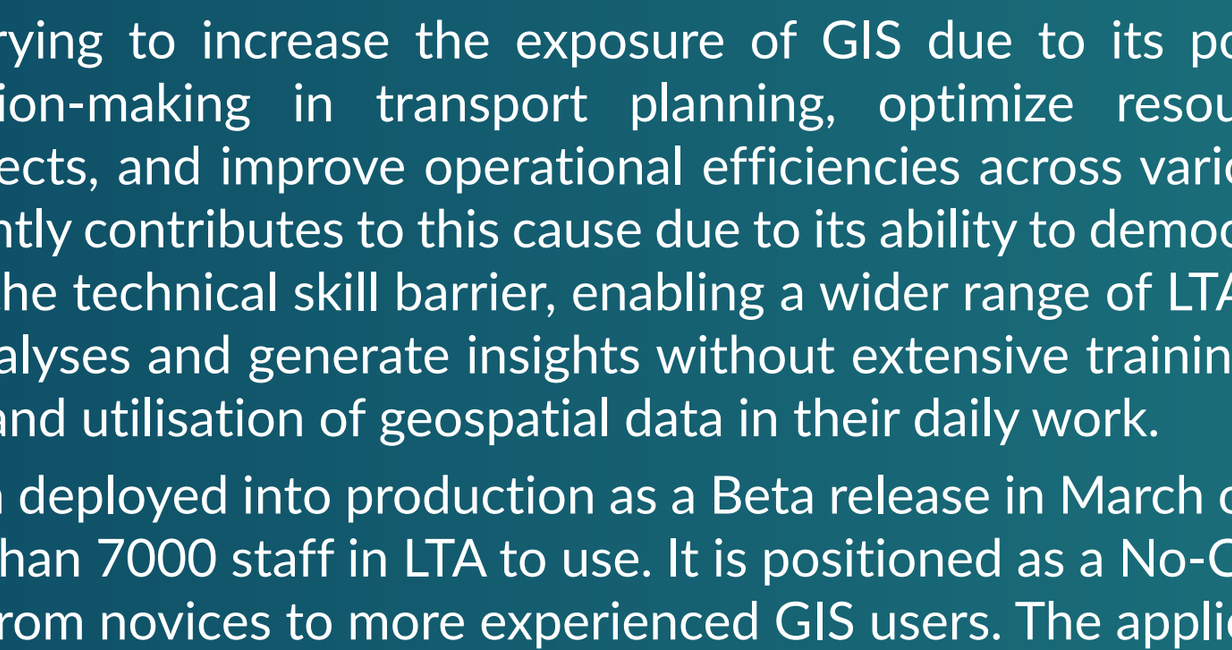

Figure 10: Discovering available GIS layers

With the data available, the insights derived from finding spatial relationships across the 67 layers is only limited by users' use cases and creativity in crafting the prompts.

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AskIgnite currently enables some of these valuable use cases (not limited to):

1. [Advisor Engagement] Finding Electric Vehicle Chargers in any given Constituency
2. [Operating and Maintaining Potholes] Pothole related feedback along a given road across any given time period
3. [Trend Analysis for Enforcement] Hotspots related to Illegal Parking Feedback
4. [First-Last Mile Connectivity] Searching for Bus Stops, Bicycle Racks and Cycling Paths within 200m of an MRT Station
5. [Barrier Free Access] Finding pedestrian overhead bridges that are nearby transport nodes such as Rapid Transit Stations and Bus Stops.

These queries represent important questions that LTA focuses on as part of its public service delivery and helps officers to derive these insights with unprecedented convenience and without a steep learning curve.

The GIS Team organised a Brown Bag alongside the launch of the product to triage and gather interest for the use of the chatbot in their work. There were more than 60 attendees all representing 32 unique divisions under work groups such as

1. Traffic and Road Operations (TRO),
2. Policy and Planning (P&P),
3. Active Mobility (AMG),
4. Infrastructure Design Engineering (IDE),
5. Information Technology, Cybersecurity and Digital Services (ITCD),
6. North South Corridor (NSC),
7. Public Transport Group (PT),
8. Road & Commuter Infrastructure Development (RCID) and
9. QSMO, Community & Customer Engagement (QSC2)

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IMPACT AND VALUE-CREATION

A survey was conducted and more than 75% of responses indicated a score more than 4 (out of 5) in reflecting the ease of use of the chatbot and overall satisfaction of using the GIS chatbot. 95% of the responses also indicated that they would recommend AskIgnite to their colleagues.

AskIgnite provides unprecedented convenience and productivity gains in enabling officers (with zero to little knowledge in GIS) to leverage on GIS technology for their work (e.g. making spatial queries and analysis).

Traditionally, the learning process is rather time consuming, requiring officers to learn key geospatial concepts and tools (e.g. ESRI's online open courses or LTA's inhouse GIS courses) and familiarise themselves with the huge spectrum of GIS tools in the ArcGIS software.

If learners are committed to learning daily and following these steps, they could realistically go from knowing nothing about GIS to creating their own simple map-based query tool with a minimum of 1 week (56 hours) of learning.

Figure 11: AskIgnite Brown Bag Sharing and Hands On

Figure 12: AskIgnite Brown Bag User Engagement

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Training	Time Taken
Gaining a foundational understanding of GIS Basics such as: 1. Spatial data, 2. Coordinate systems, 3. Layers 4. Spatial Relationships 5. Buffers	2 days/ 16 hours
Learning how to use GIS Systems ArcGIS Online or ArcGIS Pro and to perform actions such as: 1. Importing GIS Datasets 2. Adding and Configuring Layers 3. Performing basic spatial queries like filtering by location or attribute searches 4. Creating simple maps for visualisation	3-5 days/ 40 hours

However, these 56 hours of learning can be condensed into a less than 5-minute conversation with AskIgnite. The chatbot can understand the user's intents and perform the complex spatial processing under the hood and return the valuable results on the map as well as provide a natural language response to the user. AskIgnite can also assist regarding any questions about GIS knowledge and provide technical explanations to concepts or terms that they do not understand. This greatly reduces the barriers to entry to applying GIS to officers' work and smoothens out the learning curve for novice users that have little or no experience with GIS.

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AskIgnite also has the potential to deliver productivity gains through time savings / manpower avoidance costs, training fees savings, and software licence savings.

After factoring the costs and quantifiable benefits of AskIngite (based on 5 year project timeline), the Benefit-Cost Ratio is computed to be 4.6

FY2025 to FY2029	**Calculation**
Training Time Savings per officer	7 days / 56 hours
Total Time Savings (based on current users)	1000*7 = 7000 days or 56,000 hours
Manpower Avoidance Cost (LTE8 Engineer hourly rate)	56,000*137 = S$7,672,000
Training Cost Savings (based on current users)	1000*1000 = S$1,000,000
Software Licence Savings (based on current users)	1000*2000 = S$2,000,000
Total Savings	S$10,672,000
Development Cost (based on LTE7/8 Prof track)	12,377.58*3*12*5 = S$2,227,964.40
Ops (cloud hosting, LLM utilisation)	1300*12*5 = S$78,000
Total Cost	S$2,305,964.40
Benefit-Cost Ratio	10,672,000/2,305,964.40 = 4.628

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Implementing Generative AI to create a chatbot in the field of GIS is a challenging task due to the complexity and niche nature of interacting with spatial data. The AskIgnite application is one-of-a-kind not just in the public transport domain but also in the wider GIS industry. From a technical standpoint, the application and its architecture is difficult to replicate because it requires prior knowledge and expertise in not just Artificial Intelligence but also Geographic Information Systems.

To date, there has not been a more comprehensive and fully-fledged GIS chatbot product deployed at a large scale to serve more than 7,000 staff in the public and commercial domain.

The GIS Team has also presented this solution at Whole-of-Government forums such as the Geospatial Systems and Tech Coordination Group (GSTCG), and many agencies such as NEA, NPARKS, URA and SLA have expressed interest and recognise its value in making GIS more accessible and easier to use.

The team is positioned to onboard more use cases onto AskIgnite from divisions to raise adoption rates across LTA. We currently collaborating with users (Planning, IDE & TRO) to triage their requirements and onboard their use cases onto AskIgnite.

The team is also exploring how to open extend this capability to the Whole-Of-Government by interfacing our product with agencies' own data and offering the GIS GenAI capabilities as a service. There are ongoing talks with the planning agencies (i.e. JTC, NParks, HDB) to include this chatbot as part of the new smart city dashboard.

The GIS Team is also in an exclusive collaboration with Environmental Systems Research Institute (ESRI) on this project. ESRI is a global leader in GIS software and is one of the most influential companies in the industry as a market leaders with a worldwide impact on national governments as well as 90% of Fortune 100 companies. This two-way collaboration established at the ESRI User Conference and Developer Summit in 2024 facilitates pushing the boundaries of using Generative AI in GIS as well as cross-sharing LTA's learnings during the development and related use cases in the transport domain.

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AskIgnite is thus a game changing product and its deployment as a force multiplier enables LTA to carry out its mission and enhance public service delivery.

Outcome:

The deployment of AskIgnite has provided unprecedented convenience and productivity gains for at least 1,000 LTA officers. AskIgnite has democratised GIS usage across various departments and enabled officers to generate valuable insights from 67 geospatial layers with ease, thereby serving as a force multiplier and enhancing LTA's public service delivery.

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FEASIBILITY AND SCALABILITY

AskIgnite is a fully in-house developed AI-powered GIS agent, built by the Geospatial Systems division of LTA's ITCD group. It integrates OpenAI's LLMs with ESRI's ArcGIS platform, Azure infrastructure, and custom-built JavaScript interfaces to deliver a seamless, no-code GIS experience. The system was developed over a one-year period by a lean team of two software engineers and one DevOps engineer, demonstrating high feasibility even under constrained resources.

The agent is web-based, requiring no installations or costly software licenses, and is accessible to all LTA staff. It has already been deployed in production as a beta release since March 2025, and is available to all 7,000 officers in LTA.

AskIgnite supports a wide range of spatial queries—attribute, spatial, and temporal—and can perform complex multi-layer analytics such as identifying pothole feedback along specific roads, locating EV chargers within electoral boundaries, and generating illegal parking heatmaps.

Its architecture includes preprocessing and retrieval agents that structure GIS data into vector databases for semantic search, enabling fast and accurate responses from the upload to utilisation of data. The system also integrates with Elasticsearch for robust logging and is powered by GPT-4o for smarter, faster, and cheaper responses.

Figure 13: Exclusive Collaboration with ESRI Inc AI Product Development Team at the ESRI User Conference 2025 in San Diego

Figure 14: DCE(T) Wee Shann showing ESRI Inc President Jack Dangermond LTA's GIS Vision and AskIgnite Capabilities

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FEASIBILITY AND SCALABILITY

Figure 15: LTA with ESRI President Jack Dangermond, and CEO of ESRI Singapore Joe Lee

Scalability:

AskIgnite is designed for cross-domain scalability and Whole-of-Government (WOG) adoption. It has been actively shared across agencies through the Geospatial Systems and Tech Coordination Group (GSTCG), with demos conducted for GovTech, NParks, PUB, SLA, and URA.

The agent's modular architecture supports integration into bespoke agency platforms via Node Package Manager (NPM) packages and Application Programming Interface (API) endpoints, allowing agencies to plug AskIgnite into their own ArcGIS portals or web applications.

Internationally, AskIgnite has inspired a strategic AI collaboration between LTA and Esri Inc to create GIS AI Products for the global GIS community. Esri's Founder and President, Jack Dangermond, remarked that LTA is "one year ahead of us," highlighting the global relevance and pioneering nature of LTA's product and solutioning capabilities.

The AskIgnite GIS agent has also inspired ESRI's own commercial offerings to the global market, further validating the scalability of such technology.

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AskIgnite's impact is also evident in its user metrics: over 75% of users rated it highly for ease of use, and more than 95% would recommend it to colleagues. It has reduced GIS task time from ten minutes to under one-minute, democratizing access to geospatial layers and enabling officers to perform spatial analysis without prior GIS training.

AskIgnite can potentially support real-world operations such as EV charger network planning, illegal parking feedback analysis, and last-mile connectivity assessments. It can also be used to support strategic planning, design tracking, and operations across the LTA project lifecycle.

Future scalability is further supported by ongoing enhancements, including User Interface / Experience revamps, integration with Geoprocessing services, and roadmap alignment with ESRI's GenAI development efforts. AskIgnite is positioned not just as a tool, but as an agent of change for transforming how GIS is accessed, understood, and applied across government and industry.

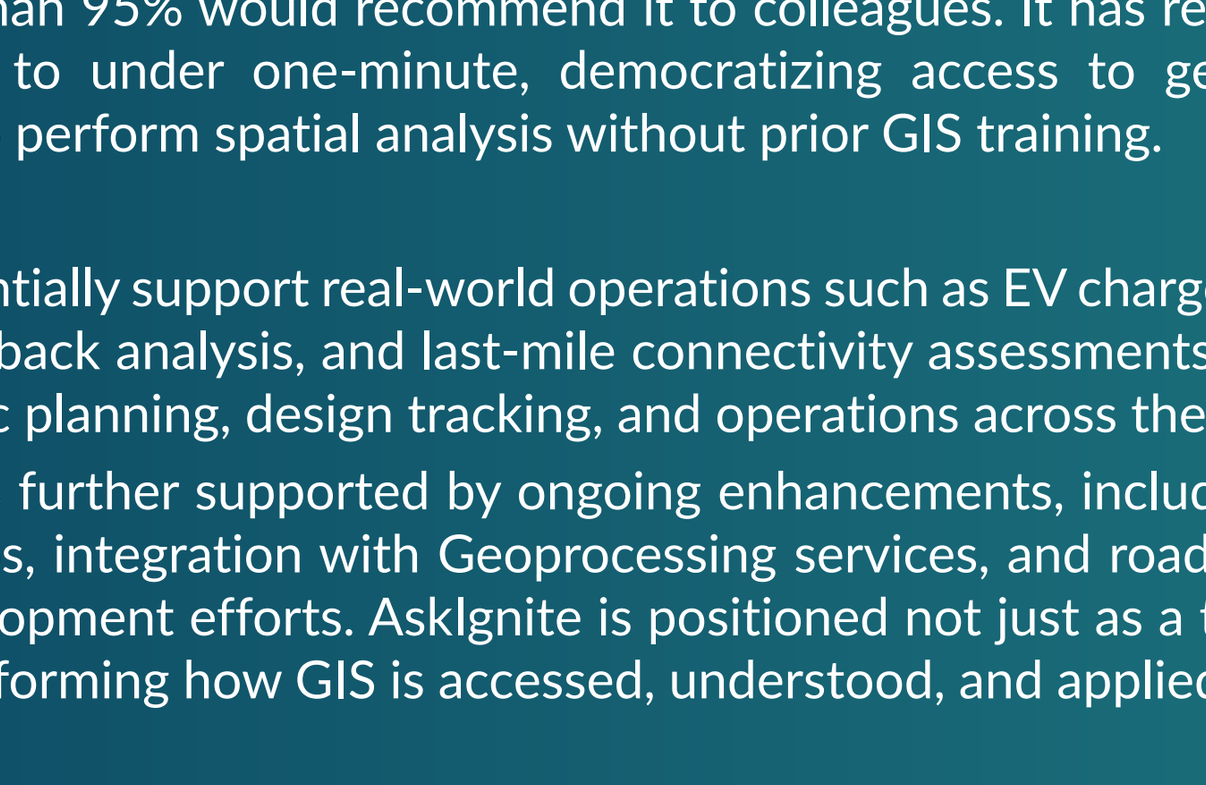

Figure 16: Sharing of AskIgnite at WOG Geospatial Forum

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Potential of Project:

AskIgnite, a fully in-house AI-powered GIS agent developed by a lean LTA team in just one year, has already empowered over 1,000 officers to perform complex spatial analysis in under a minute without prior GIS training, and—with its no-code interface, modular architecture, cross-agency adoption, and international recognition from Esri—is a highly feasible and scalable platform poised to transform geospatial intelligence across various domains in LTA and Whole-of-Government in Singapore.