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Finally, I would like to thank all the people working in the Land Transport Authority (LTA) for their reception and their friendliness. Because of them, my time at LTA was a very enriching experience, and it was a genuine pleasure to work with them.

EXECUTIVE SUMMARY

LTA is a statutory board under the Ministry of Transport, responsible for Singapore's land transport systems and infrastructure. I was attached to the Road and Traffic Specialists as a Software Developer Intern working on the Path Safety Assessment Tool (PSAT), a web tool that scores the safety of cycling and active-mobility paths. Using computer vision, GIS analysis and LiDAR data, it assigns a risk score to any path segment based on the CycleRAP methodology. My responsibilities included full-stack development, geospatial algorithms, UI/UX, UAT, documentation, and assisting management of team processes.

I made five major contributions during my internship. Firstly, I overhauled the team's engineering process, introducing proper Git version control, Jira tracking, and onboarding documentation so the project could survive team turnover. Next, I built a fully automated pipeline that derives path gradient from raw LiDAR point clouds, producing data that was previously unavailable for Singapore's paths. I also proposed and led a comprehensive UI redesign, restructuring the tool around clearer visual hierarchy and grouping to make it faster and more usable. Next, I added polygon and planning-area selection, allowing assessors define assessment areas visually on the map rather than manually selecting individual roads. Lastly, I designed a profile and project management system, making PSAT viable for multi-user deployment on shared departmental devices.

From this internship, one thing I learnt is that correctness and documentation weigh as heavily as speed of development in a safety-critical context. Moreover, I learnt the limits of a web-developer only skillset, which pushed me to explore data science. Lastly, I learnt that documentation and early user feedback is vital and should be treated as tools rather than chores.

Overall, this internship presented me with a breadth of knowledge across multiple fields, and allowed me to understand the pressures and responsibilities of a project of this scope. Through all of this, I was able to exercise and improve my self-directed learning process and come out of this project with a net-positive impact.

I INTRODUCTION

This report documents my internship experience at the Land Transport Authority (LTA) from 16th March 2026 to 31st July 2026, undertaken as part of my Internship Immersion Programme at Republic Polytechnic.

LTA is a statutory board under the Ministry of Transport, responsible for planning, operating, and maintaining Singapore's land transport infrastructure and systems.

During my internship, I was attached to the Road and Traffic Specialists team as a Software Developer Intern. My primary project was the Path Safety Assessment Tool (PSAT), a web tool that uses CycleRAP to score path segments for safety risk from survey imagery and GIS data, where I was involved in developing and extending core features across the full stack, including geospatial analysis algorithms (gradient, curvature, path intersections), GIS layer integration, UI/UX improvements, and tooling for project and profile management.

II BACKGROUND INFORMATION OF ORGANISATION

The Land Transport Authority (LTA) is a statutory board under Singapore's Ministry of Transport, established in 1995. It is responsible for the planning, operation, and maintenance of Singapore's land transport infrastructure and systems, encompassing roads, rails, and active mobility networks.

LTA's mission is to keep Singapore moving forward by providing a safe, efficient, and sustainable land transport system. It serves a broad base of stakeholders, from daily commuters and motorists to cyclists and pedestrians, and works closely with public transport operators, urban planners, and other agencies to coordinate Singapore's transport ecosystem.

LTA organisationally operates across a few specialist divisions, encompassing infrastructure, operations, policy and technology. I was attached to the Road and Traffic Specialists division, which focuses on the technical assessment and management of roads and path infrastructure.

Within the broader organisational context, PSAT sits at the intersection of LTA's active mobility agenda and its data-driven approach to infrastructure management. In recent years, LTA has significantly expanded Singapore's cycling path network as part of the Islandwide Cycling Network (ICN) programme, which targets 1,300km of cycling paths by 2030 (Land Transport Authority, 2024). As the network grows, systematically assessing the safety of these paths becomes increasingly critical, which is the problem PSAT is designed to address.

III THE TRAINING AND WORK ASSIGNMENTS

3.1 Roles and Responsibilities

I was brought on as a Software Developer Intern to work on PSAT. My responsibilities spanned full-stack feature development, geospatial algorithm implementation, UI/UX work, bug fixing, UAT support, and documentation. My day-to-day tasks involved collaborative Git workflows, Jira ticket tracking, and iterative delivery, working in a team of three developers under one supervisor. Beyond feature work, I also took on responsibility for the team's engineering process and internal coordination.

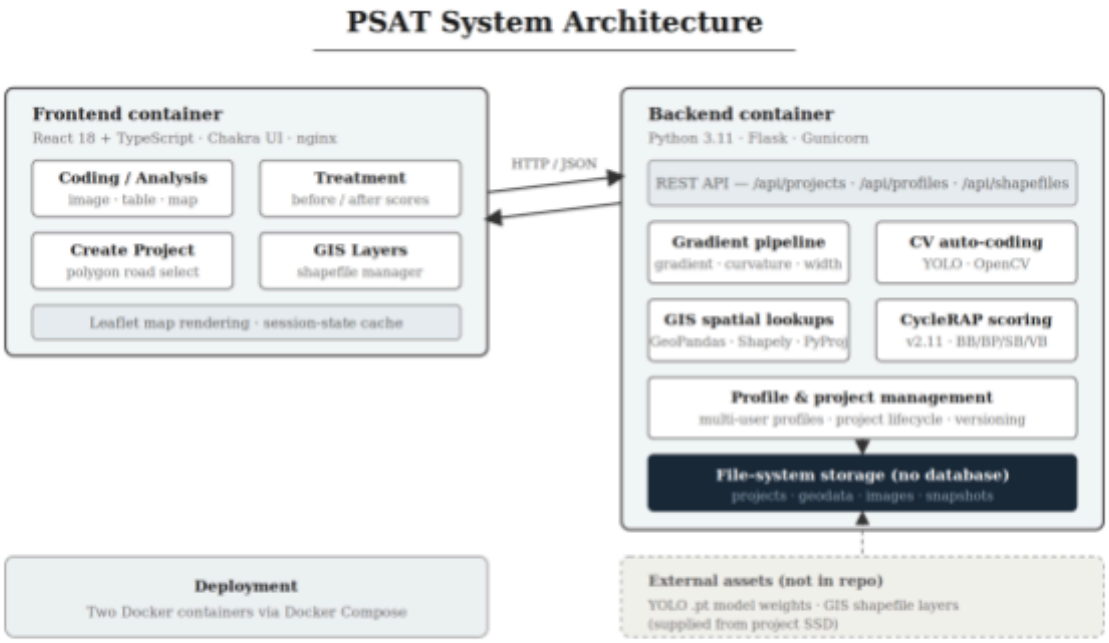

Figure 1: PSAT System Architecture

3.2 Application of Prior Knowledge

During my time studying at Republic Polytechnic, I learnt skills such as UI/UX, React Development, Git workflows, and most importantly, collaborative work through soft skills like proper communication, and hard skills like version control, and Jira for task coordination. These few skills carried the bulk of my work at LTA, allowing me to find comfort when working with such skills despite the foreign environment.

3.3 Knowledge Gaps and How I Addressed Them

In regards to skills directly tied to my field of study, I had large knowledge gaps in geospatial data handling, alongside the interpretation of LiDAR data. This was clearly demonstrated when I had to develop a new method to obtain gradient data from LiDAR point clouds. Given the context of Singapore, and the specific tools used by contractors and surveyors, I found that many of the "plug-and-play" tools simply did not work, leading me to develop my own full automated pipeline for gradient processing, starting from stitching a road centerline and sampling it against raw LiDAR point clouds totalling tens of terabytes, then through outlier and seam-jump filtering to compute a centered baseline slope per sample point, and lastly, proper documentation to ensure future collaborators on this project can carry on my work. This end to end process forced me to learn coordinate reference systems, point cloud coverage, and centerline geometry from a low level, rather than relying on tools to abstract them.

Beyond skills directly tied to software development, I found myself constantly learning about context-specific information, such as how LTA constructs roads, the processes, the jargon and terminology, and collaborative work. The best demonstration of this is not during the development itself, but during presentations and UATs. Oftentimes when presenting my work, questions are always more related to the user-facing side, i.e. how is this useful to me and my department? It is in times like these where it is vital for me to understand the target audience, their methods and processes, and where precisely PSAT can help. As daunting as it may be to face questions to which I do not know the answers, it is just as meaningfully a learning opportunity for me to be "in sync" with the various departments, allowing me to understand their daily tasks and hardships and thus gear PSAT better to them.

3.4 Mode of Learning

My primary mode of learning was self-directed and hands-on. Given the specialised nature of the project, formal instruction was rarely available, and what I needed to learn had been built through independent research, experimentation, and iteration.

In regards to geospatial and LiDAR-related skills, learning was largely driven by necessity. Each issue I faced during development of the gradient pipeline, be it coordinate reference mismatches, point cloud coverage gaps, or geometry issues, required me to research and understand the underlying concepts before I could resolve it. Documentation such as technical references for geospatial libraries served as my primary learning resource (e.g. GeoPandas developers, 2023; pyproj developers, 2023). Where this fell short, I relied simply on trial and error, which gave me a much deeper understanding of the material than a guided approach would have. Moreover, by writing documentation for future collaborators, I found myself asking questions that I otherwise would have missed, and this further strengthened my knowledge.

For context-specific knowledge, my learning happened organically through collaboration and exposure. Regular interactions with my teammates and supervisor allowed me to ask questions and build up domain knowledge about LTA's processes, terminology, and operational constraints over time. Presentations and UATs were particularly formative, as being questioned directly by stakeholders from different divisions forced me to actively seek out information I did not presently have, and to synthesise technical knowledge with an understanding of how different teams actually use and think about the tool.

In both cases, I found that effective learning came not from any single resource or event, but from the cumulative experience of encountering a problem, attempting a solution, and reflecting on the outcome.

3.5 Major Contributions

Over the course of my internship I made five major contributions to PSAT, three of which I proposed myself.

3.5.1 Team Process and Engineering Practice

Although PSAT was developed by many developers before me, at the time of joining it was only being maintained by a single developer. Because of this, the project did have a GitHub repository, but it was not actively maintained and used. Moreover, the task and bug tracking system was lacklustre, holding everything in multiple Word documents. Another issue was that project credentials were tied to individual accounts, making a transfer of ownership difficult.

The same week I joined, I pushed for proper Git version control and management, giving us breathing room before presentations to roll back to a stable version should there be any conflict, which did end up happening. Then, with endorsement from my supervisor, I introduced Jira for tasks, bugs, and timelines, and since then as a team, have had over 100 tickets tracked. The other developers and I also created a shared project Gmail on which we could hold documents, thus access was not tied to any one person. I then wrote the onboarding documentation for account access, Jira, and Git, to assist my team members and supervisor in navigating the systems, as well as allowing new developers or managers of the project to easily take over.

From this, tasks and bugs stopped getting lost between all the documents. When I joined, the project was informally projected to complete around December, but is now on track to deploy the first version by end-July. Regardless, the most important outcome was structural. Every developer on this project is an intern on a fixed term, and the project will outlast all of us. Credentials tied to individual accounts and knowledge held in one person's head were a handover risk, and thus the shared account and onboarding documentation exists so that the next developers can take over without the project losing anything.

My prior experience in development has always been as a junior developer, receiving instructions, and decisions being already made. This was the first time I operated above that, helping to assign work, deconflict, deciding on specific infrastructure, and managing expectations upward. This coordination was a large part of my work, but is often overshadowed by the development of features, which is why I felt the need to push for such changes. In previous jobs and projects, I have seen management begin to crumble the moment a tough deadline is being pushed, which is why it mattered to me that this was enforced.

3.5.2 Automated Gradient Processing Pipeline

The most technically demanding contribution I made was the development of the gradient processing pipeline. The final output is a single gradient number in degrees for each segment, but much of my time at LTA was spent getting just this number. Although the full processing of gradient data is not yet complete, I have set up and fully automated the systems, and now it becomes a question of resources and processing time, with each segment taking up to 30 seconds each, thus each road taking from minutes to hours. Spread across thousands of named roads, this is easily the most time consuming part of developing PSAT. No further development is needed for this, what remains is compute time.

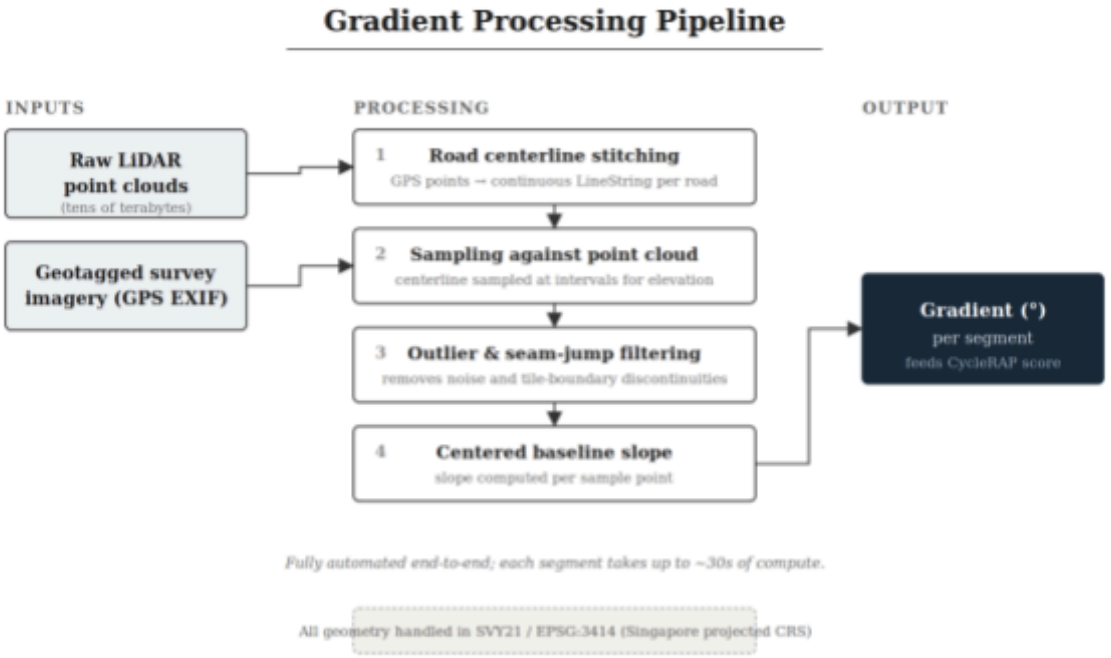

Figure 2: Gradient Processing Pipeline

A gradient system was needed for planners and land developers to determine path safety and development suitability (International Road Assessment Programme, 2026). Moreover, PSAT uses a modified system of CycleRAP, suited to our contextual needs. The most noticeable one is that LTA uses gradient ratios compared to percentages found elsewhere. Prior to this, gradient data for Singapore's paths was not available in a form PSAT could use, and the available tools just did not work given our context and data types. This pipeline now produces it automatically for any road, repeatably, without requiring specialist knowledge of point cloud processing.

On a personal level, this was the contribution that most clearly exposed the ceiling of a purely web-development skillset. Working end-to-end on LiDAR and geospatial data, rather than through tools that abstracted it away, was what made me want to pursue data science specifically, rather than computer science generally.

3.5.3 Comprehensive UI Redesign

A significant portion of my later internship was dedicated to a comprehensive UI redesign of PSAT. Both during UATs and internally, we have faced issues with our UI being unclear, unresponsive, and in certain scenarios, just downright unusable. As such, I proposed to redesign the UI to, put simply, work better. My whole redesign involved understanding every function deeply, grouping functions by context, and understanding how colors and gestalt principles affect the interpretability of the UI. Throughout the implementation of the new UI, I wrote detailed documentation for the design system, ensuring that any developers on the future project can adhere to the UI design principles. Through this redesign, usage of PSAT becomes more streamlined and efficient, requiring less clicks for navigation, less movement around a page, and clearer semantic understanding.

On a personal level, the UI redesign served as a meaningful refresher of design principles I had been formally taught but had not actively applied in some time. Concepts such as gestalt grouping, visual hierarchy, and semantic colour use came back to me naturally through the process of solving real usability problems, and I found that relearning them in a practical context gave me a far stronger intuition for them than classroom instruction alone had.

3.5.4 Polygon and Planning Area Selection

Another part of my work was polygon and planning area selection. This allows users to define an area visually on the map for assessment, rather than manually selecting roads. This required the import of shapefiles such as land ownership layers, overlaying them onto a map gives assessors spatial context for what they are selecting, thus tying administrative boundaries to actual segments of path. This feature was requested by a number of testers during UAT, such as one tester mentioning the need to select all segments that lie on a cycling path. From this, usage of PSAT becomes much faster, and gives a more accurate scoping of assessment areas, and directly addresses stakeholder requests.

Moreover, this was a great learning opportunity for me to build features that closed a feedback loop from end users to implementation. The feature itself was never on any backlog, but I learnt from this that the highest-value requirements are the cheapest to obtain and easiest to miss, often requiring a simple remark from a tester to discover.

3.5.5 Profile and Project Management System

My last major contribution was the profile and project management system. As PSAT is intended to be distributed to shared devices within departments, an organisation system was bound to be a reality. In preparation for UAT, I realised that I had no way of making sure testers did not accidentally delete all my personal projects on PSAT, so I proposed the profile system and got to work. The system was designed to separate work and projects, which is a basic but critical operational requirement for a tool like this. This makes PSAT viable for actual multi-user deployment, not just personal testing. For me, this was my first taste during LTA of what it meant to think beyond feature development and into real operational constraints, such as the users and the user environments.

IV REFLECTIONS

4.1 Impact on Personal and Career Goals

I initially came into this internship knowing I liked building software, but through it, I learnt I also want to work on problems where the software touches something physical and consequential, such as actual pathways and actual cyclists, rather than abstract things. Throughout this, I also learnt to redefine what "good engineering" meant based on the organization. Coming from an SME background, success was measured largely by shipping fast. At LTA, simple mistakes like a wrong gradient number are far more consequential and can misinform a real safety assessment. Correctness and traceability here weigh just as heavily as velocity. Moreover, being here exposed gaps I would like to close. Working on LiDAR and geospatial data showed me the limits of a purely web-development skillset. I spent roughly four weeks learning GIS layers and data manipulation before I could make progress, and found it to be the part of the work I enjoyed most, which is what has pushed me towards Data Science specifically rather than Computer Science generally.

4.2 Applying These Learnings to Future Work

I also realised that designing software like this requires me to sit down and think ahead. The development of the profile management system came from realising shared devices will break single-user assumptions, and moving forward, I always aim to ask myself, who else touches this and on what machine.

This internship also changed how I viewed documentation. Instead of being a chore, I realised that documentation can also be a learning and thinking tool, as by writing documentation for things like the gradient pipeline and the UI design system, it surfaced questions I would otherwise have missed. Thus, I learnt that it is important to document during, not after development.

I also learnt how to close the loop with end users. The polygon area select feature only existed because a UAT tester mentioned it in passing. This, to me, is incredibly cheap, yet high-value input, and I learnt to actively seek it, and to treat unstructured user contact as a requirements source in its own right.

Stakeholder communication was also something that developed with me. I realise that no one will ask “what algorithm does this use?” and instead “how does this help my department?”, and from this, I learnt that translating technical work into user value is a skill I will need, regardless of my role.

I also strengthened my mindset of building systems and not one-offs. As time went on, it dawned on me that this project’s development and maintenance will outlast any team member at that time, and the importance of automation and repeatability throughout, such as building an automated gradient pipeline that will allow all future team members to work on it without significant effort.

4.3 Handling Challenges

The earliest major hurdle I faced was the presentation to a large portion of the Active Mobility Group, with over 40 attendees, and five days’ notice. At that point in time, the build was highly unstable, but the unstable features were exactly the ones being showcased, so rolling back to a stable version was not an option. For those five days, I did my best to handle it, clocking into the office earlier and clocking out later. The team and I ended up finishing on the morning of the presentation itself. Looking back, the failure was upstream of those five days. I allowed the build to drift into an unstable state because no demo was scheduled, so when one appeared, the only option left was to work through it. Managing it more effectively would have meant never letting the build get there.

This was my first time in such a situation, and afterwards, I picked up an important piece of advice from my supervisor. In an organisation where seniors are busy and you are not at the top of the pyramid, notice periods are short and unpredictable. Sprint recovery is not a strategy, and the correct posture is to keep a demo-ready build at all times, so even a day’s notice is survivable. This was put to the test when we had another presentation later on, given a five days’ notice again. This time though, it went much smoother because we had maintained a good pace rather than sprinting and recovering.

Another challenge I faced was learning by doing without preparation. I usually learn almost exclusively hands-on, with no significant preparation going into tasks. Because of this, I reviewed my work a week later to find that it no longer met my standards. The two biggest examples of this is the gradient pipeline and the curvature detection algorithm, both had to be partly redone. Although deadlines were still met, the cost was re-work. From this, I learnt to front-load documentation and background reading before implementation, even when a deadline made it feel like it was a delay, even when I felt it was unnecessary. Although I mentioned previously that trial and error helped me learn, it could still have been a less costly lesson.

4.4 Colleagues and Qualities I Hope to Develop

I largely looked up to my supervisor, Puay Ping. Her efficient and low-volume communication is one of the reasons I was able to clear tasks and finish features as quickly as I did, and is a sharp contrast to my typical, fast and high-volume style. From this, I hope to learn the discipline to say less and mean more.

This also ties into the next quality. Trust as a management instrument. She trusted my work, enough to let me, an intern, restructure the team's engineering process and organization despite my lack of familiarity overall. This trust is what produced the ownership and responsibility I felt towards the project. From this, I learnt that giving space to others is often more effective than just directing.

V CONCLUSIONS

5.1 Overall Value of the Internship

The internship was valuable to me largely because it was unsupervised in the right way. I was given a real feature backlog, along with the opportunity to give my own ideas, not just intern busywork. Because of this, I felt a genuine sense of responsibility towards the project, pushing myself to make sure everything went accordingly. Working with such breadth added to this value. I had to do full-stack development, geospatial algorithms, UI/UX, UAT support, and documentation, all in one project. Talking to those around me, it's rare for an internship to span both low-level data processing and user-facing design.

Moreover, my learning and training was almost entirely self-directed. The specialisation of the work meant there was effectively no course that existed to teach it. This internship at LTA instead provided access to domain experts, real stakeholders, and the room to fail and iterate. The geospatial and LiDAR skills are especially specific, but taught me skills that would carry across roles, such as designing for deployment, documenting during development, seeking user feedback early, and communicating value rather than implementation. Coming into this, I knew working in a larger corporate environment like a statutory board is slow paced, but as time went on, I realised this was not an inefficiency, but a safety net in a place where bad decisions directly affect lives. This changed my outlook on a startup environment versus a more corporate one.

5.2 Self-Evaluation

During my time here, I made five major contributions. Team process and engineering practice, the automated gradient pipeline, the UI redesign, polygon and planning area selection, and the profile and project management system. Of the five, three were proposed by me, being the team processes, UI redesign, and the profile management system.

To start with my strengths, I believe I worked well independently and effectively closed the loop between UAT and shipped features, and left behind documentation so the work survives after my departure. I was also able to pick up unfamiliar technical domains under the pressure of deadlines.

Moving onto my weaknesses, one of which, as discussed in my reflections, is my hands-on-first approach that cost me avoidable rework. Another weakness I have identified within myself is attitude. Having come from an environment where deliverables were the only judging factor, I came into this internship with that same mentality. I delivered my work well and on time, and I could clock in early and stay late when a deadline demanded it, but I had not built the same consistency in ordinary weeks. However, I was taught just how much a good attitude mattered when my supervisor reprimanded me on my punctuality, and on seeming unfocused in the office. Since then, I have identified the issues and moved forward to rectify it. I now understand that the baseline matters more than the sprint, because it is what people rely on when nothing is being rushed. Regardless, I believe this is a journey that stretches beyond my time at LTA, and requires a long-term shift in character and mentality.

Moving onto unfinished business in LTA, my biggest one is the gradient pipeline processing. It is an incredibly large time sink, and requires raw computing power to finish all roads in Singapore. Despite my best efforts, I have only processed gradients for the North-East region, and a portion of the Central region of Singapore. This work will have to be carried on by a future team member.

Nonetheless, I believe I have had a net positive contribution on this project. I came into the project when it was missing features, did not have proper team processes, and had no documentation. I pushed for features to be implemented, pushed for the implementation of standard team practices, and hammered the need for proper documentation for all parties involved with the project.

5.3 Advice to Juniors

For an internship in general, it cannot be stressed just how important conduct is. Your deliverables are not your whole performance. Conduct, presence, and pace are read as signal about whether you can be trusted with more.

For an internship in my team at LTA specifically, the number one thing is familiarity. This project has incredible depth, and a lack of knowledge in any single area will result in ineffective or incomplete work. Ask questions early about users and use cases. Code can be explained with any LLM coding agent, but to understand how a user will interact with the tool requires actual conversations. The best way to learn is to volunteer for the problems no one wants. It was never my intention to trailblaze the gradient pipeline, I only took on the assignment because no one in the team wanted to, but in doing so, I learnt so much in a domain I have no experience in. Most importantly, the best measurement is not in features shipped, but in the project's short-term and long-term scope. Constantly look for how the project as a whole can be improved, and ensure the maintainability of it.

REFERENCES

Esri. (n.d.). *ArcGIS Pro documentation*. Retrieved July 20, 2026, from https://pro.arcgis.com/en/pro-app/latest/help/main/welcome-to-the-arcgis-pro-app-help.html

Fiona developers. (n.d.). *Fiona documentation*. Retrieved July 20, 2026, from https://fiona.readthedocs.io

GeoPandas developers. (n.d.). *GeoPandas documentation*. Retrieved July 20, 2026, from https://geopandas.org

International Road Assessment Programme. (2026). *CycleRAP methodology factsheet* (Version 2.11). iRAP. https://www.irap.org/cyclerap

Land Transport Authority. (n.d.). *Cycling path network*. Retrieved July 20, 2026, from https://www.lta.gov.sg/content/ltagov/en/getting_around/active_mobility/walking_cycling_infrastructure/cycling.html

Norman, D. A. (2013). *The design of everyday things* (Rev. ed.). Basic Books.

OpenCV team. (n.d.). *OpenCV documentation*. Retrieved July 20, 2026, from https://docs.opencv.org

pyproj developers. (n.d.). *pyproj documentation*. Retrieved July 20, 2026, from https://pyproj4.github.io/pyproj

Shapely developers. (n.d.). *Shapely documentation*. Retrieved July 20, 2026, from https://shapely.readthedocs.io

Ultralytics. (n.d.). *Ultralytics YOLO documentation*. Retrieved July 20, 2026, from https://docs.ultralytics.com