MACQUARIE
University

Faculty of Science and Engineering

DEPARTMENT OF COMPUTING

Semester 1, 2025

ASSIGNMENT TWO

Project Plan – Development of Autonomous Car

Group 5
COMP8770: Information Systems Project and Risk Management

Table of Contents

1. Executive Summary

1.1. Project Overview

This report outlines a strategic six-year initiative to advance a Level 4 self-driving car from concept to commercial reality. The organization is initiating this program with an estimated investment of US $1.9 to 2.0 billion. With the autonomous mobility market projected to reach four trillion dollars by 2034, this initiative positions the company to assume a leadership role. Throughout the program, proprietary capabilities in AI perception, sensor fusion, and high-fidelity simulation will be developed, establishing a strong foundation for sustained competitive advantage.

1.2. AI-Driven Planning

During the planning phase, two AI tools were utilized to draft preliminary project plans. One emphasized rapid prototyping to accelerate hardware and software integration, while the other focused on in-depth testing and validation to ensure safety and reliability. These drafts provided invaluable insights and also highlighted several gaps. Leveraging project management expertise, domain-specific knowledge, and best elements from the AI project plans, a unified third project plan was developed. This consolidated plan combines the agility of the prototype-first approach with the rigor of the test-first model and incorporates critical elements that the AI tools overlooked - such as structured stakeholder engagement and dedicated sprints for regulatory alignment.

1.3. Anticipated Benefits

1. Up to US $10 billion in annual revenue, driven by premium vehicle sales, recurring software subscriptions, and managed-fleet services.
2. Significant cost savings for fleet operators through reduced accidents, lower insurance premiums, and improved fuel efficiency.
3. Internal rate of return above 25 percent, with break-even expected in 2032-2033 and substantial cash flows thereafter.

1.4. Preparatory Studies

To minimize potential risks, we will complete five essential studies before full-scale development begins:

1. Front-end feasibility assessment to align technical requirements with regulatory pathways.
2. Proof-of-concept prototypes for core AI perception and sensor-fusion features.
3. Iterative hardware and software sprints to refine system integration.
4. Real-world pilot programs to validate performance and user experience.
5. Targeted outreach to key stakeholders and regulators to build trust and secure early approvals.

1.5. Execution Framework

A Spiral-Agile hybrid methodology will guide execution through five phases. Each phase will include structured reviews, hardware-in-the-loop testbeds, and digital twins to guide decisions and accelerate learning.

1. Feasibility and Planning
2. Risk Analysis and Proof of Concept
3. Agile Development and Prototyping
4. Testing and Evaluation
5. Regulatory Feedback

1.6. Risk Management and Governance

A dedicated risk budget of US $3.5 million will fund targeted mitigation efforts, including multi-sensor simulations, diverse dataset acquisition, real-time performance monitoring, regular retraining cycles, explainable AI modules and a robust incident-response protocol. Progress and benefits will be tracked via monthly dashboards, with clear ownership assigned to each outcome and oversight provided by a senior steering committee, a project management office and an independent safety board. Key performance indicators include zero serious incidents during pilot trials, no more than 5 percent budget variance, 99.9 percent obstacle-detection accuracy and a user satisfaction score of at least 4.5 out of 5.

1.7. Recommendation

Immediate initiation of the front-end feasibility phase is advised to refine project scope, confirm resource requirements, and secure early regulatory feedback. With an AI-informed, expert-refined plan, disciplined governance, and robust risk controls, the program is positioned to deliver breakthrough technology, strong financial returns, and enduring leadership in safe, reliable autonomous mobility.

2. Context

2.1. Project Background

The concept of autonomous vehicles dates back to the 1920s, when radio-controlled prototypes such as the “American Wonder” first demonstrated the promise of self-driving technology (Kröger, 2017). Significant progress occurred in the 1980s with breakthroughs in computer vision and robotics. Carnegie Mellon University’s NavLab project showcased these advances, laying the groundwork for future systems (Kröger, 2017). The early 2000s saw the DARPA Grand Challenge catalyse real-world development. In 2005, Stanford’s “Stanley” completed a 212-km off-road course autonomously, proving the feasibility of complex navigation without human intervention (Thrun et al., 2006).

Today, industry leaders pursue divergent strategies towards Level 4 autonomy:

1. **Waymo** operates geofenced autonomous fleets in select cities.
2. **Cruise** focuses on dense urban robotaxi services.
3. **Tesla** integrates its Autopilot and Full Self-Driving features into consumer vehicles, leveraging vast real-world driving data to refine performance (Marsh, 2025).

These varied approaches illustrate both the rapid pace of innovation and the enduring technical, regulatory, and ethical challenges that remain on the path to fully reliable, safety-critical autonomy.

2.2. Strategic Role of AI in This Project

Autonomous vehicles promise transformative improvements in safety, efficiency, and sustainability. Human error accounts for approximately 94 % of crashes - an opportunity for AVs to dramatically reduce accidents (Mueller et al., 2020). Coordinated, AI-driven traffic management could also cut emissions by up to 25 % while optimizing flow and advancing urban mobility and environmental goals. Within project management, AI augments traditional planning tools, such as Gantt charts and critical-path analysis, by analyzing historical data to forecast risks, optimize resource allocation, and simulate alternative outcomes. A recent review found that AI-powered project tools significantly enhance forecasting accuracy and foster adaptive planning in complex technology initiatives (Salimimoghadam et al., 2025).

For this six-year autonomous-car program, two AI tools were initially employed to generate distinct preliminary plans:

1. **Rapid Prototyping Roadmap:** Prioritized accelerated hardware and software integration sprints.
2. **Testing & Validation Blueprint:** Emphasized exhaustive safety testing, regulatory compliance, and performance validation.

Building on these foundations, a third, consolidated plan was crafted by combining the most effective elements of both AI-generated drafts with expert project-management judgement. This unified roadmap retains the prototype-first agility and test-first rigor of the initial versions while filling critical gaps, such as structured stakeholder engagement, dedicated regulation sprints, and formal phase-gate criteria, that the AI tools did not address.

3. Business Case

3.1. Financial Analysis & Justification

3.1.1. Estimated Costs

Developing a Level 4 autonomous car demands a major upfront investment due to the technology's complexity. A high-level cost estimate, shown in Table 1, aligns with industry trends and reflects the personnel and resources needed for R&D, prototyping, infrastructure, and regulatory compliance.

Cost Category	Description	Estimated Cost
R&D and Prototyping	Core development covers AI training, sensor integration, prototyping, simulation, and pilot trials. Costs range from \$100M–\$1B for AI and data infrastructure, with simulation environments costing \$10M–\$500M depending on scale (Tran, 2025).	~\$1.2B
Infrastructure & Equipment	This includes compute units (\$2K–\$20K), sensor suites (\$10K–\$100K), and test infrastructure (\$5M–\$650M) (Tran, 2025).	~\$400M
Staffing & Training	Project delivery requires a specialized team of 500+ engineers and experts, supported by continuous training. Competitive hiring is essential, as top OEMs invest heavily, BMW and Ford employ thousands with \$1-\$3B in annual software R&D (AWS & SBD Automotive, 2021).	~\$300M

Table 1: High-Level Development Costs for a 6-year program (AWS & SBD Automotive, 2021)

Achieving Level 4 autonomy demands heavy investment in R&D, infrastructure, and talent. The projected \$1.9-2.0 billion investment aligns with industry benchmarks and allows for scalable growth.

1. **R&D and Prototyping** are the largest cost drivers, driven by the need for scalable AI and extensive testing. Industry leaders spend up to \$1 billion annually on AI training infrastructure, while simulation platforms, vital for rare edge case testing, can cost hundreds of millions (Tran, 2025).
2. **Infrastructure and Equipment** demand significant funding. Each prototype vehicle, equipped with full sensor and computing suites, can cost over \$100,000, while fleet deployment, testing facilities, and data infrastructure add substantial expenses (Tran, 2025).
3. **Talent** is critical to success. Competing with OEMs and tech firms for AV specialists necessitates strong compensation and development programs. With leading firms spending billions on software talent (AWS & SBD Automotive, 2021), this budget includes incentives, training, and workforce development to ensure long-term capability.

3.1.2. Expected Benefits

Despite high upfront costs, Level 4 autonomy offers substantial financial and strategic returns. Revenue will come from premium AV sales, software subscriptions, and autonomous fleet services. A single successful model can yield strong recurring income, supported by cost savings from fewer accidents, lower insurance, and improved fuel efficiency. Commercial buyers gain from higher vehicle utilization and operational efficiency, further driving sales. The investment also strengthens market position and builds valuable IP in AI, robotics, and automotive tech. With the AV sector projected to exceed \$4 trillion by 2034 (Zoting, 2025), the program ensures access to high-growth markets. Future expansion into autonomous trucking and delivery, each billion-dollar opportunities, adds to long-term potential (Tran, 2025). Early deployment enables industry leadership through standard-setting, key partnerships, and licensing. Controlling the full AV stack is increasingly vital for future competitiveness (AWS & SBD Automotive, 2021). Projected returns are detailed in Table 2 below.

Benefit Category	Description	Estimated Benefit
Revenue Opportunities	Level 4 autonomy enables revenue from premium vehicle sales, software subscriptions, and fleet services. Private AVs may generate $300–$400B annually by 2035 (Deichmann et al., 2023). A 0.5% share of the $2.1T global AV market by 2032 (Zheng, 2024) could yield ~$10B/year, ensuring strong long-term returns. Multi-billion dollar annual revenue potential with modest market share by 2032.	~$5–10B/yr
Cost Savings & Efficiency Gains	Level 4 autonomy cuts costs by removing driver labor, enabling 24/7 use, and reducing accidents, potentially saving $500B annually by 2032 (Tran, 2025). Added savings from lower insurance and 10–15% fuel efficiency make AVs highly cost-effective. Significant cost reduction per mile and per vehicle and fewer accidents lowering insurance costs	~50% reduction in labor costs for taxi services; up to 10–15% fuel savings.
Strategic Market Positioning	Early entry into Level 4 autonomy strengthens tech leadership, brand value, and pricing power. Proprietary IP and fleet data enhance competitiveness and licensing potential. Success can significantly boost valuation (e.g. Waymo projected at $850B) (Munster and Baker, 2024), while in-house capabilities enable strategic mobility partnerships.	~$300M

Table 2: Estimated Benefits after Commercial Lauch

3.1.3. Return on Investment (ROI)

Initial ~$2B investment yields strong projected ROI by 2032 after the commercial launch, with potential for ~$10B/year revenue, >25% IRR over 10 years, and high long-term strategic value as detailed in ROI analysis in Table 3 below. ROI builds over time as market adoption scales and recurring revenue grows.

Metric	Estimate
Total Investment (2025–2031)	~$2.0 billion
Market Size (Global AV, by 2032)	~$2.1 trillion
Forecasted Market Share (2031-2032)	0.50%
Projected Annual Revenue (2032)	~$10 billion
Revenue-to-Investment Ratio	5× annual return vs. total investment
ROI (%)	**400–500% (based on projected annual revenue)**
Breakeven Year	Year 5-6
Long-Term IRR (10-year outlook)	Estimated >25%
Customer Lifetime Value Model	Recurring revenue via software + services per vehicle
Strategic ROI (non-financial)	IP assets, market leadership, early data advantage
NPV (Base Case Scenario)	Positive under conservative adoption and pricing assumptions
*****ROI and ratio based on projected annual revenue, not net profit***	

Table 3: High-Level ROI Calculations

3.2. Project Success Criteria

Clear success criteria, covering qualitative feedback, quantitative performance, and formal acceptance standards, will guide project execution and serve as benchmarks for evaluating outcome.

3.2.1. Qualitative Success Measures

1. **Safety and Public Trust** - The autonomous car must demonstrate safety performance exceeding that of human drivers, with zero serious incidents during pilot programs and validation by third-party safety assessors. Earning public and regulatory trust is a key success factor, as safety remains the primary barrier to AV deployment (Trustworthy AI, 2021).
2. **Regulatory Approval & Compliance** - The car must meet or exceed all regulatory standards for Level 4 operation in target markets. Success is defined by securing permits or approvals in key jurisdictions, demonstrating legal readiness and regulatory trust, comparable to approvals achieved by leaders like Waymo and Cruise (Tran, 2025).
3. **Customer/User Acceptance** - Success is measured by high user satisfaction in early trials, with passengers reporting safety, comfort, and willingness to ride again. Positive media coverage, public sentiment, and strong demand in pilot deployments indicate successful user acceptance and trust in the technology.

3.2.2. Key Performance Indicators

Specific KPIs will be tracked to quantitatively assess progress and success of the project across technical performance, project execution, and business outcomes as detailed in Table 4 below.

Metric	KPI
Safety	The autonomous vehicle shall demonstrate a minimum of 20,000 miles per disengagement, maintain zero at-fault accidents during defined pilot deployments, and achieve at least 99% operational uptime throughout testing and service phases.
Technical	The autonomous system shall achieve 99.9% object detection accuracy for pedestrians and critical obstacles, maintain localization precision within 10 cm, and respond to hazards within 0.1 seconds, as verified through testing and validation.
Development	The project shall meet all major milestones on schedule, maintain budget variance within ±5%, and resolve at least 95% of critical issues identified in testing prior to the next phase.
Deployment/ Market	The initial pilot shall deploy at least 50 fully operational Level 4 vehicles, achieve a ride completion rate above 99% without human intervention, maintain average daily utilization targets, ensure customer wait times remain within acceptable limits, and reduce cost per autonomous mile to below $0.50.
Financial	The project shall achieve payback within 5 years of launch, maintain a positive gross margin on autonomous services, and secure a measurable share of the autonomous vehicle market, such as a portion of robotaxi rides or the projected 37% of AV new car sales by 2035.

Table 4: Key Performance Indicators (KPIs)

3.2.3. Acceptance Criteria Overview

This section outlines how project success will be formally recognized. It defines the essential conditions that must be met for final management approval and stakeholder acceptance as detailed in Table 5 below. The project will be accepted when the Level 4 autonomous car meets technical specs, secures regulatory approval, and fulfills defined safety and performance metrics.

Acceptance Criterion	Description	Validation Method
Achieves True Level 4 Autonomy	Vehicle must operate without human intervention within its defined domain, completing 1,000+ test miles with zero disengagements. Must meet SAE Level 4 definition and handle all driving tasks, including system failures.	Final driverless testing, internal safety assessments
Regulatory Certification Obtained	All required permits and certifications must be secured for driverless operation in target markets (e.g., California, EU). Includes compliance with vehicle safety, cybersecurity, and automated driving regulations.	Official regulatory approvals, homologation completion
Performance and Safety Benchmarks Met	System must pass defined safety and reliability tests (e.g., emergency braking, fail-safe response, long-duration uptime) and achieve a minimum score in independent safety assessments. Evidence of improved performance over time (e.g., 90% fewer interventions) is required.	Internal benchmark testing, third-party AV safety evaluation
User and Stakeholder Acceptance	Pilot deployments must achieve high user satisfaction (e.g., >4.5/5 survey ratings) and demonstrate user trust and repeat usage. Business deliverables must meet defined scope, quality, and critical scenario coverage as outlined in the project plan.	Post-ride surveys, stakeholder reviews, scope verification, scenario testing

Table 5: Acceptance Criteria

3.3. Benefits Realization Approach

This section outlines a structured framework to track, govern, and evaluate benefits, ensuring value is realized and maximized and also, adjustments are made as needed post-implementation.

3.3.1. Tracking and Reporting Framework

A structured Benefits Realization Management (BRM) framework will be used to measure outcomes against defined benefit metrics. Key practices include:

1. Defined Metrics: Specific KPIs for each expected benefit.
2. Baseline and Targets: Pre-launch baselines and post-launch targets for comparison.
3. Dashboards & Cadence: Regular reporting through dashboards; reviewed monthly or quarterly.
4. Benefit Ownership: Designated owners responsible for monitoring each key benefit.
5. Adaptive Management: Corrective actions taken if benefits deviate from expected targets.

3.3.2. Governance and Oversight Mechanisms

Given the high stakes of Level 4 AV development, strong multi-layered governance is essential to ensure strategic alignment, risk management, and accountability throughout the project.

1. Steering Committee: Senior leadership reviews progress, makes strategic decisions, and ensures alignment.
2. PMO Oversight: Tracks delivery, cost, risk, and timeline independently; may include external audits.
3. Safety Oversight Board: Independent expert body ensures all safety standards are met before deployment.
4. Executive Reviews: Regular updates to C-suite and investors to validate continued business value alignment.

3.3.3. Post-Implementation Review

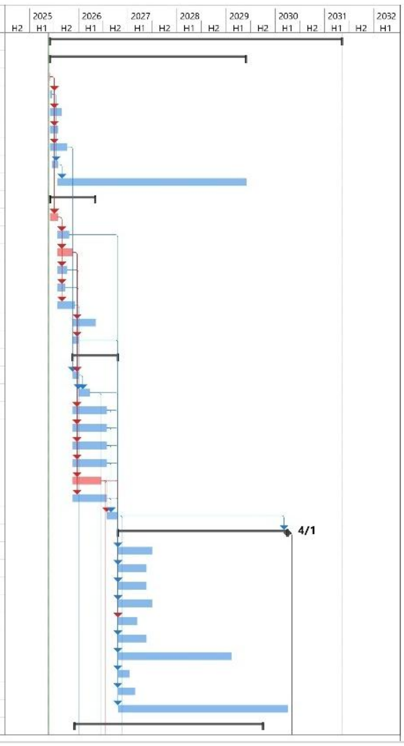
A Post-Implementation Review (PIR) will be conducted to assess whether project objectives were met and to capture key lessons for future improvement.

1. Outcome Evaluation: Compares actual vs. expected KPIs, benefits, and acceptance criteria.
2. Process Review: Analyzes what worked or didn't in execution, governance, and vendor management.
3. Benefit Verification: Checks early indicators of revenue, cost savings, and user adoption.
4. Stakeholder Feedback: Gathers qualitative insights from users, team, and partners.
5. Action Plan: Develop follow-up measures to address gaps or scale successful aspects.
6. Independent Facilitation: Ensures objectivity and transparency in PIR findings.

3.4. Gantt Charts: Project Planning

This 6-year project plan for Level 4 autonomous car development has been developed through a comparative analysis of two independently generated plans, one using GenAI 1 (Gemini) and another using GenAI 2 (ChatGPT). A third, consolidated plan was then created using the project management skills and knowledge, combined with the strongest elements of both AI-generated versions while also incorporating additional components that the AI tools had overlooked. This final plan aligns closely with the strategic and technical priorities outlined in the business case and provides a detailed comprehensive, phased roadmap from Project Initiation through Commercial Launch. It includes detailed summary tasks, sub-tasks, start and finish dates, durations, dependencies and key milestones. The original GenAI 1(Gemini) and GenAI 2(ChatGPT) plans are included in Appendix A and Appendix B, respectively.

ID	Task Name	Start	Finish	Duration	Predecessors
1	**Autonomous Car Development**	**Mon 6/2/25**	**Mon 5/12/31**	**1551 days**	
2	**Project Initiation & Management (Mid 2025)**	**Mon 6/2/25**	**Mon 5/28/29**	**1041 days**	
3	Project Kickoff	Mon 6/2/25	Mon 6/2/25	1 day	
4	Business Case Alignment & Project Plan Finalization	Tue 6/3/25	Mon 6/16/25	10 days	3
5	Core Team Hiring & Formation	Tue 6/3/25	Mon 8/25/25	60 days	3
6	Establish Development & Testing Facilities	Tue 6/3/25	Mon 7/28/25	40 days	3
7	Establish OEM/Vehicle Platform Partnership	Tue 6/3/25	Mon 10/6/25	90 days	3
8	Define Intellectual Property Strategy	Tue 6/17/25	Mon 7/28/25	30 days	4
9	Patent & IP Management (Filing & Protection)	Tue 7/29/25	Mon 5/28/29	1000 days	8
10	**Requirements & System Design (Mid/Late 2025)**	**Tue 6/3/25**	**Mon 5/4/26**	**240 days**	
11	Define System Requirements (Functional, Safety, Regulatory)	Tue 6/3/25	Mon 7/28/25	40 days	3
12	Hazard Analysis & Safety Concept (Functional Safety)	Tue 7/29/25	Mon 10/20/25	60 days	11
13	System Architecture Design (Hardware & Software)	Tue 7/29/25	Mon 11/17/25	80 days	11
14	Sensor Suite Selection & Procurement	Tue 7/29/25	Mon 10/6/25	50 days	11
15	Compute Platform Selection & Procurement	Tue 7/29/25	Mon 9/22/25	40 days	11
16	Simulation Platform Development & Integration	Tue 7/29/25	Mon 12/1/25	90 days	11
17	Develop Mapping Platform & Tools	Tue 11/18/25	Mon 5/4/26	120 days	13
18	Plan Data Management & AI Training Infrastructure	Tue 11/18/25	Mon 12/29/25	30 days	13
19	**Core Development & Integration (Late 2025–2027)**	**Tue 11/18/25**	**Mon 10/19/2(**	**240 days**	
20	Acquire Test Vehicles for Prototyping	Tue 11/18/25	Mon 12/29/25	30 days	13,7
21	Build & Instrument Prototype Vehicles (Sensor & Hardware Integratio	Tue 12/30/25	Mon 3/23/26	60 days	14,15,20
22	Perception Module Development – Initial Version	Tue 11/18/25	Mon 7/27/26	180 days	13
23	Localization & Mapping Module Development – Initial Version	Tue 11/18/25	Mon 7/27/26	180 days	13
24	Prediction Module Development – Initial Version	Tue 11/18/25	Mon 7/27/26	180 days	13
25	Planning & Decision Module Development – Initial Version	Tue 11/18/25	Mon 7/27/26	180 days	13
26	Control Module Development – Initial Version	Tue 11/18/25	Mon 6/15/26	150 days	13
27	AV Middleware/Integration Framework Development – Initial	Tue 11/18/25	Mon 7/27/26	180 days	13
28	System Integration & Vehicle Bring-up (Full Stack Integration)	Tue 7/28/26	Mon 10/19/26	60 days	22,23,24,25,26,27
29	**Prototype Vehicle Ready (Milestone)**	**Tue 10/20/26**	**Mon 4/1/30**	**900 days**	**28**
30	Perception Module Refinement & Optimization	Tue 10/20/26	Mon 6/28/27	180 days	22
31	Localization & Mapping Module Refinement	Tue 10/20/26	Mon 5/17/27	150 days	23
32	Prediction Module Refinement	Tue 10/20/26	Mon 5/17/27	150 days	24
33	Planning & Decision Module Refinement	Tue 10/20/26	Mon 6/28/27	180 days	25
34	Control Module Refinement	Tue 10/20/26	Mon 3/8/27	100 days	26
35	AV Middleware/Integration Refinement	Tue 10/20/26	Mon 5/17/27	150 days	27
36	Functional Safety Implementation (Development & Validation)	Tue 10/20/26	Mon 2/5/29	600 days	12
37	Implement Data Center / Cloud Infrastructure	Tue 10/20/26	Mon 1/11/27	60 days	18
38	Develop Data Ingestion & Labeling Pipeline	Tue 10/20/26	Mon 2/22/27	90 days	18
39	Continuous Data Collection & Model Training (Ongoing)	Tue 10/20/26	Mon 4/1/30	900 days	21
40	**Testing & Validation (2026–2028)**	**Tue 12/2/25**	**Mon 10/1/29**	**1000 days**	



ID	Task Name	Start	Finish	Duration	Predecessors
41	Continuous Simulation Testing & Validation (Ongoing)	Tue 12/2/25	Mon 10/1/29	1000 days	16
42	Closed-Course Testing (Initial Prototype)	Tue 6/16/26	Mon 9/7/26	60 days	26,21
43	**Public Road Testing Approval (Milestone)**	**Tue 9/8/26**	**Mon 11/29/2**	**320 days**	**42**
44	Public Road Testing (with Safety Drivers)	Tue 9/8/26	Mon 6/14/27	200 days	42
45	SOTIF Analysis for Unknown Scenarios	Tue 10/20/26	Mon 3/8/27	100 days	28
46	Final Safety Validation & Verification	Tue 6/15/27	Mon 11/29/27	120 days	44
47	**Driverless Pilot Deployment Approval (Milestone)**	**Mon 11/29/2**	**Mon 11/29/2**	**0 days**	**44,46**
48	**Pilot Deployment & Expansion (2028–2029)**	**Tue 9/8/26**	**Mon 9/16/30**	**1050 days**	
49	Secure Pilot Program Partnership (City/Transit Authority)	Tue 9/8/26	Mon 2/22/27	120 days	42
50	(Build) Remote Operations Center & Fleet Monitoring System	Tue 4/2/30	Mon 9/16/30	120 days	29
51	Build Pilot Fleet Vehicles (Production-Ready Hardware)	Tue 11/30/27	Mon 4/3/28	90 days	46
52	Pilot Deployment (Driverless Operation in Geofenced Area)	Tue 4/4/28	Mon 3/19/29	250 days	51,47
53	Pilot Results Evaluation & System Refinement	Tue 3/20/29	Mon 6/11/29	60 days	52
54	Expanded Pilot Deployments & Trial Operations	Tue 6/12/29	Mon 3/18/30	200 days	53
55	Commercial Deployment Regulatory Approval (Milestone)	Mon 3/18/30	Mon 3/18/30	0 days	54
56	**Commercialization & Launch Preparation (2027–2030)**	**Tue 3/19/30**	**Mon 5/12/31**	**300 days**	**54**
57	Develop Commercial Launch & Go-to-Market Strategy	Tue 4/2/30	Mon 8/19/30	100 days	29
58	Plan Manufacturing & Operations Scale-up	Tue 8/20/30	Mon 11/11/30	60 days	57
59	Marketing & Customer Outreach Campaign	Tue 3/19/30	Mon 5/12/31	300 days	52
60	Establish Customer Support & Maintenance Processes	Tue 3/19/30	Mon 5/12/31	300 days	52
61	**Commercial Launch (Milestone)**	**Mon 5/12/31**	**Mon 5/12/31**	**0 days**	**55,59,60**

Figure 1: Final Project Gantt Chart

4. Process Model

4.1. Introduction

The development of autonomous vehicles represents one of the most complex undertakings in information systems, combining advanced AI capabilities (Badue et al., 2021), stringent safety requirements (Graubohm et al., 2020), and rapidly evolving regulatory demands (Taeihagh & Lim, 2018). This complexity is further amplified by the multidisciplinary integration of hardware, software, and human factors - necessitating value-sensitive design approaches to ensure societal acceptance and public trust (Graubohm et al., 2020). Given these intertwined challenges, traditional linear (Waterfall-style) project models prove insufficient for autonomous-vehicle innovation. Instead, a robust, iterative framework - grounded in front-end feasibility studies that uncover uncertainties, prototype solutions, and reduce risks - offers greater adaptability throughout the lifecycle (McLeod, 2021). By embedding continuous learning, rapid prototyping, and risk-reduction cycles at every stage, project teams can better validate emerging technologies, align with regulatory shifts, and build the public trust essential for widespread adoption.

4.2. Additional Studies/Preparatory Work

A sequence of preparatory studies is essential to manage the high uncertainty and risk in autonomous vehicle development. Each activity de-risks the subsequent phase, informs investment decisions, and aligns with the business case's staged approach.

1. **Front-end feasibility** studies align project objectives with technical viability and evolving regulatory frameworks, minimizing costly false starts (McLeod 2021; Funder 2022; Taeihagh & Lim 2018).
2. **Proof-of-concept development** addresses critical risks such as sensor-fusion integration and real-time AI perception, providing early validation of core technologies before major capital commitments (Tajmilur Khemlani et al. 2023; Yeong et al., 2021).
3. **Iterative prototyping** supports rapid refinement, empirical testing, and stakeholder feedback, which is vital for complex R&D projects (Ilkiv, 2025; Graubohm et al., 2020).
4. **Pilot testbeds** and **structured user studies** generate crucial performance and safety data, build public acceptance, and map to regulatory approval pathways for commercial scaling (National Instruments, 2019; Graubohm et al., 2020; Taeihagh & Lim 2018).

A summary of each preparatory activity, highlighting its purpose, key outputs, cost/duration, and impact on subsequent phases, is provided in Appendix C.

4.3. Process Model Options & Rationale

Several established process models are available for complex systems engineering. Waterfall provides clear structure for well-defined projects but lacks the adaptability needed for dynamic, high-uncertainty environments. Agile methods promote iterative delivery and rapid stakeholder feedback, but can fall short in safety-critical domains without added governance. The Spiral model, recognized for its focus on risk analysis and prototyping, is well-suited for R&D-driven projects with evolving requirements. The V-Model emphasizes verification and validation, supporting compliance but often at the expense of flexibility.

For this autonomous-vehicle program, a **hybrid Spiral-Agile** model is recommended, because it:

1. De-risks AI-perception integration through low-cost, iterative proof-of-concepts of vision-based obstacle-detection prototypes (Tajmilur Khemlani et al., 2023).
2. Mitigates sensor-fusion technical risk via early multi-sensor calibration and integration tests that validate foundational perceptual inputs before full-system fusion (Yeong et al., 2021).
3. Supports staged investment allocation across feasibility, prototyping, and validation phases—aligning budget commitments with discrete deliverables and milestone gates (Funder, 2022).
4. Enables early regulatory engagement by mapping requirements to emerging compliance frameworks and adapting iteratively to evolving standards (Taeihagh & Lim, 2018); and embeds value-sensitive, iterative adaptation to integrate stakeholder values throughout development (Graubohm et al., 2020).

4.4. Proposed Process Model: Spiral-Agile Hybrid

The Spiral-Agile hybrid process is tailored for the unique complexity, high-safety standards, and staged risk profile of autonomous-vehicle development. Each spiral loop corresponds to a project stage, mapping directly to the business case's annual milestones and staged investment plan (Funder, 2022). Major technical, regulatory, and market risks are systematically reduced through iterative learning, targeted PoCs, and phase-gate reviews. **Key features of the Spiral-Agile model include:**

1. **Iterative, risk-driven cycles -** Each loop targets top-priority risks - sensor fusion (Yeong et al., 2021), AI perception (Tajmilur Khemlani et al., 2023), and regulatory alignment (Taeihagh & Lim, 2018) - via focused PoCs and prototypes.
2. **Agile sprints -** Within each spiral iteration, time-boxed sprints drive rapid prototyping, continuous integration, and early stakeholder feedback - expediting refinement and de-risking innovation.
3. **Early regulatory engagement -** A lightweight regulatory PoC in the first cycle surfaces compliance gaps and secures early feedback from certification bodies (Taeihagh & Lim, 2018).
4. **Hardware-in-the-Loop (HiL) and digital-twin testbeds -** HiL frameworks validate integration and performance under realistic conditions, while digital twins enable virtual validation of system behavior - minimizing late-stage surprises (National Instruments, 2019; Tajmilur Khemlani et al., 2023).

Phase	Main Activities	Cost/Duration	KPI/Success Criteria	Top Risks Addressed	Tools/Outputs
1. Feasibility & Planning	Tech, regulatory, ops feasibility; regulatory PoC	$100 M / Yr 1	Go/no-go; baseline safety targets	Market fit; early compliance	Feasibility report; Reg PoC
2. Risk Analysis & PoC	Sensor fusion, AI PoCs, digital-twin test	$240 M / Yr 2	PoC: <0.1 s hazard response; regulator feedback	Sensor/AI; regulatory; integration	PoC demos; risk log
3. Agile Dev/Prototyping	Iterative build; HiL; sprint testing; stakeholder input	$300 M / Yr 3–4	Prototype built; <5 % budget variance	Supply chain; system integration	Prototype vehicles; sprint logs
4. Testing & Evaluation	Simulation; HiL; pilot; real-world validation	$300 M / Yr 5	≥ 99.9 % detection; 20,000 mi/disengagement	Performance; reliability	Test reports; pilot data
5. Regulatory & Feedback	Compliance; acceptance; public/user feedback	$60 M / Yr 6	Regulatory sign-off; > 4.5 / 5 user rating	Late-stage regulatory; public trust	Reg docs; survey results

Table 6: Spiral-Agile Model Phases and Alignment with Business Case

This process ensures**:**

1. **Budget & timeline alignment -** Each phase's budget matches the staged investment plan from the business case (Funder, 2022).
2. **KPI validation -** Each phase unlocks a clearly defined business case KPI (e.g., hazard-response latency; detection accuracy) as proof of milestone achievement.
3. **Risk reduction -** Phases directly target and close the top project-specific risks through dedicated PoCs and prototypes.
4. **Regulatory engagement -** Early and ongoing regulator involvement supports compliance throughout development (Taeihagh & Lim, 2018).
5. **Adaptive governance -** Frequent gate reviews and adaptive sprints maintain stakeholder alignment and enable rapid adjustment to new insights or evolving regulatory requirements (National Instruments, 2019).

4.5. Process Model Diagram Description

The process model diagram below illustrates the Spiral-Agile hybrid approach, where each phase represents a critical cycle in the autonomous vehicle project. Key activities, decision points, and deliverables for each phase are summarized in the table above - including details on cost, key performance indicators (KPIs), and top risks addressed per cycle.

Within the diagram, **red diamond shapes mark "phase-gate" decision points**: these gates require the project to meet specific criteria - such as achieving target KPIs, closing critical risks, and remaining within budget - before proceeding to the next phase. If any gate is not passed, the process loops back for further iteration and improvement. Agile sprints are depicted within the development phase to highlight rapid prototyping and stakeholder engagement. Once all gates are successfully passed, the project advances to deployment and scale-up. This visual workflow ensures clear governance, accountability, and direct alignment with the business plan.

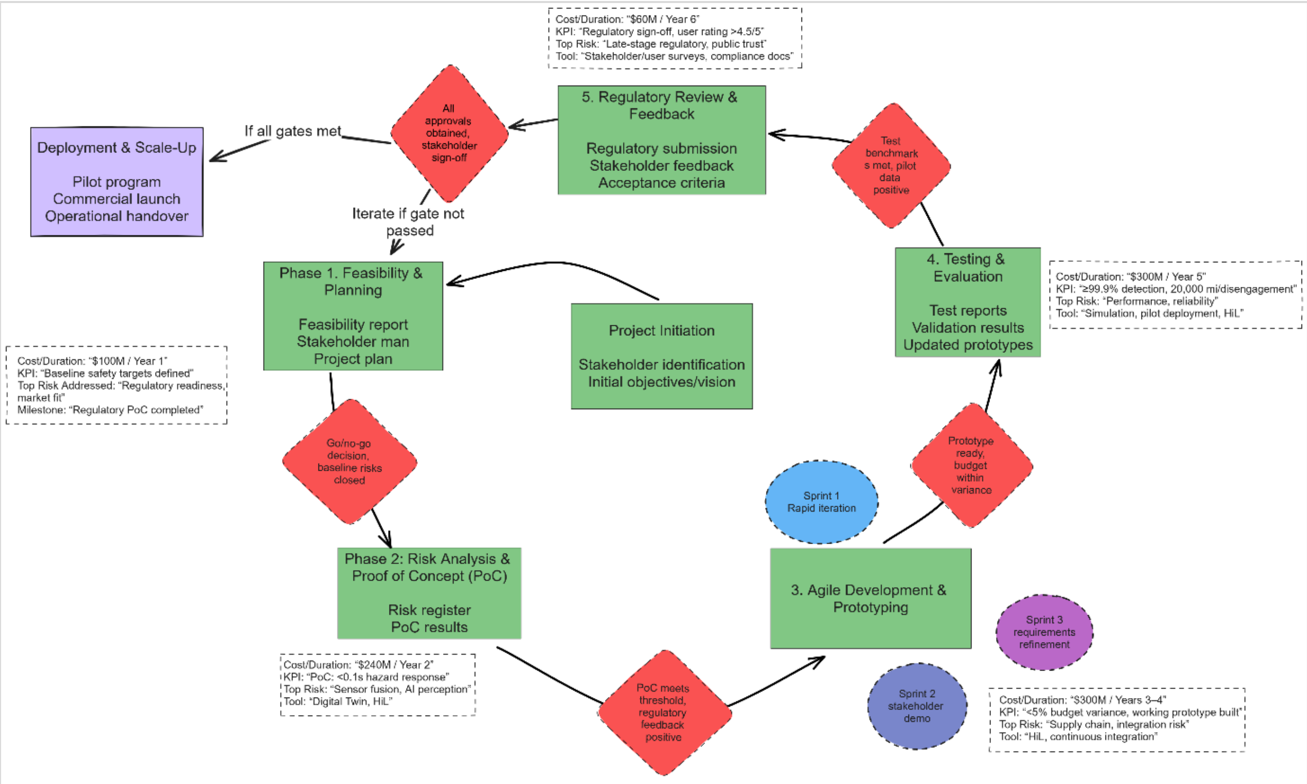


Figure 2: Process Model Diagram

5. Risk Management Plan

Developing a Level 4 autonomous vehicle entails managing complex, project-specific risks, particularly those associated with advanced AI systems, high-precision sensor integration, and evolving safety regulations. This section presents a consolidated risk management strategy developed by the project team to directly address the unique challenges of Level 4 AV deployment. It overcomes key limitations identified in two preliminary AI-generated drafts (Gemini and ChatGPT), which offered only surface-level insights and lacked stakeholder realism, contextual depth, and financially grounded mitigation strategies.

The final plan aligns closely with the priorities set out in the business case: safeguarding the $2 billion investment, ensuring regulatory compliance, and building public trust. It adheres to ISO 31000 principles and applies structured procedures for risk identification, assessment, treatment, monitoring, and response. Each mitigation action is designed to be both practical and cost-justified, ensuring the project's long-term viability, safety, and operational resilience.

5.1. Risk Identification

The risks in this project were identified through a structured analysis of autonomous vehicle (AV) subsystems, including sensor integration, AI behavior, localization, and inter-vehicle communication. A bottom-up analysis was applied to identify specific failure points that may affect safety, performance, or compliance (ISO, 2018). All risks are directly linked to AV technologies and testing environments.

To support this process, a Risk Breakdown Structure (RBS) was developed to categorize project-specific threats by their root causes. This classification ensured a comprehensive scan across technical, operational, and regulatory domains. The RBS helped in organizing risks logically before their assessment and treatment in subsequent stages.

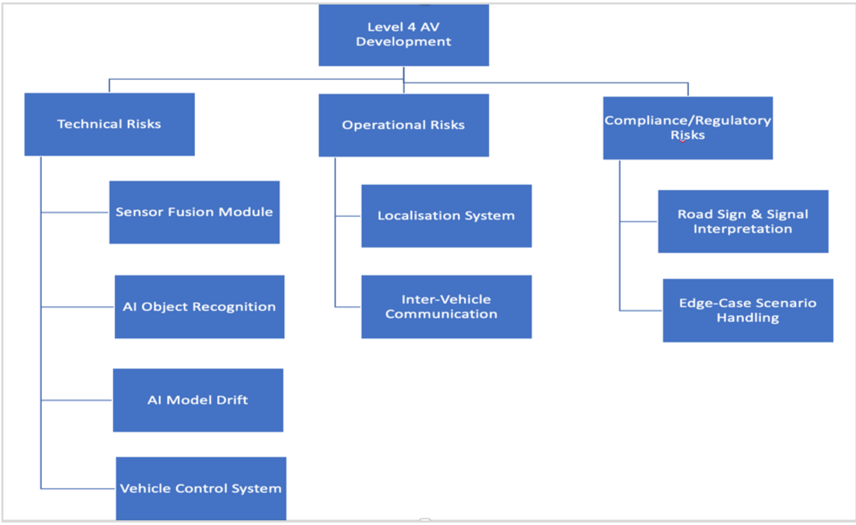


Figure 3: Risk Breakdown Structure (RBS) for Level 4 AV Development

5.2. Risk Register

Risk ID	Source	Event	Consequence	Likelihood	Impact	Existing Controls	Initial Risk Rating
R1	Sensor Fusion Module	Failure to merge sensor inputs accurately in dense urban settings	Unsafe manoeuvres; invalidates test results in key metro zones	Medium	High	Real-time system checks and testing in complex traffic environments	High
R2	AI Object Recognition	Inability to detect or classify rare or ambiguous road users	Accidents or legal challenges due to misinterpretation of user intent	High	High	Use of large, diverse training datasets and regular model testing for edge cases	High
R3	Driving Model Training Data	Data drift in AI model due to unseen or evolving road conditions	Degradation of AV performance over time; requires retraining	Medium	Medium	Scheduled reviews of AV performance and retraining when performance drops	Medium
R4	Localization System	GPS and navigation loses accuracy in tunnels or obstructed areas	Localization failure, triggering fallback or unsafe stops	Medium	Medium	Use of alternative navigation methods like stored maps and proximity sensors	Medium
R5	Road Sign & Signal Interpretation	AV misinterprets region-specific signs or lights	Non-compliance with road laws; test vehicle rejection by local authorities	Medium	Medium	Localised testing and regional data training before deployment	Medium
R6	Edge-Case Scenario Handling	Poor decisions in rare social or rule-exception events	Unpredictable or socially inappropriate AV behaviour on public roads	Low	High	Scenario-based simulation and review of past rare incidents	Medium
R7	Vehicle Control System	Inability to make real-time decisions at high speeds	Increased crash risk and inability to pass safety benchmarks	Medium	High	High-speed test runs in controlled environments before public trials	High
R8	Inter-vehicle Communication Module	Delay or failure in AV-to-AV communication during fleet trials	Coordination failures; safety and efficiency breakdowns	Low	Medium	Regular testing of communication systems and use of backup signals	Medium

Figure 4: Risk Register for Level 4 AV Development

5.3. Qualitative Risk Analysis

Each risk was assessed using a 3×3 matrix following ISO 31000 standards, with likelihood and impact rated as Low, Medium, or High. Initial risk ratings in the Risk Register were derived from these values to prioritize risks by severity and support informed treatment planning. This qualitative approach enables the project team to visually categorize risks and focus resources on those with the highest potential to disrupt safety, compliance, or schedule. The assessment also guided the selection of appropriate treatment strategies, ensuring that mitigation efforts were proportional to the assessed threat level. The matrix provides a consistent framework for ongoing risk review throughout the project lifecycle.

Impact \ Probability	Low	Medium	High
Low			
Medium	Risk 8(R8)	Risk 3(R3) Risk 4(R4) Risk 5(R5)	
High	Risk 6(R6)	Risk 1(R1) Risk 7(R7)	Risk 2(R2)

Figure 5: Qualitative 3×3 Risk Assessment Matrix

5.4. Risk Treatment Plan

For each identified project-specific risk, a targeted treatment strategy has been proposed to reduce its likelihood, impact, or both. The selected treatments focus primarily on mitigation through technical adjustments, testing enhancements, and data improvements. Responsibilities, cost justifications, and the expected effectiveness of each treatment were also assessed. Cost estimates were based on benchmarking autonomous vehicle R&D investments and guidance from industry sources.

1. **Sensor Fusion Testing** - For example, the $500,000 allocated for sensor fusion testing covers both hardware and deployment-related costs. Two prototype vehicles, each equipped with a full sensor suite - LiDAR, radar, and cameras - are estimated at $100,000 each (Tran, 2025), totaling $200,000. The remaining $300,000 accounts for simulation platform access, technical personnel for test execution, and post-test data analysis to refine the fusion algorithm (Intuition, 2024). These resources support iterative testing in complex urban environments to ensure system performance and safety.
2. **AI Perception: Bias and Misclassification Risks** - Similarly, $600,000 is allocated to address the risk of object misclassification and algorithmic bias in AI perception. This includes the acquisition of rare and edge-case datasets, the use of synthetic data tools, and the engagement of a third-party AI ethics auditor. These measures enhance the AV's ability to recognize diverse road users and minimize the risk of accidents, legal issues, or certification delays (Galvao & Huda). Investing in data quality and fairness validation at this stage not only reduces reputational and compliance risks but also supports public trust and long-term adoption of Level 4 autonomy (Matin & Dia, 2024).
3. **AI Model Drift Management** - For AI model drift (R3), $400,000 is budgeted for real-time performance monitoring and periodic retraining using real-world driving data.

While individual treatment costs vary, all are strategically aligned with the severity of the associated risks. Collectively, these efforts target high-priority technical threats that could otherwise compromise safety, compliance, and public trust, ensuring proactive alignment with project objectives. The table 7 below summarizes each risk alongside its treatment strategy, treatment type, responsible party, cost rationale, expected effectiveness, and residual risk rating after mitigation.

Risk ID	Treatment Strategy	Treatment Type	Responsible Party	Cost Justification	Effectiveness	Residual Risk Rating
R1	Improve fusion algorithms; conduct extensive urban testing under varied conditions	Mitigation	Sensor Systems Lead	$500K avoids delays in city test approval	High	Medium
R2	Expand dataset to include rare objects; perform bias audit of recognition model	Mitigation	AI Perception Team	$600K reduces risk of legal/regulatory action	High	Low
R3	Implement AI model drift monitoring; retrain with real-world feedback regularly	Mitigation	Machine Learning Engineer	$400K ensures stable AV performance in dynamic conditions	Medium	Low
R4	Integrate HD maps; simulate GPS outages during validation phases	Mitigation	Navigation & Mapping Lead	$300K reduces navigation failure risks in tunnels or dense zones	Medium	Low
R5	Train model with region-specific signage; conduct cross-region driving simulations	Mitigation	Compliance & Training Officer	$350K improves regulatory acceptance across jurisdictions	Medium	Low
R6	Use scenario-based simulation for rare cases; consult with ethics advisory board	Mitigation	AV Strategy and Testing Team	$450K ensures socially acceptable AV behaviour	High	Low
R7	Test AV response at high speeds under varied traffic densities	Mitigation	Vehicle Control Specialist	$500K ensures reliability at critical speeds	High	Medium
R8	Improve V2V protocol reliability and introduce fallback messaging system	Mitigation	Communications Engineer	$400K ensures smooth AV fleet coordination	Medium	Low

Table 7: Risk Treatment Plan

5.5. Risk Monitoring and Review

Risk monitoring will be embedded into the overall project governance structure to ensure early detection of emerging issues and the effectiveness of applied treatments. The Project Manager will oversee regular risk reviews at key project milestones, supported by the use of dashboards and risk logs maintained within the PMO. High-priority risks will be tracked continuously, while residual risks will be re-evaluated quarterly to determine if further treatment is required. Internal audits and feedback from testing teams will support adaptive risk response and continuous improvement, consistent with ISO 31000 recommendations for active risk oversight.

5.6. Controls and Mitigation

To support the effectiveness of risk treatments and ensure risks remain within acceptable thresholds, a multi-layered control strategy has been implemented. These controls span technical, procedural, and external domains:

1. **Technical controls** include system fail-safes, explainable AI modules for improved decision transparency, automated logging for traceability, and penetration testing to identify security vulnerabilities.
2. **Procedural controls** involve formal ethics reviews, stakeholder consultation during critical phases, and version control systems to track changes in software and AI models.
3. **External controls** include independent third-party safety audits, regulatory pre-approvals, and alignment with global AV safety standards.

These controls are embedded into the project workflow and integrated with monitoring and escalation systems. Together, they help ensure that residual risks remain within tolerance levels and that treatments continue to be effective throughout the AV development lifecycle.

5.7. Resource and Budget Alignment

To ensure consistent execution and oversight of risk strategies, a total of $3.5 million has been allocated to project-wide risk mitigation and monitoring. This figure reflects both financial and staffing resources dedicated to supporting safety-critical areas, such as AI validation, simulation testing, and compliance assurance. Rather than funding isolated treatments, this allocation supports integrated, cross-functional efforts embedded across technical, regulatory, and governance teams.
Although this represents less than 0.2% of the total $2 billion project budget, it is proportionate to the potential losses avoided and adheres to ISO 31000's principle of cost-effective, scalable risk treatment. The inclusion of dedicated roles within project teams further ensures that risk controls are implemented, monitored, and escalated effectively throughout the development lifecycle.

5.8. Response Planning

Despite proactive treatment and continuous monitoring, some risks may still materialize. To manage such scenarios, an Incident Response Framework has been established. Each high-priority risk is assigned to a designated owner responsible for initiating the appropriate response if predefined escalation triggers are met. In the event of critical incidents such as sensor failure during testing or regulatory non-compliance, the response will include immediate containment actions, internal reporting, and, where applicable, regulatory notification or public disclosure. A root cause analysis will be conducted for all significant events to identify underlying issues and inform updates to the risk register and control mechanisms. Lessons learned will be captured and integrated into the project's continuous improvement process. This structured approach ensures organizational readiness, accountability, and alignment with regulatory expectations throughout the autonomous vehicle development lifecycle. The diagram below summarizes the key stages of the project's incident response process.

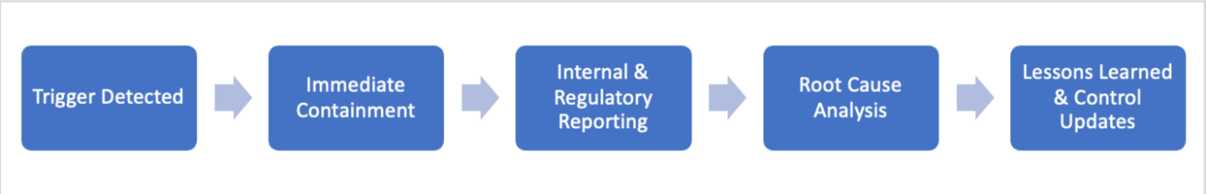


Figure 6: Incident Response Framework for AV Development Risk Events

6. Conclusion and Future Directions

This report reviewed and assessed three different project plans for developing a Level 4 autonomous car. Two of the plans were created using generative AI tools: Plan A using Gemini and Plan B using ChatGPT. A third, hybrid plan, Plan C, was developed by integrating the strongest elements from the AI-generated drafts with human-led project management expertise and additional components critical for real-world execution. After comparing all three plans across criteria such as technical clarity, realistic timelines, risk handling, regulatory fitness, and stakeholder needs, Plan C is recommended as the most suitable and balanced approach.

6.1. Comparison Summary

1. **Plan A, developed using Gemini**, showcased a strong technical framework and effectively used AI to generate detailed Gantt charts and identify standard dependencies. However, it lacked nuance in project-specific risk recognition and governance. Key milestones, such as those related to regulatory approvals, were overly optimistic and didn’t reflect real-world complexity.
2. **Plan B, created using ChatGPT**, delivered a more thorough process map and demonstrated greater sensitivity to stakeholder priorities. Yet, it still generalized risk treatment and fell short in financial modelling, particularly in accommodating cost variations and resource uncertainties.
3. **Plan C, the hybrid plan**, stood out by blending AI-generated efficiencies with human judgment. It adopted a Spiral-Agile hybrid lifecycle that aligned better with the staged investment approach, regulatory uncertainties, and the reliability required in AV development. By taking the best elements from the AI plans and enriching them with contextual understanding, tailored risk treatment, and stakeholder trust-building strategies, Plan C provided a grounded and adaptable roadmap.

6.2. Recommendation Rationale

Plan C offers the most practical, well-supported, and regulator-ready roadmap. It effectively leverages AI’s strengths, such as task automation, pattern recognition, and scheduling speed, while overcoming typical AI limitations in contextual judgement, ethics, and nuanced risk management. Key features include the following:

1. Built-in phase gates and regulatory proof-of-concept checkpoints.
2. Customized risk treatment aligned with ISO 31000 and safety-critical standards.
3. A strong emphasis on stakeholder communication and trust.
4. Financial realism and operational flexibility, supported by adaptive planning cycles.

This hybrid approach positions the project for sustainable innovation in a high-stakes environment, ensuring compliance, reliability, and market relevance.

6.3. Future Directions: The Role of AI in Project Delivery

From the consultant’s perspective, AI is not a replacement but is a powerful accelerator in delivering complex, high-accountability projects like autonomous vehicle development. AI excels at generating draft schedules, identifying common risk patterns, and running multi-scenario simulations with increasing sophistication. However, it still falls short when:

1. Contextual judgement is required.
2. Ethical implications are involved.
3. Governance and stakeholder sensitivities need careful handling.

Looking ahead, it is anticipated that hybrid delivery models will become the standard. In these models:

1. AI handles routine and structured tasks, like work breakdown structures (WBS), timeline generation, and initial cost modelling.
2. Humans lead in risk governance, ethical decision-making, stakeholder engagement, and adapting plans based on emerging realities.

As AI capabilities mature and become more embedded in enterprise tools and PMO platforms, their role will grow. Yet, human oversight will remain critical, especially in projects where safety, public trust, and regulatory scrutiny are central.

6.4. Key Persuasion Factors

The decision to recommend Plan C, along with a human-led approach, was based on several key considerations:

1. The real-world deployment of AI in safety-critical domains requires rigorous ethical responsibility and oversight.
2. Risk treatment must be customized and aligned with established standards such as ISO 31000.
3. Public and regulatory trust is essential and cannot be secured through automation alone.

AI provides the greatest value when applied selectively and thoughtfully, serving to support, rather than replace, expert-led judgment.

6.5. Final Thought

AI is a transformative force in project management, but when the stakes involve lives, trust, and large investments, the human factor remains irreplaceable. Plan C embraces the best of both worlds, speed and structure from AI, contextual intelligence from humans, delivering a resilient and future-proof roadmap.

References

AWS & SBD Automotive (2021) 'The Hidden Costs of Software-Defined Vehicles', Amazon Web Services. Available at: https://pages.awscloud.com/rs/112-TZM-766/images/Hidden-costs-of-software-defined-vehicles-2_3P.pdf (Accessed: 6 May 2025).

Badue, C., Guidolini, R., Carneiro, R. V., Azevedo, P., Cardoso, V. B., Forechi, A., Jesus, L., Berriel, R., Paixao, T. M., Mutz, F. and de Paula Veronese, L. (2021) 'Self-driving cars: A survey', Expert Systems with Applications, 165, p. 113816. doi:10.1016/j.eswa.2020.113816.

Funder, M. (2022) Automotive Feasibility Study – 4 steps to validate your vision, Magna. Available at: https://www.magna.com/stories/inside-automotive/vision-to-reality/automotive-feasibility-study (Accessed: 22 May 2025).

Galvao, L. G. and Huda, M. N. (2024) 'Pedestrian and vehicle behaviour prediction in Autonomous Vehicle System — A Review', Expert Systems with Applications, 238, p. 121983. doi:10.1016/j.eswa.2023.121983.

Graubohm, R., Schräder, T. and Maurer, M. (2020) 'Value sensitive design in the development of driverless vehicles: A case study on an autonomous family vehicle', Proceedings of the Design Society: DESIGN Conference, 1, pp. 907–916. doi:10.1017/dsd.2020.140.

Ilkiv, I. (2025) Automotive Product Design and Development: Navigating the Road to Innovation, Insoftex. Available at: https://insoftex.com/automotive-product-design-and-development/ (Accessed: 22 May 2025).

Intuition (2024) Cost-efficient simulation in the cloud: Applied intuition, Cost-Efficient Simulation in the Cloud: Paving the Way for Scalable Autonomy. Available at: https://www.appliedintuition.com/blog/cost-efficient-simulation-in-the-cloud (Accessed: 20 May 2025).

ISO (2018) ISO 31000:2018, ISO. Available at: https://www.iso.org/standard/65694.html (Accessed: 20 May 2025).

Kröger, F. (2016) 'Automated Driving in Its Social, Historical and Cultural Contexts', in Autonomous Driving. Springer, Berlin, Heidelberg, pp. 41–68. Available at: https://doi.org/10.1007/978-3-662-48847-8_3.

Marsh, A. (2025) 'Past Forward: The Starting Line for Self-Driving Cars: 20 Years Ago, Stanley Won the DARPA Grand Challenge, But the Tech is Still Niche', IEEE Spectrum, (ON), pp. 1–4.

Matin, A. and Dia, H. (2024) 'Public perception of connected and automated vehicles: Benefits, concerns, and barriers from an Australian perspective', Journal of Intelligent and Connected Vehicles, 7(2), pp. 108–128. doi:10.26599/jicv.2023.9210028.

McLeod, S. (2021) 'Feasibility Studies for novel and Complex Projects: Principles synthesised through an Integrative Review', Project Leadership and Society, 2, p. 100022. doi:10.1016/j.plas.2021.100022.

Mueller, A. S., Cicchino, J. B. and Zuby, D. S. (2020) 'What humanlike errors do autonomous vehicles need to avoid to maximize safety?', Journal of Safety Research, 75, pp. 310–318. Available at: https://doi.org/10.1016/j.jsr.2020.10.005.

National Instruments (2019) Build smart prototypes for autonomous and Connected Cars, IEEE Spectrum. Available at: https://spectrum.ieee.org/build-smart-prototypes-for-autonomous-and-connected-cars (Accessed: 22 May 2025).

Salimimoghadam, S. et al. (2025) 'The Rise of Artificial Intelligence in Project Management: A Systematic Literature Review of Current Opportunities, Enablers, and Barriers', Buildings, 15(7), p. 1130. Available at: https://doi.org/10.3390/buildings15071130.

Taeihagh, A. and Lim, H. S. (2018) 'Governing Autonomous Vehicles: Emerging Responses for safety, liability, privacy, cybersecurity, and industry risks', Transport Reviews, 39(1), pp. 103–128. doi:10.1080/01441647.2018.1494640.

Tajmilur Khemlani, T., Xing, Y. and Shin, H.-S. (2023) 'Development and feasibility study of an autonomous obstacle detection system for landing operations', Lecture Notes in Networks and Systems, pp. 183–200. doi:10.1007/978-3-031-26889-2_17.

Thrun, S. et al. (2006) 'Stanley: The robot that won the DARPA Grand Challenge', Journal of Field Robotics, 23(9), pp. 661–692. Available at: https://doi.org/10.1002/rob.20147.

Tran, B. (2025) The cost of self-driving technology: How much do AV components really cost? (market breakdown), PatentPC. Available at: https://patentpc.com/blog/the-cost-of-self-driving-technology-how-much-do-av-components-really-cost-market-breakdown (Accessed: 20 May 2025).

Trustworthy AI (2021) 'Keeping Score: Evaluating Safety Metrics for Autonomous Vehicles', Trustworthy AI, 7 May. Available at: https://trustworthy.ai/2021/05/07/keeping-score.html (Accessed: 6 May 2025).

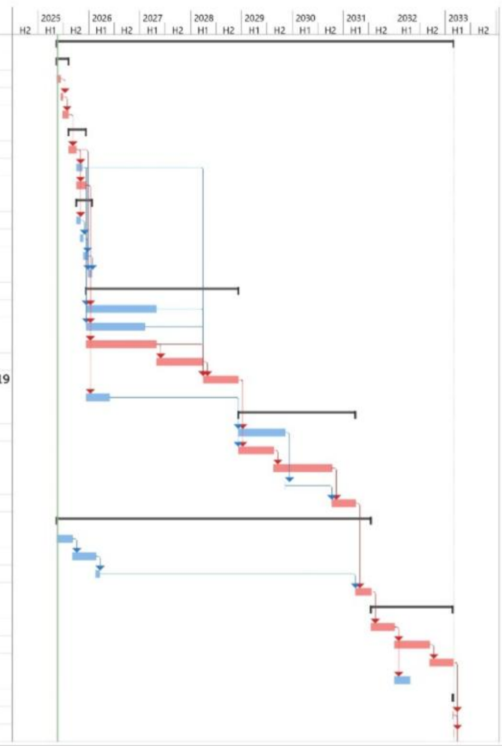
Yeong, D. J. et al. (2021) 'Sensor and Sensor Fusion Technology in autonomous vehicles: A Review', Sensors, 21(6), p. 2140. doi:10.3390/s21062140.

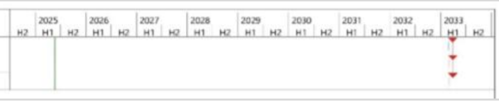
Zoting, S. (2025) 'Autonomous Vehicle Market Size to Surpass USD 4450.34 Bn by 2034', Precedence Research, 31 March. Available at: https://www.precedenceresearch.com/autonomous-vehicle-market (Accessed: 6 May 2025).

Appendices

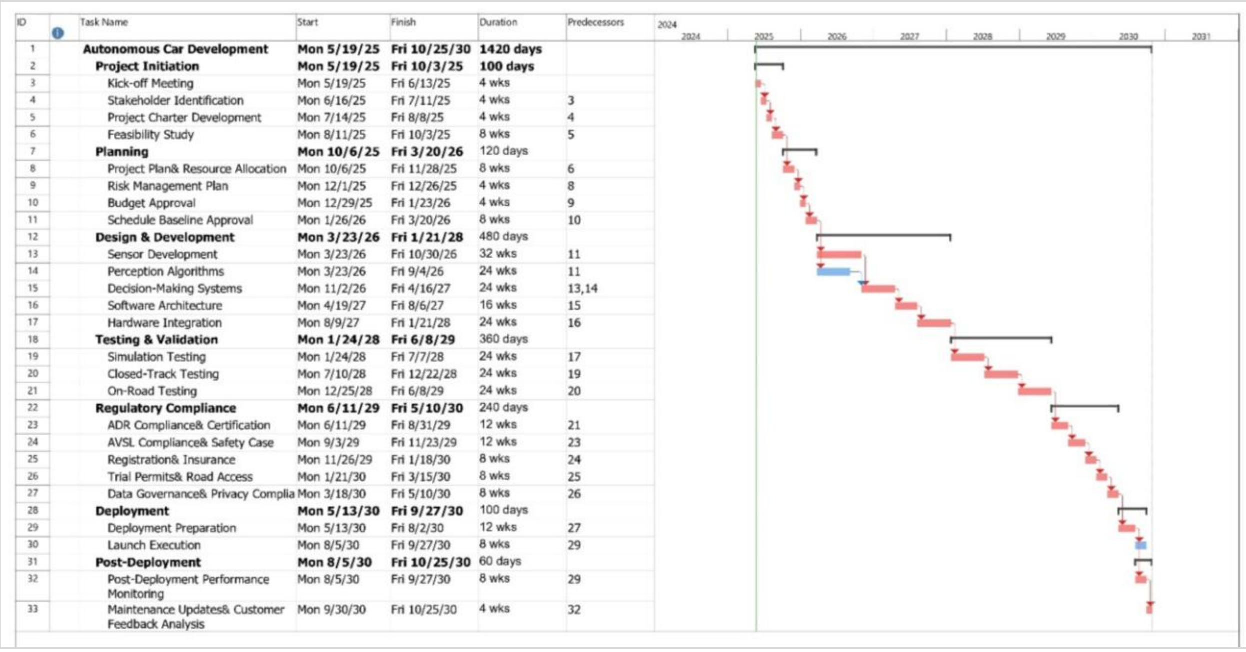
Appendix A: Gantt Chart 1: Google Gemini Generated Plan

ID	Task Name	Duration	Start	Finish	Predecessors
1	**Autonomous Car Development**	**2032 days**	**Fri 5/16/25**	**Mon 2/28/33**	
2	**Project Initiation**	**60 days**	**Fri 5/16/25**	**Thu 8/7/25**	
3	Define Project Scope and Objectives	4 wks	Fri 5/16/25	Thu 6/12/25	
4	Establish Project Team and Governance Structure	2 wks	Fri 6/13/25	Thu 6/26/25	3
5	Initial Feasibility Study and Technology Assessment	6 wks	Fri 6/27/25	Thu 8/7/25	4
6	**Planning**	**90 days**	**Fri 8/8/25**	**Thu 12/11/25**	
7	Develop Detailed System Architecture	8 wks	Fri 8/8/25	Thu 10/2/25	5
8	Define Sensor Suite Requirements and Selection	6 wks	Fri 10/3/25	Thu 11/13/25	7
9	Develop Software Requirements and Specifications	10 wks	Fri 10/3/25	Thu 12/11/25	7
10	**Risk Management**	**80 days**	**Fri 10/3/25**	**Thu 1/22/26**	
11	Identify Potential Risks	4 wks	Fri 10/3/25	Thu 10/30/25	7
12	Analyze and Prioritize Risks	3 wks	Fri 10/31/25	Thu 11/20/25	11
13	Develop Risk Mitigation and Contingency Plans	5 wks	Fri 11/21/25	Thu 12/25/25	12
14	Create Detailed Project Schedule and Budget	4 wks	Fri 12/26/25	Thu 1/22/26	7,8,13
15	**Design and Development**	**780 days**	**Fri 12/12/25**	**Thu 12/7/28**	
16	Develop Perception System	18 mons	Fri 12/12/25	Thu 4/29/27	8,9
17	Develop Localization and Mapping System	15 mons	Fri 12/12/25	Thu 2/4/27	8,9
18	Develop Path Planning and Decision-Making System	18 mons	Fri 12/12/25	Thu 4/29/27	9
19	Develop Vehicle Control System	12 mons	Fri 4/30/27	Thu 3/30/28	18
20	Integrate Software Modules and Hardware Components	9 mons	Fri 3/31/28	Thu 12/7/28	8,16,17,18,19
21	Develop Human-Machine Interface (HMI)	6 mons	Fri 12/12/25	Thu 5/28/26	9
22	**Testing and Validation**	**600 days**	**Fri 12/8/28**	**Thu 3/27/31**	
23	Simulation Testing	12 mons	Fri 12/8/28	Thu 11/8/29	20,21
24	Closed-Track Testing	9 mons	Fri 12/8/28	Thu 8/16/29	20,21
25	Public Road Testing with Safety Driver	15 mons	Fri 8/17/29	Thu 10/10/30	24
26	Data Logging and Analysis	1 day	Fri 11/9/29	Fri 11/9/29	23
27	Validation of Safety and Reliability	6 mons	Fri 10/11/30	Thu 3/27/31	25,26
28	**Regulatory Compliance**	**1610 days**	**Fri 5/16/25**	**Thu 7/17/31**	
29	Identify Applicable Regulations and Standards	4 mons	Fri 5/16/25	Thu 9/4/25	
30	Develop Compliance Strategy and Documentation	6 mons	Fri 9/5/25	Thu 2/19/26	29
31	Engage with Regulatory Agencies	17 days	Fri 2/20/26	Mon 3/16/26	30
32	Conduct Independent Safety Assessments and Audits	4 mons	Fri 3/28/31	Thu 7/17/31	27,31
33	**Deployment**	**420 days**	**Fri 7/18/31**	**Thu 2/24/33**	
34	Secure Necessary Permits and Approvals	6 mons	Fri 7/18/31	Thu 1/1/32	32
35	Establish Deployment Infrastructure and Processes	9 mons	Fri 1/2/32	Thu 9/9/32	34
36	Pilot Deployment and Initial Service Launch	6 mons	Fri 9/10/32	Thu 2/24/33	35
37	Public Awareness and Education Campaign	4 mons	Fri 1/2/32	Thu 4/22/32	34
38	**Post-Deployment**	**2 days**	**Fri 2/25/33**	**Mon 2/28/33**	
39	Ongoing Monitoring and Performance Evaluation	1 day	Fri 2/25/33	Fri 2/25/33	36
40	Software Updates and System Enhancements	1 day	Mon 2/28/33	Mon 2/28/33	39
41	Fleet Maintenance and Management	1 day	Fri 2/25/33	Fri 2/25/33	36
42	Data Analysis and Reporting	1 day	Mon 2/28/33	Mon 2/28/33	39
43	Monitor and Control Risks	1 day	Mon 2/28/33	Mon 2/28/33	39





Appendix B: Gantt Chart 2: ChatGPT Generated Plan



ID	Task Name	Start	Finish	Duration	Predecessors
1	**Autonomous Car Development**	**Mon 5/19/25**	**Fri 10/25/30**	**1420 days**	
2	**Project Initiation**	**Mon 5/19/25**	**Fri 10/3/25**	**100 days**	
3	Kick-off Meeting	Mon 5/19/25	Fri 6/13/25	4 wks	
4	Stakeholder Identification	Mon 6/16/25	Fri 7/11/25	4 wks	3
5	Project Charter Development	Mon 7/14/25	Fri 8/8/25	4 wks	4
6	Feasibility Study	Mon 8/11/25	Fri 10/3/25	8 wks	5
7	**Planning**	**Mon 10/6/25**	**Fri 3/20/26**	120 days	
8	Project Plan& Resource Allocation	Mon 10/6/25	Fri 11/28/25	8 wks	6
9	Risk Management Plan	Mon 12/1/25	Fri 12/26/25	4 wks	8
10	Budget Approval	Mon 12/29/25	Fri 1/23/26	4 wks	9
11	Schedule Baseline Approval	Mon 1/26/26	Fri 3/20/26	8 wks	10
12	**Design & Development**	**Mon 3/23/26**	**Fri 1/21/28**	480 days	
13	Sensor Development	Mon 3/23/26	Fri 10/30/26	32 wks	11
14	Perception Algorithms	Mon 3/23/26	Fri 9/4/26	24 wks	11
15	Decision-Making Systems	Mon 11/2/26	Fri 4/16/27	24 wks	13,14
16	Software Architecture	Mon 4/19/27	Fri 8/6/27	16 wks	15
17	Hardware Integration	Mon 8/9/27	Fri 1/21/28	24 wks	16
18	**Testing & Validation**	**Mon 1/24/28**	**Fri 6/8/29**	360 days	
19	Simulation Testing	Mon 1/24/28	Fri 7/7/28	24 wks	17
20	Closed-Track Testing	Mon 7/10/28	Fri 12/22/28	24 wks	19
21	On-Road Testing	Mon 12/25/28	Fri 6/8/29	24 wks	20
22	**Regulatory Compliance**	**Mon 6/11/29**	**Fri 5/10/30**	240 days	
23	ADR Compliance& Certification	Mon 6/11/29	Fri 8/31/29	12 wks	21
24	AVSL Compliance& Safety Case	Mon 9/3/29	Fri 11/23/29	12 wks	23
25	Registration& Insurance	Mon 11/26/29	Fri 1/18/30	8 wks	24
26	Trial Permits& Road Access	Mon 1/21/30	Fri 3/15/30	8 wks	25
27	Data Governance& Privacy Complia	Mon 3/18/30	Fri 5/10/30	8 wks	26
28	**Deployment**	**Mon 5/13/30**	**Fri 9/27/30**	100 days	
29	Deployment Preparation	Mon 5/13/30	Fri 8/2/30	12 wks	27
30	Launch Execution	Mon 8/5/30	Fri 9/27/30	8 wks	29
31	**Post-Deployment**	**Mon 8/5/30**	**Fri 10/25/30**	60 days	
32	Post-Deployment Performance Monitoring	Mon 8/5/30	Fri 9/27/30	8 wks	29
33	Maintenance Updates& Customer Feedback Analysis	Mon 9/30/30	Fri 10/25/30	4 wks	32

Appendix C: Preparatory Activities for Autonomous Vehicle Project

Activity	**Purpose**	**Key Output**	**Cost/Duration**	**Phase Impact**
Feasibility Study	Assess technical, regulatory, and operational fit	Feasibility report, go/no-go	$20M / 6 months	Informs initial scope & cycle budgeting
Proof of Concept (PoC)	Validate core tech (AI, sensor fusion)	PoC demo/results, risk log	$30M / 6 months	De-risks sensor fusion for Agile Development
Prototyping	Iterative hardware/software builds	Prototype vehicles, sprint demos	$80M / 1 year	Early testing, rapid learning, stakeholder buy-in
Pilot Program	Real-world validation, user feedback	Pilot fleet data, safety results	$50M / 1 year	Triggers commercial readiness & regulatory filing
Stakeholder Studies	User, regulator, and public acceptance	Survey data, feedback reports	$5M / parallel to phases	Informs requirements and compliance at each gate