ArtMED

PROMOTING GREEN LIVING AREAS

Investment Plan for AMOD Municipality of Palaio Faliro

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Executive Summary

Palaio Faliro is taking its first step towards envisioning a transport service for three target groups and a separate case for waste disposal. Specifically, the three user-based scenarios will cater for elderly residents, school-aged children, and the general public, all enhanced by automated vehicles. This report evaluates the technical feasibility and economic viability of implementing such a service with 1 to 3 automated vehicles for the three target groups.

According to the analysis, the foreseen deployment area and intended service are very suitable for deploying automated vehicles. The area is rather small, flat, and most of the roads are one-way, ideal for a small fleet of up to 3 vehicles.

However, the main potential bottleneck are the needs of the target groups. Elderly people who cannot move around on their own may not be able to get in and out of the vehicles without assistance. Also, since booking the trip might be a challenge, the target group would need to be carefully analysed to determine the level of assistance required.

For school children, the limitation is both the financial viability of the project, as well as the time limitations imposed due to the school's timetable. Specifically, with a fleet of only 3 vehicles, a limited number of children can be serviced, and multiple trips need to be made to accommodate for them. Another issue is that children require adult supervision, which introduces costs that may offset the overall financial viability introduced due to not requiring a driver or a fossil fuel.

The general population use-case is hampered by the sheer size of the population, creating a huge bottleneck in services, since only a minute fraction of residents can use the service, and there is no capacity to increase the fleet size. Additionally, the repeated use of the service can cause damage to the fleet, introducing increased maintenance costs, in relation to other use cases.

The waste disposal case scenario is promising, but it does face the problem that the required vehicles are considerably more expensive and more difficult to acquire, which introduces logistical problems.

The reason multiple populations were examined was due to the economic viability of the transport service, in comparison with a conventional service with drivers, does not look as promising as other use-cases in other parts of Europe. This is due to the combination of the relatively low impact of driver wages on operations costs and the limited size of the fleet and target group. Therefore, it could be considered to expand the target group with other types of travellers such as students and tourists.

Automated transport shows great potential to improve the mobility and quality of life of its elderly residents, students and general population, within a medium-term period through the use of automated vehicles. However, it requires further examination and additional funding to allow for further analysis and testing.

Introduction

As cities worldwide strive to modernize their infrastructure and improve quality of life for residents, Automated Mobility on Demand (AMOD) systems have emerged as a transformative solution. These systems leverage autonomous vehicle technology to provide efficient, adaptable, and sustainable services tailored to specific urban needs. In Palaio Faliro, a coastal municipality in Athens, the potential of AMOD systems has been carefully examined through the lens of two use cases: transport services for elderly residents and automated waste disposal. These cases were chosen not solely for their financial viability but because they align closely with the municipality's overarching goals of enhancing accessibility, sustainability, and community well-being.

This report serves as the investment plan for the municipality's vision statement, translating ambitious ideas into actionable strategies. The objectives of the study are to evaluate the feasibility, costs, and benefits of these AMOD implementations while identifying the necessary steps for successful deployment. The scope of the study encompasses technical, financial, and societal dimensions, focusing on both the challenges and opportunities of integrating automated systems into Palaio Faliro's urban landscape. Key challenges include the high initial capital expenditures, the need for public acceptance, and the logistical hurdles of adapting existing infrastructure.

For elderly transport, the focus lies on addressing the unique mobility challenges faced by aging residents, such as limited access to essential services and the need for physical assistance. Automated waste disposal, on the other hand, aims to modernize a critical municipal service by introducing electric autonomous garbage trucks, thereby reducing operational costs and environmental impact. Both cases represent Palaio Faliro's commitment to innovation and its willingness to invest in long-term solutions that prioritize inclusivity and sustainability.

The report begins by outlining the goals and context of the study, providing an overview of the municipality's demographics, infrastructure, and priorities. It then delves into the technical and operational aspects of the proposed AMOD services, highlighting the suitability of Palaio Faliro's urban layout for autonomous systems.
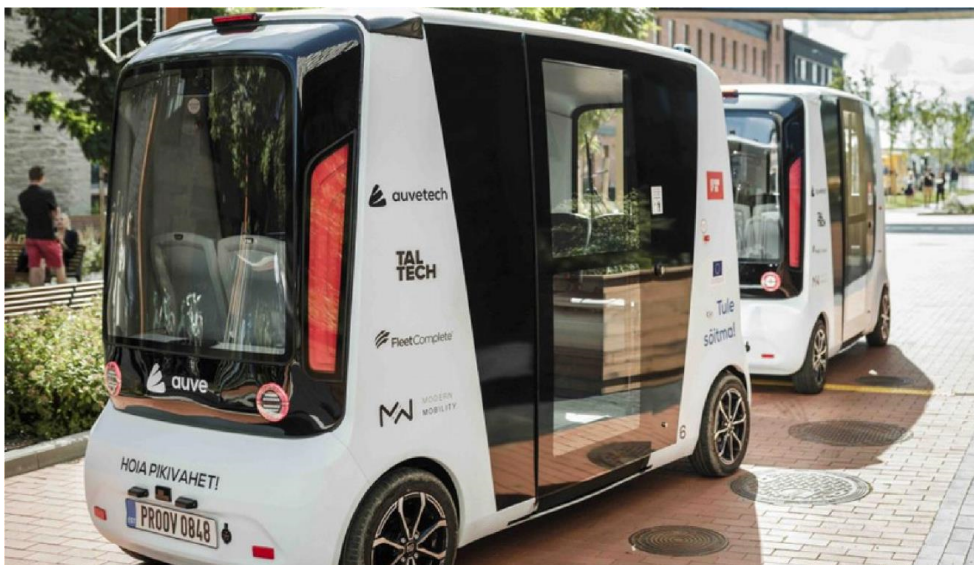

Figure 1. Pilot in Lamia (GR), part of the EU project FABULOS, with automated vehicles from Auve Tech.

Financial analyses are presented to compare the costs and benefits of these implementations against traditional alternatives, with considerations for external funding opportunities and pilot programs. Finally, the report addresses potential challenges, such as public acceptance and regulatory hurdles, and proposes strategies to ensure successful deployment.

By focusing on elderly transport and automated waste disposal, Palaio Faliro aims to demonstrate the transformative potential of AMOD systems in addressing pressing urban challenges. While these initiatives require significant upfront investment, their long-term benefits—from improved mobility for vulnerable populations to greener and more efficient municipal services—make them a compelling choice for the municipality. This introduction sets the stage for a detailed examination of these cases, their implications, and the steps required to bring them to fruition.

1. Main results of the vision statement

The vision statement for Palaio Faliro outlines a forward-looking strategy to integrate Automated Mobility on Demand (AMOD) systems into its urban framework, with a focus on enhancing mobility for the elderly and modernizing waste disposal processes. These two cases were selected to address the municipality's critical needs while demonstrating its commitment to innovation and sustainability.

Elderly Transport Case

The case for implementing AMOD shuttles for elderly residents is rooted in the municipality's goal to improve accessibility and independence for this vulnerable demographic. The findings indicate that Palaio Faliro's small, flat, and predominantly one-way street network is highly suitable for deploying a fleet of 1-3 autonomous shuttles. These shuttles would provide on-demand, door-to-door transport to essential services such as healthcare facilities, community centers, and shopping areas.

While the technical feasibility is promising, several challenges must be addressed to ensure the success of this initiative. Elderly passengers may require physical assistance for boarding and alighting, and many are unfamiliar with digital booking platforms. These challenges highlight the need for support measures, such as on-board attendants during the initial phase and user-friendly booking interfaces.

Economically, the high initial costs, including an estimated €250,000 per shuttle, mapping costs of €20,000, and infrastructure adjustments, pose a barrier. However, the long-term operational cost savings due to the absence of driver salaries and the potential for external funding opportunities make the case viable.

Waste Disposal Case

The waste disposal case envisions the deployment of automated electric garbage trucks to modernize this critical municipal service. The findings underscore the environmental and economic advantages of transitioning from conventional diesel trucks to AMOD vehicles. Over a 12-year period, the total cost for an AMOD truck is projected at €552,560, compared to €665,880 for a diesel truck, resulting in long-term savings of over 17%.

AMOD trucks significantly reduce greenhouse gas emissions, with an estimated 83% reduction compared to diesel vehicles. They also minimize noise pollution, improving the quality of life for residents. However, the high upfront costs, including €500,000 per truck and infrastructure upgrades like charging stations, present a financial challenge. Simplified permitting processes, as waste disposal falls entirely under municipal jurisdiction, provide an advantage.

The pilot program proposed for this case will assess the performance, cost-effectiveness, and public acceptance of AMOD trucks, enabling the municipality to refine its approach and address potential issues before full-scale deployment.

2. Deployment Area

The successful implementation of Automated Mobility on Demand (AMOD) systems in Palaio Faliro relies on the clear definition of responsibilities among key stakeholders. The municipality, regional authorities, private operators, and other collaborators must work cohesively to ensure that the transport services for elderly residents and the automated waste disposal systems are seamlessly integrated into the city's infrastructure. The following outlines the roles and responsibilities assigned to each stakeholder for achieving the envisioned outcomes.

Financial and Resource Management

The Municipality of Palaio Faliro will take the lead in securing funding for the AMOD projects. This includes applying for grants from European Union programs such as the Connecting Europe Facility and exploring partnerships with private investors. The municipality is also tasked with allocating resources for initial investments, including vehicle procurement, digital mapping, and infrastructure upgrades.

Regional and national authorities will support the municipality by providing subsidies and ensuring that funding mechanisms align with broader transportation and sustainability policies. They will also contribute to financial oversight and strategic evaluations, such as cost-benefit analyses for the AMOD initiatives.

Private operators, contracted to manage day-to-day operations, will oversee resource optimization. This includes determining fleet size, scheduling maintenance, and managing operational budgets. Operators will collaborate with the municipality to develop key performance indicators (KPIs) for monitoring service efficiency and user satisfaction.

Policy and Regulation

The Municipality of Palaio Faliro will lead efforts to adapt local regulations to accommodate AMOD systems. This includes creating policies for the safe operation of autonomous shuttles and garbage trucks, ensuring compliance with national and EU safety standards, and establishing protocols for data privacy and cybersecurity.

National authorities will play a complementary role by developing and maintaining the overarching legal framework for autonomous vehicle deployment. This includes periodic updates to ensure alignment with technological advancements and international best practices.

Public consultations will be organized to address ethical and social concerns, particularly those related to the elderly transport use case. Stakeholder feedback will be incorporated into the regulatory framework to ensure that the service meets community needs.

Infrastructure and Technology

The Municipality of Palaio Faliro will oversee the planning and development of physical infrastructure, including the installation of charging stations for electric vehicles and modifications to roadways to support autonomous operations. This responsibility extends to the identification and preparation of designated stops for the elderly transport service, ensuring these stops are accessible and safe for all

users. Additionally, the municipality will coordinate with utility providers to ensure that the necessary electrical infrastructure is in place to support the charging requirements of AMOD vehicles.

The municipality will also be responsible for enhancing road infrastructure to accommodate autonomous vehicles, such as improved signage, road markings, and traffic calming measures where necessary. Integrating AMOD-compatible features into existing smart city frameworks will ensure seamless communication between vehicles and infrastructure, promoting efficiency and safety.

Collaborating technology partners will design and deploy the digital infrastructure necessary for AMOD systems. This includes creating user-friendly apps for ride booking and waste collection tracking, as well as implementing traffic management systems tailored to the specific needs of autonomous vehicles. These systems will integrate real-time data collection to optimize routes and enhance operational efficiency.

National and regional authorities will provide guidance on integrating these systems with existing smart city initiatives. They will also assist in coordinating the standardization of technologies to ensure interoperability across municipalities in Greece. Maintenance of public roads, where ownership is shared between local and regional authorities, will require joint efforts to ensure ongoing infrastructure reliability.

Operations and Management

Day-to-day operations of the AMOD services will be handled by private operators contracted by the municipality. These operators will be responsible for training personnel, including on-board attendants for the elderly transport service during its initial phases. They will also manage fleet dispatching, monitor operational efficiency, and maintain the autonomous vehicles.

The Municipality of Palaio Faliro will maintain a strategic oversight role. This includes setting operational guidelines, monitoring service delivery, and ensuring that the objectives of accessibility and sustainability are met. Additionally, the municipality will handle public communications to keep residents informed about the AMOD services.

Stakeholder Engagement and Capacity Building

The Municipality of Palaio Faliro will spearhead public engagement efforts to ensure community buy-in for the AMOD initiatives. This will include organizing workshops, seminars, and public forums to educate residents about the benefits and functionalities of the new systems. Special emphasis will be placed on addressing the concerns of elderly residents and raising awareness about the environmental advantages of automated waste disposal.

National and regional authorities will provide support by sharing insights from similar projects across Greece and Europe. Collaborative exchanges with other municipalities will allow Palaio Faliro to refine its approach and adopt best practices.

Private operators will play a supporting role in capacity building by providing technical expertise during training sessions and by participating in public awareness campaigns. Operators will also facilitate feedback collection from users to improve service delivery and address potential issues.

By defining these roles and responsibilities, Palaio Faliro aims to create a collaborative ecosystem that supports the successful implementation of AMOD systems. This structured approach ensures that each stakeholder contributes effectively to the municipality's goals of enhancing mobility and sustainability.

3. Roadmap to implementation

3.1. Elderly Mobility Scenario (AMOD)

The roadmap for implementing Automated Mobility on Demand (AMOD) services for elderly residents in Palaio Faliro outlines the key steps, milestones, and financial investments required to bring this project to fruition. By addressing the technical, financial, and operational aspects, the municipality aims to create a reliable and accessible mobility solution tailored to the needs of its elderly population.

Phase 1: Preparatory Work (2024-2025)

The initial phase involves conducting a detailed feasibility study to assess the specific needs of elderly residents and ensure alignment with local urban dynamics. This study, estimated to cost €30,000, will provide a comprehensive understanding of the challenges and opportunities associated with the project. Community engagement activities, such as workshops and public forums, will be essential during this phase, requiring an additional €10,000 investment. These initiatives aim to gather input on service design and build trust in the AMOD system.

To secure funding and partnerships, the municipality will apply for grants through European Union programs such as the Connecting Europe Facility (CEF) and explore co-funding opportunities with private stakeholders. Administrative expenses for these activities are expected to total €15,000. Partnerships with technology providers will also be established to facilitate vehicle procurement and app development. Infrastructure planning will commence with the identification and preparation of designated stops and charging stations, alongside digital mapping of the municipality to support autonomous vehicle navigation. These preparatory activities will require an estimated €20,000.

Phase 2: Initial Deployment (2025-2026)

The second phase focuses on vehicle procurement and testing. The municipality will acquire a fleet of 1-3 autonomous shuttles designed specifically for elderly users, equipped with accessibility features such as ramps and handrails. Each vehicle costs approximately €250,000, bringing the total expenditure to €750,000 for three shuttles. Comprehensive testing will follow to ensure compliance with safety and operational standards, with an estimated cost of €50,000.

Infrastructure deployment will proceed with the installation of charging stations at key locations and necessary upgrades to the electrical grid, requiring an investment of €100,000. Road markings and signage enhancements will also be implemented to optimize conditions for autonomous vehicle operation, costing an additional €25,000. A six-month pilot program will then be launched to test service effectiveness and gather user feedback. Operational costs for this pilot phase are projected at €60,000.

Phase 3: Full-Scale Deployment (2026-2028)

During the final phase, the municipality will analyze pilot program data to refine routing algorithms and adjust operational protocols. An intuitive mobile app and call-in service will be developed to facilitate ride booking, ensuring accessibility for elderly users with varying levels of digital literacy. App development and support costs are estimated at €40,000.

The full rollout of AMOD services will expand coverage across the municipality, focusing on connecting elderly residents to essential services such as healthcare facilities, shopping centers, and community hubs. The annual operational costs for the three-vehicle fleet are projected at €100,000 per vehicle. To enhance user confidence, on-board attendants will be provided during the initial deployment phase, with annual staffing costs of €50,000. Real-time monitoring systems will be implemented to track service performance and promptly address operational issues. Regular maintenance and software updates, costing approximately €15,000 per vehicle annually, will ensure vehicle reliability and safety.

Financial Overview

The financial breakdown of the roadmap includes the following estimated costs:

Activity	Estimated Cost (€)
Feasibility study and community engagement	40,000
Funding and partnership development	15,000
Infrastructure planning	20,000
Vehicle procurement (three vehicles)	750,000
Testing	50,000
Charging stations and grid upgrades	100,000
Road enhancements	25,000
Pilot program	60,000
App development	40,000
Annual operations (three vehicles)	300,000
On-board attendants (initial rollout)	50,000
Maintenance (annual, three vehicles)	45,000

Table 1. Financial breakdown of Roadmap Scenario No1

In total, the estimated cost for the project from 2024 to 2028 amounts to €1,495,000. This roadmap positions Palaio Faliro as a leader in deploying AMOD systems to address the mobility challenges faced by elderly residents. By adhering to this structured approach, the municipality can achieve its vision of creating an inclusive and sustainable transportation solution.

3.2. Waste Collection Use-Case

The implementation of Automated Mobility on Demand (AMOD) systems for waste collection in Palaio Faliro represents a forward-thinking initiative to modernize municipal services and enhance sustainability. While technically not defined as AMOD, the idea is to implement a system in which the waste collection sites will use weight sensors to indicate which locations are more in need of immediate collections, which is where the "on-demand" aspect of the project comes into play. This scenario was significantly more difficult to assess, as it does not include direct users or passengers. Instead, the analysis was made to assess the cost necessary, which will be covered by the municipality, since we are already covering the existing waste collection service. The concept is to gradually replace

our fleet with electric, automated vehicles, based on the initial one-vehicle pilot. This roadmap details the phased approach required to transition from conventional diesel garbage trucks to automated electric garbage trucks, with an emphasis on financial planning, stakeholder collaboration, and infrastructure development.

Phase 1: Preparatory Work (2024-2025)

The first phase focuses on establishing a foundation for the deployment of AMOD waste collection systems. A comprehensive feasibility study will analyze current waste collection routes, energy requirements, and traffic patterns to determine the adjustments needed for integrating autonomous vehicles. Additionally, a simple waste collection tracking system will be added to the municipality's existing waste disposal infrastructure. This study and the waste detection system, estimated to cost €40,000, will ensure that the system is optimized for local conditions. Simultaneously, stakeholder engagement will involve waste management personnel and residents to align expectations and address concerns. Community engagement activities will require an additional €15,000.

The municipality will also focus on securing funding from European Union grants and exploring partnerships with technology providers. Administrative costs for these efforts are estimated at €12,000 - 20,000. Planning for infrastructure will include identifying suitable locations for charging stations and mapping digital requirements for autonomous vehicle navigation. Digital mapping, and initial assessments are projected to cost €25,000.

Phase 2: Initial Deployment (2025-2026)

During the second phase, the municipality will procure a single automated electric garbage truck to initiate operations. The cost of this vehicle is estimated at €500,000, reflecting the integration of advanced technology and autonomous capabilities. Comprehensive testing will ensure the vehicle meets safety and operational standards, with associated costs projected at €50,000.

Infrastructure upgrades will involve the installation of charging stations at waste collection depots and other strategic locations, costing approximately €100,000. Road enhancements, such as updated signage and markings, will further support the autonomous operation of the garbage truck, requiring an investment of €30,000.

A six-month pilot program will be launched to evaluate the performance, cost-effectiveness, and public acceptance of the system. The pilot phase will include real-world operations on designated routes, with operational expenses estimated at €80,000.

Phase 3: Full-Scale Deployment (2026-2028)

Insights from the pilot program will inform the full-scale deployment of AMOD waste collection services. The municipality will procure additional automated garbage trucks, with each vehicle costing €500,000. Depending on operational needs, the fleet may be expanded to two or three trucks, requiring a total investment of €1,000,000 to €1,500,000.

Expanded charging infrastructure will be necessary to accommodate the larger fleet, with additional stations installed at key locations. Upgrades to the electrical grid will also be required to support increased energy demands, with costs estimated at €150,000. Regular maintenance and software updates, projected at €20,000 annually per vehicle, will ensure the system's reliability and efficiency.

To optimize operations, advanced route-planning algorithms and real-time monitoring systems will be implemented. These tools will improve efficiency, reduce energy consumption, and lower operational costs. The development and deployment of these systems will require an investment of €50,000.

Financial Overview

The financial breakdown of the roadmap includes the following estimated costs:

Activity	Estimated Cost (€)
Feasibility study and community engagement	55,000
Funding and partnership development	20,000
Digital mapping and infrastructure planning	25,000
Vehicle procurement (one truck)	500,000
Testing and certification	50,000
Charging stations and grid upgrades	100,000
Roadway enhancements	30,000
Pilot program	80,000
Additional vehicle procurement (two trucks)	1,000,000
Expanded charging infrastructure	150,000
Maintenance and software updates	60,000
Route optimization and monitoring tools	50,000
Total Estimated Cost (2024-2028)	2,120,000

Table 2. Financial breakdown of Roadmap Scenario No2

This roadmap provides a comprehensive plan for transitioning Palaio Faliro's waste collection services to an automated, sustainable model. By adopting AMOD technologies, the municipality can achieve significant cost savings, reduce environmental impact, and enhance operational efficiency, setting a precedent for innovative urban management in Greece.

4. Closing Remarks

The journey towards implementing Automated Mobility on Demand (AMOD) systems in Palaio Faliro represents a bold and transformative step for the municipality. By addressing the specific needs of elderly residents through accessible transport solutions and modernizing waste collection with automated electric garbage trucks, Palaio Faliro has demonstrated its commitment to innovation, sustainability, and the well-being of its community.

While the financial and logistical challenges of such initiatives are significant, the benefits far outweigh the initial hurdles. From reduced greenhouse gas emissions to enhanced operational efficiency and improved quality of life for vulnerable populations, the potential impacts of these projects are profound. The careful planning outlined in this report—from feasibility studies and community engagement to phased deployment and continuous monitoring—ensures that every aspect of the implementation process has been considered.

Furthermore, the collaboration between local authorities, national governments, private operators, and technology providers underscores the importance of a unified effort in achieving these ambitious goals. By leveraging European Union funding and fostering partnerships, Palaio Faliro can overcome financial constraints and set a benchmark for other municipalities in Greece and beyond.

As Palaio Faliro moves forward, the lessons learned from these pilot programs will not only refine the AMOD systems but also pave the way for further innovation in urban management. This vision of a smarter, more sustainable municipality serves as an inspiration for other cities striving to adapt to the challenges of the 21st century. By investing in technologies that prioritize people and the environment, Palaio Faliro takes a significant step toward a brighter, greener future.

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