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DELIVERABLE 3.2.1
PLAN FOR THE UPSCALING OF THE SOLUTIONS IN THE PROJECT AREAS

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Abbreviations

AI	Artificial Intelligence
CAPEX	Capital Expenditure
CCTV	Closed Circuit Television
DMO	Destination Management Organisation
HERIT-DATA	Sustainable heritage management towards mass tourism impact thanks to a holistic use of big and open data project
ICT	Information and Communications Technology
LTE	Long Term Evolution
MHS	Monitoring Heritage System
OPEX	Operating Expenses
PAX	Passengers
RTO	Regional Tourism Organisation
SME	Small and Medium Enterprise
UAV	Unmaned Aerial Vehicles

Executive summary

This deliverable outlines the strategy for the sustainability, adoption, and scaling up of the results of the European TOURISMO project, which aims to improve the sustainable management of tourist flows through digital technologies, data analytics, and collaborative governance. The project has been implemented in eight Mediterranean pilot sites with very diverse characteristics (historic centers, ports, beaches, natural areas, and cultural heritage sites) across seven European countries.

The common technological solution is based on a modular architecture comprising monitoring sensors (thermal cameras, people counters, IoT sensors, WiFi/BLE devices, and drones), the Snap4City data integration platform, and visualization and analysis tools to support decision-making. This infrastructure has made it possible to measure tourist flows in real time, analyze mobility patterns, assess carrying capacities, and generate useful information for public administrations, destination managers, tourism companies, and citizens.

The results show that the technologies implemented help improve the management of tourist congestion, optimize visitor distribution, protect cultural and natural heritage, and support evidence-based decision-making. Key achievements include the creation of early warning systems in Rhodes, the monitoring of cruise ship passengers in Valencia, the definition of carrying capacities in Malta, the preventive protection of heritage sites in the city of Valencia, and visitor management in sensitive natural areas such as Biševo.

The document concludes that the sustainability of these solutions depends on four fundamental dimensions: technical, organizational, financial, and social sustainability. It also identifies common elements of success, such as the use of interoperable technologies, the institutional integration of systems, formal medium- and long-term maintenance agreements, and the active participation of local stakeholders.

Finally, a methodological framework is established for replicating and scaling up the solutions in other Mediterranean destinations, based on the reuse of technological components, transferable methodologies, collaborative governance, and continuous capacity building, thereby ensuring the continuity and impact of the results beyond the project's duration.

1. Introduction

1.1. TOURISMO Project

Until about 10 years ago, the tourism industry focused on growth. However, we have reached a point where it is necessary to adopt a more sustainable approach in order to reduce the impact on local areas. TOURISMO project addresses this challenge through innovative approaches, involving ecosystem stakeholders, improving the tourist experience, and fostering greater engagement among end users.

TOURISMO will continue to drive innovation through new methodologies and tools in areas with high tourism pressure, with the primary goal of better managing tourist flows. The approach relies on utilizing data from various datasets and on-site technologies (e.g., smart cameras, people counters, drones, tags) relevant to tourists' presence, density, movement patterns, and behaviors, supported by an enhanced version of the platform developed in the previous HERIT-DATA project. The project is implementing these solutions at 8 MED pilot sites.

The partnership embeds a variety of location profiles (UNESCO areas, ports, city centers, beaches, cultural monuments, parks etc.) from 7 European countries (GR, IT, ES, CY, BG, HR & MT) & different stakeholders of the value chain (Development Agencies, RTOs, Scientific experts, Innovation Institutes and Intermediaries, NGOs) allowing to test solutions in different environments, as well as capitalizing previous experience, guaranteeing simultaneously a high degree of innovation.

Actions foreseen address directly or indirectly the key groups of stakeholders namely public authorities, tourist agencies, DMOs, solution providers &the traditional tourism SMEs.

The objectives of TOURISMO project are:

- Utilize open-big-smart data, ICT tools, on-site equipment, and innovative methodologies for tourism flow management
- Deliver a monitoring & decision-making support management system, exploiting innovative data technologies
- Conduct pilot tests in 8 MED pilot areas with a variety of characteristics, enabling replicability in other areas
- Ensure the transferability and sustainability of project results by way of communication and exploitation of results

1.2. Purpose and scope of the document

This document forms part of the project's third work package. In the first work package, tourist habits and flows were analysed, the set of tourism indicators to be collected was reviewed, complementary data was gathered, and the pilot actions in the selected pilot areas were specified. In addition, the platform responsible for managing all the data received—inherited from the HERIT-DATA project—was improved.

In the second work package, the pilot schemes were implemented, collected data was integrated with complementary data to make predictions of tourism flows and measure the impact of the pilot schemes, and work was carried out on a framework for certifying destinations as sustainable.

Finally, the third work package has focused on the exploitation, sustainability and scaling up of the project results. It involves communicating the TOURISMO objectives and key findings to the target stakeholders through local workshops, facilitating the wider adoption of the tested solutions by developing use case scenarios, and ensuring the sustainability of the approach.

This document forms part of the second activity within this work package, which is dedicated to the sustainability and scaling up of the solution.

Upscaling refers to upgrading or improving the solution, or to extending its scope, e.g. from the local to the regional level or from the technical to the policy level. A transnational cooperation project may serve as a 'start-up', acting as the first step towards further developments (e.g. a larger investment) and improvements (e.g. an improved policy). It also refers to the concrete uptake of developed solutions by relevant organisations, in order to have an impact on the territory. The concept of sustainability encompasses various aspects, such as the durability of the project's results, the relevance of the solutions and the involvement of stakeholders in their design. In our case, upscaling refers to incorporating additional datasets and functions, applying the solution to more areas of interest, and incorporating additional features for tourists, local SMEs, citizens and other ecosystem stakeholders. It also includes the creation of a supportive mechanism to facilitate the adoption of the solution, both in the target areas and beyond, by targeted stakeholders, i.e. public authorities and DMOs, solution providers and traditional tourism SMEs.

2. Overview of TOURISMO solutions to be upscaled

2.1. Core technological components

Across the eight pilots, the same layered technology stack recurs, adapted to each site's constraints:

Layer	Technology	Function	Pilots
Sensing hardware	AI-edge cameras (thermal/optical), radar people-counters, Wi-Fi/BLE sniffers (PAX counters), UAV-mounted cameras, indoor environmental IoT sensors	Capture raw visitor and environmental data on-site	All 8, in different combinations
Connectivity	4G/LTE, LoRaWAN, PoE over municipal fibre (e.g. FINET), Wi-Fi/MQTT gateways	Transmit sensor data from the field to the backend	All 8, matched to local infrastructure
Middleware	Node-RED	Ingests and transforms MQTT/JSON/HTTP REST messages into the common Snap4City data model	All 8
Data platform	Snap4City	Central data repository, analytics engine and dashboard builder	All 8
Site-specific platform layer	Monitoring Heritage System (MHS)	Conservation-focused layer correlating occupancy with environmental risk indicators	Valencia City (FSMLR)
Legacy infrastructure reuse	Municipal traffic/security camera poles, existing ticketing	Pilots integrate with, rather than duplicate, existing city or site infrastructure	Rhodes, Biševo, Valencia Port

	systems		

Table 1 – Core technological components across TOURISMO pilots

2.2. Data sources and sensing technologies

The sensing technology selected in each pilot reflects local heritage sensitivity, connectivity constraints and privacy requirements:

Pilot	Core sensing technology	Data captured
Rhodes	8 SensMax TAC-B 4G radar counters, one per city gate	Anonymous pedestrian counts and directional flow (non-optical, GDPR-exempt by design)
Florence	2 AXIS thermal cameras (Piazza del Duomo) + 6 Wi-Fi/BLE sniffers	People/bike/stroller counts; anonymised Wi-Fi/BLE detections for flow and origin-destination matrices
Port & City of Valencia	PAX (Wi-Fi/BLE) counters + AXIS AI cameras at the terminal and 3 heritage sites	Cruise passenger counts; object-analytics people counts at La Lonja, the Cathedral and Torres de Serranos
Limassol (Cyprus)	5 AXIS Q1971-E thermal network cameras	Visitor flow, crowd density, temperature variation
Varna	UAV (DJI Mavic 3T / Autel EVO 2) with thermal and optical cameras	Aerial visitor distribution; surface-temperature and thermal-comfort mapping
Biševo	2 Wi-Fi/BLE sniffers + LED rerouting display integrated with ticketing	Crowd density, dwell time, origin-destination flow (Blue Cave to Visitor Centre)
Golden Bay, Malta	5 AI-edge CCTV cameras + 2 Wi-Fi/BLE sniffers + drone baseline imagery	Pedestrian/vehicle counts, unique visitors/dwell time, dune-erosion baseline
Valencia City (La Lonja & Museum)	25 LoRaWAN sensors across 21 monitoring points	Indoor occupancy plus temperature, humidity, CO_2 and noise

Table 2 – Data sources and sensing technologies by pilot

2.3. Services and functionalities for stakeholders

The data collected feeds a common set of stakeholder-facing functions, built on top of Snap4City:

Function	Description	Examples
Real-time and historical dashboards	Core Snap4City visualisations of flow and occupancy	Port Call, Cruise Passenger Counting and People Monitoring dashboards (Valencia); thermal/people-counting dashboards (Florence)
Public-facing visitor information	Direct communication to tourists to influence behaviour in real time	Biševo's video wall/rerouting display; Valencia's affluence dashboard for cruise passengers; Malta's planned Smart Beach App
Predictive and carrying-capacity tools	Forecasting and threshold-based alerts	Rhodes' gate-saturation early-warning dashboard; Malta's validated carrying-capacity ceiling (1,060 people)
Conservation/environmental correlation	Linking visitor presence to environmental risk	Valencia City's MHS traffic-light system for heritage conservation risk
Business intelligence for SMEs	Translating flow data into operational planning	Rhodes' use-case scenarios for staffing, stock and promotions
Policy and destination-management support	Evidence base for regional/institutional decisions	Rhodes' regional carrying-capacity observatory concept; Malta's Blue Flag/national statistics reporting

Table 3 – Services and functionalities for stakeholders

2.4. Key outcomes from pilot implementations

Despite their different contexts, all eight pilots produced concrete, decision-relevant results within the project timeframe:

Pilot	Key outcome
Rhodes	First systematic real-time flow-monitoring framework for the Medieval

	Town; baseline profiles at all 8 gates feeding an early-warning dashboard and SME use cases
Florence	Confirmed that privacy-safe thermal and Wi-Fi sensing reliably distinguishes pedestrians, bikes and strollers in a dense UNESCO area without collecting personal data
Valencia (Port & City)	3 operational dashboards launched; AI powered cameras (6 installed) are more accurate than WiFi sensors for queue monitoring and people counting; La Lonja found to peak at approximately 175 people/hour, with no direct causal link to cruise arrivals, supporting itinerary-redistribution recommendations
Limassol	Full 5-camera network operational since November 2025; validated as a replicable monitoring methodology for other Mediterranean destinations
Varna	UAV/thermal surveys revealed extreme surface-temperature contrasts (up to 72.4°C at the port) and confirmed visitors consistently favour shaded routes
Biševo	Sniffers and rerouting display successfully diverted visitors from queue congestion toward the visitor centre and trails during peak demand
Golden Bay, Malta	Established the beach's real carrying capacity (1,060 people; 3.8 m² per visitor at peak) and exposed an institutional silo effect limiting cross-agency action on the data
Valencia City (heritage buildings)	Confirmed measurable correlation between visitor presence and conservation-risk indicators (CO_2 above 2500 ppm, humidity up to 75% RH during peak season)

Table 4 – Key outcomes from pilot implementations

3. Dimensions of sustainability

3.1. Technical sustainability

The first area of sustainability to be assessed is the technical aspect. Here, it is necessary to assess whether the solution is robust, scalable and maintainable over time. It is important to assess at least the following five aspects:

- Infrastructure and operation: this includes the service life of the cameras and other equipment used in the pilot project, including the reliability of the equipment and technological obsolescence; the ease of maintenance and replacement of components, which is not straightforward given that much of the equipment is installed outdoors; the availability of spare parts and supplier support, as well as potential software updates; and resilience to failures (redundancies, backups, recovery).
- Scalability and flexibility: the possibility of expanding the network with new cameras and sensors at other locations across the city; compatibility with open standards, thereby avoiding dependence on specific suppliers; and integration with other systems already in operation in the city, such as police, traffic and smart city systems, etc.
- Data management: this includes storage capacity, requiring a decision on whether to opt for on-premises storage, cloud storage or a data centre; data lifecycle management, requiring clarification of how long data will be stored, when it will be deleted, and whether there will be any exceptions; and data quality, taking into account resolution (in the case of images), update frequency and reliability, given that errors may occur, particularly in adverse weather conditions.
- Cybersecurity: the system must be protected against unauthorised access, both to the cameras and sensors and to the platform on which the data is managed; encryption must be used for communications and storage, both from the sensors to the platform and from the platform to the devices used to view the results; proper identity and access management must be implemented; and firmware and software updates should be carried out on a regular basis.
- Energy efficiency: it is advisable to monitor the energy consumption of the entire system (cameras, servers, network) and, as far as possible, to use renewable energy or optimise the system from an energy efficiency perspective.

3.2. Organisational and governance sustainability

The second area focuses on how the system is managed and on collaboration between stakeholders. Five different elements can be analysed:

- Governance model: this will require clarification of the roles and responsibilities of each participant in the pilot project (local council, police, suppliers, etc.); a coordinating body must be set up, comprising all parties and meeting at predetermined intervals; and decision-making mechanisms must be defined, depending on the importance of each decision and assigning the appropriate weight to the votes of those participating in the coordinating body.
- Inter-institutional collaboration: the most important aspect is to align the objectives of the various stakeholders so that everyone works collaboratively and makes a positive contribution. These objectives will be set out in formal agreements between the different organisations involved in the project (memoranda of understanding, service level agreements, etc.). Protocols for information sharing will also need to be defined, establishing different procedures depending on the urgency and importance of the message.
- Legal framework: particularly with regard to data protection arising from the collection of images and data, starting with compliance with personal data protection regulations. This can be followed by a Data Protection Impact Assessment, which enables the identification, assessment and mitigation of privacy and data protection risks, and the establishment of policies governing the use, access and processing of images, especially where these clearly show features that identify individuals.
- Organisational capabilities: if necessary, those in charge of the project (operators, technicians, managers) will need to be trained so that they are familiar with the specifics of the work to be carried out and the applicable regulations; staffing requirements for the project will need to be analysed, as will internal capabilities compared to those of external suppliers and the project's reliance on them.
- Transparency and control: finally, in the interests of transparency, it may be necessary to implement regular audits of the system, or integrate it into systems that are already audited regularly; to ensure the traceability of camera usage to confirm they are not being used for purposes not initially intended or, indeed, fraudulently; and to establish accountability mechanisms for those primarily responsible for the project.

3.3. Financial sustainability

The third aspect to consider is the financial one, which involves assessing whether the project is economically viable in the medium and long term. In this case, it is advisable to examine four different aspects:

- Costs: first, it is essential to have a clear understanding of CAPEX, or capital expenditure, which includes the purchase of equipment—not just the cameras but all mounting systems, data transmission systems and power supply systems; their installation, typically in locations that are difficult to access, which entails higher installation costs; and the deployment of the entire information chain, involving various tests and the adaptation of certain management systems. Next, we have OPEX, or Operating Expenses, which includes the maintenance of the equipment and the systems supporting it, user licences—particularly for the software required for data management—and the costs of communication, storage, and the staff required to operate the system and assess its performance.
- Funding model: once we know the costs, it is important to identify where the revenue will come from to cover them. Projects of this kind can generate revenue from various sources (public funding, grants, European funds, PPPs), some of which are compatible with one another, but others are subject to restrictions that must be fully understood. If we manage to secure external funding, we must be fully aware of its limitations so that it does not constrain the project, whether in terms of duration or scope.
- Cost-benefit analysis: it is also advisable to carry out a cost-benefit analysis to determine the project's viability and efficiency. To do this, we must quantify the potential benefits, in terms of increased tourism or higher spending per tourist; the savings generated, for example, through traffic optimisation; and the costs avoided (queues at tourist sites, fewer problems for local residents, etc.).
- Long-term sustainability: We can include here a plan for technological renewal at regular intervals, depending on the advances that may occur in the technological elements we use; budget flexibility in the face of changes such as budget cuts or difficulties in securing external funding; and financial risks arising from potential cost increases (of energy, for example) or the rapid obsolescence of equipment.

3.4. Social and stakeholder sustainability

Finally, we outline the three key points to consider when analysing sustainability from a social perspective, a particularly crucial issue in projects involving CCTV due to their impact on the public.

- Social acceptance: this includes public perception, which will be influenced by concerns regarding potential invasions of privacy and the improvements the project may bring to the management of tourist flows; the level of trust in the institutions that will manage the cameras and the information and results they can provide; and the handling of complaints or claims regarding the installation and operation of new systems which, in principle, will monitor busy tourist areas rather than residential spaces.

- Privacy and fundamental rights: this relates primarily to the type of information that is collected and analysed. That is why it is important to minimise the data collected (including images), limiting it to what is strictly necessary for each specific purpose; to make proportionate and justified use of the information obtained, in line with the initial plan; and to apply privacy and anonymisation techniques where possible and necessary, such as the option to pixelate certain images captured by cameras. This is closely linked to the ethical impact the project may have, due to the risks of misuse and excessive surveillance.
- Social value: which the project may have through synergies with other public services such as security, if the images are used by the police or the fire service; through the benefits it can generate for other public services such as emergency services, which can have access to additional information when dealing with a problem; and through the trust it can build if communicated effectively, by informing citizens, via posters or municipal apps, of the system's objectives and how it is used.

4. Pilot sites sustainability plans

4.1. Plan for the sustainable implementation of the TOURISMO solution in the Medieval City of Rhodes

The following sections present the **plan for the sustainable implementation of the TOURISMO solution in the Medieval City of Rhodes,** which is a UNESCO World Heritage site, following the completion of the project.

- **Introduction to Pilot Action in the Medieval City of Rhodes**

The implementation of the TOURISMO solution in the Medieval City of Rhodes aims to enable data-driven monitoring and sustainable management of tourism congestion, with a particular focus on the redistribution of visitor flows within the specific destination context. The Medieval City of Rhodes, a UNESCO World Heritage Site, presents a highly sensitive historical and cultural environment, requiring the adaptation of technological interventions to strict heritage preservation requirements.

The pilot implementation included the deployment of eight outdoor people-counting radars installed at the eight main gates of the Medieval City to monitor tourist flows entering and exiting the area and provide the Snap4City platform with real-time data. The solution was tested through a dedicated dashboard developed for Rhodes, covering the Medieval City and presenting data collected through data sources integrated into the Snap4City platform.

The platform supports the analysis and visualisation of multiple indicators related to tourism congestion and mobility patterns. More specifically, it calculates the proportion of visitors entering and exiting through each gate, as well as the number and type of vehicles crossing the gates. In addition, the platform provides comparative analyses between high summer and low winter tourism seasons and generates predictive insights regarding visitor flows per gate depending on the time of day and seasonality conditions. The dashboard also presents the overall carrying capacity of the Medieval City, supporting more informed and proactive destination management practices.

The initial target users of the solution included key public authorities involved in the governance and management of the destination. These consisted of the Municipality of Rhodes, as the local authority responsible for the pilot area, the Ephorate of Antiquities of the Dodecanese, the

competent department of the Ministry of Culture responsible for the protection and management of monuments and antiquities within the Medieval City and the South Aegean Region, which is responsible for the regional implementation and adaptation of national tourism policy. In addition, the solution has been made available to local tourism SMEs, technology providers, visitors, and residents of the Medieval City.

- **Key Pilot Activities and Outcomes**

The pilot design was based on meetings and consultations with local stakeholders, and was adapted to the specific spatial, cultural, and operational characteristics of the Medieval City. The implementation process required the submission of a detailed technical study describing the equipment to be installed, the exact installation locations, and the technical works necessary for deployment. The technical proposal was subsequently assessed by the Municipality of Rhodes and the Ephorate of Antiquities of the Dodecanese to ensure compliance with local regulations, GDPR requirements, and heritage preservation guidelines. Official approval was granted only after the proposal had been thoroughly evaluated and confirmed to comply with legal, technical, and cultural preservation standards.

As a next step, an electronic open tender was prepared, approved by the TOURISMO project coordinator, READ S.A., and subsequently launched on the national electronic platform for public procurement of supplies and services. Upon completion of the tendering process and the selection of the contractor fulfilling the specified, technical operational and financial requirements, the procurement and installation procedures for the equipment were initiated. Particular emphasis was placed on ensuring compliance with GDPR provisions and with the preservation requirements applicable to the Medieval City. A key installation condition was that the equipment should utilise existing urban infrastructure in order to avoid any physical alteration or damage to the medieval walls and monuments. For this reason, the outdoor people-counting radars were installed at the eight main gates of the Medieval City and connected to pre-existing security and traffic camera infrastructure for power supply and internet connectivity.

All equipment installation procedures were completed in early November 2025, with the radars becoming fully operational by mid-November 2025. Following this, a dedicated dashboard for the Rhodes pilot site was developed to integrate and visualise the data collected from the installed monitoring infrastructure within the Snap4City platform. The dashboard consolidates real-time and historical data streams related to tourism flows in the Medieval City of Rhodes, enabling systematic monitoring and analysis of visitor dynamics. Tourism flow monitoring is expected to continue throughout the duration of the TOURISMO project, enabling comparisons, interim conclusions, and periodic progress assessments based on data collected across successive timeframes, up to the end of 2031. Based on the data collected so far, a preliminary comparative

analysis has been conducted between December 2025 and April 2026. The analysis highlights seasonal differences, enabling conclusions to be drawn on tourism flow patterns between high and low tourism periods.

During pilot implementation, an info day was also organised to present the objectives, activities, results, and benefits of the pilot to the wider public, with particular emphasis on engaging and facilitating synergies among the solution's main target groups, namely local authorities/DMOs, SMEs, technology providers, as well as visitors, and local residents. In addition, workshops have been conducted to enable a deeper exploration of the adoption barriers, implementation challenges, and corresponding support mechanisms that could facilitate and incentivise the uptake of the solution, forming the basis for the development of use case scenarios tailored to each stakeholder category.

Overall, the pilot has created the institutional mechanisms and technical foundations necessary for the long-term continuation and potential scaling of the TOURISMO solution beyond the project lifecycle. In addition, it has strengthened the capacity of Rhodes to manage tourism in a more sustainable, evidence-based, and proactive manner, while safeguarding the cultural and historical integrity of the Medieval City.

- **Purpose, Scope and Key Dimensions of the Sustainability Plan**

Following the successful implementation of the pilot action in Rhodes, the TOURISMO solution is expected to **continue supporting the monitoring and sustainable management** of tourism congestion, primarily through the redistribution of visitor flows within the Medieval City of Rhodes. As a result, the sustainability plan aims to support the sustainable and inclusive uptake and upscaling of the solution **within the destination ecosystem**. Namely, it enables the uptake of the solution by diverse local user groups and its upscaling within the destination ecosystem beyond the pilot, while preserving and further enhancing the pilot's impacts over time. The sustainability plan contributes to the mission of developing Rhodes into a sustainable tourism destination, as pursued by the newly established Directorates of Sustainable Tourism Development and Carrying Capacity, both of which form part of the General Directorate for Sustainable Development and Innovation (INNOV) of the South Aegean Region.

To support the sustainable and inclusive uptake and upscaling of the solution following the completion of the project, the sustainability plan elaborates on a set of key dimensions that need to be addressed.

- **Technical Sustainability Dimension**

The Technical Sustainability Dimension aims to ensure the long-term functionality, reliability, and

scalability of the digital infrastructure supporting the TOURISMO solution. It focuses on maintaining the technological infrastructure, ensuring interoperability mechanisms that enable the integration of external datasets and continuous high-quality data flows from heterogeneous sources, and supporting future system extensions.

Consequently, **a key priority is the establishment of robust maintenance protocols for both hardware and software components**, building on the operational experience gained during the pilot phase. This includes periodic calibration and performance validation of the eight installed people-counting radars at the main gates of the Medieval City of Rhodes, preventive maintenance of the associated connectivity infrastructure leveraging existing security and traffic camera networks, as well as structured software maintenance cycles covering platform updates, dashboard optimisation within the Snap4City environment, data backup procedures, and continuous cyber security monitoring. In addition, operational protocols should ensure regular system checks to maintain data accuracy, continuity of real-time data streams, and compliance with GDPR requirements throughout the system lifecycle.

Interoperability constitutes a second strategic priority and is ensured through the continued use of open standards, an interoperable data model, and API-based integration mechanisms, as demonstrated during the pilot integration of heterogeneous data sources into the Snap4City platform. In practical terms, this includes the standardisation of data formats, the maintenance of documented API endpoints for real-time and historical data exchange, and the establishment of procedures for the onboarding of new datasets from additional stakeholders, such as transport operators or cultural heritage systems. This approach ensures the seamless integration of new data sources and services while preserving data consistency, quality, and comparability across time periods, including seasonal and long-term analysis.

In addition, **future system extensions are prioritised,** building on the modular architecture validated during the pilot implementation. These extensions are driven by the evolving needs of destination management, including the emergence of environmental monitoring requirements, the widening of the user base and associated new user needs, the need for more resource-efficient operation of the system, and the progressive scaling of the solution within the destination ecosystem. Indicatively, these developments may necessitate the incorporation of data from new external sources, the enhancement of existing analytical and decision-support functionalities, including improvements in predictive modeling tools for visitor flows by gate, time of day, and seasonal conditions and refinements of carrying capacity assessment methodologies to support more efficient and evidence-based destination management, as well as the deployment of additional monitoring technologies and sensors in new locations within the Medieval City to expand spatial coverage and data collection capacity.

- **<u>Social, Cultural and Environmental Sustainability Dimension</u>**

The Social, Cultural and Environmental Sustainability Dimension ensures that the solution contributes positively to local communities, visitor experiences, and environmental and cultural sites preservation. It focuses on balancing tourism flows with social interests, as well as the improvement of environmental conditions and the preservation of natural and cultural sites.

Consequently, **a key priority is strengthening community inclusion, participation, social acceptance, and the quality of visitor and resident experience** through awareness-raising and communication activities, such as info days aimed at increasing understanding of overtourism impacts and supporting the uptake of the solution among local communities and visitors. This will be complemented by participatory activities, including workshops, consultations, and stakeholder engagement sessions with key local actors, ensuring that local perspectives are considered and that the solution delivers balanced benefits for all stakeholders.

Stakeholder engagement mechanisms will be oriented towards regional and local authorities, primarily including the Municipality of Rhodes, as the local authority responsible for the Medieval City of Rhodes, the Ephorate of Antiquities of the Dodecanese, as the competent department of the Ministry of Culture responsible for the protection and management of monuments and antiquities within the Medieval City, and the South Aegean Region, which is responsible for the regional implementation and adaptation of national tourism policy, in particular through the Directorates of Sustainable Tourism Development and Carrying Capacity, both forming part of the General Directorate for Sustainable Development and Innovation (INNOV) of the Region. Engagement with tourism SMEs and technology providers will be enabled through key business representative organisations, including the Chamber of Commerce and Industry of the Dodecanese, which covers businesses operating within the Medieval City, and the Association of Businessmen and Professionals of the Medieval City of Rhodes, as well as sectoral representatives of local tourism SMEs, such as the Hellenic Institute of Transport Department established in Rhodes, which supports a balanced relationship between the supply and demand of transportation services, the Association of Travel Agents of the Dodecanese and the Qualified Guides' Association of the Dodecanese, both representing travel agents and tour operators in the Medieval City, and the Rhodes Hoteliers Association, which also represents hotel owners in the Medieval City. Lastly, resident perspectives will be considered through municipal and community representative structures, such as neighbourhood or local community associations, the local Community Council, while visitor interests will be reflected through destination management organisations and tourism intermediaries such as travel agents, tour operators that interface directly with visitors.

A further **priority is reducing congestion, emissions and negative impacts on natural and**

cultural sites, facilitated by data-driven visitor flow management, that is real-time data analytics, enabling the redistribution of visitor flows, the amelioration of environmental conditions, and the protection of sensitive cultural and environmental sites. In addition, **inclusive, equitable access and evidence-based governance is prioritised** and facilitated by capacity-building activities aimed at strengthening the ability of diverse stakeholders and particularly local authorities to use data-driven tools for sustainable destination management. Further adoption and implementation support mechanisms such as digital vouchers, incubation programmes will also be used to facilitate a broad and inclusive uptake of the solution.

- **Financial Sustainability Dimension**

The Financial Sustainability Dimension ensures the long-term economic viability of the solution. The focus is on ensuring the financial capacity for the continuous operation, maintenance, and future development of the solution.

A key priority is the **establishment of diversified and stable funding base,** through mechanisms such as co-financing schemes among public authorities, EU and regional funding programmes, and potential public-private partnerships. Core operational and maintenance costs will be progressively integrated into the budgeting frameworks of participating public authorities, while future upgrades and innovation-oriented developments may be supported through external funding programmes and private-public partnership schemes. In addition, **financial risk management will be prioritised** through due diligence procedures, ensuring that the operation, maintenance, and future development of the solution remain compliant with local regulations, GDPR requirements, and heritage preservation guidelines, thereby reducing potential operational and financial risks. **Lastly, resource-management efficiency** will be prioritised through the use of resource-efficient technical infrastructure and data-driven management approaches that optimise resource allocation, improve decision-making, reduce operational inefficiencies, and lower long-term operational and maintenance costs, thereby strengthening the financial sustainability of the solution.

- **Institutional Sustainability Dimension**

The Institutional Sustainability Dimension ensures that the necessary governance structures and mechanisms across all dimensions for the inclusive and sustained uptake and upscaling of the solution beyond project completion are in place and are effective.

To this end, **the plan foresees a clear allocation of roles and responsibilities** among the key stakeholders of the destination ecosystem. At the operational level, the Municipality of Rhodes, which will have institutional ownership of the TOURISMO solution, is expected to play a central role in due diligence stakeholder engagement and in the day-to-day use of the solution,

particularly in utilising monitoring data and dashboard functionalities to support tourism flow management and destination decision-making processes.

At the strategic governance level, the South Aegean Region, through its relevant directorates, is expected to provide institutional oversight and ensure alignment of the solution with the broader sustainable destination management objective of transforming Rhodes into the world's first holistic sustainable tourism destination, as well as with regional policy priorities such as strengthening collaboration between local, regional, national and international agencies and leveraging data-driven solutions to facilitate sustainability transitions across the tourism sector.

Specialised technology providers and platform operators will be responsible for system maintenance, software updates, technical troubleshooting, cyber security protection, and the continued functioning of interoperability mechanisms. Where required, external technical expertise will be urged to support future upgrades, integration of new services and system extensions. Financial responsibilities among participating stakeholders will be defined through governance agreements specifying revenue and cost-sharing arrangements, budget commitments and funding responsibilities.

Monitoring responsibilities will be attributed to a monitoring committee, consisting of representatives responsible for overseeing performance across each sustainability dimension. In addition, monitoring processes, such as periodic data collection and performance reviews will be established to support the systematic evaluation of system operations and the effectiveness of the solution, as well as the timely implementation of corrective actions where necessary. To this end, stakeholder feedback mechanisms and a KPI framework combining both process-oriented and outcome-oriented indicators will be developed. This integrated approach enables the identification of gaps between implementation efforts and achieved outcomes, thereby supporting adaptive governance and informed decision-making.

- **Concluding Remarks**

By addressing the Technical, Social, Cultural and Environmental, Financial, and Institutional dimensions in an integrated manner, the plan ensures that the TOURISMO solution is not treated as a standalone technological intervention, but rather as a living component of Rhodes' broader transition towards sustainable destination management. In particular, it strengthens the capacity of local and regional authorities to rely on real-time, data-driven insights for managing tourism flows, while safeguarding the cultural integrity of the Medieval City and improving the overall balance of needs and interests among local stakeholders.

4.2. Florence

- **Local context and stakeholders**

The Florence Pilot was implemented within one of Europe's most intensely visited urban destinations, where tourism represents a primary economic driver while simultaneously generating significant and multifaceted pressures on public spaces, mobility networks, cultural heritage ecosystems, and residents' quality of life.

Within this specific socio-economic context, the initiative focused directly on improving the systematic monitoring and management of tourism flows. This objective was achieved through the effective deployment of innovative technological solutions combining thermal imaging cameras, Internet of Things (IoT) sensors, and advanced Artificial Intelligence-based data processing pipelines.

The entire architecture of the pilot was built upon a close, structured cooperation between three primary local entities: the Municipality of Florence, the Foundation for Research and Innovation (FRI), and the DISIT Lab of the University of Florence. Each stakeholder assumed a distinct and complementary role within the project framework:

- **The Municipality of Florence** acted as the public authority, institutional owner, and primary end-user of the technological solution, identifying the core operational needs, local territorial priorities, specific urban policy objectives, logistical constraints, and strategic pilot locations.
- **The Foundation for Research and Innovation (FRI)** coordinated the overarching pilot activities, supporting the strategic stakeholder engagement processes, driving methodological definitions, and managing cross-sectoral knowledge transfer.
- **The DISIT Lab of the University of Florence** was directly responsible for the design and maintenance of the technological infrastructure, including sensor integration, multi-source data processing, and the deployment of AI-driven analytics.

This institutional collaboration enabled the successful development, testing, and validation of an innovative monitoring system. Through this integrated framework, the partnership significantly enhanced the comprehensive understanding and management of visitor dynamics within the urban environment.

- **Operational model after project completion**

Following the formal completion of the TOURISMO project, the Florence Pilot will transition into long-term deployment governed by our integrated model, which is strategically structured to

ensure sustained institutional cooperation and the ongoing utilisation of the technological infrastructure established during the project lifecycle.

This framework fundamentally envisages that the collection, processing, and analysis of tourism flow data will continue seamlessly. This data pipeline will be tailored to guide evidence-based decision-making processes by local public authorities and relevant tourism management organisations. Consequently, the monitoring system will remain fully functional as a permanent decision-support tool. It will provide actionable insights for analysing visitor dynamics, identifying critical congestion patterns in public spaces, supporting strategic destination planning, and evaluating the objective effectiveness of future tourism management measures.

Furthermore, the model will guarantee that the collective knowledge, administrative methodologies, and specific procedures developed throughout the project will remain fully accessible to local stakeholders. This continued accessibility will facilitate the systematic integration of data-driven approaches into the routine, day-to-day destination management activities and subsequent urban planning processes of the city.

The practical experience gained through the implementation of this pilot will serve to strengthen local institutional capacities regarding the use of innovative digital technologies for tourism governance, thereby creating highly favourable conditions for the widespread adoption of these smart administrative approaches.

- **Maintenance of technological infrastructure and data flows**

The long-term sustainability of the Florence Pilot will rely fundamentally upon preserving the functional integrity of the technological infrastructure and the associated data flows established during the project execution phase.

The installed thermal cameras and IoT monitoring devices have demonstrated their effectiveness in generating reliable, continuous, and high-quality data regarding tourism movements, while simultaneously operating in full compliance with all relevant privacy and data protection requirements.

Following the completion of the project, coordinated actions will be actively pursued by the Municipality of Florence, the Foundation for Research and Innovation (FRI), and the DISIT Lab of the University of Florence to ensure absolute continuity across all data acquisition, processing, and analysis activities. This shared commitment will extend to guaranteeing the ongoing functionality, security, and technical reliability of the physical and digital monitoring infrastructure.

Within this coordination framework, joint efforts will be consistently devoted to upholding high standards of data quality and ensuring the complete interoperability of the different technological

components.

The data management architecture developed within the scope of the project will continue to enable the structured collection, secure storage, and advanced analysis of tourism-related information. Wherever practically and administratively feasible, the merging of pilot-generated data with pre-existing municipal databases and wider tourism datasets will be further explored. This alignment aims to enhance overall analytical capabilities, eliminate information silos, and maximise the public value derived from the monitoring system.

The specific knowledge, methodologies, and expertise acquired by the designated teams during the project will directly facilitate both the future routine maintenance and the potential enhancement of the monitoring system, ensuring that the generated data continuously supports tourism management, urban planning, and evidence-based decision-making.

- **Institutional ownership and long-term commitments**

The Municipality of Florence will assert full institutional ownership over the pilot developments, incorporating the TOURISMO methodologies as a core reference within its enduring sustainable tourism governance and urban management vision. The empirical results generated during the implementation phase will provide the necessary evidence to facilitate the integration of data-driven approaches into future local strategic guidelines and urban mobility frameworks.

To ensure the long-term sustainability of this initiative, the partnership—comprising the Municipality of Florence, the Foundation for Research and Innovation (FRI), and the DISIT Lab of the University of Florence—aims to maintain a shared post-project commitment. This coordinated approach is envisioned to address three strategic axes:

- **Policy Integration**: The insights derived from the monitoring infrastructure will serve as a resource to assist public decision-makers in designing targeted tourism management measures, mitigating overtourism pressures, and promoting sustainable visitor distribution across the city space.
- **Capitalisation and Knowledge Transfer**: The partners will actively promote the TOURISMO model at regional, national, and European levels through participation in sectoral networks and academic conferences. This collaborative effort will focus on sharing the technological and methodological framework as a scalable practice for other heritage destinations facing comparable tourist density challenges.
- **Sustained Research and Innovation (R&I) Synergies**: The established institutional channel will serve as a baseline for continuous advancement. This will enable the partnership to jointly explore complementary national and European funding

opportunities aimed at updating the technological solutions, refining the Artificial Intelligence models, and expanding smart city functionalities.

- **Potential future extensions (additional sensors, datasets, services)**

The Florence Pilot possesses significant potential for further scaling, adaptation, and broader evolution. Future technical and operational extensions could potentially explore the physical deployment of additional monitoring devices and thermal cameras in strategic territorial locations. This spatial broadening would be intended to increase overall geographical coverage, thereby improving the systematic understanding of visitor flows across different, less-monitored areas of the city.

In addition to physical expansion, the integration of supplementary datasets could represent a key axis for subsequent development. Merging external data sources—such as mobility patterns, public transport metrics, environmental indicators, or event-related data—would further enhance the existing analytical capabilities of the system. This multi-source data synthesis may facilitate more comprehensive, multi-dimensional assessments of tourism dynamics and their direct impacts on the wider urban environment.

Finally, prospective developments could encompass the targeted enhancement of predictive analytics functionalities, the continuous refinement of the underlying Artificial Intelligence models, and the creation of advanced, dedicated decision-making services tailored for public authorities and destination managers.

The modular and scalable architecture adopted within the pilot design is structured to facilitate this potential expansion and adaptation to emerging civic needs, ensuring that the solution can continue to evolve dynamically and contribute to sustainable tourism management and smart urban governance well beyond the formal lifetime of the TOURISMO project.

4.3. Port of Valencia

- **Local context and stakeholders**

This pilot aims to manage the flow of cruise tourists as they arrive at a destination and move around it, so that tourists can enjoy a better experience and residents do not have to face saturation problems at certain times and in certain locations. Therefore, the pilot is divided into two zones: the Port of Valencia and several areas of tourist attraction in the city of Valencia.
On the one hand, at the port, the study area includes the areas where cruise tourists embark and disembark. There is one fixed zone, the Trasmed passenger terminal, and other zones that have

undergone changes throughout the project for the docking of large cruise ships that cannot dock at the terminal. In those other zones, tents have been set up to accommodate passengers and provide them with information.
On the other hand, in the city, 3 areas have been included in the study zone:

- La Lonja de la Seda
- Valencia Cathedral
- The Serranos Towers (Torres de Serranos)

All three monuments receive a large number of tourist visits and can be conflict points in terms of tourism management.
The main stakeholders of the project are, at the port level, the Valencia Port Authority, which manages the entire port area and carries out the commercial work of attracting cruise ships, and the company that manages the passenger terminal, Trasmed, part of the Grimaldi Group. At the city of Valencia level, the main stakeholder is the Valencia City Council, which is responsible for traffic and the movement of people around the city. It is also the manager of some of the main monuments visited in the city. In addition, there is the Valencia Regional Council, which also has a project underway to manage tourism throughout the province of Valencia and with whom there has been collaboration on previous projects. Likewise, tour operators and the association of traders of the historical center are included as stakeholders, as they have a great deal of information about how tourists move around and what criteria carry the most weight in their decisions.

- **Operational model after project completion**

Once the project concludes, the system will continue operating exactly as it does now—there will be no visible disruption or sign that the project has ended. This continuity is ensured by the formal agreements signed with the Trasmed Terminal and the Valencia City Council, together with the ongoing collaboration established with the Valencia Port Authority, all of which guarantee that the installed equipment and infrastructure remain fully operational beyond the project's timeline.

- **Maintenance of technological infrastructure and data flows**

In the Valencia Port Pilot two main kinds of equipment were installed: a) the PAX Wifi Sensors and the Intelligent Cameras for people counting. In case of the PAX WiFi Sensors, this equipment belongs to the Valencia Regional Council (Diputació de València), and these sensors have been installed in the framework of national project which ensures the continuity of the service by the

subcontracted company in the installation and maintenance. These sensors belong to a network of more than 1000 sensors installed along the city.

The long-term operability of the cameras is guaranteed through the contract signed with the supplier/installer (ImesAPI), which establishes a comprehensive preventive and corrective maintenance service for a period of seven (7) years from the date of final acceptance of the installation. This contractual commitment ensures continuity well beyond the project's lifetime, based on the following provisions:

- **Preventive maintenance (annual):** The contractor is required to perform yearly upkeep, including lens and housing cleaning, verification of connectivity and power supply, inspection of cabling and mounting hardware, and firmware updates when necessary. This reduces the risk of gradual degradation or failure due to wear and environmental exposure.

- **Corrective maintenance:** In the event of malfunction or failure, the contractor must provide technical assistance and replace any damaged or defective equipment at no additional cost to Fundación Valenciaport. Replacement is carried out either under the applicable warranty (if still valid) or, once the warranty period has expired, using a reserve camera held by the installer—ensuring there is no gap in system coverage.

- **Guaranteed response time:** The contractor must intervene within a maximum of 72 business hours from the notification of any incident, ensuring rapid resolution and minimal downtime.

- **Spare parts availability:** The contractor is obligated to guarantee the availability of spare parts throughout the entire maintenance period, and to ensure the cameras remain operational under optimal conditions for the full seven years.

- **<u>Institutional ownership and long-term commitments</u>**

  Institutional ownership and long-term commitment of the pilot is firmly rooted in Fundación Valenciaport's strategic roadmap. One of its core pillars is contributing to the environmental, social, and economic sustainability of the Port of Valencia under the Blue Economy strategic line, with the aim of continuing to work on the preservation of the city's heritage, port-city integration, and the sustainable management of cruise tourism. For this reason, Fundación Valenciaport will continue the line of work established under the TOURISMO project, maintaining and supporting the deployed solution so that it remains operational and available for stakeholders to use well beyond the project's official duration.

  This institutional commitment is reinforced by the close, ongoing cooperation between Fundación Valenciaport and the Valencia Port Authority, both of which share these same strategic priorities.

As a result, institutional support from the Port Authority for the maintenance and continuity of the pilot is fully secured. The connectivity infrastructure and equipment used for the cameras installed within the port will be maintained for as long as necessary, given that the pilot delivers benefits to all parties involved: tourists, residents, and port operations alike.

At the city level, the agreement with the Valencia City Council will also remain in force after the project ends, with an initial duration of eight (8) years and the possibility of straightforward renewal or extension thereafter. This ensures that the cameras and systems deployed in the city's tourist areas continue to operate under a stable institutional framework, without depending on continued project funding.

Taken together, these commitments – from Fundación Valenciaport's own strategic direction, the Port Authority's institutional backing, and the multi-year agreement with the City Council – demonstrate that the pilot is not a standalone initiative tied to the project's timeline, but rather an integrated, institutionally-owned solution with guaranteed continuity in the medium and long term.

The ownership model of the Valencia pilot (port and city) is shared among several stakeholders, each responsible for the equipment they installed or funded. The PAX WiFi sensors are owned by the Diputació de València (Regional Council), which installed them as part of its own mobility project and, together with the subcontracted company, ensures their continuity and maintenance; these sensors form part of a network of more than 1,000 devices installed across the city. The intelligent cameras installed at the three tourist sites in the city (La Lonja, the Cathedral, and Torres de Serranos) were deployed through a collaboration agreement with the Valencia City Council, which authorizes their installation on municipal infrastructure (streetlights and existing security cameras) for a minimum period of eight years, the maximum permitted by law. The port cameras, in turn, rely on existing electrical and security infrastructure, supported by the Valencia Port Authority. Fundación Valenciaport acts as the technical coordinator of the pilot, managing the Node-RED platform and the integration of data with Snap4City, but does not physically own all the devices; instead, it operates through formal agreements and collaborations with the Diputació, the City Council, the Port Authority, and the TRASMED terminal. This results in a distributed ownership model underpinned by maintenance contracts (such as the one signed with ImesAPI for the cameras, covering seven years) and by each party's institutional commitment to ensure operational continuity beyond the project's duration.

- **Potential future extensions (additional sensors, datasets, services)**

Several avenues for future extension of the pilot have been identified:

- **Upgrade of WiFi sensors**: A firmware upgrade is planned to enable the calculation of a device footprint ID, improving the capabilities of flow monitoring. This addresses the recurring challenge posed by MAC address randomization in iOS and Android devices, which currently makes it difficult to accurately track the routes and itineraries followed by cruise tourists. Responsibility for this upgrade lies with the Valencia City Council, as the owner of these devices; however, Fundación Valenciaport will facilitate and support the sensor upgrade process to help achieve this objective.

- **Installation of new sensors in the port**: As the Port of Valencia is continuously evolving – both operationally and in terms of infrastructure – there is potential for deploying additional sensors going forward. This is particularly relevant given that a new passenger terminal is already included in the port's development roadmap, which will require its own monitoring capabilities.

- **Deployment of new cameras in the city and surrounding areas**: Coverage could be extended to additional touristic sites, such as the City of Arts and Sciences and the Oceanogràfic, as well as to points beyond the city itself, such as the Albufera Natural Park. This would allow passengers to be informed in real time about the current affluence situation at the top 10 tourist sites, significantly enhancing the monitoring coverage and the overall value of the flow management system.

- **Exploitation of additional datasets**: Subject to the necessary agreements, further datasets could be incorporated to enrich the system's predictive capabilities. One example is commercial data shared by cruise shipping companies with the Port Authority, detailing the exact number of passengers who have paid the disembarkation fee. Integrating this data would reinforce the existing dataset used to predict the number of passengers expected to disembark from a vessel during a given visit.

All of these potential extensions are technically feasible because the underlying technology and solution architecture are fully replicable and scalable by design. The system is built on open-source, widely adopted technological standards and tools, which makes it straightforward to integrate new data sources. Data processing is handled through Node-RED, using well-established protocols such as MQTT, JSON, and HTTP REST, while visualization is powered by Snap4City – a platform that offers a fully scalable and replicable way of building sensor connections and dashboards. This solid technological foundation ensures that any future extension, whether new sensors, new datasets, or new services, can be incorporated without requiring a redesign of the core system.

4.4. Cyprus

- **Local context and stakeholders**

The Limassol pilot was implemented in key tourism and commercial areas of the city, including Molos Multifunctional Park, Castle Square, Agiou Andreou Street, and Anexartisias Street. These locations experience high visitor concentrations during weekends, holidays, cultural events, and cruise ship arrivals, creating a continuous need for tourism flow monitoring and evidence-based management.

The sustainability of the pilot will rely on the continued collaboration established during the project among key stakeholders, including:

- Limassol Municipality
- Limassol Tourism Board
- Deputy Ministry of Tourism
- Limassol Chamber of Commerce and Industry (LCCI)
- Cyprus Ports Authority and cruise tourism operators
- Local businesses, restaurants, and tourism service providers
- University of Florence (UNIFI)
- Technology providers and smart-city stakeholders

These stakeholders have expressed strong interest in the continuation of data-driven approaches for tourism management and urban planning, particularly in areas affected by seasonal visitor concentration and tourism-related pressures.

- **Operational model after project completion**

Following the completion of the TOURISMO project, ANELEM intends to maintain the pilot as a demonstration and operational tool supporting sustainable tourism management in Limassol.

The operational model will focus on:

- Continued collection and analysis of visitor flow data where technically and financially feasible.
- Periodic reporting and sharing of findings with local authorities and tourism stakeholders.

- Utilisation of collected data to support tourism planning, event management, and visitor distribution strategies.
- Integration of pilot findings into future local and regional tourism development initiatives.
- Exploration of funding opportunities through national and European programmes to support further operation and expansion.

ANELEM will continue acting as a facilitator between public authorities, tourism stakeholders, and technology providers to ensure that project results remain relevant and useful beyond the project's lifetime.

- **Maintenance of technological infrastructure and data flows**

The technological infrastructure established through the pilot demonstrated its reliability and effectiveness in monitoring tourism flows while ensuring compliance with privacy and data protection requirements.

To support the sustainability of the pilot after the completion of the TOURISMO project, ANELEM signed a maintenance and technical support agreement with the installation supplier for a period of five (5) years following the end of the project. The agreement covers the maintenance, technical support, troubleshooting, and operational continuity of the installed AXIS Q1971-E Thermal Network Cameras and the associated monitoring infrastructure.

This arrangement will ensure the continued operation of the equipment, the collection of tourism flow and temperature data, and the availability of the monitoring system for future analysis and planning activities. It will also facilitate the preservation of data flows and support the integration of future datasets and smart-city applications where applicable.

ANELEM will continue to explore opportunities for maintaining and expanding the digital monitoring infrastructure through collaboration with local authorities, technology providers, and future European and national funding programmes.

- **Institutional ownership and long-term commitments**

ANELEM is committed to ensuring that the knowledge, methodologies, and partnerships developed through the pilot remain available to local stakeholders after project completion.

The organisation will continue promoting:

- Evidence-based tourism management.
- Sustainable tourism development policies.

- Smart-city approaches and digital transformation.
- Stakeholder cooperation for tourism governance.
- Use of tourism data to support decision-making processes.

The pilot results will be disseminated through local stakeholder networks, workshops, and future project initiatives. ANELEM will also seek to incorporate the pilot outcomes into future strategic planning activities related to tourism, urban development, and regional competitiveness.

The long-term commitment of local stakeholders to sustainable tourism management creates favourable conditions for the continuation and replication of the pilot approach.

- **Potential future extensions (additional sensors, datasets, services)**

The pilot has demonstrated significant potential for future expansion and scaling.

Possible future developments include:

Additional Sensors

- Expansion of thermal monitoring devices to additional tourism hotspots.
- Installation of environmental sensors monitoring temperature, air quality, noise levels, and weather conditions.
- Integration of mobility monitoring technologies to assess pedestrian and transport flows.

Additional Datasets

- Cruise ship arrival and passenger movement data.
- Public transport and mobility datasets.
- Event and cultural activity datasets.
- Accommodation occupancy and tourism demand indicators.
- Environmental and climate-related datasets.

Additional Services

- Real-time tourism dashboards for local authorities.
- Visitor flow forecasting and predictive analytics.
- Decision-support tools for event and crowd management.

- Smart tourism information services for visitors.
- Integration with municipal smart-city platforms and urban management systems.

In the longer term, the methodology developed through the Limassol pilot could be extended to other tourism destinations in Cyprus, supporting a national approach to smart and sustainable tourism management. The pilot provides a scalable model that combines technology, stakeholder engagement, and data-driven decision-making to improve tourism governance and destination resilience.

4.5. Varna Pilot

- **Local context and stakeholders**

The Varna pilot was implemented within the framework of the TOURISMO project to support sustainable tourism management through innovative monitoring and data analysis technologies. The pilot focused on three key locations in the city of Varna—Independence Square, the Sea Station Area, and the Sea Garden Entrance—where tourism activity, mobility patterns, accessibility, and environmental conditions have a significant influence on visitor experience and urban dynamics.

The long-term sustainability of the pilot is supported by the strong network of stakeholders engaged throughout the project implementation. These include the Municipality of Varna, the City Region Odessos, municipal companies, tourism organisations, the Union of Tourist Guides in Bulgaria, local businesses, cultural institutions, educational organisations, project partners, and technology providers.

Varna Economic Development Agency (VEDA) will continue to act as a facilitator between these stakeholders, promoting the use of data-driven approaches for tourism planning, destination management, sustainable mobility, and urban development. The relationships established during the project provide a solid foundation for future cooperation, knowledge exchange, and the development of new initiatives building upon the TOURISMO results.

- **Operational model after project completion**

Following the completion of the TOURISMO project, VEDA will maintain the knowledge, methodologies, and operational procedures developed during the pilot. While continuous UAV monitoring is not foreseen as a permanent activity, the monitoring methodology and data analysis framework established during the project can be reactivated whenever required for specific studies, planning exercises, or future projects.

The pilot results will continue to be disseminated through stakeholder meetings, conferences, workshops, and future project initiatives. VEDA will encourage the use of the pilot findings by local authorities, tourism stakeholders, researchers, and businesses as part of evidence-based decision-making processes.

The operational model will focus on maintaining the availability of project outputs, sharing lessons learnt, supporting future monitoring activities when required, and integrating the pilot experience into broader territorial development and tourism management initiatives.

- **Maintenance of technological infrastructure and data flows**

The technological infrastructure established during the pilot primarily consists of data processing workflows, analytical methodologies, datasets, dashboards, and platform-based visualisation tools developed through the Snap4City environment.

The data collected during the project will remain available for future reference, analysis, and comparison purposes, subject to applicable data protection and project requirements. VEDA will maintain the laptop and supporting equipment acquired through the project for future data processing, reporting, and project implementation activities.

The data integration workflows developed in cooperation with the University of Florence (UNIFI) provide a reusable framework for future data collection and platform integration activities. Should additional monitoring campaigns be undertaken, the established procedures for data extraction, processing, transformation, and publication can be reused and further expanded.

Where feasible, VEDA will seek opportunities to maintain access to the Snap4City environment and explore future interoperability with other smart-city, GIS, environmental monitoring, and territorial information platforms.

- **Institutional ownership and long-term commitments**

VEDA assumes institutional responsibility for preserving the knowledge, methodologies, and results generated through the Varna pilot. The organisation is committed to promoting the continued use of data-driven approaches in tourism management and territorial development.

The pilot outcomes align closely with VEDA's mission to support sustainable economic development, innovation, digitalisation, and evidence-based policy making. As a result, the experience and knowledge gained through TOURISMO will be incorporated into future project development activities and strategic initiatives.

VEDA will continue engaging with local authorities, public institutions, tourism organisations, businesses, educational institutions, and project partners to ensure that the pilot results remain

visible and accessible. The Agency will also seek opportunities to leverage the pilot experience in future national and European projects addressing tourism, mobility, environmental sustainability, climate adaptation, and digital innovation

- **Potential future extensions (additional sensors, datasets, services)**

The Varna pilot has demonstrated the value of integrating UAV monitoring, thermal imaging, and digital data platforms. Several opportunities exist for future expansion and further development of the pilot approach.

Potential extensions include:

- Periodic UAV-based monitoring campaigns to assess long-term tourism trends and seasonal variations;
- Integration of additional datasets related to mobility, environmental conditions, cultural events, transport systems, and tourism services;
- Development of advanced analytics and predictive models supporting tourism planning and visitor management;
- Expansion of monitoring activities to additional tourism destinations within Varna Municipality and neighbouring municipalities;
- Integration with smart-city, GIS, and environmental monitoring platforms to support cross-sectoral planning and decision-making;
- Application of the methodology in other sectors, including environmental monitoring, climate adaptation, biodiversity conservation, and territorial planning.

Particular opportunities for continuation already exist through VEDA's participation in the Euro-MED IDRON project, where UAV technologies will be used for monitoring soil moisture, identifying water sources, and supporting the management of forest and Natura 2000 areas in municipalities surrounding Varna.

In addition, the establishment in 2026 of the new educational specialty "Unmanned Aerial Apparatus" at High School "Academic Blagovest Sendov" in Varna creates opportunities for knowledge transfer, skills development, and future collaboration in the field of UAV technologies. This educational initiative contributes to building local capacity and supports the long-term adoption of innovative monitoring technologies across multiple sectors, including tourism, environmental management, and regional development.

The sustainability of the Varna pilot is based not only on the technological solutions tested during

the TOURISMO project, but also on the institutional capacity, stakeholder partnerships, data management practices, and knowledge generated throughout its implementation. The pilot has established a strong foundation for future innovation, evidence-based decision-making, and cross-sectoral cooperation, ensuring that its benefits continue to support sustainable tourism and territorial development well beyond the project's lifetime.

4.6. The Biševo Island Pilot

- **Local context and stakeholders**

Biševo Island is a highly sensitive area facing the challenges of mass tourism during the summer months, alongside depopulation and a lack of infrastructure.

The Island Biševo pilot project's main goal is to monitor tourism's impact on the natural heritage of the Vis Archipelago area. By focusing on two key sites, Modra špilja (Blue Cave) and the Visitor Center on Biševo Island, the project aims to gather data to better understand how tourism affects these important locations, in order to promote sustainable tourism on the islands of Biševo and the City of Komiža. This includes tracking the flow of guests entering the famous 'Blue Cave' on Biševo island.

During the summer, the Blue Cave area sees a significant surge in visitors, who are mainly tourists from around the world. Usually, this leads to issues with overcrowding, as large groups of people and boats arrive at the same time without coordination. Instead of managing multiple groups efficiently through gathered information from various sensors, there is little to no control, resulting in chaotic situations and dissatisfied visitors.

The upscaling plan for the solutions is based on deploying new technologies for data collection and smart flow management:

- **Technological Monitoring:** Installing sensors (thermal cameras, passenger counters, drones, tags) to track visitor presence, density, and movement patterns in real time.
- **Management Tools:** Using data to calculate the destination's carrying capacity, allowing limits on landscape consumption and better visitor management.
- **Sentiment Analysis:** Deploying QR codes for visitor satisfaction surveys to gather feedback for tailoring the tourism offer.
- **Flow Redirection:** Developing strategies based on collected data for better vessel anchoring management in bays (e.g., Mezoporat).

For successful implementation and upscaling, the project involves a range of stakeholders:

- **Public Administration:** Public Institution RERA S.D., Town of Komiža, Town of Vis, Split-

Dalmatia County.

- **Tourist Boards:** Tourist Board of the Town of Komiža
- **Local Community & Associations:** Geopark Vis Archipelago, "Spasimo Biševo" Association (active in cultural and natural heritage protection), FLAG „Škoji“ Komiža, Komiža and Biševo residents.
- **Tourism Service Providers:** Nautical Center Komiža, private boat/taxi boat operators, hospitality businesses on the islands Vis and Biševo.
- **Scientific Community & Experts:** University of Florence (platform development), Institute for Tourism (visitor management planning).

The objective is to create a "people-powered tourism" model, where the tourism offer is built on authenticity and local identity preservation, supported by smart solutions.

- **Operational model after project completion**

Following the formal conclusion of the TOURISMO project in October 2026, the Biševo Island Pilot shifts from an experimental phase into a permanent, data-driven operational model. This transition ensures that the tools deployed during the project continue to actively mitigate overtourism and protect the local ecosystem.

Within the framework of the TOURISMO project, the upscaling plan for Biševo Island and the Blue Cave area follows strict quantitative and qualitative Key Performance Indicators (KPIs). The goal is to shift from merely counting arrivals to smart management of carrying capacity and the preservation of local resources.

- **Maintenance of technological infrastructure and data flows**

RERA SD and Nautical Center Komiža signed an Agreement about the use of devices for counting visitors and LED modular screens for advertising and ticketing with associated software, where the parties (RERA SD – NCK) agree that Nautical Center Komiža d.o.o. will:

- Use the equipment described in Article I., paragraph l., item 1 of this Agreement for the performance of professional activities, i.e., for the purposes for which it is intended, and take care of it with the care of a good businessman.
- assume management and responsibility for damage to the specified equipment, protect it from damage, and maintain it in accordance with the instructions of the manufacturer and supplier of the equipment, i.e., assume responsibility for constant care for the correctness of the equipment and undertake work to eliminate any defects and deficiencies observed on it and bear the costs of its maintenance.

Given the seasonal nature of work at the Blue Cave/Modra špilja location and the fact that the Blue

Cave/Modra špilja itself is closed to visitors during the winter months, the equipment is uninstalled and stored indoors to prevent exposure to the effects of salt, sea, and strong wind. Therefore, it is necessary to provide professional assistance to the NCK concessionaire for the installation/uninstallation of the equipment and its re-commissioning.

The equipment supplier also ensures adjustment and calibration of the equipment in the event of a possible interruption in the transfer of collected data.

Given the remoteness of the island of Biševo and its micro location in the open Adriatic Sea, problems with internet service and network connectivity may occasionally occur, which may require simple on-site interventions, such as restarting the device or reconnecting the system to restore data transmission. This part of the maintenance is the responsibility of the employees of the Nautical Center Komiža.

- **Institutional ownership and long-term commitments**

The implementation and long-term sustainability of the pilot project are secured by a strong network of local and regional institutions that guarantee resource management:

- **Public Institution RERA S.D:** The Regional Development Agency of Split-Dalmatia County leads operational coordination, equipment procurement, and the integration of technological solutions into local strategies.
- **City of Komiža:** As the key local authority, it is directly involved in decision-making and long-term spatial and economic planning on the island.
- **Nautical Center Komiža:** As the concessionaire of the Blue Cave site, it directly determines and manages tourist flows on the island of Biševo.
- **Blue Cave – Biševo Visitor Centre:** The newly renovated center serves as the physical base for monitoring tourist flows, education, and testing innovative systems.
- **Public Institution "Sea and Karst":** Ensures compliance of all tourist activities with nature protection measures and the preservation of the sensitive island ecosystem.

Long-term Commitments, the sustainability of the results after the conclusion of the TOURISMO project in October 2026 is based on three key pillars:

- **Smart Infrastructure for Flow Management:** The acquired technological equipment (sensors, visitor counters, vessel tracking systems at anchorages) remains in the permanent ownership of local partners.
- **Integration into the Snap4City TOURISMO Platform:** All collected data is permanently integrated into the expanded Snap4City Platform, managed by the University of Florence, enabling ongoing data-driven decision-making.
- **Balancing Local Needs and Tourism:** All key stakeholders, DMO Institutions have

committed to a long-term dialogue, to ensure that tourism development does not diminish the quality of life for the remaining residents and the authentic island heritage.

- **Potential future extensions (additional sensors, datasets, services)**

To meet the project's target KPIs, expanding the Libelium Smart Spot infrastructure on Biševo Island from basic passenger tracking to a comprehensive environmental and management system is crucial. The modular design of Libelium IoT hardware enables future firmware updates and probe expansions without requiring new physical network deployments.

Upgrading existing Libelium Smart Spot (or similar IoT platforms like Plug & Sense!) devices to monitor meteorological and oceanographic parameters on Biševo Island involves adding specific sensor probes, expanding hardware modules, and integrating external systems.

Monitoring air temperature in Mezoporat is the simplest upgrade, as it uses a standard plug-and-play sensor—adding a Libelium temperature, humidity, and pressure probe (a combined sensor). The sensor connects to a dedicated analog/digital input on the device housing via a waterproof (IP67) connector.

Given that access and entry to the Blue Cave is directly dependent on weather conditions, especially wind speed and wave height, it would be necessary to consider monitoring the sea conditions at the Blue Cave micro-location.

To **measure wind speed and direction** around the open and gusty locations near the Blue Cave and Mezoporat Bay, a weather station can be integrated—specifically, a Libelium Weather Station, which includes an anemometer for speed and a wind vane for direction.

Wave monitoring (height, period, and direction) requires a different approach: since Smart Spot devices are installed on solid ground (such as the ticketing office), they cannot directly measure waves. The upgrade involves installing and connecting a Smart Buoy (recommended for Mezoporat/Blue Cave), an autonomous mini-buoy equipped with an accelerometer and gyroscope. Placed in the water, it tracks sea surface movement and transmits wave height and period data wirelessly via LoRaWAN or BLE protocols to the nearby Libelium Smart Spot. The Smart Spot then acts as a local gateway, forwarding data to the central platform.

The need to expand anchorage and moorings for boats transporting visitors to the Blue Cave and Biševo Island is growing each year. The new concessionaire managing the anchorage in Mezoporat Bay is the Nautical Center Komiža, so it would be beneficial to include anchorage monitoring as part of the comprehensive tourist flow monitoring at the Blue Cave site.

Smart Anchorage Regulation: Data on maritime density and vessel trajectories in Mezoporat bay feed directly into mooring management strategies executed by the Public Institution "Sea and

Karst" and Nautical Center Komiža as concessionaire of the smart anchoring site in the pilot location.

4.7. Ramla tal-Mixquqa (Golden Bay) & Majjistral Nature and History Park, Malta Pilot

- **Local Context and Stakeholders**

The pilot is situated on a pocket-beach within a high-sensitivity Natura 2000 site and a Special Area of Conservation (SAC), chosen specifically due to the high visitor flows especially during the tourism peak months. Key stakeholders include the The Heritage Parks and Federation (Majjistral Park), the Mellieħa Local Council, the Malta Tourism Authority (MTA), the Environment & Resources Authority (ERA). These entities have been provided with open access to the dashboards in order to help them transition from traditional observation and organic growth, to a data-led management approach whihc leverages the IoT dashboard to monitor the intersection of peak tourism, crowd flow and environmental protection.

- **Operational Model After Project end**

At the end of the Project we intend to shift the operational model from an experimental phase to a permanent smart management system. The real-time data from the AI-counting cameras and environmental sensors will be formally integrated into the daily management protocols of the Majjistral Park rangers, the Malta Tourism Authority, Red Cross and Local Enforcement wardens. This allows for dynamic decision-making, such as triggering traffic diversions or waste collection based on real-time occupancy rather than fixed schedules.

- **Maintenance of Technological Infrastructure and Data Flows**

To eliminate the risk of hardware failure in the corrosive coastal environment, a five-year maintenance agreement has been signed and fully paid up-front, effective from December 2024. This ensures that the AI-edge cameras, solar-powered units, and data transmission links remain functional for 60 months. The data flow will continue to be hosted via the Snap4City platform, ensuring a stable "Digital Twin" of the site remains accessible to authorised decision-makers.

- **Institutional Ownership and Long-Term Commitments**

Full ownership of the technological infrastructure will be formally transferred to the Majjistral Nature and History Park, the ultimate beneficiary. By transferring the assets to the park's management, the project ensures that the entity with the direct mandate for conservation has the tools to enforce carrying capacity limits. This transfer is supported by long-term commitments

from the MTA to utilise the data for Blue Flag certification reporting and national tourism statistics. MRDDf Will continue to aggregate data and report on the yearly counts.

- **Potential Future Extensions**

1. Expansion of the Network: The "pocket beach" methodology—utilizing natural bottlenecks for low-cost, high-accuracy counting—is planned for upscaling to 10 additional sites across Malta and Gozo (including Għajn Tuffieħa, Ramla l-Ħamra, and Comino).
2. Additional Sensors: Integration of sea-water quality sensors and smart waste-bin level indicators to provide a more holistic environmental dashboard.
3. Public-Facing Services: Development of a "Malta Smart Beach App" or live digital signage at the top of access roads to "nudge" visitors away from saturated sites toward underutilised areas in real-time.
4. Advanced Data Correlation: Further correlating human density with increasing tourist numbers, marine vessel traffic and biodiversity impact studies (e.g., dune erosion rates) to establish legally binding carrying capacity thresholds.

4.8. Valencia City Pilot

- **Local context and stakeholders**

The Valencia City Pilot was implemented in the historic centre of Valencia, focusing on the close analysis of tourism flows and the impact of tourism activity on **two emblematic cultural heritage sites** with significant tourism relevance: **La Lonja**, a UNESCO World Heritage Site, and **Museum of the City of Valencia** (nineteenth-century Palace of the Marquis of Campo).

In recent years, Valencia has experienced a steady increase in tourism demand. In 2024, the city received a total of 2,419,998 visitors (+4.5% compared to 2023), with international tourism accounting for 59% of the total and domestic tourism for 41% (Source: INE – EOH + EOAT, published by Fundación Visit Valencia). This growth reflects the **city's increasing attractiveness as a cultural and gastronomic destination**. However, this upward trend has also generated **growing pressure on the historic centre and its heritage assets**.

The pilot therefore addressed the need for **more sustainable and evidence-based tourism management approaches** capable of balancing visitor experience, heritage conservation and a better distribution of visitor flows within the historic centre. The focus on these two pilot sites provided an opportunity to **analyse the impact of tourism activity in two historic buildings**

with different characteristics, uses and visitor dynamics: on the one hand, an exceptionally well preserved Gothic civil monument, and on the other, a historic palace currently functioning as a museum and cultural space.

As in many Mediterranean destinations, tourism management in Valencia's historic centre has traditionally focused on promoting cultural heritage, ensuring access to key landmarks and increasing visitor numbers year after year. While these efforts have been effective in strengthening the city's tourism attractiveness and promoting its heritage assets, they have not always been supported by detailed information on **how tourism activity affects specific historic sites** on a daily basis.

In practice, this meant that many operational decisions were often based on general visitor trends or direct observation, without a precise understanding of how visitors move between different points of the city, where they tend to concentrate, or how peaks in visitor presence affect both tourism dynamics and the environmental conditions required for the proper conservation of heritage buildings. This highlighted the need to **complement existing tourism management approaches with a more detailed and data-driven perspective**, particularly in locations that receive large numbers of visitors throughout the year.

At the beginning of the TOURISMO project, **key stakeholders** were identified. Due to the installation of monitoring systems inside protected heritage buildings, close coordination with the **site managers** and the **Municipal Artistic Heritage Service** was essential from the early stages of the pilot. As the project evolved, additional stakeholders became involved, including local tourist **guides, tourism SMEs, technical experts and managers of other heritage spaces** within the historic centre, such as L'Almoina Archaeological Centre.

The integration of **complementary data sources** and the possibility of visualising all information jointly through a single platform (Snap4city) enables a more comprehensive analysis of trends and patterns. This allows risks to be identified **before they become critical situations** and supports more immediate operational actions whenever needed, such as improving ventilation when CO_2 levels increase significantly or controlling visitor capacity when indoor environmental conditions become unfavourable.

This approach makes it possible to understand what is happening inside the monitored buildings in a more precise and continuous way, highlighting the importance of going beyond simple visitor capacity limits and incorporating environmental conditions into heritage and tourism management strategies.

- **<u>Operational model after project completion</u>**

Following the conclusion of the project, the Valencia City Pilot is expected to remain operational in

the coming years through the **maintenance of the installed monitoring infrastructure** and the **continued support provided to platform users** whenever needed. Feedback collected from stakeholders and users will also be valuable for improving the system in the future and for its potential replication in other heritage sites and tourism contexts.

Public authorities in Valencia and the managers of the monitored heritage sites have shown interest in continuing to use the generated data as a support tool for operational and strategic decision-making. The local administration has also expressed interest in **integrating the collected data into the Smart City digital environment*** (currently under development), as well as exploring synergies with other digital initiatives and applications related to tourism and visitor management, such as **ON VAS**, promoted by a local tourist guide. These integrations could represent one of the main opportunities for scaling up the pilot beyond the project framework.

The long-term objective is for the system is to progressively become more integrated into the daily routines of the personnel working in the management of the monitored sites and **to support routine operational decisions related to visitor management, indoor environmental quality and preventive conservation strategies.**

In this context, it may also be useful to organise **short training sessions** for stakeholders interested in learning how to interpret and use the available data, helping to increase the number of active users regularly consulting the platform. The long-term sustainability of the pilot depends on **maintaining an active ecosystem of users and stakeholders regularly interacting with the platform and contributing feedback,** as they may help identify operational issues, such as sensors temporarily stopping data transmission or abnormal measurements requiring technical attention.

**Valencia Smart City initiatives and Geoportal development projects aim to integrate geospatial and urban data through interoperable digital services and APIs to support holistic city management and decision-making. See: Smart City València.*

***ON VAS is a mobile application proposal currently under development, created for and fed by tourist guides to share real-time information on group movements and congestion levels in historic urban areas of Valencia.*

- **Maintenance of technological infrastructure and data flows**

The installed equipment includes **wireless battery-powered environmental sensors, and people-counting camaras directly connected to the energy grid,** capable of continuously collecting information related to visitor presence and indoor environmental conditions. The data obtained from the sensors are hosted within the **MHS monitoring system database** of FSMLR and **transferred via API to the Snap4City dashboard**. T

Sensors requiring **battery replacement** will be maintained by the technical team of Fundación Santa María la Real. Battery levels can be monitored remotely through the MHS platform, which is regularly reviewed by the technical team to ensure that the system operates correctly and continuously.

Only a limited number of devices, such as people-counting cameras or sensors installed at height, require access using ladders or other technical equipment. In all cases, these maintenance activities must be coordinated with the management teams of the monitored buildings and carried out during periods when the sites are closed to visitors or outside opening hours.

As mentioned before, maintaining a close relationship with the personnel working daily inside the monitored buildings is important, as occasional connectivity issues may arise and require simple on-site interventions, such as restarting a device or reconnecting a system to restore data transmission.

- **Institutional ownership and long-term commitments**

The pilot has demonstrated the value of generating reliable, real-time information to support heritage conservation and sustainable tourism management. The positive engagement shown by local authorities, heritage managers and tourism stakeholders suggests a favourable context for long-term continuation of the monitoring approach.

The progressive incorporation of the monitoring tools into daily operational practices, together with the interest shown by local authorities in integrating the generated data into broader Smart City strategies, may contribute to strengthening the long-term sustainability and institutional adoption of the pilot beyond the maintenance and support period initially established within the project framework.

- **Potential future extensions (additional sensors, datasets, services)**

The Valencia City Pilot presents significant opportunities for future scalability and extension. The solution can be adapted relatively easily to other heritage buildings and tourism contexts, as the deployed system is based on a modular architecture.

Future developments, potentially implemented in collaboration with public authorities and private stakeholders interested in monitoring tourism impacts and visitor flows, may include:

- Expansion of environmental and occupancy monitoring systems to other heritage buildings and tourism hotspots within the historic centre;
- Integration of external open public or private datasets related to mobility, transport or tourism accommodation indicators;

- Integration of sensor data into other digital platforms, including the local Smart City initiative;
- Development of predictive analytics and early-warning functionalities to support proactive tourism flow management;
- Incorporation of simple qualitative visitor feedback mechanisms, such as quick rating systems, to complement quantitative monitoring data with perception-based information;
- Deployment of additional smart services for tourism SMEs, cultural managers and public authorities.

Due to its modular, non-invasive and interoperable nature, the Valencia pilot provides a **transferable approach for other Mediterranean destinations** facing similar challenges related to tourism pressure, heritage conservation and data fragmentation. With additional dissemination and knowledge-sharing activities, the pilot could potentially encourage other destinations to explore similar approaches adapted to their own territorial and heritage contexts.

5. Common sustainability principles, governance and ownership models

Drawing on the eight individual sustainability plans presented in Section 4, a set of shared patterns emerges across the TOURISMO pilots. While each destination has adapted its approach to its own institutional and territorial context, all eight plans converge around the same four pillars: shared guiding principles, multi-actor governance, common data infrastructure, and continuous stakeholder coordination. These shared foundations are what make replication and upscaling possible without rebuilding each pilot's sustainability model from scratch.

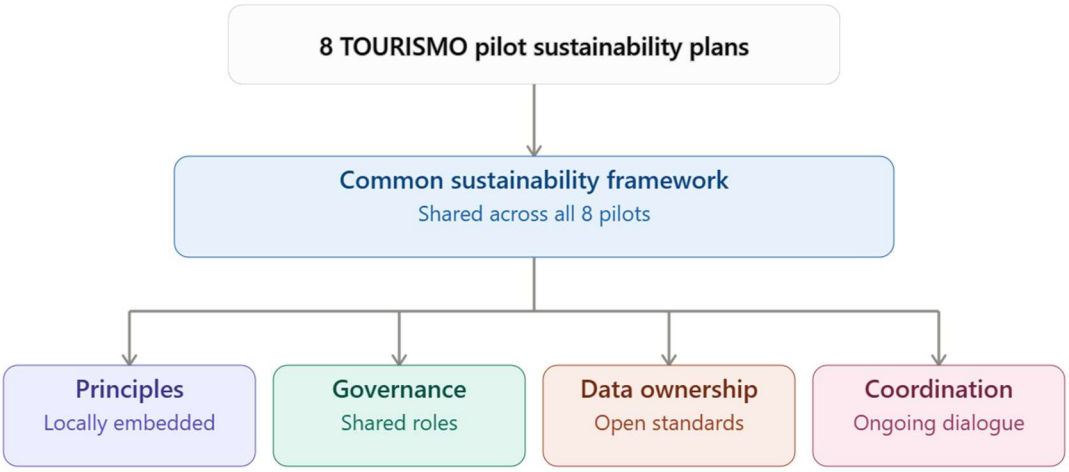

Figure 1 – TOURISMO foundations

Shared sustainability principles across TOURISMO pilots

Across all eight pilots, sustainability is treated as something built into the solution from the outset rather than added on after the project ends. Three principles recur consistently:

- **Institutional anchoring over project dependency.** In every pilot, ownership and continuity are assigned to a locally rooted entity — a municipality, regional development agency, park authority, or foundation — rather than remaining tied to TOURISMO's own funding cycle (e.g. Fundación Valenciaport's Blue Economy strategic line, the Municipality of Rhodes'

institutional ownership, ANELEM's role as long-term facilitator in Limassol).

- **Formalised, time-bound commitments.** Sustainability is secured through binding instruments — collaboration agreements, concessions, or maintenance contracts — typically spanning five to eight years, with renewal mechanisms built in, rather than informal or verbal understandings.
- **Technological reuse over technological replacement.** All pilots build on the same open, modular architecture (Node-RED middleware, Snap4City visualisation), which keeps the marginal cost of extending or maintaining the system low and avoids vendor lock-in.

Governance structures supporting long-term operation

A recurring governance pattern across the pilots is a three-actor model:

- A **public authority** as institutional owner and primary end-user (e.g. Municipality of Florence, Municipality of Rhodes, Valencia City Council, Majjistral Nature and History Park).
- A **scientific or technical partner** providing platform development, data architecture, and analytical capacity (e.g. DISIT Lab/UNIFI, Fundación Valenciaport, VEDA).
- A **private supplier or operator** bound by a maintenance contract with defined service levels (e.g. the seven-year maintenance agreement with ImesAPI in Valencia, the five-year agreement in Limassol, the five-year pre-paid agreement in Malta).

Where the pilot involves a sensitive or regulated site, this structure is complemented by a dedicated oversight or monitoring body — such as Rhodes' monitoring committee — responsible for tracking KPIs and coordinating corrective action across sustainability dimensions.

Data management, interoperability and system ownership

All eight pilots feed into the same Snap4City platform, using common protocols (MQTT, JSON, HTTP REST) and Node-RED-based middleware. This shared backbone is what allows methodologies developed in one pilot to be transferred to another without redesigning the underlying data architecture. Two further patterns stand out:

- **Distributed rather than centralised ownership.** Equipment is typically owned by whichever local entity installed or funded it (e.g. in Valencia, the Regional Council owns the WiFi sensors while the cameras operate under a City Council agreement), with the technical coordinator (often the scientific partner) responsible for integration rather than physical ownership.
- **Privacy and data governance by design.** All pilots apply data minimisation, anonymisation/aggregation, and encrypted transmission (SSL/TLS, secured MQTT), with public/private dashboard access levels used to control who sees what.

Coordination among ecosystem stakeholders

Long-term sustainability across the pilots depends on keeping a broad stakeholder base actively engaged, not just informed. Common mechanisms include stakeholder forums, info days, co-creation workshops, and living labs (used in Rhodes, Biševo, and Florence, among others), as well as structured feedback loops that let site managers flag issues such as sensor downtime or data anomalies. Engagement typically spans four stakeholder categories present in nearly every pilot: public authorities/DMOs, technology providers, tourism SMEs and operators, and local communities/residents — reflecting the project's broader view that technological reliability alone does not guarantee adoption; institutional trust and social acceptance have to be actively maintained.

6. Supportive mechanisms for upscaling and adoption

6.1. Framework for scaling solutions within pilot areas

One of the key objectives of the TOURISMO project is to ensure that the solutions developed, tested, and validated within the designated pilot areas can be effectively adopted, replicated, and scaled beyond their original implementation contexts. The project has therefore established a comprehensive framework designed to facilitate the wider deployment of the tested solutions across additional tourism areas, while deliberately avoiding the need to design and develop entirely new systems from the outset. This architecture allows subsequent territories to capitalise on existing pilot results, thereby bypassing the initial resource-intensive phases of research and custom development.

The upscaling framework builds upon the collective knowledge, technical methodologies, technological tools, collaborative governance approaches, and direct operational experience generated throughout the project lifecycle. Through the practical implementation of pilot activities, the project has demonstrated that sustainable tourism management can be significantly enhanced through the use of data-driven approaches, multi-sectoral stakeholder collaboration, and innovative monitoring and analytical tools. These accumulated experiences provide an empirically verified foundation for future replication and upscaling activities across diverse geographic and administrative levels.

A fundamental enabling factor for scaling is the modular, open and highly adaptable nature of the technological and operational solutions developed within the TOURISMO framework. Rather than being restrictively designed for a single territorial context or an isolated administrative setup, the solutions were intentionally conceived as flexible components that can be adapted to different tourism destinations, urban scales, and governance environments. This modular approach enables public authorities and tourism management organisations to adopt individual technological components or fully integrated solution packages according to their specific local needs, territorial priorities, and available resources.

The project has also generated a rigorous set of common methodologies that systematically support the monitoring and analysis of tourism flows, the objective assessment of tourism impacts on local infrastructure, stakeholder engagement processes, and evidence-based decision-making. These methodologies provide a shared operational framework that can be seamlessly transferred to other destinations without requiring a substantial structural redesign of the core architecture.

At the same time, they allow sufficient operational flexibility to accommodate distinct local characteristics, shifting tourism patterns, varied institutional arrangements, and specific territorial priorities inherent to different participant regions.

An important mechanism supporting future widespread adoption is the direct availability of validated pilot experiences and technical configurations. The solutions tested within the initial pilot areas have already undergone rigorous practical implementation, real-world evaluation, and subsequent refinement processes. As a result, future adopters can benefit from proven approaches, comprehensive lessons learned, and practical recommendations derived from large-scale applications. This baseline significantly reduces systemic uncertainty, initial implementation risks, and unexpected development costs compared to introducing entirely unverified, bespoke solutions.

Knowledge transfer and targeted capacity building constitute another central element of the upscaling framework. Throughout the implementation of the project, partners have accumulated considerable technical and administrative expertise regarding the deployment, daily operation, and strategic management of innovative tourism solutions. The technical documentation, standard operating methodologies and procedures, and comprehensive guidance developed during the project provide valuable, accessible resources for future adopters. These strategic assets can support public authorities, destination management organisations (DMOs), and other local stakeholders in planning and implementing similar solutions more efficiently, transparently, and effectively.

The active involvement of stakeholders throughout the project has further demonstrated the critical importance of collaborative governance models. The pilot activities highlighted that successful implementation depends not only on pure technological innovation but also on the structural engagement of relevant actors, including public authorities, academic research organisations, tourism stakeholders, technology providers, and local communities. The governance approaches tested during the project therefore represent an additional transferable asset that can support the successful adoption and social acceptance of solutions in other tourism destinations facing intensive visitor pressures.

Another important supportive mechanism concerns the interoperability and seamless integration of data streams. The TOURISMO approach inherently promotes the use of multiple data sources—such as thermal imaging datasets, IoT data feeds, and local mobility registries—and strongly encourages the integration of existing datasets wherever possible. This allows expanding destinations to structurally build upon their available information systems and pre-existing technological infrastructures rather than replacing them entirely. Such an approach drastically reduces initial capital expenditure, facilitates rapid institutional acceptance, and enhances the long-term economic and technical sustainability of the adopted solutions.

The project has also demonstrated the distinct value of combining technological innovation with official policy-making and strategic planning processes. The solutions developed within TOURISMO are not intended to function as standalone technological tools; rather, they are specifically designed to support real-time decision-making, adaptive tourism management, and long-term policy development. This strict alignment with institutional needs increases the potential for long-term administrative adoption and facilitates the structural integration of project results into existing municipal governance frameworks, urban mobility plans, and routine operational practices.

To support future replication activities, TOURISMO has identified a scalable implementation pathway based on four interrelated dimensions:

- **Technological Adaptability**: Ensuring that the core hardware and software components can interface with diverse sensor types and regional digital platforms without requiring a complete rewrite of the underlying algorithms.
- **Methodological Transferability**: Providing standardised templates for data collection, anonymisation protocols, and indicator calculation that can be readily applied to any European historic centre, coastal destination, or diverse tourism ecosystem.
- **Stakeholder Collaboration**: Exporting the tripartite governance model to coordinate public authorities, academic researchers, and private sector providers around shared metrics for monitoring visitor density and managing tourism impacts**.**
- **Institutional Integration**: Aligning data outputs directly with strategic policy-making, urban mobility management, and the long-term institutional planning duties of local public administrations.

Together, these dimensions provide a highly structured, repeatable framework through which destinations can progressively expand the application of the solutions according to their specific local circumstances and long-term development objectives. Future upscaling activities may involve the physical extension of existing solutions to additional tourism areas, the integration of new datasets and real-time information sources, the deployment of complementary technological components, and the development of enhanced predictive analytics and advanced decision-support functionalities. Because the solutions have been designed around reusable methodologies and adaptable, modular architectures, these developments can be undertaken incrementally and iteratively, without requiring a complete redesign of the underlying framework.

By capitalising on the tools, methodologies, operational procedures, and knowledge already developed and validated through TOURISMO, destinations can significantly accelerate the adoption process and drastically reduce the human and financial resources required for implementation. This framework therefore provides a highly practical, secure, and sustainable pathway for expanding the use of innovative tourism management solutions across participating

countries and beyond, while directly supporting the broader objective of promoting smarter, more resilient, and more sustainable tourism destinations.

6.2. Replication in additional touristic areas and points of interest

The long-term value of the TOURISMO solutions extends beyond their successful implementation within the pilot areas. A key objective of the project is to enable the replication of proven methodologies, tools, and governance approaches in additional touristic areas and points of interest across participating countries and, more broadly, across Mediterranean destinations facing similar tourism management challenges.

Replication should not be understood as the direct duplication of a technological solution from one destination to another. Instead, it should be approached as a structured adaptation process through which the core functionalities, methodologies, and operational principles developed within TOURISMO are transferred and adjusted to local territorial, environmental, and governance conditions. This approach allows destinations to benefit from the knowledge and experience generated during pilot implementation while reducing development costs, implementation time, and operational risks.

The pilot activities demonstrated that many tourism destinations experience comparable challenges despite significant differences in size, tourism intensity, governance structures, and environmental characteristics. Issues such as visitor concentration, seasonal overcrowding, environmental pressure, mobility constraints, limited tourism intelligence, and fragmented governance arrangements were identified across several pilot areas. As a result, many of the solutions developed within TOURISMO address needs that are not unique to individual destinations but are widely shared throughout the Mediterranean region.

The replication process should therefore focus on the transfer of reusable solution components rather than complete system replication. Such components may include visitor monitoring methodologies, tourism flow analytics, data integration frameworks, dashboard structures, digital twin functionalities, governance models, stakeholder engagement approaches, and decision-support mechanisms. By reusing existing components and adapting them to local requirements, destinations can significantly accelerate deployment while ensuring contextual relevance.

A particularly important aspect of replication concerns the identification of suitable target areas. Potential replication sites may include historical city centres, UNESCO heritage sites, protected natural areas, coastal destinations, ports and cruise terminals, cultural attractions, archaeological sites, urban tourism districts, and other locations experiencing visitor management challenges. The selection of replication sites should be based on a systematic assessment of tourism pressures, environmental sensitivity, governance readiness, data availability, and stakeholder commitment.

The experience gained through the TOURISMO pilots highlights the importance of adopting a phased replication approach, the comprehensive TOURISMO solution.

- **The first phase** should focus on assessing local needs, identifying relevant tourism management challenges, and evaluating the suitability of existing TOURISMO solution components.
- **The second phase** should involve the adaptation and configuration of the selected tools and methodologies according to local operational requirements.
- **The third phase** should focus on pilot deployment and validation under real-world conditions, followed by gradual scaling and integration into regular destination management practices.

An important enabling factor for successful replication is the modular architecture of the TOURISMO solution. The ability to deploy individual components independently allows destinations to adopt only those functionalities that address their specific needs. For example, a destination primarily concerned with visitor concentration may focus on tourism flow monitoring and dashboard functionalities, while another destination may prioritise environmental monitoring, predictive analytics, or mobility management tools.

Furthermore, replication can be significantly accelerated through the creation of common implementation guidelines, standardised technical documentation, reusable data models, interoperability frameworks, and shared governance methodologies. Such assets reduce the need for extensive redesign efforts and facilitate knowledge transfer between destinations.

Finally, successful replication depends not only on technological readiness but also on institutional commitment and stakeholder engagement. Destinations seeking to adopt TOURISMO solutions should establish collaborative governance structures capable of supporting long-term implementation, data sharing, operational coordination, and continuous improvement. Replication should therefore be viewed as a socio-technical process combining technological adaptation, organisational learning, and governance innovation. The replication of TOURISMO solutions in additional touristic areas and points of interest represents a key pathway for scaling project results, extending impact beyond the pilot territories, and supporting the broader transition towards smarter, more sustainable, and more resilient tourism management across Mediterranean destinations.

6.3. Integration of additional datasets, sensors and functionalities

To ensure the long-term sustainability, scalability, and effectiveness of the solutions developed within TOURISMO, it is important that they can progressively integrate additional datasets, sensing technologies, and functionalities over time. The pilot activities carried out during the project have demonstrated the value of combining different sources of information to support evidence-based tourism management and decision-making. However, tourism destinations are constantly

evolving, and their monitoring and management needs may change over time. For this reason, the TOURISMO solutions have been designed according to modular, interoperable, and scalable principles, allowing new data sources and services to be incorporated without requiring significant changes to the existing architecture.

One of the main opportunities for future development lies in the integration of additional datasets. While the pilot implementations have mainly focused on tourism flows, environmental monitoring, cultural heritage management, and visitor-related indicators, future deployments could benefit from a broader range of information sources. Mobility data, public transport information, parking occupancy levels, accommodation statistics, event calendars, weather information, and environmental quality indicators can contribute to a more comprehensive understanding of tourism dynamics. Likewise, open data made available by municipalities, regional authorities, national tourism organisations, and private operators can provide valuable contextual information to support destination management and policy-making.

The use of interoperable data management frameworks, such as the one provided by Snap4City, facilitates the integration and harmonisation of datasets originating from different domains and stakeholders. Through standardised APIs, semantic models, and data integration mechanisms, new information sources can be progressively connected to the platform. This approach enables destinations to build a richer and more complete knowledge base, helping to overcome one of the most common challenges in tourism management: data fragmentation across organisations and sectors.

Beyond the integration of additional datasets, future scalability can also be achieved through the deployment of new sensing technologies. The pilots have already demonstrated the usefulness of environmental sensors and people-counting systems for monitoring visitor presence and environmental conditions in tourism areas. Building on these experiences, destinations may extend their monitoring capabilities by introducing additional sensors capable of collecting complementary information. Examples include air quality sensors, noise monitoring devices, weather stations, smart parking systems, mobility counters, pedestrian flow monitoring technologies, and occupancy sensors installed in public spaces, cultural sites, or tourism facilities.

The introduction of new sensing devices can provide destinations with a more comprehensive understanding of the interactions between tourism activities, environmental conditions, infrastructure usage, and visitor behaviour. Such information can support more proactive management approaches, particularly in areas affected by seasonal peaks, overcrowding, or environmental pressures. Furthermore, the growing availability of cost-effective and energy-efficient IoT technologies makes the gradual expansion of monitoring networks both technically feasible and economically sustainable for many destinations.

Another important area for future development concerns the introduction of advanced functionalities capable of transforming data into actionable knowledge. The current solutions already provide monitoring dashboards and reporting tools that support operational decision-making. However, additional analytical services can further increase the value generated by the collected information. Predictive analytics, for example, can help anticipate tourism demand, visitor flows, and potential congestion situations by combining historical data, real-time information, and contextual factors such as weather conditions, events, and transport disruptions. These capabilities enable destination managers to move from reactive responses to more proactive and preventive management approaches.

Similarly, early-warning functionalities can be developed to automatically identify abnormal situations or emerging risks. Alerts related to overcrowding, environmental stress, infrastructure saturation, or unusual tourism patterns can provide timely information to decision-makers and support rapid interventions when necessary. Such functionalities can be particularly valuable in destinations where tourism pressures fluctuate significantly over short periods.

Future developments may also focus on integrating additional qualitative information alongside quantitative monitoring data. While sensors and statistical datasets provide objective measurements, understanding visitors' perceptions and experiences remains equally important. For this reason, future implementations should incorporate additional visitor feedback mechanisms, satisfaction surveys, sentiment analysis tools, and digital participation platforms. Combining quantitative indicators with qualitative insights can provide a more complete understanding of tourism impacts, visitor expectations, and overall destination performance.

Additional functionalities may also be developed to address the specific needs of different stakeholder groups. Tourism operators could benefit from business intelligence services offering insights into visitor profiles, demand trends, and tourism market dynamics. Cultural institutions may use advanced analytics to better understand visitor engagement and optimise the planning of exhibitions, events, and cultural activities. Public administrations could benefit from integrated decision-support systems combining tourism, mobility, environmental, and socio-economic indicators within a common governance framework.

The scalability potential of the TOURISMO solutions that is based on Snap4City technology, is further strengthened by their compatibility with broader Smart City ecosystems. Thanks to the flexibility and interoperability offered by the Snap4city technology, tourism-related data can be integrated with urban management platforms, enabling cross-sectoral analyses and supporting more coordinated policy interventions. This approach encourages collaboration among tourism authorities, municipal departments, transport operators, cultural organisations, and environmental agencies, creating a shared evidence base for decision-making and strategic planning.

Ultimately, the integration of additional datasets, sensors, and functionalities should be considered as a continuous process aimed at strengthening a destination's capacity to understand, monitor, and manage tourism dynamics. By progressively enriching the information ecosystem and expanding analytical capabilities, destinations can improve governance, support sustainability objectives, enhance visitor experiences, and promote more resilient tourism development models. Thanks to the modular and interoperable architecture adopted within TOURISMO powered by Snap4City, these future extensions can be implemented incrementally, allowing destinations to adapt the solution to their evolving needs while preserving the investments already made during the pilot phase.

6.4. Best practices and common methodology derived from pilots

The operational deployment of the TOURISMO pilot initiatives has yielded a wealth of practical insight, institutional learning, and technically sound approaches that establish a robust groundwork for the extensive roll-out and capitalisation of project outputs. By systematically evaluating diverse technical configurations across different regional environments, the partnership has successfully crystallised **a set of transferable best practices as well as core principles and methodologies**. These strategic assets are structured to directly guide the integration, local refinement, and territorial upscaling of the solutions in additional target zones without necessitating a resource-intensive development of entirely new systems from scratch.

A primary best practice emerging from the pilot implementation phase revolves around the critical importance of **adopting a data-driven approach to sustainable tourism management.** Across all involved pilot areas, the systematic collection, analysis, and interpretation of tourism-related data proved essential for improving the objective understanding of visitor behaviour, localised tourism flows, and wider destination dynamics. The utilisation of reliable and continuously updated information enabled local stakeholders to make more informed decisions, identify emerging territorial challenges, and assess the empirical effectiveness of implemented visitor dispersal measures. This shared experience demonstrates that data-driven decision-making represents an indispensable cornerstone for any future replication or scaling process.

Furthermore, the pilots have validated a rigorous, step-by-step solution engineering cycle that standardises the path from initial territorial diagnostic to final evaluation. Throughout the project, pilot activities followed a shared, comprehensive methodology based on problem identification, stakeholder engagement, solution mapping, technical design, customisation, implementation, and continuous evaluation. This **phased management model** provided a clear, logical framework for developing targeted solutions that respond directly to local needs while maintaining total consistency with the overarching project objectives. The methodology can be readily applied in additional tourism destinations, significantly reducing initial implementation risks and facilitating the seamless transfer of knowledge and operational experience.

A cross-cutting operational principle confirmed by the partnership is the necessity of **active stakeholder involvement** and the continuous mobilisation of territorial actors throughout the pilot lifecycle. The practical execution of the pilots established that technical reliability alone is insufficient to guarantee long-term operational success; indeed, digital tracking platforms cannot operate efficiently without a structured participation encompassing public authorities, research centres, tourism operators, tech providers, and host communities. Securing early consensus and alignment during the initial co-design phase proved crucial to map local constraints accurately, build institutional trust, and secure early user endorsement. Consequently, future adopters are urged to embed these verified participatory mechanics into every stage of their local upscaling plans to foster the broad social acceptance required for sustained crowd-monitoring initiatives.

In parallel, the pilot outcomes have highlighted the importance of **combining technological innovation with suitable institutional governance frameworks**. While high-resolution hardware networks and automated analytical modules offer unprecedented clarity for flow tracking, their long-term effectiveness depends heavily on the existence of appropriate governance structures, institutional commitment, and adequate operational capacities. The common methodology derived from the project clearly demonstrates that successful capitalisation requires a balanced implementation logic, where innovative software environments are structurally integrated into daily urban management workflows and existing public decision-making loops.

Another highly transferable best practice identified during the field trials involves **prioritising architectural flexibility through component-based software design**. The pilot applications proved that replication efforts are substantially accelerated when the core technical systems are conceived as decoupled, independent functional layers that can be adapted to different territorial conditions, shifting tourism patterns, and varied organisational environments. This structural modularity allows target areas to leverage pre-existing local assets, infrastructures, and digital networks while adapting individual components to specific local priorities. Such flexibility significantly facilitates future scaling, drastically lowering development resource requirements.

Simultaneously, the **importance of interoperability and the synchronisation of heterogeneous data registers** has emerged as a fundamental shared prerequisite across all pilot landscapes. Modern sustainable governance increasingly requires the multi-dimensional correlation of different data matrices, blending visitor density indicators with public transport frequency, environmental parameters, and socio-economic datasets. The pilot activities confirmed that bridging these separate information channels significantly enhances overall analytical capabilities and provides a more comprehensive, multifaceted overview of destination dynamics. Future replication strategies should therefore promote full technical interoperability and foster the adoption of open data communication standards wherever possible.

Capacity building and knowledge transfer represent additional core elements of the common methodology derived from the pilots. Throughout the project, partners continuously exchanged

experiences, methodologies, and technical expertise, fostering a resilient ecosystem of shared learning. This collaborative approach significantly strengthened local execution skills and enhanced enduring institutional preparedness. Future replication activities can benefit from the structured insights, transfer frameworks, and core lessons learned generated by the project, thereby avoiding duplicative design efforts and accelerating implementation processes.

Finally, the pilot experiences also confirmed the **deep value of iterative refinement protocols** by applying evaluation loops directly to the live software setups. The systematic, ongoing assessment of the deployed monitoring systems enabled technical teams to identify hardware bottlenecks, optimise algorithmic accuracy, and recalibrate tracking parameters in real time. This iterative approach underpins a culture of constant quality improvement, ensuring that the system remains highly reliable and responsive to shifting territorial trends. Future adopters are strongly encouraged to integrate these internal auditing and refinement procedures from the outset in order to guarantee a resilient, self-optimising architecture.

Drawing upon this extensive body of empirical knowledge, TOURISMO has consolidated these operational lessons into a comprehensive common methodology that can support the wider deployment of project solutions across various territories, and which is organised around key strategic pillars:

- **Data-Driven Governance**: Grounding all destination management interventions on continuous, empirically verified data streams to eliminate reliance on static or outdated statistical estimates.
- **Structured Solution Engineering**: Following a rigorous, phased cycle from initial territorial diagnostics and design to final evaluation to standardise tool deployment pathways.
- **Participatory Frameworks**: Standardising the early-stage mobilisation of local stakeholders and community actors to secure operational relevance and long-term socio-political alignment.
- **Institutional Framework Integration**: Structurally embedding innovative tracking networks within permanent workflows and existing public decision-making loops.
- **Component-Based Design**: Prioritising architectural flexibility through decoupled software layers and modular hardware configurations that can be readily adjusted to distinct destination environments.
- **Data Interoperability and Synchronisation**: Facilitating the multi-dimensional correlation of heterogeneous datasets to provide a comprehensive, multifaceted overview of destination dynamics.
- **Capacity Building and Knowledge Transfer**: Strengthening execution skills through structured insights and transfer frameworks to ensure enduring preparedness and avoid duplicative design efforts.

Together, these pillars provide a highly structured, repeatable pathway for extending the application of validated solutions to new tourism areas while avoiding the need to develop entirely new systems or methodologies from scratch. By capitalising on the best practices, operational experience, and common methodologies generated through the pilot activities, destinations can significantly accelerate the adoption of innovative tourism management solutions, reduce implementation resource requirements, and minimise operational risks. This comprehensive approach contributes to the long-term sustainability of project results and directly supports the broader objective of promoting smarter, more resilient, and more sustainable tourism destinations.

6.5. Capacity building and stakeholder engagement mechanisms

The successful adoption, scaling, and long-term sustainability of the TOURISMO solutions depend not only on technological deployment but also on the capacity of stakeholders to effectively understand, utilise, manage, and continuously improve these solutions over time. Consequently, capacity building and stakeholder engagement constitute fundamental enabling mechanisms supporting the transferability and operational integration of TOURISMO results.

The pilot experience demonstrated that technological innovation alone does not automatically lead to adoption. In several cases, barriers related to limited digital skills, insufficient technical expertise, fragmented governance arrangements, low awareness of potential benefits, and resistance to organisational change were identified as significant constraints affecting implementation. Addressing these barriers requires a structured capacity-building strategy capable of strengthening both individual competencies and institutional capabilities. Capacity building within the TOURISMO framework is understood as a continuous learning process rather than a one-off training activity. It encompasses the development of technical skills, analytical capabilities, governance competencies, and collaborative practices necessary for the effective management of tourism data, monitoring systems, decision-support tools, and stakeholder networks.

Different stakeholder groups require different forms of support. Public authorities and Destination Management Organisations often need training related to data-driven decision-making, tourism intelligence interpretation, governance coordination, interoperability management, and evidence-based policy design. Tourism SMEs may require practical guidance on the use of tourism analytics, digital tools, sustainability practices, and participation in collaborative destination initiatives. Technology providers and solution developers benefit from greater understanding of destination governance processes, operational requirements, and stakeholder expectations.

A key lesson emerging from the pilot activities is that learning processes are most effective when directly linked to real operational challenges. Consequently, capacity-building activities should prioritise practical and experiential approaches, including demonstration actions, pilot testing

environments, hands-on workshops, peer-learning activities, mentoring schemes, and collaborative problem-solving exercises. Such approaches allow stakeholders to gain practical experience while building confidence in the operational value of the solutions.

Stakeholder engagement represents a complementary mechanism supporting adoption and long-term sustainability. The implementation of smart tourism solutions typically involves a wide range of actors operating across different sectors and governance levels. These include local and regional authorities, DMOs, tourism businesses, technology providers, transport operators, environmental agencies, cultural organisations, local communities, and visitors themselves. Effective engagement mechanisms are therefore necessary to align interests, facilitate collaboration, and support shared ownership of the solutions.

The pilot experience stressed that stakeholder participation should begin during the early stages of implementation and continue throughout the entire solution lifecycle. Early engagement contributes to the identification of local needs, increases acceptance, and helps ensure that solutions remain relevant to operational realities. Continuous engagement, in turn, supports feedback collection, collaborative learning, and long-term commitment. Several engagement mechanisms can support this process. These include stakeholder forums, co-creation workshops, thematic working groups, governance committees, living labs, community consultations, and regular feedback sessions. Such mechanisms facilitate dialogue between different stakeholder categories while strengthening transparency, trust, and collective ownership.

Knowledge-sharing activities also play an important role in supporting transferability and scaling. The dissemination of lessons learned, implementation experiences, technical documentation, case studies, and good practices enable destinations to benefit from existing knowledge and avoid repeating common implementation challenges. Cross-pilot exchanges and peer-learning activities can further accelerate the adoption process by facilitating direct knowledge transfer between destinations.

Finally, capacity building and stakeholder engagement should be viewed as long-term investments supporting the sustainability of project results beyond the duration of the project itself. As tourism systems continue to evolve and new challenges emerge, stakeholders must retain the ability to adapt, innovate, and collaboratively manage tourism pressures using data-driven approaches and evidence-based decision-making tools. In this respect, capacity building and stakeholder engagement do not merely support the deployment of the TOURISMO solutions; they constitute essential prerequisites for ensuring their long-term effectiveness, scalability, and transferability across different tourism contexts and territorial environments.

7. Conclusions and recommendation

TOURISMO project has demonstrated that the combination of monitoring technologies, data integration platforms, and participatory governance mechanisms is an effective tool for addressing one of the main challenges facing Mediterranean tourist destinations: the sustainable management of tourist pressure. The eight pilot projects carried out have made it possible to validate solutions in a wide variety of contexts, confirming that while there is no single answer to the problem of tourist congestion, there is a common methodology capable of adapting to different territories and needs.

One of the main conclusions is that the availability of reliable, real-time data significantly improves the ability of local governments and destination managers to make informed decisions. Continuous monitoring of visitor flows, mobility patterns, space occupancy, and environmental variables enables a shift from reactive models to preventive and predictive management models. This capability is particularly relevant in heritage destinations, protected natural areas, and tourist sites subject to seasonal peaks in demand.

The project has also shown that technology alone does not guarantee the sustainability of solutions. The success of the pilot projects has been driven by the active involvement of local authorities, tourism management organizations, scientific institutions, technology companies, tour operators, and local communities. The cases analyzed show that social acceptance, clarity regarding institutional responsibilities, and inter-institutional collaboration are just as important as the technological infrastructure itself.

Another key finding is the validity of the technological architecture adopted. The use of open standards, interoperable APIs, Node-RED-based middleware, and the Snap4City platform has made it possible to integrate sensors and heterogeneous information sources in very different environments. This modularity facilitates both the maintenance and future expansion of the systems, reducing the risks of technological dependency and facilitating replication in other regions.

The pilot projects have also demonstrated the value of combining tourism information with environmental, mobility, and heritage conservation data. The results obtained in Valencia, Malta, Varna, and Biševo show that an integrated view of the destination provides a much more comprehensive understanding of the impacts of tourism and facilitates the adoption of more

effective corrective measures.

From a sustainability perspective, the plans developed by each pilot project highlight the importance of securing financial and organizational resources once European funding ends. The existence of maintenance contracts lasting between five and eight years, formal institutional agreements, and the gradual integration of the systems into the day-to-day management of the participating organizations are positive signs for ensuring the continuity of the results.

Finally, TOURISMO has confirmed that the transferability and scalability of the solutions are feasible as long as a balance is maintained between standardization and local adaptation. The methodologies developed can be replicated in other destinations, but it will be necessary to tailor sensors, indicators, governance models, and participation mechanisms to the characteristics of each region.

The main recommendations for the transferability of these solutions are:

1. **Strengthen the institutional integration of solutions**: The relevant government agencies and entities should gradually incorporate the tools developed under TOURISMO into their standard procedures for tourism management, urban planning, and heritage protection. The usefulness of these systems increases when their results are routinely used in decision-making and not merely as experimental tools derived from European projects.

2. **Ensure sustainable funding models**: It is recommended to establish blended funding models that combine public resources, European programs, regional funds, and potential public-private partnership mechanisms. The continuity of these systems should not depend exclusively on project calls for proposals but should instead be incorporated into the operating budgets of the managing entities.

3. **Strengthen interoperability and open standards**: All future expansions should maintain the approach based on open standards and interoperable architectures. This will facilitate the integration of new data sources, minimize adaptation costs, and prevent technological dependence on specific vendors.

4. **Enhancing Predictive Capabilities**: It is recommended to move from descriptive functions toward predictive models capable of anticipating situations of congestion, pressure on heritage sites, or environmental risks. Artificial intelligence and advanced analytics can become key tools for proactively managing tourism demand.

5. **Strengthen stakeholder engagement**: Long-term sustainability requires maintaining ongoing channels of dialogue among government agencies, the tourism sector, technology providers, residents, and civil society organizations. The co-creation mechanisms used

during the pilot projects should be institutionalized to ensure continuous improvement of the solutions.

Tables and figures

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