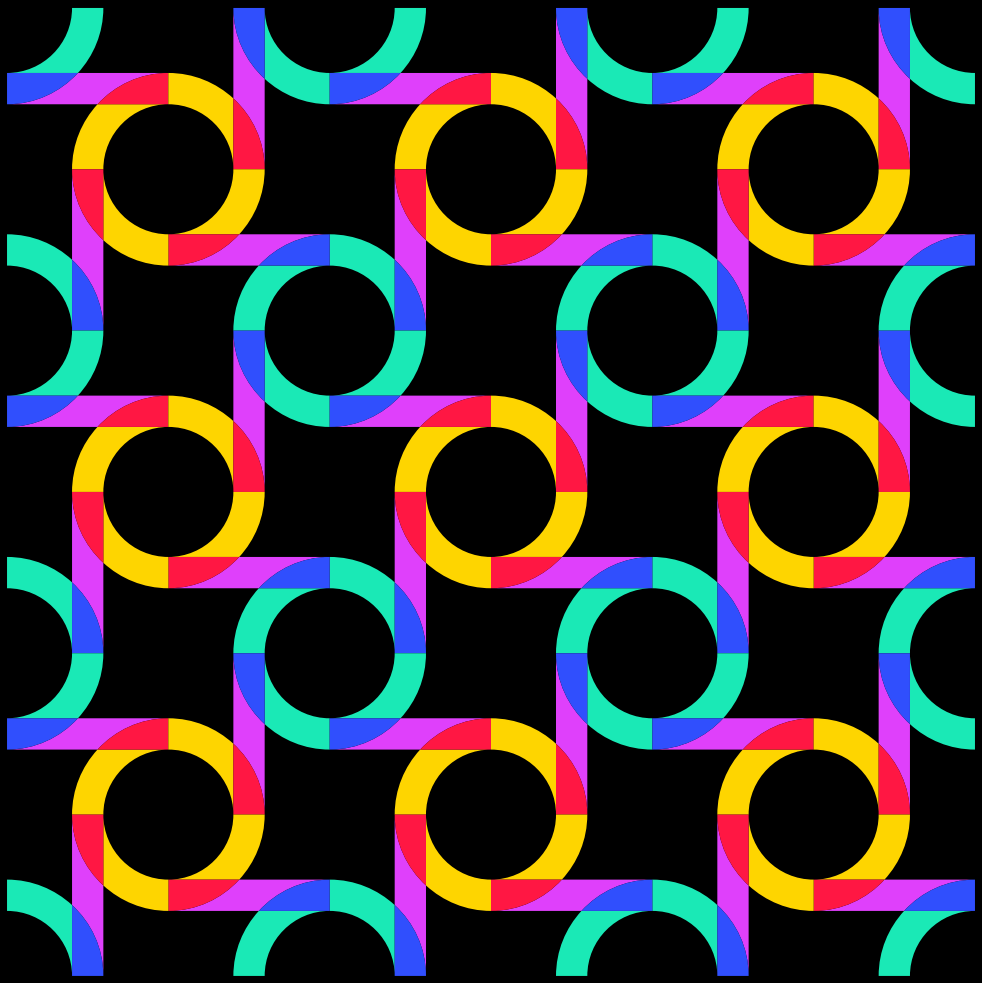
i4Trust



Tidy City

Mobile computer vision solution
to monitor public space infrastructures

i4Trust – Data Spaces for effective and trusted data sharing

www.i4trust.org

Smart Cities and Smart Buildings

Tidy City: Mobile computer vision solution to monitor public space infrastructures

With the contribution of:

- Logimade
- Trans Bag - Transportes de Mercadorias
- IL Technologies, Lda.
- Sicaprep (Madeira)

- MWR - Madeira Waste Recycling

- Promerch https://www.promerch.pt

- Smart Islands Hub https://www.smartislandshub.org

Challenge & Context

Cities worldwide have become complex products that compete for a share of the growing population choosing urban living. According to the UN [1], the world population living in urban areas will increase from 55% in 2018 to 68% in 2050 and is expected to reach 84% in 2100.

However, the challenges faced by these sprawling urban metropolises are not just about accommodating this influx. Contemporary cities are evolving beyond mere dwelling spaces. There is an ongoing metamorphosis, wherein cities, to retain their allure, are compelled to provide advanced infrastructural facilities that directly enhance the quality of life for their inhabitants. Consider the example of the "Tidy City" project. It is not enough for urban spaces to only offer foundational amenities. A city's attractiveness now hinges on intricate details: solar-powered LED lights marking crosswalks and bike lanes, barriers that limit vehicular pollutants in city cores, technologically enhanced public playgrounds that impart educational values, consistently maintained aesthetics of streets and edifices, digital kiosks at cultural landmarks, easily accessible electric vehicles, and sophisticated waste management systems that not only forecast container capacity but also monitor the quality of waste segregation.

These enhancements, while elevating urban life, also amplify the infrastructural complexities that need daily oversight. Traditional management practices by

public authorities often fall short in this context. The optimal route, as epitomised by the "Tidy City" project, is a symbiotic collaboration between the public and private sectors. Herein, leveraging technological innovations becomes indispensable. Such technologies, which prioritise data sharing, astute analysis, and process automation, become the linchpins ensuring that these urban behemoths function seamlessly 24/7.

Solution

As urbanisation accelerates, cities face intricate challenges triggered by swift population growth and expansive infrastructure. Addressing these challenges is imperative to maintain urban sustainability and functionality. The Tidy City project provides an innovative and methodical solution, designed to resonate with the dynamic needs of the contemporary urban sphere.

At its core, the Tidy City initiative capitalises on mobile devices equipped on a diverse fleet of city vehicles including waste collection trucks, police cars, inspection units, and express delivery services. As these vehicles navigate through the city streets for their regular duties, they serve as continuous data collection conduits. Images from the streets are captured in real-time, stored on these devices, and then systematically relayed to the project's central servers. Leveraging cellular communications, this transfer can occur in real-time or get deferred to moments when Wi-Fi connectivity is accessible.

Post-collection, the images undergo meticulous scrutiny by sophisticated AI algorithms. These algorithms are adept at recognizing a myriad of infrastructural inconsistencies such as:

- Improper Waste Disposal: Detecting anomalies like tires dumped astray, malfunctioned appliances, or other discarded materials.
- Graffiti: Identifying unauthorised or offensive artwork on public or private properties.
- Vegetation Growth: Pinpointing overgrown vegetation, which could impede city functionalities or aesthetics.

- Infrastructure Deterioration: Recognizing faults in critical infrastructure segments like water, electricity, gas, and communication distribution networks.
- Advertisement Discrepancies: Detecting damages or inconsistencies in billboards and other advertising mediums.
- Stolen Vehicles: Assisting law enforcement by identifying vehicles that match stolen databases.

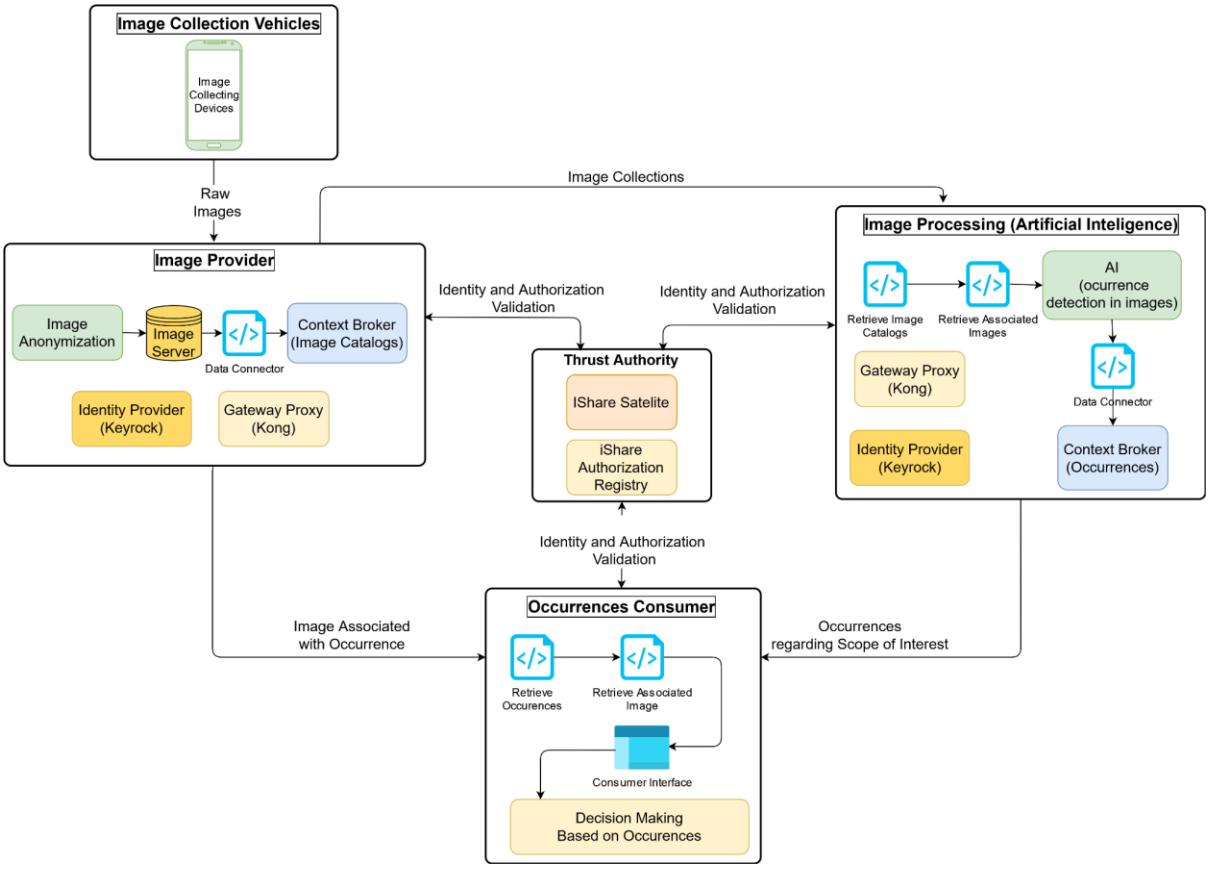
Post-analysis, these detections, categorised and geotagged, are distributed to the relevant urban management divisions and companies, ensuring swift and effective rectification measures.

One of the salient features of Tidy City is its staunch commitment to privacy. Adopting rigorous protocols similar to systems like Google Street View, all personal identifiable information from images is meticulously erased, ensuring compliance with RGPD and other pertinent regulations.

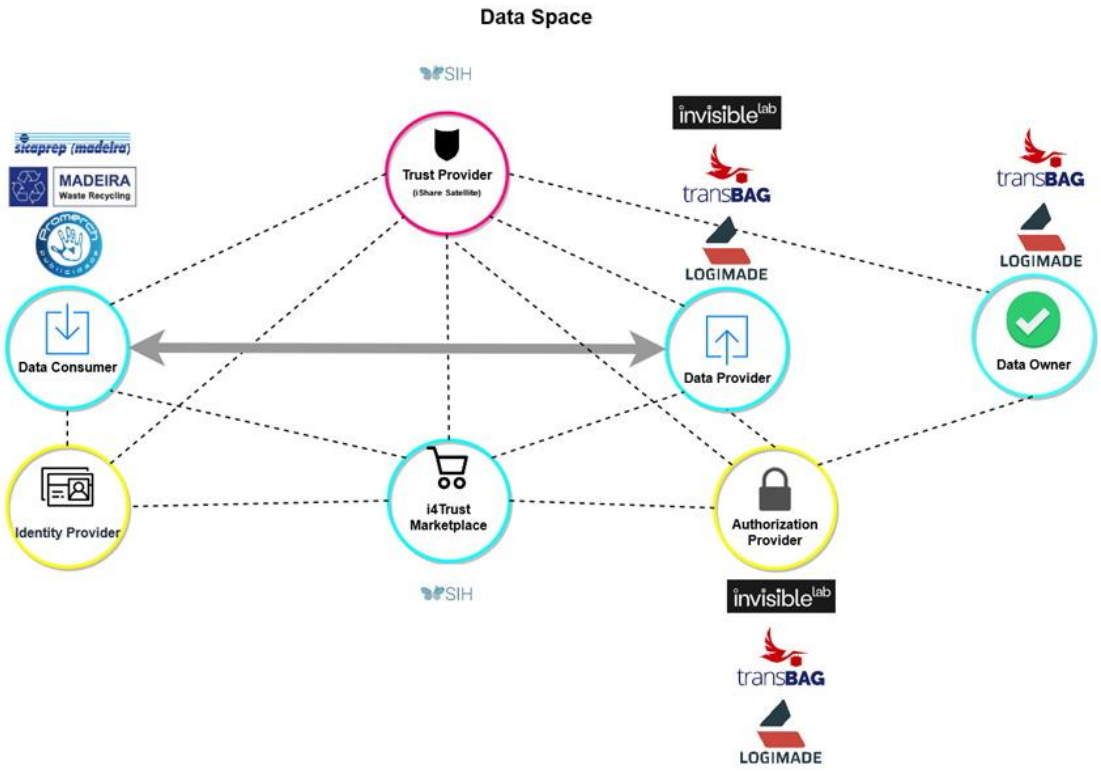
The economic implications of Tidy City are profound. Enhanced urban monitoring can lead to cost savings by facilitating proactive maintenance, reducing vandalism costs, and even assisting in the recovery of stolen assets. From a societal perspective, a well-maintained city improves the quality of life, bolsters citizen trust, and augments the city's appeal to tourists and potential residents.

Tidy City is not merely an urban monitoring solution; it is a vision for the future, harmoniously blending technological ingenuity with sustainable urban management, all while steadfastly preserving individual privacy.

How it works



The high-level architecture on display features four participants of the data space and the iSHARE satellite. Within each participant, we see which components have been deployed and used. Arrows illustrate a high-level data flow among the participants.



The Data Space for our experiment is illustrated in the image above. In this experiment, the data owner role is being performed by Logimade and Transbag. Both Logimade and Transbag have equipped their vehicles, as well as some of their partners' vehicles, with image capturing equipment. This equipment is used to identify issues during their regular routes. InvisibleLab subsequently accesses these images from the marketplace, applying their AI to transform them into occurrences. These occurrences are then made available through the marketplace.

Logimade, Transbag, and InvisibleLab have taken on the role of data providers by making their collected data available in the marketplace, richly characterised with metadata. This data includes the captured images from Logimade and Transbag and the processed images (occurrences) from InvisibleLab. Meanwhile, Promerch, Sicarep, and MWR have been functioning as data consumers, accessing occurrences relevant to them from the marketplace pool based on location and class. InvisibleLab, in addition to their other roles, also acts as a data consumer, accessing the images before processing.

This exchange has been facilitated using an instance of the i4trust marketplace, and the access control of the entities has been ensured by the iShare Satellite. Furthermore, Logimade, Transbag, and InvisibleLab have undertaken the roles

of Authorization Providers, limiting access to their shared data with the assistance of the access policies established at the marketplace.

To detail the Data Space's implementation, Logimade and TransBag have equipped their and their partners' vehicles with image collecting devices. After undergoing a process of anonymization, these images are fed into their local context brokers, which are safeguarded by a gateway proxy (Kong). Their access is controlled by their respective Identity Providers (Keyrock), which applies the access policies at the Authorization Registry.

These images are then made available to InvisibleLab, which employs its AI software to detect anomalies in the images that could be of relevance to any data consumers. These anomalies, termed occurrences, are subsequently added to InvisibleLab's Context Broker, also shielded by a gateway proxy (Kong) and with access governed by their Identity Provider (Keyrock) applying the access policies at the Authorization Registry.

Like the images, occurrences are also shared on the i4Trust Marketplace and accessed by multiple interested parties, which, at this stage of the experiment, include Promerch, Sicarep, and MWR. These entities integrate the acquired datasets with their systems to optimise their maintenance or repair jobs.

The i4Trust Marketplace, controlled by the Identity Provider (Keyrock) and protected by the gateway proxy (Kong), has been deployed by the Smart Islands Hub. The iShare Satellite ensures the legitimacy of all parties involved and verifies they possess the appropriate authorization to access the data they request.

Benefits & Impact

The innovative Tidy City project is set to revolutionise the way urban infrastructure and public spaces are monitored and managed. Through the continuous collection of images via everyday city vehicles and the subsequent AI-driven analysis, the project taps into a multitude of real-world applications that span several industries.

Projected User Base and Engagement

In our vision of the future, the primary beneficiaries of this system will be:

- Public Authorities: Both local and national will leverage this data to maintain, manage, and plan urban infrastructures effectively.
- Advertising Companies: They can monitor outdoor advertising mediums for quality, visibility, and state of repair.
- Facility Companies: Utilizing up-to-date images of public spaces, they can gain insights into door numbers, street details, and other infrastructure specifics to enhance their operations.
- Waste Recycling Companies: Directing waste collection efforts towards areas highlighted by the system will lead to efficient waste management.
- Tourism Bureaus: By ensuring tourist hotspots are pristine and functional, the city's image as an attractive tourist destination can be maintained.

In the foreseeable future, as the benefits of the Tidy City project become more evident, we anticipate an exponential growth in our customer base. As stakeholders witness the project's tangible outcomes, we project a significant influx of new potential clients, driven by the practical evidence showcasing the project's success.

Monetizing the Initiative: Revenue Streams

- Event Detection and Characterization Sales: By pinpointing various events like improper waste disposal, graffiti, infrastructure anomalies, and vegetation growth, among others, the system can provide actionable insights to stakeholders, leading to an increased demand for this data.
- API Access for Third-Party Applications: By offering API access, third-party entities can seamlessly integrate with the Tidy City infrastructure, spawning numerous innovative applications and solutions.
- Sales of Up-to-Date Public Space Imagery: High-resolution, recent images of public spaces are a goldmine for facilities companies and other stakeholders, enabling them to effectively carry out their functions.

Business and Innovation Impacts

Harnessing the capabilities of vehicles to gather data isn't just inventive, it's transformative. This system eliminates the need for specialised data collection missions, instead leveraging the ubiquity of city vehicles. The plethora of real-

world applications - from monitoring shop windows, assessing road conditions, to tracking construction works - is indicative of the boundless potential of this initiative.

Crucially, our approach places heavy emphasis on stakeholder feedback. This iterative feedback loop ensures that the project continually evolves to meet the expectations and requirements of all involved parties.

Indeed, while isolated components of our system have been explored previously, the amalgamation of these facets to create a comprehensive city-wide monitoring system is pioneering. The symbiotic relationships forged among our partners - data producers, intermediaries, and consumers - exemplify the holistic approach of the Tidy City initiative.

Each of our partners, from Logimade's enhanced waste management system to Trans Bag's innovative image collection approach and Promerch's advanced advertising monitoring, stands to gain uniquely. This multifaceted benefit system underscores the versatility and expansive reach of the Tidy City project.

Tidy City not only promises substantial economic benefits but also sows the seeds for a collaborative ecosystem. This ecosystem, nurtured by cross-sectoral interactions, will undoubtedly birth novel services and sales avenues, propelling urban management into a new era of efficiency and innovation.

Added value through i4Trust

Utilising the i4Trust ecosystem to implement the Tidy City project brings a host of advantages, from which we highlight the following.

- Standardised Data Sharing:
  - Benefit: i4Trust emphasises standardised approaches to data sharing. Tidy City, being a data-centric project, benefits immensely from this, as it relies on the collection, analysis, and sharing of images and derived insights across the urban environment.
  - Value-Add: With standardised data sharing, Tidy City faces fewer technical hurdles when integrating with various stakeholders, from local

authorities to advertising companies. This speeds up deployment and ensures consistent data quality and format.

- Trustworthiness and Data Security:
  - Benefit: Ensuring the privacy and security of the shared data is a priority for i4Trust. Given that, Tidy City captures street-level images, ensuring a strong protection system to access the data is paramount.
  - Value-Add: Through i4Trust, stakeholders and the general public would have confidence in Tidy City's commitment to data privacy and security, thus enhancing the project's acceptability and reputation.
- Networking and Collaborative Opportunities:
  - Benefit: The i4Trust community brings together a diverse set of stakeholders, from SMEs to large enterprises and public entities. This network provides a unique platform for collaborations and business partnerships.
  - Value-Add: Tidy City could explore partnerships for technological enhancements, expansions to new regions, or even identifying novel use-cases for their data, all through connections established in the i4Trust ecosystem.
- Business Model Innovation Support:
  - Benefit: i4Trust encourages the creation of innovative business models leveraging shared data. Tidy City, with its unique approach to urban monitoring, stands to gain from this business-centric perspective.
  - Value-Add: Through interactions within the i4Trust ecosystem, Tidy City can refine its revenue streams, discover potential markets, and optimise its service offerings.
- Coaching and Support:
  - Benefit: i4Trust offers comprehensive support and coaching to its participants. This ranges from technical assistance in implementing i4Trust standards to business coaching for market penetration strategies.
  - Value-Add: With expert guidance, the Tidy City project is better positioned to avoid pitfalls, capitalise on opportunities, and achieve its objectives faster.
- Integration with Other Systems:

- Benefit: Given the collaboration of i4Trust with platforms like FIWARE, Tidy City can more easily integrate its operations with other smart city solutions and platforms.
- Value-Add: Such integrations could expand Tidy City's scope, allowing it to become a more holistic urban solution, combining its insights with other urban datasets for richer, more comprehensive urban management solutions.

Why i4Trust is the Right Technology for Tidy City:

i4Trust provides a holistic ecosystem that aligns with the core objectives of Tidy City. The initiative's emphasis on secure, standardised data sharing, combined with a vast network of stakeholders and comprehensive support structures, makes it an ideal platform for Tidy City's vision of efficient urban monitoring. By leveraging i4Trust's ecosystem, Tidy City can enhance its operational efficiency, expand its network, innovate its business model, and ensure the highest standards of data privacy and security, making the project more robust, scalable, and future-ready.

Next steps

For the near future of the Tidy City project, we anticipate a series of focused advancements:

- Completion of the MVP: We will finalise our Minimum Viable Product, ensuring it robustly addresses the challenges found in dynamic urban environments and is ready for scalable deployment.
- Website Development: A comprehensive digital platform will be launched, offering an immersive experience for potential clients. Here, they can delve into the solution, understanding its multifaceted benefits, and visualise its capacity to reshape urban monitoring and management.
- Diverse Online Package Offerings: Upon accessing the website, clients will encounter three distinct package types available for purchase:
  - Events Package: Tailored for clients requiring real-time insights into specific urban events, ensuring rapid response and management.

    - API Access: Ideal for developers and businesses looking to integrate Tidy City's powerful urban monitoring capabilities into their systems or applications.
    - Up-to-Date Image Access: Targeted at entities, particularly facilities companies, that need the latest street imagery for planning, maintenance, or strategic purposes.
    - These packages will be purchasable without manual intervention, streamlining the acquisition process.
- Promotion and Marketing: We will ramp up our promotional activities with a dual-pronged approach. This will involve aggressive digital marketing to capture the tech-savvy audience and traditional marketing to engage institutions and local governments.
- Incentivizing Image Collector Partners: Recognizing the paramount importance of image collection in our ecosystem, a concerted effort will be made to create an attractive incentive scheme for our image collector partners. One pioneering approach we are keen on exploring is the integration of blockchain technology. By developing a dedicated cryptocurrency, we aim to set up a system where 'mining' is tied to image collection. Rates of crypto rewards will be intricately linked to the geographical significance of the area covered and the quality of images procured. This not only ensures a consistent flow of high-quality data but also paves the way for a novel, decentralised incentive structure, fostering participation and commitment.

Through these steps, Tidy City aims to cement its position as a leading solution for urban monitoring and management, making cities smarter, cleaner, and more sustainable.

References

- [1] United Nations, Department of Economic and Social Affairs, Population Division (2019). World Urbanization Prospects: The 2018 Revision. (ST/ESA/SER.A/420). New York: United Nations.

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Key words:

SmartCities, Infrastrustructure Monitorization, Digital Twin

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Do you have questions or want to know more?

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Founding Partners

FIWARE FOUNDATION

iSHARE

FundingBox

i4Trust has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement no 951975.

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