CITY OF MIAMI BEACH

MIAMIBEACH RISING ABOVE

Smart Lighting

Preliminary Order of Magnitude

Public Benefit Use Case Analysis & Data Strategy

February 2020

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Overview

In alignment with the Smart Lighting Implementation Plan by the City of Miami Beach, our research focused on data captured as a commodity, deriving both value from insights as well as syndication of the data. With a strong focus on creating value using data, this strategies uses descriptive statistics to better understand activity, machine learning models to create probability-based future outcomes, and prescriptive analytics to provide guidance for decisions to be made. This data-centric approach also leads to the creation of a set of data offerings and a strategy around how to syndicate such products.

This Phase 1A iteration of a Preliminary Order of Magnitude Public Impact Use Case Analysis and Data Strategy is designed to explore the opportunities that data as a service can provide to the City of Miami Beach in the area of increased service levels based on city-provided services from smart lighting initiatives. The assumptions included in this report reflect the following activities in Phase 1A by the Smart Lighting city stakeholders, Johnson Controls and additional partners included in the discovery and exploration, as well as significant research in other smart-city implementations around the globe.

Discovery and Research Activities

- Smart city and smart lighting research, including previous city implementations
- Explore potential data consumers and level of interest
- Use Case Analysis and Technical Workshops with representatives from Environment and Sustainability, Information Technology, Parking, Police, Public Works, and Transportation
- Additional feedback sessions with all city department representatives to validate high-level assumptions and estimates

Sensor Features Considered

Smart Lighting

Remote management and control to improve communication between systems and to access more real-time data. Energy usage monitoring, lighting level adjustments and pinpointing outages can be handled remotely using wired or wireless communications. No more night patrols or waiting for citizens to call about outages.

Wi-Fi Access

Public Wi-Fi will ensure a better connected society and a more technologically advanced city. Not only this but it will attract tourists and increase business trips as a result. Providing Wi-Fi will give everyone access to a range of information including health advice, job opportunities and online education.

Weather Station

Adjust lighting levels during weather events, warn people that a storm is approaching using predictive analytics and sensors.

Camera

Cameras can provide climate-based intensity, intelligent brightness, ability to curb crimes in public spaces and home safety.

Motion Detector

Motion detection devices on the street may help to save up to 40% of energy per month, still ensuring 100% of the required lighting norms for all road users.

Audio Microphone

Microphones allow for monitoring traffic, monitoring the ambient sounds of the city, and help give a diverse and articulate reading of the urban soundscape, including congestion, gunshots, and pollutants.

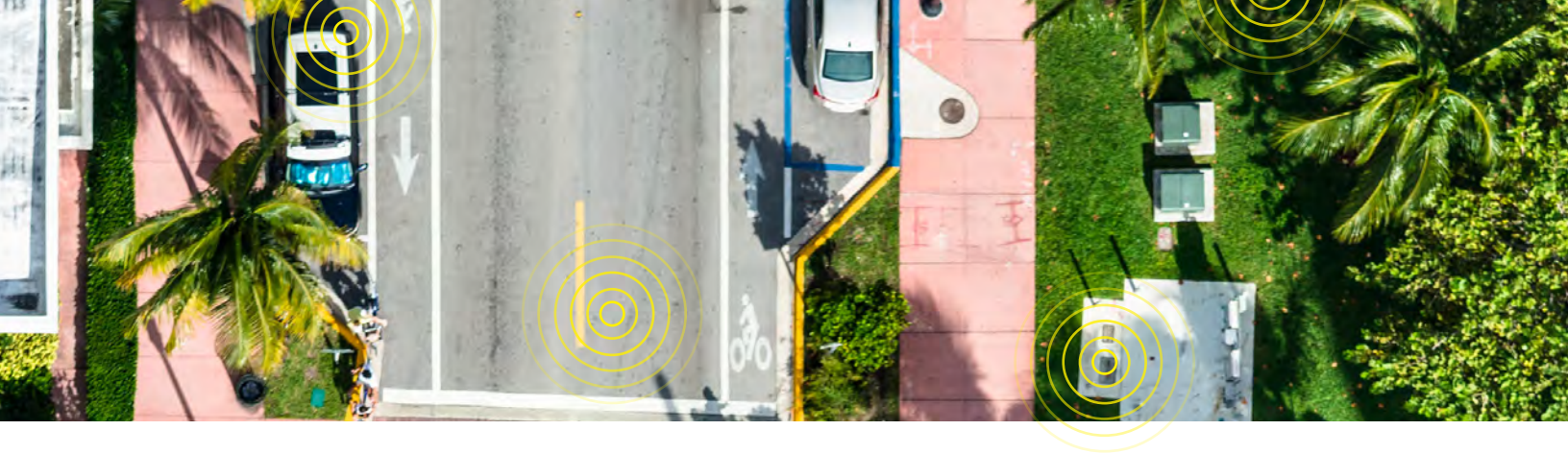
Air Quality

Increase the density of air quality sensing which in turn increases the relevance of air quality information to communities and the individuals within them.

Electromagnetic

Radar is an object-detection method that uses radio waves to determine the range, angle or velocity of objects through electromagnetic waves. Typical radar systems consist of several elements including a transmitter that produces electromagnetic pulses or waves in the radio or microwave frequency range, a transmitting antenna, separate receiving antenna and a receiver that includes the ability to process received signals.

State of the Technology & Data Privacy Trends



Artificial Intelligence, Computer Vision & Machine Learning

In 2019, global private AI investment was over $70B, with AI-related startup investments over $37B, M&A $34B, IPOs $5B, and Minority Stake valued around $2B. Globally, investment in AI startups continues its steady ascent. From a total of $1.3B raised in 2010 to over $40.4B in 2018 (with $37.4B in 2019 as of November 4th), funding has increased at an average annual growth rate of over 48%. Autonomous Vehicles (AVs) received the largest share of global investment over the last year with $7.7B (9.9% of the total), followed by Drug, Cancer and Therapy ($4.7B, 6.1%), Facial Recognition ($4.7B, 6.0%), Video Content ($3.6B, 4.5%), and Fraud Detection and Finance ($3.1B, 3.9%).

58% of large companies surveyed report adopting AI in at least one function or business unit in 2019, up from 47% in 2018. Only 19% of large companies surveyed say their organizations are taking steps to mitigate risks associated with explainability of their algorithms, and 13% are mitigating risks to equity and fairness, such as algorithmic bias and discrimination

In a year and a half, the time required to train a large image classification system on cloud infrastructure has fallen from about three hours in October 2017 to about 88 seconds in July, 2019. During the same period, the cost to train such a system has fallen similarly.

Progress on some broad sets of natural-language processing classification tasks, as captured in the SuperGLUE and SQuAD 2.0 benchmarks, has been remarkably rapid; performance is still lower on some NLP tasks requiring reasoning, such as the AI2 Reasoning Challenge, or human-level concept learning task, such as the Omniglot Challenge.

AI results closely tracked Moore's Law, with compute doubling every two years. Post-2012 compute has been doubling every 3.4 months.

SOURCE: Raymond Perrault, Yoav Shoham, Erik Brynjolfsson, Jack Clark, John Etchemendy, Barbara Grosz, Terah Lyons, James Manyika, Saurabh Mishra, and Juan Carlos Niebles, "The AI Index 2019 Annual Report", AI Index Steering Committee, Human-Centered AI Institute, Stanford University, Stanford, CA, December 2019.

Using Computer Vision to Make Sense of Image Data: A Human/AI Balance

In the past few years, imaging-capturing hardware, such as drones and remote sensors, have been combined with powerful image-processing tools to help enterprises understand more of their operations. Today, critical information can be extracted from imagery in real-time without a human ever having to look at a single frame. The use cases for leveraging this unstructured data span a variety of industries, from manufacturing quality control and construction site safety, to weed detection and powerline management.

The computer vision (CV) market is growing by leaps and bounds. According to a recent report by Tractica (https://tratica.com), the computer vision and hardware market is expected to reach $48.6 billion by 2022. With this proliferation comes the challenge of integrating a smart technology with humans who might, depending on the circumstances, be the best option to take the next action.

In other words, in order for CV initiatives to work, there needs to be a human-in-the-loop decision-making model that automates who pays attention to what.

A Smarter Allocation of Investment

Modern computer vision frameworks like Inception and Yolo utilize state-of-the-art transfer learning. This approach provides a broad base of knowledge (trained on massive image libraries like ImageNet) as a starting point, which allows seemingly unique models to be developed much faster than would otherwise be possible.

It is a misconception that most of the effort in building AI/ML is about building a smart algorithm, a better mousetrap. At times it may be necessary, but in most cases, effective AI implementations are largely about curating good data - and as much of it as you can. With enough good data, you can solve many problems that justify the investment.

Johann Beukes
VP of Data Science and Analytics, Levatas

Data Privacy Trends & Ethics

From the City of San Diego Website (https://www.sandiego.gov/sustainability/energy-and-water-efficiency/programs-projects/smart-city)

While this project is a tremendous technological benefit to the city and our citizens, we recognize and value the importance of privacy. Raw video and image data are not accessible to general city staff or any members of the public. These raw data are only retained by GE locally on the sensor (not in their cloud database) for 5 days then overwritten/deleted. The primary purpose of video and image information is to be used by a software program to generate metadata such as vehicle counts. Special and limited access to video/image data exist exclusively for the San Diego Police Department. Authorized personnel in SDPD may request access to specific video/images within the 5-day period at the discretion of the Chief of Police for criminal investigations only.

From the City of Toronto Website (https://www.toronto.ca/city-government/accountability-operations-customer-service/long-term-vision-plans-and-strategies/smart-cityto/)

Digital technologies are bringing Toronto new benefits, challenges and ways of working. To help guide future decisions on how our city should regulate these technologies and data use, the City of Toronto is developing a Digital Infrastructure Plan.

A Community Advisory Group PDF (CAG) will be established in 2020 to provide input on the design of additional consultations and implementation, as well as on the project content itself. The CAG application period closed on December 20, 2019. The project team will be in touch with applicants in early 2020.

Legal Considerations

The California Consumer Privacy Act, for example, introduces greater privacy requirements relating to undisclosed collection and sharing of information for companies that interact with California consumers. While largely designed to prevent surprises or undisclosed third parties from acquiring and/or misusing personal information in AdTech and target marketing, these requirements will challenge the growth of smart cities and chip away at their technical infrastructure, as these cities rely upon connected buildings, vehicles and other IoT devices, extensive data sharing, and the new information eco-system of private company partners and suppliers. For example, the expanded definition of “Personal Information” under the CCPA includes IP addresses (a provision designed to limit the ability of technology/AdTech companies to target consumers who have not provided consent), which may inadvertently have a material, long-term impact on the ability of companies to collect and/or gain access to the mission critical IP-address-related mobile, geolocation and other data that smart cities depend upon (e.g., behaviors, location) for just-in-time services and information.

Data Privacy Trends & Ethics

The European Union's General Data Protection Regulation, which took effect last year, requires additional protections for the data of individuals in the EU, including valid legal bases for data processing and enhanced rights for data subjects. More recently, and in the absence of a federal U.S. data privacy law, certain states have proposed or passed regulations that likewise increase the level of protection afforded to consumers. Cities, too, are following suit: A bill was introduced at the end of July that would make it illegal for cell phone companies and mobile app developers to share location data gathered while a customer's mobile device is within New York City's five boroughs. These regulations contain provisions that would be exceptionally challenging for many smart cities.

The GDPR and CCPA provide individuals with rights to access, correct, delete and/or move (port) their data to another provider. These requirements pose technical and operational challenges for smart city companies that must collect and store data in an organized manner, be capable of retrieving the data within a reasonable time period and present it to the individual in a readable format. As with data selling/sharing, smart city companies will need to implement repeatable processes to identify the vast troves of data held for each individual and respond to data subject requests.

The Federal Trade Commission advises that, given the risk of re-identification, it is important to have accountability mechanisms in place. Owners should take reasonable steps to prevent re-identification, including de-identifying the data whenever (and as soon as) possible, publicly committing to not re-identify, and having enforceable contracts in place that prohibit re-identification by any third parties with whom the data is shared

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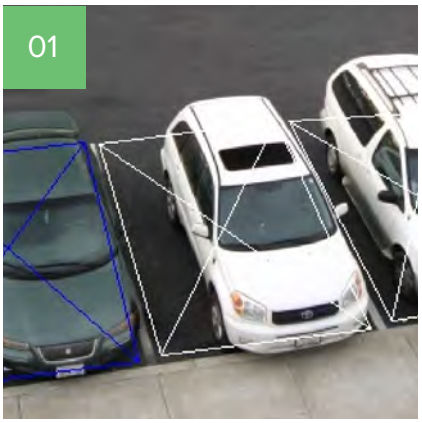
The adoption of deliberate, risk-based approaches for data analytics and marketing provides another safeguard. Establishing rules to de-identify personal information decreases risks of inappropriate data use while increasing the ability to share data with third parties. For example, for a smaller dataset, the "rule of 25" mandates that data analysis may be conducted only on a dataset that contains a minimum of 25 individuals. The "rule of 76+" grades age selection and filtering into tiered ranges with the maximum age tier set to 76+, which ensures that octogenarians cannot be explicitly selected and filtered. Location-based de-identification standards are also particularly relevant in smart cities, where limitations on the granularity of location data (e.g., to the street or neighborhood level instead of precise GPS coordinates) or limitations based on the type of location (e.g., a residential address) help protect the privacy of individuals, especially when the data is analyzed in conjunction with other activity or behavioral information. Often, many rules are needed for the same dataset to prevent re-identification.

SOURCE: https://www.lexology.com/library/detail.aspx?g=11cbc0e7-07d6-47b1-861f-329779a20957

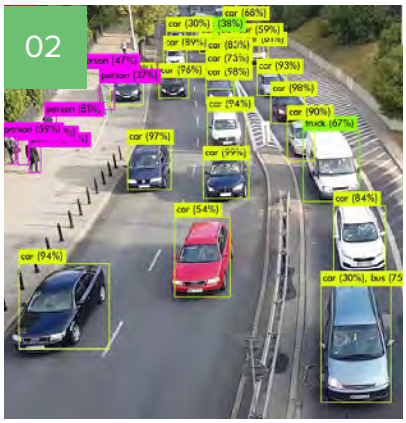
Prioritized Use Cases

The smart lighting data use case capabilities outlined in this report are selected to showcase the most viable ideas to create increased service levels and public benefit based on the data captured from sensors and technology on smart poles. These five use cases were prioritized based on discussions during our use case and technical workshops January 16-17 with the City of Miami Beach stakeholders, showcasing key strategies with anonymized data and enhancing existing computer vision opportunities with existing cameras and datapoints Use cases showcased here identify public and private partnership opportunities with key audiences like hotels, marinas and smart parking vendors..



Parking Detection

Computer vision and visual analytics to detect empty and filled parking locations

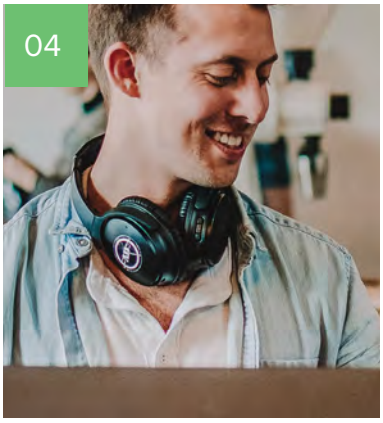


Traffic Flow

Computer vision and visual analytics to determine congested traffic patterns and light traffic patterns

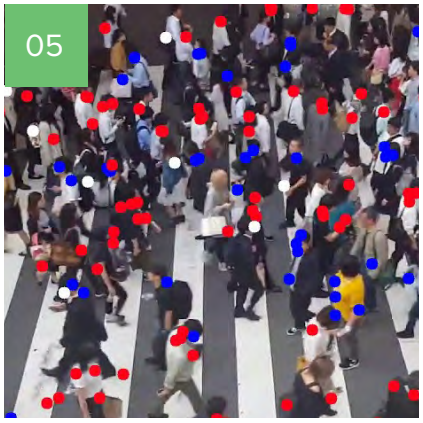
Severe Weather/Flood Detection

Computer vision, audio detection, visual analytics and machine learning to identify areas of flooding and areas prone to flooding



Wi-Fi Access

Wi-Fi, Bluetooth and GPS technology on poles to provide residents access to free/discount Wi-Fi access and opportunities for digital advertising

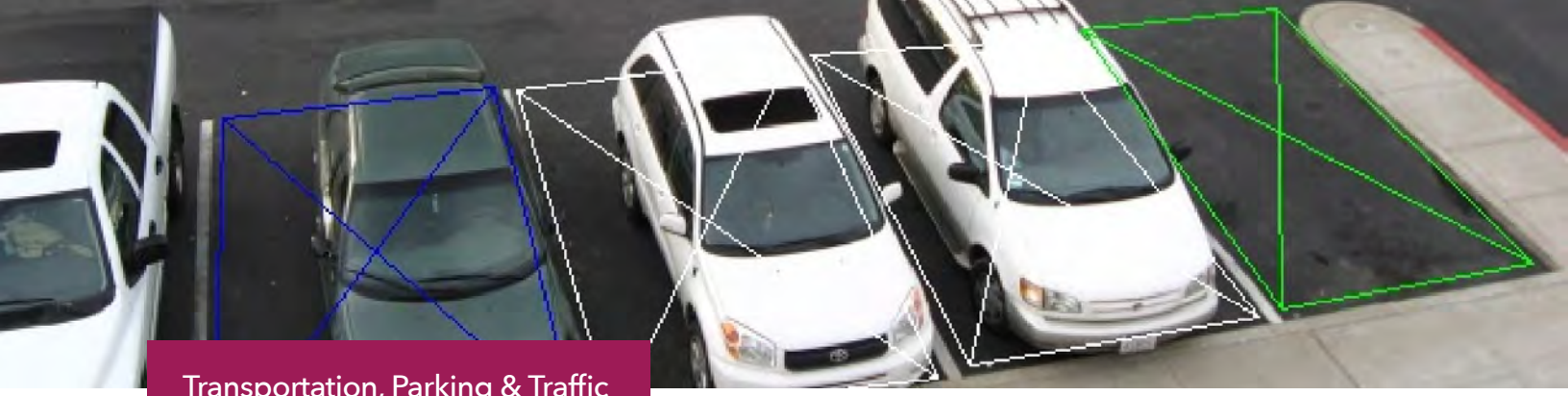


Crowd Detection

Computer vision and visual analytics to identify areas of crowd congestion and crowd disbursements

Camera Based Monitoring

Collection of recorded video camera footage based on multiple smart pole positions as a data service



Transportation, Parking & Traffic

Parking Detection

Computer vision and visual analytics to detect empty and filled parking locations

Impact Score: **8** Complexity Score: **4**

Public Impact

Public Health & Safety

Traffic congestion around the surface parking lots and garages in the City of Miami beach can be minimized by knowing what parking locations are still available for tourists and residents alike. As parking locations fill up, law enforcement and city services can proactively address incoming traffic needs before they become major issues.

Assumptions

- Increase potential revenue of paid parking by guiding people to available parking
- Improved public safety due to reducing traffic congestion caused by drive arounds (people looking for parking)

Marinas

Parking detection solutions can be used for detection empty and filled boat slips so that marinas can provide real-time updates to their customers. Boat ramp parking detection will also provide ways for customers to know when is the optimal time to arrive to launch their watercrafts.

Smart Parking, Rideshare & Scooter Share

Identification of open parking spaces to accommodate specific sizes and shape of transportation allow private parking garages, rideshare services, and scoot share companies to update customers on exactly where to find the perfect space.

Infrastructure

City of Miami Beach can leverage parking detection historical data to identify areas for parking infrastructure improvements, both temporary and permanent based on events, traffic, and usage. It can also identify key areas where scooters and bike locations can be added to alleviate overflow.

Assumptions

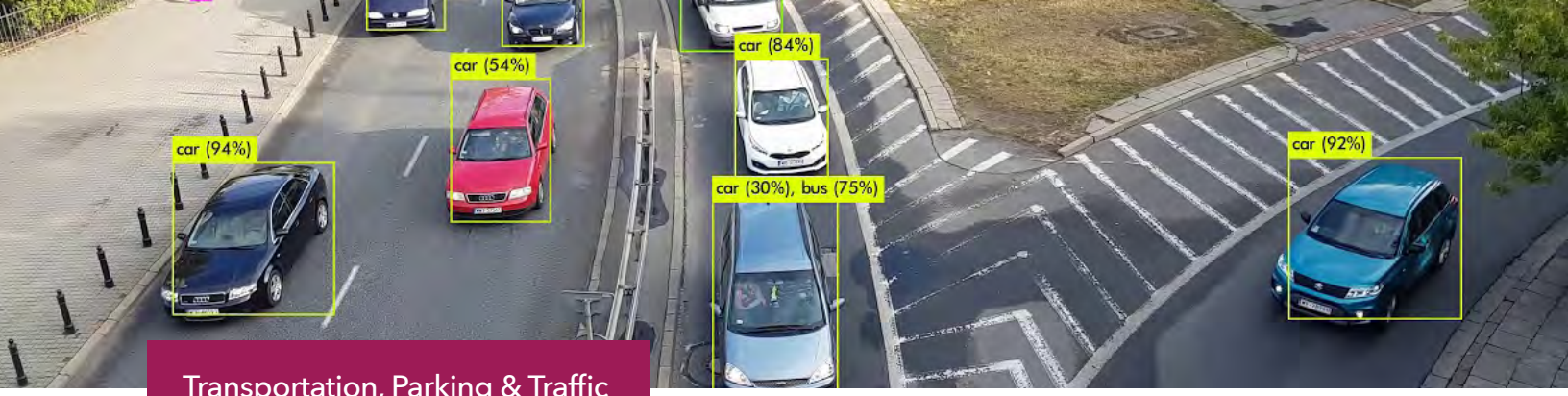
- Based on parking analytics, the city can optimize scooter and rideshare services
- Based on parking analytics, the city can prioritize planning of new lots or parking structures
- Based on parking analytics, the city can plan for seasonal contracts with private parking providers as needed

Retail/Hotels

Parking detection can provide key information to retail locations to message customers about alternate parking locations and hotels about valet parking opportunities based on volume.

Traffic & Mapping Companies

Related to the safety issues, traffic congestion around parking locations can be key data points in real-time traffic information to be shared with regional consumers of traffic and mapping vendors.



Transportation, Parking & Traffic

Traffic Flow

Computer vision and visual analytics to determine congested traffic patterns and light traffic patterns

Impact Score: **8** Complexity Score: **6**

Public Impact

Homeowners' Associations

With 44 Homeowners' Associations in the City of Miami Beach, gate traffic and surrounding area congestion define where security attention is needed and additional access points may be required

Public Health & Safety

Scheduled Maintenance of Traffic activities have been the most likely indicator of traffic impacts in the City. However, real-time traffic flow data would allow law enforcement to be deployed in strategic locations to relieve congestion and re-route traffic.

Television & Radio

Traffic coverage by television and radio stations provide a valuable service to residents and visitors to the City of Miami Beach. The traffic flow service can allow the messages around traffic issues and accidents to be delivered as quickly as possible through multiple delivery channels.

Infrastructure

Video monitoring can help cities better understand traffic and pedestrian patterns and make infrastructure adjustments to improve consistently impacted areas with the City of Miami Beach Based on congestion analytics, the city can decide to redirect traffic patterns for improved efficiencies, optimizing MOT Contracts.

Smart Parking, Rideshare & Scooter Share

Placement of scooters and bikes can be redirected in real-time with traffic flow data on the user's mobile device map integration.

Traffic & Mapping Companies

Real-time traffic can leverage additional insights from traffic flow capabilities from the smart lighting sensors in addition to existing data sources to enhance the reporting of incidents to avoid and alternate routes to recommend. Existing mapping services like Waze or GoogleMaps could increase their real-time updates to existing customers with more camera coverage in highly populated areas like Lincoln Road

Retail/Hotels

Traffic Flow can provide key information to retail locations to message customers about congested traffic situations around retail spaces and help customers know optimal times to shop or check into the hotels. Redirection of customers to accommodate high-traffic situations will increase the value thta businesses bring and raise the bar on service levels for community involvement.

Environmental / Health

Severe Weather / Flood Detection

Computer vision and visual analytics and machine learning to identify areas of flooding and areas prone to flooding. Weather, rain and lightning sensors to detect thunder, tornadoes and tropical disturbances.

Impact Score: **4** Complexity Score: **1**

Public Impact

Public Health & Safety

With the City of Miami Beach's highest elevation at 4 feet above sea level, the streets and beaches are prime locations for the impact of flooding. Law enforcement and city safety officials can leverage this data historically to identify key areas to fortify in advance of severe weather or deploy resources quickly when detected

As each hurricane season reminds all of us, the need for accurate & timely warnings about severe weather in the City of Miami Beach can be a matter of life and death. Law enforcement, health & safety officials, and city leaders can leverage up to the square foot information about where severe weather is threatening the population and address manpower to assist.

Assumptions

- Improved response time by safety officials when detecting flooded conditions

- Improved response time by safety officials when detecting flooded conditions. Law enforcement, health & safety officials, and city leaders can leverage up to the square foot information about where severe weather is threatening the population and address manpower to assist.

Homeowners' Associations

As the city of Miami Beach as a whole is located inside a Hurricane evacuation zone, severe weather detection is a key service to keep residents safe. Everything from storm surge to lightning & thunder detection would keep residents up-to-date on the key neighborhood sheltering and evacuation plans.

Traffic & Mapping Companies

Live traffic reports can leverage severe weather detection from smart lighting locations to provide detailed locations to avoid due to hazardous conditions.

Flooded locations cause traffic challenges, especially when it causes road closures. Real-time updates on flooded locations ensure that new traffic routes can be recommended prior to major congestion & bottleneck

Marinas

Flood Detection & Storm Surge detection ensure marinas can provide timely information to customers about their individual boat status and the marina's ability to weather the additional water on the property.

Assumptions

- Improved customer service inquiries and liability calculations based on flood data enhanced by computer vision.

Television & Radio

Severe weather coverage by television and radio stations provide a valuable service to residents and visitors to the City of Miami Beach. The real-time severe weather detection service can enhance the existing data to inform the messages around sheltering in place or evacuating to be delivered as quickly as possible through multiple delivery channels.

Smart Parking, Rideshare & Scooter Share

No one likes to park in a flooded parking space. Flood detection allows parking vendors to notify potential customers of flooded spaces and redirect them to a drier location. Scooter vendors can redirect customers to drier drop-off and return locations in order to minimize the effects of water damage on their equipment.

Infrastructure

Historical flooding information can ensure accurate storm surge zones are identified for residences and businesses. These guidelines also inform the property appraisers to ensure residents and business owners obtain the right insurance coverage based on actual flooding data for each location.

Assumptions

- Improved infrastructure decisions and informed flood zone identification with historical flood data enhanced by computer vision.

Connected Citizens

Wi-Fi Access

Wi-Fi, Bluetooth and GPS technology on poles to provide residents access to premium Wi-Fi access and opportunities for digital advertising in heavy tourist areas

Impact Score: **6** Complexity Score: **1**

Public Impact

Homeowners' Associations

Homeowners' Associations in the past may not have offered Wi-Fi as a service to their residents due to costs or infrastructure challenges. With public Wi-Fi options, residents can reduce their individual costs and additional speed options can be applied neighborhood-wide.

Advertising

Wi-Fi provides all consumers with the ability to receive additional advertising based on the Geolocation of the mobile device accessing it. The City of Miami Beach will continue to attract big-name businesses and will be an ideal location to start an entrepreneur.

Retail/Hotels

Businesses and Hotels provide Wi-Fi services to customers to ensure mobile apps and social media experiences continue to advertise their goods and services. Providing free Wi-Fi to businesses and hotels, it reduces the cost to the business leader and the consumer to allow for consistent, fast internet speeds.

Marinas

Marinas may take advantage of Wi-Fi services to provide customers with additional information or online registration/docking information to simplify the check-in, check-out process of boat slips.

Residential Premium Service

Wi-Fi provides all consumers with the ability to upgrade to premium Wi-Fi service during major events and in popular tourist areas like Lincoln Road and Ocean Drive. Enticing international tourists to subscribe to Wi-Fi to minimize their cellular costs encourages word-of-mouth advertising about the City of Miami Beach's leading technology experience.

Safety & Security

Crowd Detection

Computer vision and visual analytics to identify areas of crowd congestion and crowd disbursements

Impact Score: **9** Complexity Score: **1**

Public Impact

Public Health & Safety

The City of Miami Beach's heavily populated areas like South Beach require heavy police presence and constant surveillance. With threshold alerts on the size and scope of the crows, public safety personnel can know precisely where attention is needed.

Infrastructure

In crowded City of Miami Beach streets like Collins Avenue, city facilities and landmarks could be planned and maintained more efficiently and effectively.

Retail/Hotels & Marinas

With 4 marinas over 23,000 hotel rooms and large number of business retailers within the City of Miami Beach, understanding the crowds outside of their businesses could be a valuable commodity worth purchasing.

Rideshare

Crowded locations, especially outside bars and restaurants in the City of Miami Beach, would be valuable marketing targets for services like Uber, Lyft as well as the Trolly service and bus transit.

Television & Radio

Crowded locations usually provide a significant window into a pending news story. Television and Radio broadcasters require time for crews to arrive on-site, where this service would maximize the amount of time personnel have to find the news site in question.

Safety & Security

Camera Based Monitoring

Collection of recorded video camera footage based on multiple smart pole positions as a data service

Impact Score: **10** Complexity Score: **1**

Public Impact

Homeowners' Associations

With 44 Homeowners' Associations in the City of Miami Beach, most employ private security to monitor gate areas and common facilities - which lends itself to purchasing the service to optimize manpower.

Television & Radio

Today, Television Stations send personnel out to City of Miami Beach locations with camera crews to film key intersections and capture B-Roll video. This service would optimize the number of personnel needed to travel on location for this footage.

Traffic and Mapping Companies

With few streets in the City of Miami Beach with speed limits over 30 miles per hour, identification of traffic congestion as a result of criminal behavior can make a significant difference.

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Retail/Hotels & Marinas

With 4 marinas over 23,000 hotel rooms and large number of business retailers within the City of Miami Beach, these three audiences may save some manpower dollars, but they will definitely receive some much-needed peace of mind with actual visual evidence from all angles around their businesses.

Smart Parking, Rideshare & Scooter Share

Combing these video feeds with ParkMobile and ParkMe would help companies with the abiilty to evaluate the safety of current parking sites. Citi Bike Miami would be able to find lost assets and purchase visual monitoring of pick up and drop off locations.

Public Health & Safety

Surveillance for law enforcement ensures cost reduction in manpower, time on-site of an investigation or crime, and reduction in unplanned maintenance of traffic projects. The high-traffic areas within the City of Miami Beach, including Lincoln Road, Ocean Drive and Collins Avenue provide additional oversight without increasing public safety presence.

Data Service Audiences

The City of Miami Beach audiences identified in this report were selected based on those most likely to have a vested interest in the data captured from the sensors and technologies on smart poles. These audiences may be focused on purchasing the data for optimization, optimizing their current manpower costs, or increase their public safety footprint.

Homeowners' Associations

With 44 Homeowners' Associations in the City of Miami Beach, most employee private security to monitor gate areas and common facilities - which lends itself to purchasing the service to optimize manpower.

Public Health & Safety

The City of Miami Beach's safety departments like law enforcement and health are most interested in using data to optimize the manpower to collect information and address significant public concerns, including large populated areas like South Beach and environmental hazards such as sea turtle nesting activities.

City Infrastructure

As a condensed residential and commercial municipality, the City of Miami Beach would value sensor and camera data in planning infrastructure changes and updates. In crowded streets like Collins Avenue, city facilities and landmarks could be planned and maintained more efficiently and effectively with the data services smart lighting can provide.

Retail/Hotels

With over 23,000 hotel rooms and large number of business retailers within the City of Miami Beach, sensor and camera data could be a valuable commodity worth partnering with the City to keep their businesses safe and profitable.

Smart Parking, Rideshare & Scooter Share

ParkMobile, ParkMe, Citi Bike Miami and future scooter & Rideshare vendors would benefit from the sensor and camera data from smart poles as well as the machine learning & computer vision technologies call out in the use case capabilities of smart lighting.

Traffic & Mapping Companies

Uber, Lyft, Trolly service, Bus transit and traffic report vendors would value sensor and camera data regarding weather, traffic flow, crowds and additional insights from smart pole technology. Public/Private partnerships would allow these services to present a win-win to residents and tourists alike.

Local Television & Radio Stations

Today, Television Stations send personnel out to City of Miami Beach locations with camera crews to report key news stories, traffic and weather. Data services provided by smart lighting would optimize the number of personnel needed to travel on location and reduce the need for on-site cameras dramatically.

Marinas

With 4 marinas within the City of Miami Beach with more than 400 boat slips and access to Biscayne Bay, sensor and camera data could be a valuable commodity worth partnering with the City to keep their businesses safe and profitable.

Advertising

This reflects any data consumer interested in taking advantage of advertising opportunities from the data strategy of smart poles. As the City of Miami Beach has a large tourism industry, these are the prime targets for advertisers through digital and print methods.

Solution Architecture

Technology Solution Explained

The solution is an Microsoft Azure and Snowflake based IoT and Analytics environment. This include 4 main components:

1) Azure IoT Device gateway services to collect data from sensors

2) Azure ingestion services which will stream the data to storage devices in Azure data lake. Data from the data lake will then be processes based on purpose of use.

3) Azure stream analytics which will prepare the data for use which could be consumed

4) Storage and Presentation through storage on CosmosDB, Snowflake or Azure Data Lake, presentation through Enterprise API services, Azure Machine Learning or analytics through tools such as PowerBI.

Solution Architecture

Overview

The solution architecture for the City of Miami Beach has 5 main components:

- Data Collection Points - These are the sensors that are on the Smart Light Pole technologies. Initial implementation will include cameras from Axis
- Data Storage and Processing Layer
    - Data Lake Storage - Storage area for the raw data collected from the sensors as well as other sources that may be needed in the solutions. Cloud storage option that can handle any type of structure or unstructured data such as Azure - Data Lake Storage
    - Multi Input/Output (Azure IoT) - Technologies are required to connect the lake to the data sensors.
    - Databases - Snowflake and MS Cosmos may be required to store the transformed data for use.
    - Azure Machine Learning algorithms will be needed for Analytic Use Cases
- API Layer - Data Services that will present the data in formats needed by applications
- Applications - Purpose built applications for various use cases defined
- Business Market - Data consumers could be through the application or they can use their own systems and access the data via the APIs available.

Data Collection Points

Sensor Locations

Sensors are identified in each use case and can do not need to be added to every light pole. For example, if cameras are needed to monitor parks, then the sensors should be added only to those poles adjacent to parks.

Camera Sensor Vendor - Axis

Brands and vendors that will provide the sensors will be identified in a future phase of the project.

Technology Selection

Technologies identified are those related to the initial use cases and are in line with City of Miami Beach's technology strategy and leveraging existing vendors (ie. Axis for camera).

Applications and APIs Development Considerations

Applications and APIs can be implemented in an agile manner based on roadmap of the use cases to be implemented. These implementations will need to also include the data components to support those applications. Data components may be reusable, therefore the first application needing the data would incur the development of that data source.

Integration with Consumers

Once the APIs are built according to City of Miami standards, external consumers of the data will need to comply with all connectivity and security requirements for each service.

Data Security and Governance

Data Security and Governance processes and procedures will need to be developed to support the data collected and shared in this system. We recommend the city create a cross functional Data Governance Council to determine what data they will make available to each type of user. In addition to ensuring State Laws for data are followed the council will build data policy for city level decisions. IT will ensure that the solution will implement the policy as set by the Data Governance Council.

Network Requirements

Security

- IoT Device - Password complexity, encryption via TLS, X.509 certificates, OS patches and updates
- Network administration - Switch authentication (central LDAP/RADIUS server)), disabling insecure protocols, DoS filtering, OS hardening, Data plane protection, communication through firewalls allowed and controlled via specific policies
- Integrity - accuracy, consistency, trustworthiness of data being transmitted on the network
- Confidentiality - Data protected from bad actors while in transit and at rest
- Threat Mitigation and Remediation - identifying and isolating compromised device from network.

Availability

- Redundancy without single point of failure
- Automatic recovery upon failure
- Maintenance tasks performed in-service

Scalability

- Capable of scaling to support number of devices, bandwidth, etc.

Performance

- High, continuous throughput, low latency
- Network traffic prioritization
- Congestion management

Environmental

- Rugged equipment
- Subject to harsh conditions - extreme temp, high winds, vibration, dust, moisture, etc.

Hardware Requirements

Fiber Network

- Ability to back-haul traffic, meaning that it distributes the RF signal from the edge of the network back to the operator's core network.
- Back- up power sources.

Cameras

- Low resolution image capture (Minimum: 256x256 pixels
- Higher resolution options for deep learning models

Internet of Things & Gateways

- Edge computing refers to the computation and analysis of data on distributed devices positioned at the edge of a network rather than on centralized systems
- Data ingestion refers to device telemetry data being imported and converted into a format usable by cloud-based IoT services.
- Device management covers the hardware, software and processes that ensure devices are properly registered, managed, secured and upgraded, and that the staff and systems are notified if a device fails.

Complexity

Safety & Security

Camera Based Monitoring

- API access to video footage
  - Video footage pipeline to store footage in cloud
  - API created to provide data to consumers

Complexity is based on

Relatively small because there is not modeling effort just exposing an API to allow access to the data that has been collected.

Safety & Security

Crowd Detection

- API access to video footage
  - Video footage pipeline to store footage in cloud
  - API created to provide data to consumers

Complexity is based on

This is a medium complex project given that we are not doing facial recognition, but still will need to do tagging of data in order to train a model for counting humans.

Transportation, Parking & Traffic

Traffic Flow

- Computer vision solution with multiple patterns (auto, congested vs not)

  - Data pipeline to store video footage in cloud
  - Computer vision tagging
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers based on location of interest

Complexity is based on

This is a medium effort to train multiple classes (auto congestion, people congestions) and images will need to be tagged for model training. There might be some pre-trained models that can be used for vehicles, but it would still need additional training.

Transportation, Parking & Traffic

Parking Detection

- Computer vision solution with one pattern (parking occupied vs empty)

  - Data pipeline to store video footage in cloud
  - Computer vision tagging
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers based on location of interest

Complexity is based on

Medium complex since we will be training models on detecting a parking spot so that anything else, like a car, motorcycle etc., will be an anomaly from what the model was trained on. This limits the classes to train a machine learning model since we don't have to train it for detecting cars, motorcycles, trucks etc.

Environmental / Health

Severe Weather / Flood Detection

- Computer vision solution with one pattern (flooding)
  - Data pipeline to store video footage in cloud
  - Computer vision tagging
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers based on location of interest

Complexity is based on

This effort is to train based on images that will need to be tagged for a very specific chance detection model to be trained. This model is starting from scratch as there are not available as a starting point.

Connected Citizens

Wi-Fi Access

- Wi-Fi enabled light poles
- Integration with city app to join network

Complexity is based on

Relatively small because this is enabling access to an API via app

Appendix

Contents

Smart City Use Case Capabilities Explained

Mobility

Smart mobility refers to using modes of transportation alongside or even instead of owning a gas-powered vehicle. This can take on many different forms, including ride-sharing, car-sharing, public transportation, walking, biking, and more.

Possible smart city applications	Customer Benefits						
	Time	Health	Environment	Safety	Cost of living	Jobs	Social Connectedness
Real-time public transit information	✓			✓	✓		
Digital public transit payment	✓			✓			
Autonomous vehicles				✓			✓
Predictive maitenance of transporation infrastructure	✓	✓		✓		✓	
Intelligent traffic signals	✓			✓			
Congestion pricing	✓				✓		
Demand-based microtransit				✓			
Smart parking	✓			✓			
E-hailing (private, public)	✓			✓		✓	✓
Car sharing			✓				✓
Bike sharing			✓				✓
Integrated multimodal information		✓					✓
Real-time road navigation	✓			✓			
Parcel load pooling	✓			✓			
Smart parcel lockers							

Main Customer Benefit: Time

Security

Smart security means with enough Internet connectivity and real-time data from smart city technology, environmental, social, economic, and public health issues should become more manageable.

Possible smart city applications	Customer Benefits						
	Time	Health	Environment	Safety	Cost of living	Jobs	Social Connectedness
Predictive policing				✓		✓	
Real-time crime mapping				✓		✓	
Gunshot detection				✓		✓	
Smart surveillance				✓		✓	✓
Emergency response optimization				✓			
Body-worn cameras				✓			
Disaster early-warning systems				✓			
Personal alert apps		✓		✓			✓
Home security systems	✓			✓			
Data-driven building inspections				✓			
Crowd management	✓	✓	✓	✓			✓

Main Customer Benefit: Safety

Energy

Smart energy is driven by general, wide-reaching concerns such as sustainability or by specific, local issues like air pollution, traffic congestion or growing energy costs through smart buildings, sensors, and data.

Possible smart city applications	Customer Benefits						
	Time	Health	Environment	Safety	Cost of living	Jobs	Social Connectedness
Building automation systems	✓		✓		✓	✓	
Home energy automation systems			✓		✓		
Home energy consumption tracking			✓		✓		
Smart streetlights	✓		✓	✓			
Dynamic electricity pricing			✓		✓		
Distribution automation systems			✓		✓	✓	

Main Customer Benefit: Environment

Water

Smart water points to water and wastewater infrastructure that ensures this precious resource - and the energy used to transport it - is managed effectively. A smart water system is designed to gather meaningful and actionable data about the flow, pressure and distribution of a city's water.

Possible smart city applications	Customer Benefits						
	Time	Health	Environment	Safety	Cost of living	Jobs	Social Connectedness
Water consumption tracking		✓					
Leakage detection and control		✓		✓	✓	✓	
Smart irrigation	✓		✓		✓	✓	
Water quality monitoring		✓				✓	

Main Customer Benefit: Health

Waste

Smart Waste Management uses waste bins equipped with fill-sensors, data-based management and logistics platforms to keep our homes and communities free from unwanted clutter.

Possible smart city applications	Customer Benefits						
	Time	Health	Environment	Safety	Cost of living	Jobs	Social Connectedness
Digital tracking and payment for waste disposal	✓		✓		✓	✓	
Optimization of waste collection routes	✓		✓		✓	✓	

Main Customer Benefit: Jobs Time

Engagement and Community Building

Smart Cities need to build the capability to encourage citizen participation and then combine all citizen interactions via multiple channels into a single, synchronized “customer journey.” This sort of capability enables the city to be more efficient and effective and it builds a “virtuous loop” that can convert each citizen in an agent for the municipality and a vital component of the smart city.

Possible smart city applications	Customer Benefits						
	Time	Health	Environment	Safety	Cost of living	Jobs	Social Connectedness
Local civic engagement apps							✓
Local connection platforms							✓
Digital citizen services							✓

Main Customer Benefit: Social Connectedness

Economic Development and Housing

Increasing the digital link between individual smart homes and the surrounding smart urban network will allow the city to better monitor and meet citizen needs while allowing citizens to better access city services from their homes.

Possible smart city applications	Customer Benefits						
	Time	Health	Environment	Safety	Cost of living	Jobs	Social Connectedness
Digital business licensing/permitting						✓	
Digital business tax filing						✓	
Online retail programs						✓	✓
Personalized education						✓	✓
Local e-careeer centers						✓	✓
Digital land-use and building permitting							✓
Open cadastral database						✓	
Peer-to-peer accomodation platforms						✓	✓

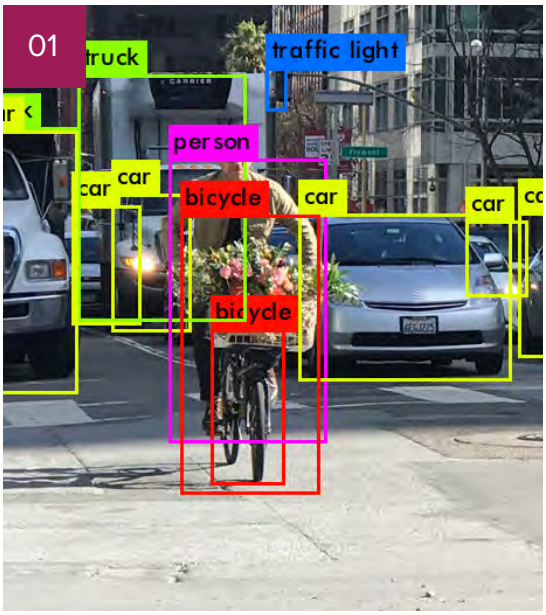
Main Customer Benefit: Jobs

Transportation, Parking & Traffic

Traffic cameras and sensors that can provide data to a traffic management system

Smart lighting cameras and sensors connected to a cloud management platform can predict where the traffic could go and take measures to prevent potential congestion.

Smart parking solutions determine whether the parking spots are occupied or available and create a real-time parking map. When pedestrians cross the road, the lights around the crossings can switch to a brighter setting; when a bus is expected to arrive at a bus stop, the streetlights around it can be automatically set brighter than those further away,



Pedestrian/Cycling Detection

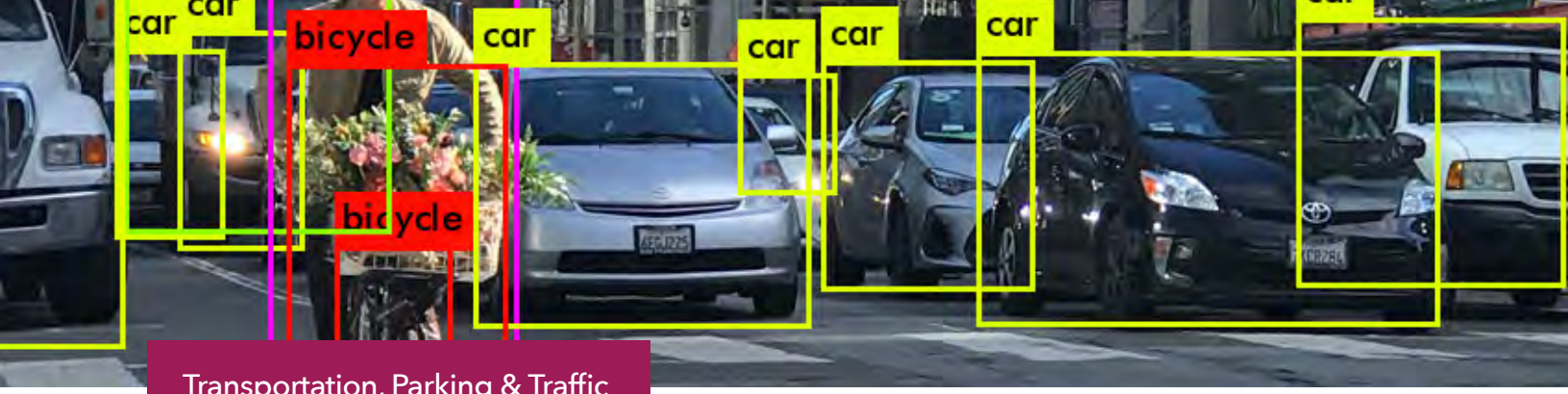
Computer vision, visual analytics and machine learning algorithms to analyze light and heavy pedestrian traffic, cycling patterns, and hazards

Hazard Detection

Computer vision, visual analytics and machine learning to identify hazards on the roads or walkways

Electric Vehicle Charging

Electric vehicle charging stations attached to poles



Transportation, Parking & Traffic

Pedestrian/Cycling Detection

Computer Vision combined with machine learning to predict specific behavior patterns such as increased cycling and pedestrian traffic. Can also be trained to identify location of scooters and for notification for unexpected crowd formation.

Impact Score: **7** Complexity Score: **6**

Public Impact

Public Health & Safety

The City of Miami Beach has planned on increasing its biking and pedestrian traffic to up to 25% by the year 2035. Reduction in automobile traffic and enhanced quality of life goals lend to reallocation of resources to enforce the public safety priorities. Insights into pedestrian congestion and cycling traffic can help deploy resources in the most optimal way.

Infrastructure

Street designs and maintenance in the City of Miami Beach can leverage historical pedestrian and cycling traffic to determine priorities and layouts that optimize traffic patterns.

Smart Parking, Rideshare & Scooter Share

Focused primarily on rideshare and scooter share, tracking pedestrian and cycling traffic will also identify scooter traffic, key drop-off/pick-up locations for scooters and notifications of unexpected route closures for customers.

Traffic & Mapping Companies

Traffic congestion is not just limited to cars. Festivals and events can congest the streets and cause traffic issues that would be helpful in any specific real-time traffic reporting service. Even causeways and bridges that allow pedestrian and cycling traffic could be optimized by insights from this service.

Television & Radio

Pop-up news events based on high pedestrian or cycling volume allows for news vehicles to deploy and route to cover stories in the most efficient ways. Areas like South Beach, where pedestrian traffic is the night-life method of travel, presents a unique venue for insights that can lead to the next big news story.

- Computer vision solution with multiple patterns (pedestrians, cycles, scooters congested versus not)
  - Data pipeline to store video footage in cloud
  - Computer vision tagging
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers based on location of interest

Complexity is based on

This is a medium effort to train multiple classes (pedestrians, cycles, scooters) and images will need to be tagged for model training. This model is starting from scratch as there are not available as a starting point.

Transportation, Parking & Traffic

Hazard Detection

Computer vision, visual analytics and machine learning algorithms to analyze light and heavy pedestrian traffic, cycling patterns, and hazards

Impact Score: **6** Complexity Score: **5**

Public Impact

Public Health & Safety

Addressing hazards in traffic patterns is a primary responsibility for city services for the health & safety of its citizens. Key Insights from hazard detection can lead to reduction in manpower for random inspections or customer service calls to report issues & violations.

Infrastructure

Similar to Vandalism/Damage detection, hazards in public locations can be addressed quickly and efficiently when it can be analyzed through machine learning algorithms. City planners can outline strategic maintenance based on hazard detection over time in the same locations.

Traffic & Mapping Companies

Real Time Traffic information needs to detect hazards in addition to traffic congestions to provide alternative routing and alerts to consumers, especially in densely populated cities like the City of Miami Beach.

Television & Radio

As traffic congestion can lead to full-stop roadways in the City of Miami Beach due to low speed limits and dense population, television & radio stations can leverage key news stories with remote camera imagery.

Retail/Hotels

Parking detection can provide key information to retail locations to message customers about alternate parking locations and hotels about valet parking opportunities based on volume.

- Computer vision solution with multiple patterns (potholes, disabled cars, etc)
  - Data pipeline to store video footage in cloud
  - Computer vision tagging
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers based on location of interest

Complexity is based on

This is a large effort to train multiple classes (potholes, disabled cars, etc) and images will need to be tagged for model training. This computer vision model is complex since there are various dissimilar objects to be detected, each requiring their own set of training data.

Transportation, Parking & Traffic

Electric Vehicle Charging

Electric vehicle charging stations attached to poles

Impact Score: **4** Complexity Score: **4**

Public Impact

Homeowners' Associations

Homeowners' Associations can provide electric vehicle charging services to residents, promoting a green footprint in line with the City of Miami Beach's Sustainability plans.

Advertising

Advertisers can leverage electric vehicle charging real estate to promote their businesses and services to customers in a captivating and environmentally friendly way.

Smart Parking, Rideshare & Scooter Share

No one likes to park in a flooded parking space. Flood detection allows parking vendors to notify potential customers of flooded spaces and redirect them to a drier location. Scooter vendors can redirect customers to drier drop-off and return locations in order to minimize the effects of water damage on their equipment.

Environmental / Health

Sensors that identify toxic chemicals, pollen counts, or air pollution levels

Smart Lighting sensors and cameras allow tracking parameters critical for a healthy environment in order to maintain them at an optimal level.

A network of sensors can deployed along busy roads and around plants. Sensors gather data on the amount of CO, nitrogen, and sulfur oxides, while the central cloud platform analyzes and visualizes sensor readings, so that platform users can view the map of air quality and use this data to point out areas where air pollution is critical and work out recommendations for citizens.

01

Irrigation Detection

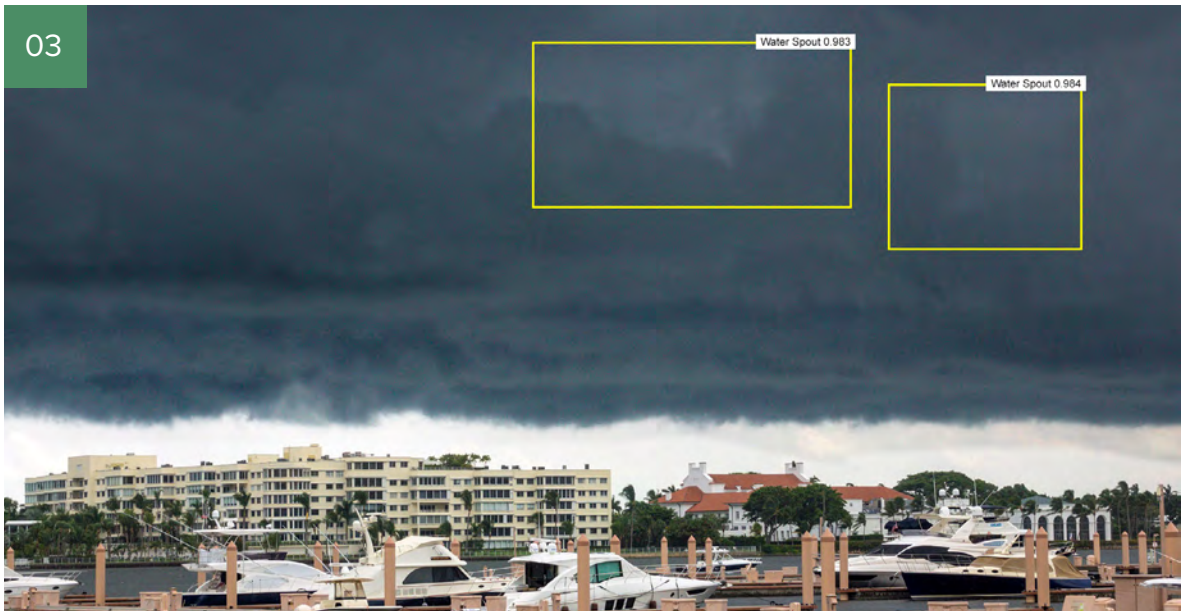
Computer vision, visual analytics and machine learning to optimizing timing of irrigation cycles for better lawn maintenance

02

Litter Detection

Computer vision, visual analytics and machine learning to detect areas containing litter and more efficiently route crews to address

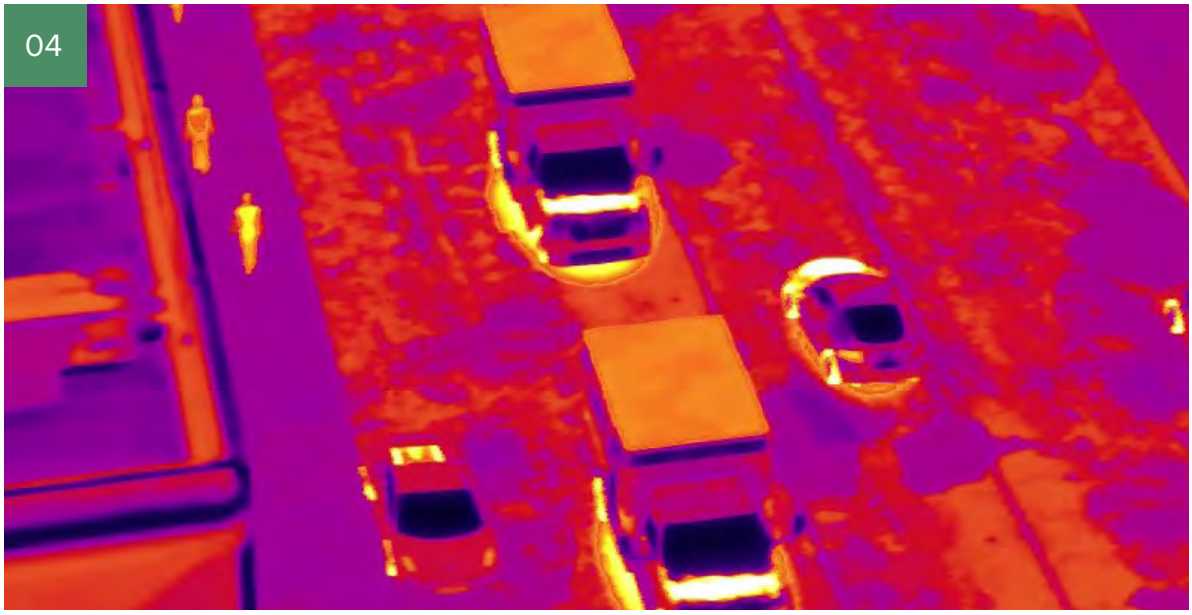
03



Severe Weather Detection

Computer vision, audio detection, visual analytics and machine learning to detect lightning, thunder, tornadoes, storm surge, and tropical disturbances

04



Thermal Detection of Objects

Thermal sensor information, analytics and machine learning to identify specific objects and conditions

Environmental / Health

Irrigation Detection

Weather and rain detection to optimizing timing of irrigation cycles for better lawn maintenance and savings related to less watering

Impact Score: **3** Complexity Score: **2**

Public Impact

Homeowners' Associations

Irrigation services purchased by Homeowners' Associations typically require heavy manpower and static timed maintenance windows that impact resident schedules and daily routines. Irrigation detection allows for smart watering implementation in common areas and can be provided as a service to residents for their laws too.

Infrastructure

City landmarks and facilities would benefit from a smart watering implementation based on irrigation detection services. The ability to gather insight as to exactly when to water city facilities including beaches and parks would allow for maximum traffic and usage by citizens as well as optimizing utility usage.

- Smart irrigation solution

  - Data pipeline to store weather and rain information in cloud
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers to integrate with smart irrigation systems

Complexity is based on

This effort is to gather rainfall metrics and train predictive model based on historical rainfall metrics gathered from the sensors. Eventually this could tie into sensors on smart irrigation type equipment.

57

Environmental / Health

Litter Detection

Computer vision, visual analytics and machine learning to detect areas containing litter and more efficiently route crews to address

Impact Score: **3** Complexity Score: **6**

Public Impact

Public Health & Safety

Litter carries germs that end up in various places and forms a breeding ground for bacteria. Public health services can leverage insights from litter detection to ensure that it is addressed as soon as possible.

Infrastructure

Key locations with clusters of recurring litter issues should be addressed through city services, either scheduled maintenance or planning enhancements to the landscape to curb the criminal activity. Littering of waterways, as in the many canals of the City of Miami Beach.

Retail/Hotels

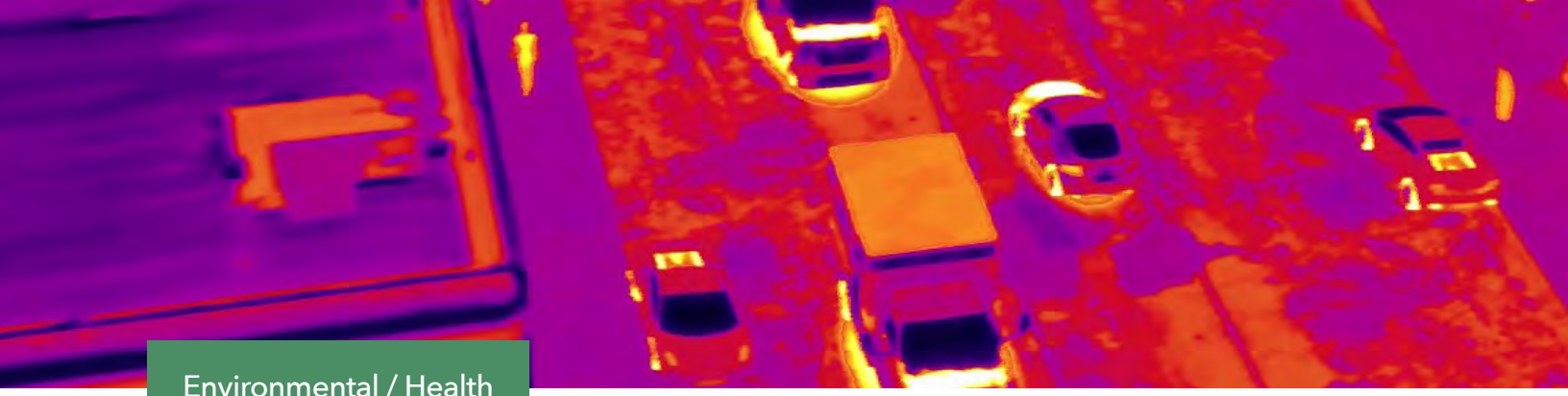
Businesses are responsible for keeping their property free and clear of litter, and litter detection services would give a window into areas that require constant maintenance.

- Computer vision solution with one pattern (litter)

    - Data pipeline to store video footage in cloud
    - Computer vision tagging
    - Model development, training, testing and deployment
    - Machine Learning Pipeline development for retraining of model for concept drifting
    - API development for consumers based on location of interest

Complexity is based on

This is a large effort to train multiple classes (different types of litter etc) and images will need to be tagged for model training. This model is starting from scratch as there are not available as a starting point.



Environmental / Health

Thermal Detection of Objects

Thermal sensor information, analytics and machine learning to identify specific objects and conditions

Impact Score: **1** Complexity Score: **1**

Public Impact

Public Health & Safety (Medium)

High temperatures in concentrated locations that are out of the ordinary throughout the City of Miami Beach can be indications of a bigger problem. This information can be used to dispatch health & safety officials, fire rescue, and law enforcement in advance of a major issue detected through visual means alone.

- Computer vision solution with multiple patterns (auto, congested versus not)
  - Data pipeline to store video footage in cloud
  - Computer vision tagging
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers based on location of interest

Complexity is based on

Relatively small assuming quality data from the thermal sensors with which to create a new model and analytics.

Connected Citizens

Public Wi-Fi hotspots and even kiosks that facilitate easy access to city services

Smart lighting can focus on delivering sustainable development of the economy.

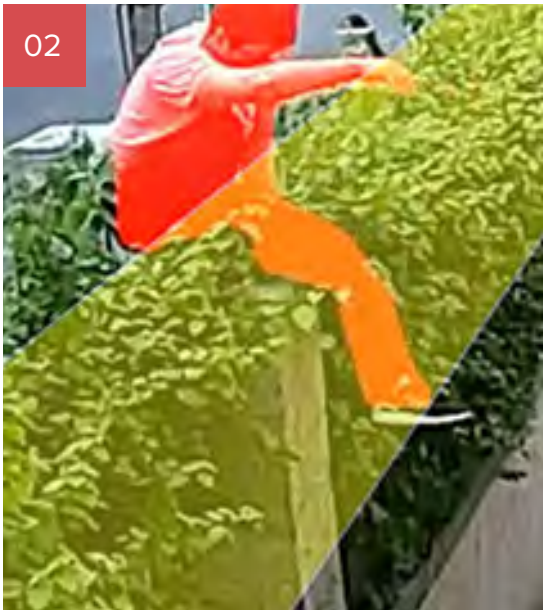
Smart lighting can promote citizen engagement, drive technological innovation with the context of a citizen friendly environment. Fundamental to this is the building of an ecosystem of partners to fundamentally change and improve the quality of citizens' daily life. Smart lighting data strategy will also compete to attract industry, enterprises and a skilled workforce by offering flexible government, citizen safety and public-sector efficiency.

01

Wi-Fi Access

Wi-Fi, Bluetooth and GPS technology on poles to provide residents access to free/ discount Wi-Fi access and opportunities for digital advertising

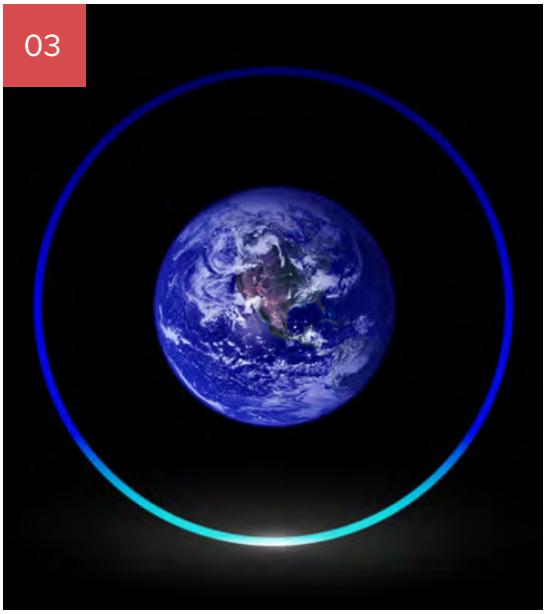
02



Rules Violation

Computer vision, audio detection, visual analytics and machine learning to determine when specific rules are being violated to report issues

03



Alexa Skills

Natural Language Processing & Understanding algorithms to provide residents and tourists details on key services

04

Smart Kiosk

Tablet style application accessible on the smart pole for residents and tourists to access key services and review retail options

05

Smart Pole Physical Advertising

Advertising physically on poles, which could be digitized or printed to provide the greatest value and coverage

Connected Citizens

Rules Violation

Computer vision, audio detection, visual analytics and machine learning to determine when specific rules are being violated to report issues

Impact Score: **4** Complexity Score: **1**

Public Impact

Homeowners' Associations

Homeowners' Associations identify residents or pay for security services to identify violation areas to the rules and regulations of the association. This can include landscaping violations, outside painting violations, parking violations, pressure-washing/mildew violations, etc... This service would allow a reduction in the manpower of identifying the issues. However, this will not affect the resource needing to make sure this service was fulfilled.

Marinas

Marinas have a similar issue as Homeowners' Associations in that customers pay for a service but are not always able to identify, capture & prosecute those that violate the rules and standards. Marinas will also be interested in rules related to Florida Fish and Wildlife Conservation Commission guidelines to report violations.

- Computer vision solution with multiple patterns (violation definition i.e.. dirty drives & roofs, lawn maintenance, noise levels)

    - Data pipeline to store video footage in cloud
    - Computer vision tagging
    - Model development, training, testing and deployment
    - Machine Learning Pipeline development for retraining of model for concept drifting
    - API development for consumers based on location of interest

Complexity is based on

High complexity because of multiple classes to be trained with rules governing it (each rule will have requirements, etc), and images will need to be tagged for model training. This model is starting from scratch as there are not available as a starting point.

Connected Citizens

Alexa Skills

Natural Language Processing & Understanding algorithms to provide residents and tourists details on key services

Impact Score: **4** Complexity Score: **4**

Public Impact

Public Health & Safety

Smart Poles equipped with natural language assistant hardware and software allows cities to direct significant numbers of customer service inquiries to a standard list of Frequently Asked Questions.

Television & Radio

Television and radio stations can advertise their services through specific natural language assistant content, voices and sponsorship/branding. In addition, the stations like WPLG that already have Alexa skills available to consumers can be enabled too.

Retail/Hotels

Natural language assistants can provide directions to local retail business and hotels, as well as share additional skills to enhance the consumers view of the business brand. Ratings and reviews can be access and read to the users, allowing surrounding guests to gain the same information.

Advertising

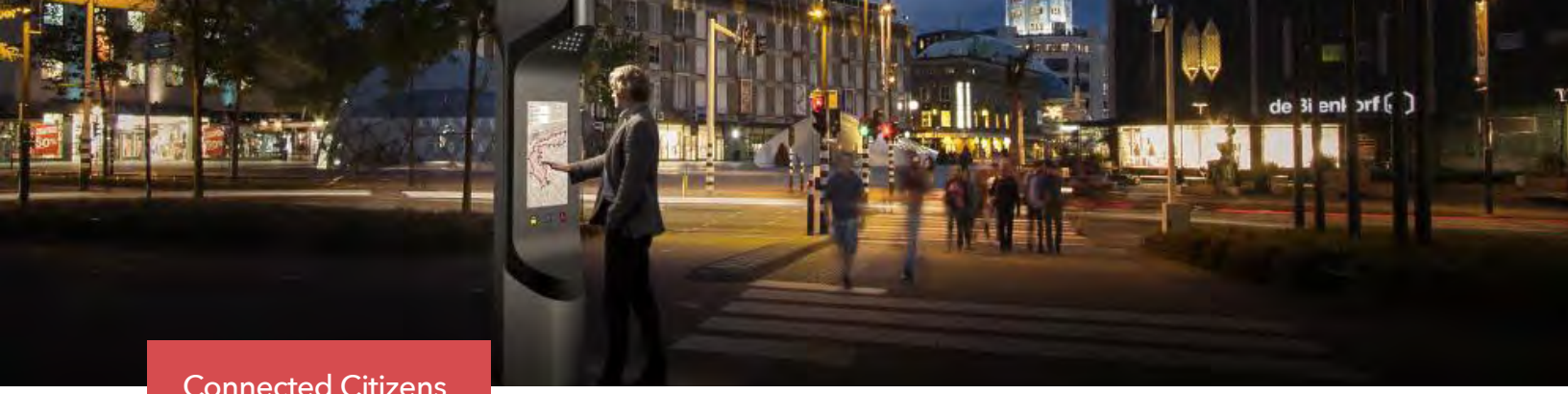
Similar to Television & Radio, local businesses and city services can advertise through sponsorship of natural language assistant technology and key advertising within messaging.

- NLU and NLP Solutions

  - NLU and machine learning model definition, training, testing and deployment
  - API development for consumers

Complexity is based on

This is a large effort to train multiple classes (each rule will have requirements, etc) and text (entities, intents etc.) will need to be tagged for model training. A possible ontology/taxonomy will need to be created from scratch to use in model training.



Connected Citizens

Smart Kiosk

Tablet style application accessible on the smart pole for residents and tourists to access key services and review retail options

Impact Score: **6** Complexity Score: **4**

Public Impact

Public Health & Safety

Information Kiosks with city information, key weather and safety alerts allow for any standardized messaging to be socialized city block by city block.

Advertising

Digital and physical advertising opportunities on the kiosk allow for sponsorship and brand messaging in strategic locations throughout the city. Special event promoters can also leverage advertising real estate to showcase one-time events or recurring events in areas where traffic tends to migrate to those venues.

Television & Radio

Television and Radio stations can purchase real estate in the digital platform for advertising, as well as possibly even load their mobile applications on the hardware for residents and tourists to use.

Infrastructure

Kiosk applications integrated with GPS map technology as well as bluetooth communication with residents and tourists can allow for a pole-by-pole customizable city tour experience with all of the details around where you are, what you see, and what is available.

Retail/Hotels

Local businesses and hotels can be key locations within kiosk applications and through fees can even have their own applications available for residents and tourists to use.

- Hardware solution that exposes City of Miami Beach application
- Tablet sized screens with protective casing
- Wi-Fi/Non-Wi-Fi Enabled
- Installed on poles in highly populated areas with minimal environmental impacts

Connected Citizens

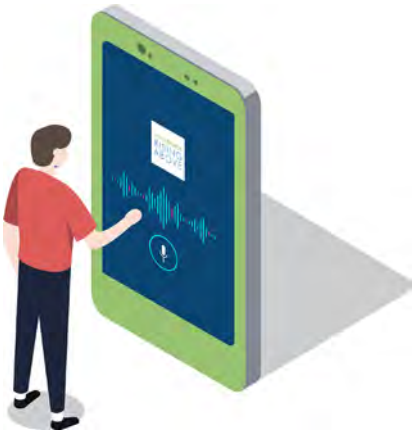
Smart Pole Physical Advertising

Advertising physically on poles, which could be digitized or printed to provide the greatest value and coverage

Impact Score: **3** Complexity Score: **1**

- Signage locations on EV charging stations, Smart Kiosk as well as all light poles in the City of Miami Beach

Public Impact



Advertising

Digital and physical advertising opportunities on the kiosk allow for sponsorship and brand messaging in strategic locations throughout the city. Special event promoters can also leverage advertising real estate to showcase one-time events or recurring events in areas where traffic tends to migrate to those venues.

Safety & Security

Security cameras, gunshot monitors and other IoT solutions designed to increase public safety

Cities are building a system of systems that leverage emergent behavior from their interaction.

Specialized engineering and design focus on the needs of vulnerable populations is required to build these systems effectively. Sensors and Cameras on smart poles provide the data to power Internet of Things (IoT) device adoption for first responders and private security resources alike. The overarching goal of these use cases steps from transparency in public activities and insights to proactively respond to situations.

01

License Plate Detection

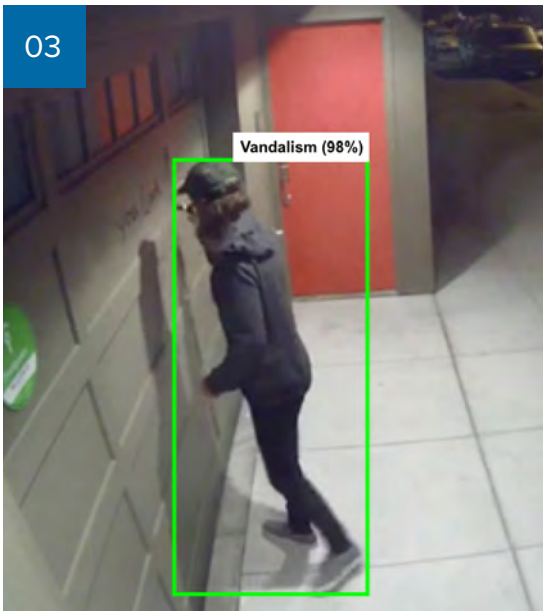
Computer vision and visual analytics to identify specific license plates from specific states or countries

02

Weapon Detection

Computer vision, visual analytics and machine learning algorithms to detect specific weapons and weapon types

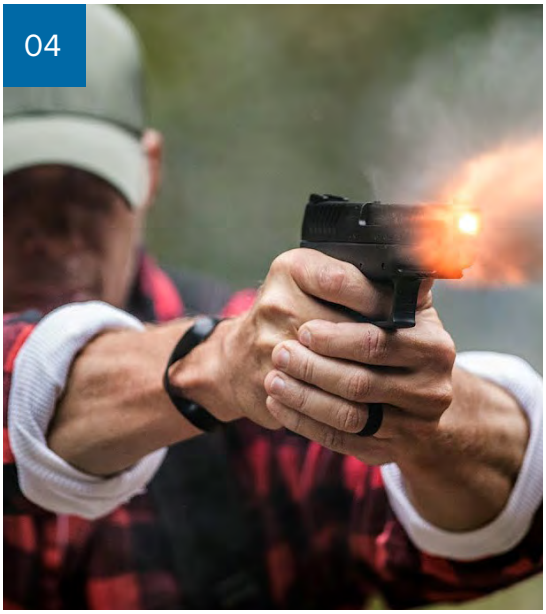
03



Vandalism/Damage Detection

Computer vision and visual analytics to detect damage in an image with additional machine learning algorithms to identify specific damage as vandalism

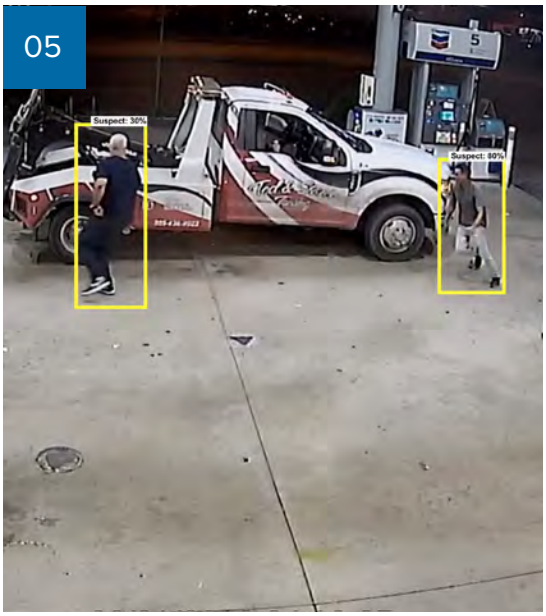
04



Audio Detection

Audio sensor information, analytics and machine learning to identify specific sounds and associate them to areas of concern including gunshots

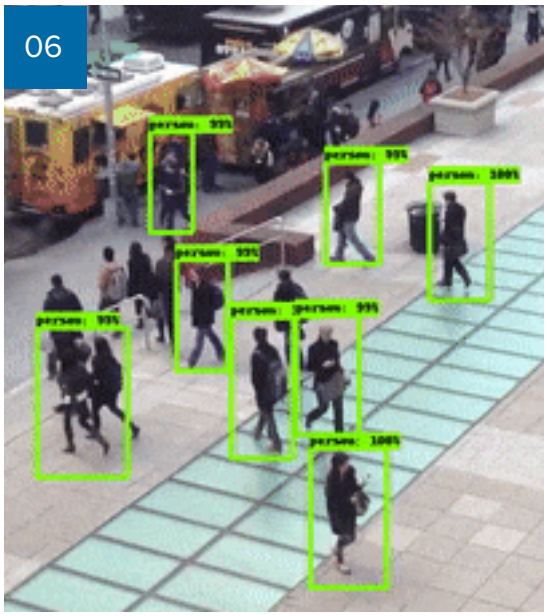
05



Video Evidence

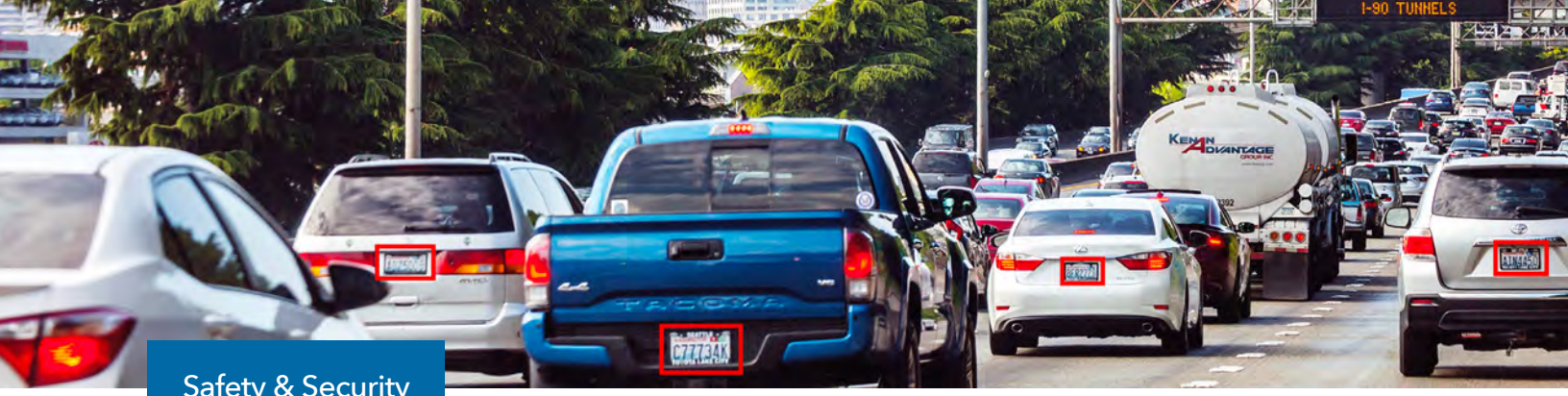
Camera footage captured to provide key information in judicial proceedings

06



Real Time Behavior Detection

Computer Vision combined with machine learning to predict specific behavior patterns



Safety & Security

License Plate Detection

Computer vision and visual analytics to identify specific license plates from specific states or countries. Does not include ownership validation with DMV only image and state / country identification.

Impact Score: **5** Complexity Score: **1**

Public Impact

Public Health & Safety

License plate recognition systems are integral to traffic safety cameras that have the capability to automatically fine vehicles jumping red lights, exceeding given speed limits or even entering restricted traffic or parking areas. Vehicles can also be checked to ensure they have passed the relevant technical inspections, with the consequent reduction in defective vehicles driven in cities reducing the number of deaths and injuries due to accidents caused by mechanical malfunction.

Infrastructure

Urban congestion charges have been implemented in several cities with the goal of reducing traffic in city centers. Others use the license plate to determine which vehicles should be permitted to drive into the congestion charge zones and on which day This capability can be central to both approaches for the automation of payment and location of offenders.

Retail/Hotels

With the number of tourists per year in the City of Miami Beach exceeding 9 million, local businesses and hotels rely on tourism dollars to and projections to keep their profits in the black. License plate recognition would greatly enhance the data analyzing the number of tourists to the day & hour in order to project sales and evaluate projections against historical data. It also will provide key insight to the target customers' residential framework for more accurate advertising techniques.

- Computer vision solution with one pattern (license plate detection)
  - Data pipeline to store video footage in cloud
  - Automatic number-plate recognition software - cost not included
  - Analytical Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers based on defining their interest, ie plate state
- Cameras assumed to be on the poles in areas of interest - cost not included
- Integration with consumers - cost not included

Complexity is based on

Relatively small because there are base models trained on license plates to help start a new Computer Vision model with, so it's expanding on existing work, rather than started from scratch.

Safety & Security

Weapon Detection

Computer vision, visual analytics and machine learning algorithms to detect specific weapons and weapon types

Impact Score: **2** Complexity Score: **6**

Public Impact

Public Health & Safety

With significant historical landmarks like the Holocaust Memorial, the Versace Mansion and additional outdoor venues with security challenges in the City of Miami Beach, the ability to detect weapons within camera footage would allow security personnel and law enforcement the ability to optimize coverage and response time to active events.

- Computer vision solution with multiple patterns (Many types Guns, Knives, bombs)
  - Data pipeline to store video footage in cloud
  - Computer vision tagging
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers based on location of interest and types of weapons to monitor

Complexity is based on

Relatively small because there are base models trained on license plates to help start a new Computer Vision model with, so it's expanding on existing work, rather than started from scratch.

Safety & Security

Vandalism/Damage Detection

Computer vision and visual analytics to detect damage in an image with additional machine learning algorithms to identify specific damage as vandalism. Detects change in image, does not include in the act vandalism behavioral analysis. Camera feeds can be also be used for evidence.

Impact Score: **6** Complexity Score: **6**

Public Impact

Homeowners' Associations

With 44 Homeowners' Associations in the City of Miami Beach, residents demand quick resolution of damage and vandalism of common areas to maintain the valuation of the their property. This service would narrow the focus of addressing those issues prior to inspection and can shorten the insurance approval window to implement changes quickly.

Marinas

With 4 marinas within the City of Miami Beach, vessels with damage or causing damage to boat slips and common areas would maximize addressing issues with boat owners and repairing damage quickly.

Retail/Hotels

With over 23,000 hotel rooms and large number of business retailers within the City of Miami Beach, these audiences can optimize manpower dollars and reduced city fines based on damage detection from all angles around their businesses.

Public Health & Safety

Quick detection of potential vandalism ensures cost reduction in law enforcement manpower, time on-site of an investigation or crime, and reduction in unplanned maintenance of traffic projects. The high-traffic areas within the City of Miami Beach, including Lincoln Road, Ocean Drive and Collins Drive provide additional oversight without increasing public safety presence.

Infrastructure

In crowded City of Miami Beach streets like Collins Avenue, city facilities and landmarks could be maintained more efficiently and effectively with quick identification of damaged locations.

- Computer vision solution with multiple patterns (Many types Guns, Knives, bombs)

  - Data pipeline to store video footage in cloud
  - Computer vision tagging
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers based on location of interest and definition of vandalism

Complexity is based on

This is a large effort to train for examples of vandalism and images will need to be tagged for model training. There is not a model to start with and you will need to train the algorithm for not only what is vandalisms what is normal conditions so that it can do comparisons for change detection.

Safety & Security

Audio Detection

Audio sensor information, analytics and machine learning to identify specific sounds and associate them to areas of concern including gunshots

Impact Score: **1** Complexity Score: **1**

Public Impact

Homeowners' Associations

With noise regulations in most City of Miami Beach communities, audio detection sensors can provide a timeline of noise violations for specific residences for effective enforcement, as well as alert notifications to security staff to address issues as they happen.

Public Health & Safety

Acoustic sensors can be strategically placed in high traffic areas like South Beach and Collins Avenue. When a gun is fired, the sensors detect shots fired allowing law enforcement to be notified and quicken response times to active shooter incidents.

- Audio analytic solution
  - Data pipeline to store audio files in cloud
  - Model development, training, testing and deployment
  - Machine Learning Pipeline development for retraining of model for concept drifting
  - API development for consumers

Complexity is based on

Tentatively small because there are base models trained on sound detection and gunshot detection to help start a new model with, so it's expanding on existing work, rather than started from scratch.

Safety & Security

Video Evidence

Camera footage captured to provide key information in judicial proceedings

Impact Score: **7** Complexity Score: **10**

Pubic Impact

Public Health & Safety

Video captured throughout the City of Miami Beach can be prepared and stored to be considered admissible evidence in civil and criminal proceedings. Law enforcement can leverage video data from city resources to cheaply reduce the number of security camera warrants and reduce the number of inadmissible video footage in the courtroom.

Television & Radio

Regional Television stations leverage video footage to identify news stories and enhanced coverage of city activities. These television stations could optimize their camera manpower and number of trucks in key location by purchasing streaming video data from triangulated cameras throughout the City of Miami Beach.

Smart Parking, Rideshare & Scooter Share

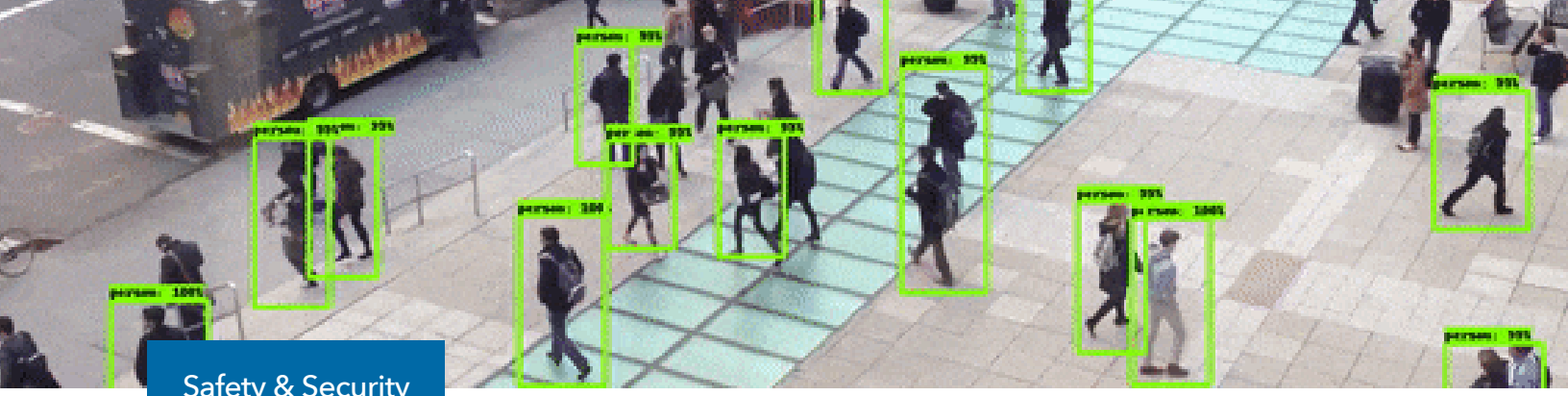
With 66 surface parking lots, 10 garages, and 17 residential parking permit zones citywide, key parking locations can leverage streaming video services to monitor safety and allow for additional eyes on multiple locations to effectively manage traffic flow and parking limitations.

- API access to video footage

    - Video footage pipeline to store footage in cloud
    - API created to provide data to consumers

Complexity is based on

In order to make the video more searchable, several models are used to capture specific meta data in the video that can be used to search the video content with. This adds a lot of complexity to the solution, since there are several types of objects that can be captured and stored as metadata, making the video text searchable.



Safety & Security

Real Time Behavior Detection

Computer Vision combined with machine learning to predict specific behavior patterns

Impact Score: **4** Complexity Score: **10**

Public Impact

Public Health & Safety

With the City of Miami Beach estimated at 15.22 square miles consisting of densely populated areas and significant areas on water, the ability for law enforcement to prioritize based on machine learning algorithms to identify criminal behavior through images would allow for redirecting resources to the most likely areas that need attention.

Smart Parking, Rideshare & Scooter Share

Parking vendors, rideshare companies and scooter vendors can leverage insights from real time behavior detection to identify criminal behavior and patterns of mischief to address in many locations at once.

Traffic & Mapping Companies

With few streets in the City of Miami Beach with speed limits over 30 miles per hour, identification of traffic congestion as a result of criminal behavior can make a significant difference.

Television & Radio

Insights that draw attention to law enforcement become the news of the day - and camera footage with key real-time behavior indicators can help television stations reduce the volume of data to prioritize the most interesting news stories.

- Computer vision solution with multiple patterns (Pushing, Hitting, etc)

    - Data pipeline to store video footage in cloud
    - Computer vision tagging
    - Model development, training, testing and deployment
    - Machine Learning Pipeline development for retraining of model for concept drifting
    - API development for consumers based on location of interest and types of behaviors

Complexity is based on

This is a large effort to train multiple classes (hitting, kicking, pushing etc.,) and data (video/images) will need to be acquired and tagged will need to be tagged for model training. This model is starting from scratch as there are not available as a starting point.

Homeowners' Associations

With 44 Homeowners' Associations in the City of Miami Beach, these data consumers will be most interested in camera footage, detection services for traffic, vandalism, noise and rules violations, Wi-Fi Services and even electric vehicle charging stations.

Resident groups provide opportunities for neighbors to come together and create a better quality of life in their respective area. Direct communication with these groups allows the City of Miami Beach to provide the best possible services. Through the data services available from the installation of smart lighting, these associations will gain access to cameras, sensors, and key data insights that will allow their residents a better quality of life, as well as cost savings that can be passed through to residents in their service fees for common areas, parking, and security services.

Safety & Security

- Camera Based Monitoring
- Audio Detection
- Vandalism/Damage Detection

Transportation, Parking & Traffic

- Traffic Flow
- Electric Vehicle Charging

Environmental / Health

- Severe Weather Detection
- Irrigation Integration

Connected Citizens

- Physical Advertising
- Rules Violation
- Wi-Fi to consumers - Push Notifications & Digital Ads

Public Health & Safety

The City of Miami Beach's safety departments like law enforcement and health are most interested in using data to avoid future costs to collect information and address significant public concerns, including large populated areas like Lincoln Road and environmental hazards such as sea turtle nesting activities.

From transport, to healthcare, to urban security, smart city initiatives and technologies render public services more efficient. This improves citizens' quality of life, strengthens a city's resilience and saves everyone time and money. Smart technologies can also be leveraged to maximize efficiency and cut costs in the fields of urban security, administrative procedures, city maintenance, education and much more. Smart city services will prevent future issues from emerging through improving both physical services and infrastructure, and strengthening social cohesion and a city's sense of community.

Safety & Security

- Audio Detection
- Camera Based Monitoring
- Crowd Detection
- Vandalism/Damage Detection
- Real Time Behavior Detection
- Weapon Detection
- Video Evidence
- License Plate Detection

Transportation, Parking & Traffic

- Hazard Detection
- Traffic Flow
- Pedestrian/Cycling Detection
- Parking Detection

Environmental / Health

- Trimming Detection
- Thermal Detection of Objects
- Litter Detection
- Flood Detection
- Severe Weather Detection
- Air Quality/Particle Detection
- Irrigation Integration

Connected Citizens

- Smart Kiosk
- Alexa Skills


FIRE DEPARTMENT
2
POLICE
HOSPITAL

City Infrastructure

As a condensed residential and commercial municipality, the City of Miami Beach would value sensor and camera data in planning infrastructure changes and updates.

In crowded streets like Collins Avenue, city facilities and landmarks could be planned and maintained more efficiently and effectively with the data services smart lighting can provide. Smart city technology allows city officials to interact directly with both community and city infrastructure and to monitor what is happening in the city and how the city is evolving. Smart lighting sensors are used to enhance quality, performance and interactivity of urban services, to avoid future costs and resource consumption and to increase contact between citizens and government. Solutions can also be developed to manage urban flows and allow for real-time responses. This leads to better informed infrastructure planning and implementation.

Safety & Security

- Vandalism/Damage Detection
- Crowd Detection

Transportation, Parking & Traffic

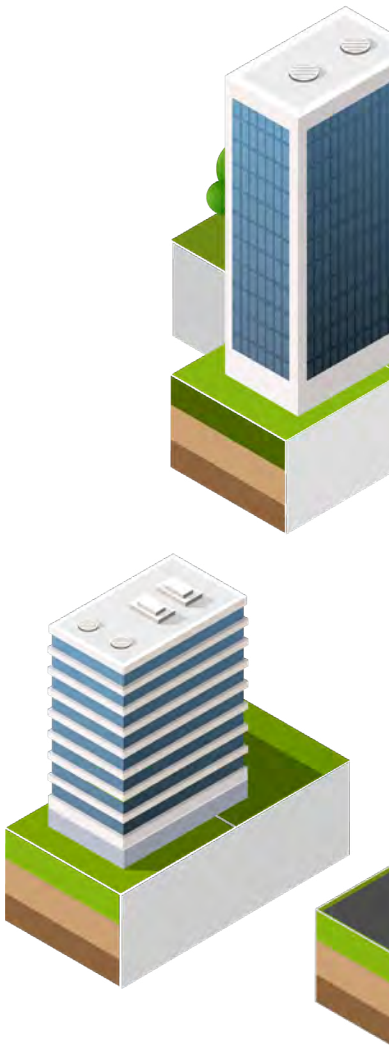
- Hazard Detection
- Traffic Flow
- Pedestrian/Cycling Detection
- Parking Detection

Environmental / Health

- Trimming Detection
- Irrigation Integration
- Flood Detection
- Litter Detection

Connected Citizens

- Physical Advertising
- Rules Violation
- Wi-Fi to consumers - Push Notifications & Digital Ads
- Smart Kiosk
- Alexa Skills



Retail/Hotels

With over 23,000 hotel rooms and large number of business retailers within the City of Miami Beach, sensor and camera data could be a valuable commodity worth purchasing to keep their businesses safe and profitable.

Information collected from sensors, cameras and smart kiosks, such as what attractions/restaurants/events are being searched for or how many people or cars are passing the kiosk can be sold to businesses in the area. Hotels and business would be very interested in information that directly impacts the flow of traffic around their location, the amount of security coverage that doesn't require additional private firms or resources, and abilities to reach customers in a new, digitally captivating way.

Safety & Security

- Camera Based Monitoring
- License Plate Detection
- Vandalism/Damage Detection

Transportation, Parking & Traffic

- Hazard Detection
- Traffic Flow
- Pedestrian/Cycling Detection
- Parking Detection

Environmental / Health

- Litter Detection

Connected Citizens

- Physical Advertising
- Smart Kiosk
- Wi-Fi to consumers - Push Notifications & Digital Ads
- Alexa Skills


HOTEL
HOTEL
BARBER
HOTEL

Smart Parking, Rideshare & Scooter Share

ParkMobile, ParkMe, Citi Bike Miami and future scooter & Rideshare vendors would benefit from the sensor and camera data from smart poles as well as the machine learning & computer vision technologies call out in the use case capabilities of smart lighting. Vendors of these services would be as interested as other businesses into the services related to safety and security, due to the risk of crime within the current business model.

Safety & Security

- Camera Based Monitoring
- Real Time Behavior Detection
- Video Evidence
- Pedestrian/Cycling Detection

Transportation, Parking & Traffic

- Traffic Flow
- Parking Detection
- Electric Vehicle Charging

Traffic & Mapping Companies

Uber, Lyft, Trolly service, Bus transit and traffic report vendors would value sensor and camera data regarding weather, traffic flow, crowds and additional insights from smart pole technology Real-time traffic information in congested locations like Collins Avenue or South Beach would provide clear commoditized data that would prove invaluable to traffic consumers

Safety & Security

Camera Based Monitoring | Real Time Behavior Detection

Transportation, Parking & Traffic

Traffic Flow | Parking Detection

Environmental / Health

Flood Detection | Severe Weather Detection

Local Television & Radio Stations

Today, Television Stations send personnel out to City of Miami Beach locations with camera crews to report key news stories, traffic and weather. Data services provided by smart lighting would optimize the number of personnel needed to travel on location and reduce the need for on-site cameras dramatically. This would provide opportunities reduce traffic congestion from news vehicles and minimize maintenance of transportation activities to accommodate high-profile news location traffic

Safety & Security

- Real Time Behavior Detection
- Video Evidence
- Camera Based Monitoring
- Crowd Detection

Transportation, Parking & Traffic

- Traffic Flow

Environmental / Health

- Flood Detection
- Severe Weather Detection
- Air Quality/Particle Detection

Connected Citizens

- Smart Kiosk
- Alexa Skills

Marinas

With 4 marinas within the City of Miami Beach with more than 400 boat slips and access to Biscayne Bay, sensor and camera data could be a valuable commodity worth purchasing to keep their businesses safe and profitable.

Information collected from sensors, cameras and smart kiosks, such as what attractions/ restaurants/events are being searched for or how many people or cars are passing the kiosk can be sold to marinas, who would be very interested in information that directly impacts the flow of traffic around their location, the amount of security coverage that doesn't require additional private firms or resources, and abilities to reach customers in a new, digitally captivating way.

Safety & Security

- Crowd Detection
- Camera Based Monitoring
- Vandalism/Damage Detection

Transportation, Parking & Traffic

- Parking Detection

Environmental / Health

- Severe Weather Detection

Connected Citizens

- Wi-Fi to consumers - Push Notifications & Digital Ads
- Rules Violation

Advertising

This reflects any data consumer interested in taking advantage of advertising opportunities from the data strategy of smart poles.

As the City of Miami Beach has a large tourism industry, these are the prime targets for advertisers through digital and print methods. Installed kiosks throughout the City of Miami Beach with maps and local information for restaurants, attractions, events and shopping. The city can sell advertising space on the screen to different advertisers who can run ads or offer coupons to users. In addition to this, users can purchase tickets to attractions, events or public transportation from these kiosks. A small fee can be charged to the company selling the ticket.

Safety & Security

Electric Vehicle Charging

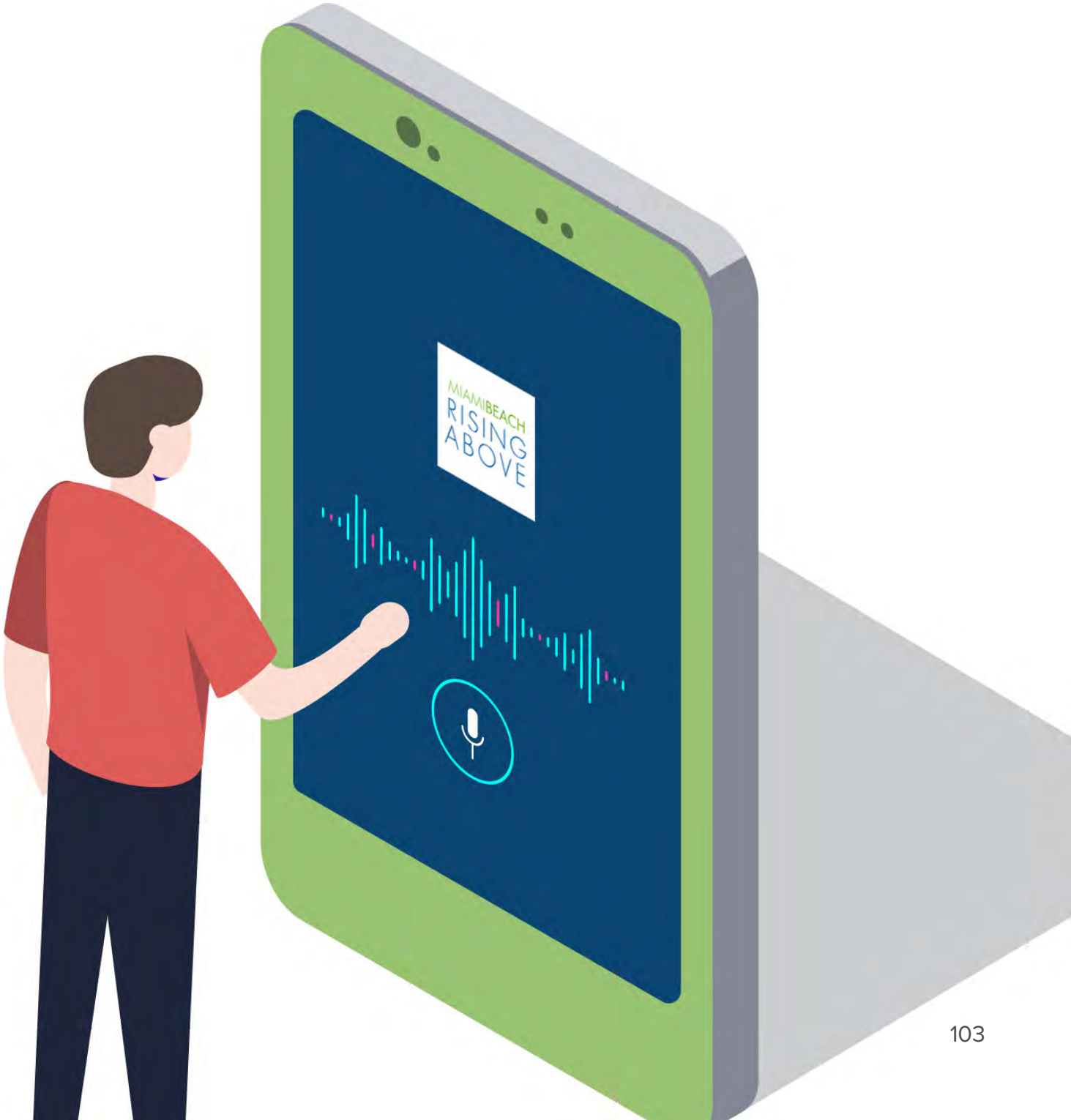
Transportation, Parking & Traffic

Physical Advertising

Smart Kiosk

Wi-Fi to consumers - Push Notifications & Digital Ads

Alexa Skills


MIAMIBEACH
RISING
ABOVE

Impact & Complexity Analysis

Impact

Reviewing the use case capabilities by audience, the team analyzed the potential revenue, future cost avoidance and public health & safety impact over the next 5 years and order of magnitude (low to high). These values were then leveraged to calculate an impact range per use case capability for ranking and prioritization purposes only.

Complexity

Analyzing each use case capability for both hardware and software potential costs and complexity, the team identify overall complexity values over the next 5 years and order of magnitude (small to large).These values were also leveraged to calculate an impact range per use case capability for ranking and prioritization purposes only.

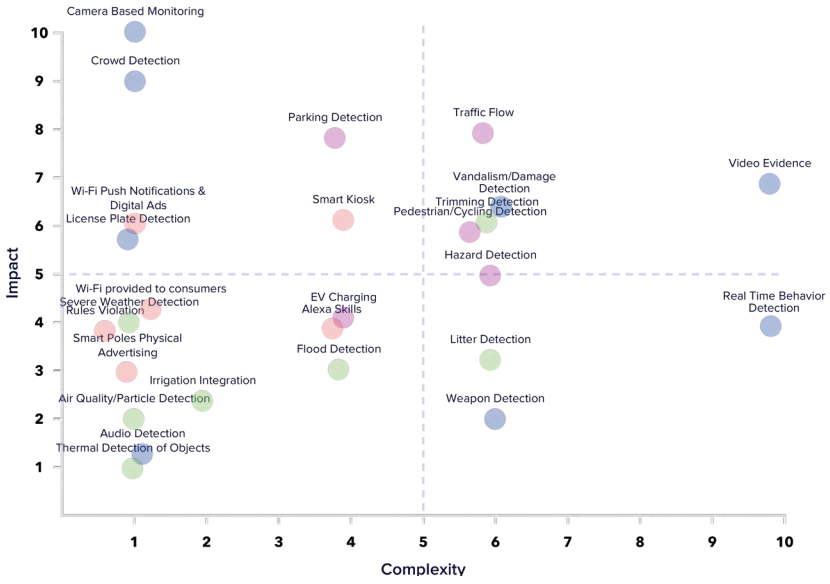
Key Considerations

The dollar estimation and complexity of each use case capability will require additional workshops and research, as outlined in the upcoming activities. Focusing research efforts on the most viable and fruitful use case capabilities will ensure efficient collaboration and innovation within the boundaries of City of Miami Beach Smart Lighting initiatives

Impact & Complexity Analysis

Impact Potential

The use case capabilities have been evaluated for revenue potential, future cost avoidance potential, and public safety value to create an overall impact potential score based on the order of magnitude on a scale of 1 through 12 - 12 being the highest impact potential and 1 being the lowest impact potential.



Complexity & Impact Potential

This visualization allows us to identify and prioritize the use case capabilities relative to complexity and impact to focus additional revenue analysis. Complexity cost & size has been normalized on a scale of 1 through 10 - 10 being the highest complexity and 1 being the lowest complexity. Impact potential has been normalized on a scale of 1 through 10 (adjusted from the 1-12 scale from the previous slide) - 10 being the highest impact potential and 1 being the lowest impact potential.

Prioritization & Ranking

The preliminary order of magnitude public impact use case analysis and data strategy's ultimate goal is to suggest a list of use cases to focus discovery workshops, additional research, vendor audits, and hardware solution recommendations. This list is to provide the team's recommendations for the City of Miami Beach with the greatest revenue potential, future cost avoidance and public impact with lowest cost and complexity.

Through the impact and complexity analysis of all highlighted use case capabilities, the team viewed each through the lens of the lowest complexity and highest impact as being capabilities to be prioritized over higher complexity use cases. In the four quadrant model, those use cases that have the lowest impact and highest complexity were prioritized as the lowest plausible use cases for further exploration.

Rank	Use Case Category	Use Case	Impact Score	Complexity Score
1	Safety & Security	Camera Based Monitoring	10	1
2	Safety & Security	Crowd Detection	7	1
3	Connected Citizens	WiFi Push Notification & Digital Ads	6	1
4	Connected Citizens	WiFi provided to consumers (free at certain speeds)	4	1
5	Environmental/Health	Severe Weather Detection	4	1
6	Transportation, Parking & Traffic	Parking Detection	8	4
7	Connected Citizens	Rules Violation	4	1
8	Connected Citizens	Smart Kiosk	6	4
9	Connected Citizens	Physical Advertising	3	0
10	Transportation, Parking & Traffic	Traffic Flow	8	6
11	Transportation, Parking & Traffic	Hazard Detection	5	6
12	Transportation, Parking & Traffic	Pedestrian/Cycling Detection	5	6
13	Transportation, Parking & Traffic	Electric Vehicle Charging	4	4
14	Environmental/Health	Trimming Detection	6	6
15	Connected Citizens	Alexa Skills	4	4
16	Environmental/Health	Flood Detection	3	4
17	Environmental/Health	Air Quality/Particle Detection	2	1
18	Environmental/Health	Thermal Detection of Objects	1	1
19	Safety & Security	Real Time Behavior Detection	4	10
20	Safety & Security	License Plate Detection	5	1
21	Safety & Security	Vandalism/Damage Detection	6	6
22	Safety & Security	Audio Detection	1	1
23	Environmental/Health	Irrigation Integration	3	2
24	Environmental/Health	Litter Detection	3	6
25	Safety & Security	Weapon Detection	2	6
26	Safety & Security	Video Evidence	3	10

Sources and Reference Documentation

IBM - The value of Smarter Public Safety

Modeling a hypothetical US. city police department to determine how smarter public safety and security competencies can drive value in different ways. Some of these are operating cost savings realized by the agency. Other benefits are calculated as resulting from fewer incidents, such as the avoidance of victim costs, criminal justice cost savings and societal benefits. Used to calculate the order of magnitude the public safety impact value in the impact analysis

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Smart cities: Digital solutions for a more livable future

Smartphones have become the keys to the city, putting instant information about transit, traffic, health services, safety alerts, and community news into millions of hands. Citizens can make better decisions that benefit themselves and their community simultaneously across many aspects of their daily lives.

Becoming a smart city is not a goal but a means to an end. The entire point is to respond more effectively and dynamically to the needs and desires of residents. Technology is simply a tool to optimize the infrastructure, resources, and spaces they share. Smart cities need to focus on improving outcomes for residents and enlisting their active participation in shaping the places they call home.

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