

GoPark: An environmentally-innovative Solution Revolutionizing Parking, Traffic, and Pollution using IoT Devices and Smart City Technologies

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Abstract

GoPark is an environmentally innovative smart parking initiative to reduce traffic congestion, improve air quality, and enhance community well-being in Hong Kong. The project utilizes sensor technology and real-time data to guide drivers seeking parking, helping them locate available spots quickly and efficiently. By reducing time spent searching for parking, GoPark decreases vehicle idling and emissions, alleviating pollution and supporting environmental sustainability goals. This paper examines GoPark's approach to transforming parking in Hong Kong through advanced technology and data-driven solutions. Analyzing the project's potential impacts on traffic, air quality, and the community demonstrates its viability as a comprehensive solution to parking difficulties in an urban setting. GoPark can serve as an example for other cities looking to implement smart, sustainable parking systems and build connected livable communities.

Objective

1. Reducing circling for parking

The endless circling for a parking spot is a significant cause of traffic congestion, leading to frustration for drivers and increased pollution. By providing real-time guidance to drivers about available parking spots nearby, GoPark helps minimize the need for extensive searching, resulting in fewer vehicles on the road and less congestion. This also reduces unnecessary idling time, a major contributor to air pollution, leading to improved air quality in the surrounding area.

2. Streamlining parking processes

Efficient parking systems, like the one proposed by GoPark, have the potential to optimize the parking process itself. By integrating advanced technology such as sensors and data analysis, the system can guide drivers to vacant spots quickly and effectively, ensuring that parking spaces are utilized efficiently. This streamlined approach minimizes the time spent entering and exiting parking facilities, reducing congestion and emissions near entry and exit points.

3. Reducing double and illegal parking

In areas with high traffic congestion, drivers often resort to double-parking or parking in unauthorized zones due to a lack of available spaces. By guiding drivers to legitimate and convenient parking options, GoPark helps discourage double-parking and illegal parking, reducing

disruptions to traffic flow. This not only benefits drivers by providing them with a hassle-free parking experience but also helps improve overall traffic flow and reduces congestion in busy areas.

4. Promoting alternative modes of transport

Efficient parking systems also encourage the use of alternative modes of transportation, such as public transit, walking, or cycling. In cases where no available parking spaces are nearby, GoPark informs drivers and encourages them to consider alternative transportation options. By providing this information in real-time, GoPark empowers drivers to make informed decisions about their transportation choices, reducing traffic congestion and air pollution.

5. Supporting sustainable urban planning

By utilizing GoPark's innovative parking system, drivers can park their cars in a more organized manner, reducing the need for parking along roadsides. This, in turn, creates opportunities for the development of green spaces, recreational areas, and cultural venues that benefit the entire community. Through its focus on optimizing space utilization, GoPark is helping to create a more vibrant and sustainable urban environment.

Problem Statement

1. Poor air quality impacting health

Hong Kong is plagued by severe air pollution, with high levels of pollutants such as PM2.5 and nitrogen dioxide (NO₂) [1]. The densely populated Hung Hom district, which is adjacent to main thoroughfares, is particularly affected, with poor air quality that poses a significant threat to public health. Studies have linked long-term exposure to air pollution with respiratory ailments, cardiovascular problems, and even premature death.

Vehicle emissions are a major contributor to air pollution in Hong Kong, accounting for over 50% of the polluted air [1]. With an estimated 275 vehicles per kilometer, the city's roadways are notorious for having the highest car density in the world [1]. Emissions from vehicles, including nitrogen oxides (NO_x), particulate matter (PM), and volatile organic compounds (VOCs), contribute to the creation of smog and other dangerous air pollutants. This has a detrimental impact on the environment and the well-being of citizens.

2. Inadequate community facilities and public spaces

The lack of public places and community centers in urban areas, such as Hong Kong, not only restricts access to outdoor activities, cultural events, and social contacts but also exacerbates the negative impact on citizens' mental health and well-being. Studies have shown that living in urban areas with limited public space is associated with a 40% higher risk of depression and over a 20% higher risk of anxiety compared to rural areas [2]. Therefore, the availability of public space plays a crucial role in promoting mental health and overall well-being in urban environments.

In comparison to other cities, Hong Kong's urban public space is particularly limited, with only 2.7 square meters of space per person. In contrast, Singapore, despite being half the size of Hong Kong, offers 7.4 square meters of urban public space per capita [2]. This stark contrast highlights the shortage of accessible outdoor recreational areas in Hong Kong, further emphasizing the need for additional public places and community centers to meet the diverse needs of its residents.

3. Congested traffic around the tunnel area

The area surrounding the Hung Hom Cross Harbour Tunnel Toll Plaza is notoriously congested, particularly during rush hour. The high volume of traffic in the area is a major cause of delays, increased pollution, and contributes to global warming. Ineffective traffic management and a lack of alternative transit options further exacerbate the situation, threatening the district's ability to function. The continuous traffic congestion also adds to the frustration and stress experienced by commuters, highlighting the urgent need for comprehensive traffic management strategies and improved transportation infrastructure in the Hung Hom district.

The overwhelming presence of private cars in the Hung Hom district of Hong Kong is the primary factor that contributes to the city's chronic traffic problems in this area [3]. The high number of private vehicles in the area exacerbates the persistent congestion, delays, and environmental issues. The widespread use of personal automobiles also contributes to the acceleration of global warming. In addition, the current transportation infrastructure and traffic management strategies are inadequate to address this pressing issue effectively.

Proposed Solution

At the heart of our solution is a network of advanced sensors and real-time data analysis, which enables us to provide accurate and up-to-date information on parking availability from both private and public parking spaces. Drivers can access this information remotely through our user-friendly mobile application, allowing them to pre-plan whether using their vehicle or public transport would be more convenient.

In addition to providing accurate parking information, GoPark aims to guide drivers directly to their designated parking space using an automated guiding system built on top of Google Maps. This system automatically updates drivers on the availability of their designated parking spot and provides automatic rerouting using Google's shortest route technology to minimize driving and parking time. GoPark also includes an all-in-one payment system, eliminating the need for physical payments and instead relying on faster mobile and online payment methods such as FPS.

To make our solution possible, GoPark offers an IoT service that can be sold to local governments and private parking institutions to prepare their parking spaces for use on our platform. This IoT service includes the installation of sensors and IoT devices, maintenance, and connecting them to our servers and databases. Private parking institutions can benefit from increased revenue through our platform guiding drivers to their parking spots, while GoPark increases the number of available parking spaces for users.

The Green Deck, a three-story parking structure, will also be utilized and transformed into a smart and eco-friendly parking space that is space and energy optimized. GoPark plans to install solar panels, miniature road-side wind turbines, sensors, and automatic energy-saving systems across the entire Green Deck. The energy-saving system automatically turns off power to upper floors when the number of cars entering the Green Deck can fit in the first or second floor(s) alone.

Ultimately, GoPark aims to reduce driving and parking time, carbon emissions, congestion near parking spaces, and driver frustration. Our unique position next to the cross-harbour tunnel will also reduce traffic in the area by providing incoming drivers from Central to TST a parking space closer to TST and MTR, reducing their driving time. Additionally, GoPark can decrease the number of drivers in the first place by encouraging users to consider using public transportation instead of their cars when parking space availability is low.

Market Analysis

Target Market & User Demographics

1. Individual vehicle owners
Individual vehicle owners are those who own private cars and motorcycles and face daily challenges in finding parking spaces. GoPark's platform provides them with up-to-date information on parking availability, enabling them to plan their parking needs in advance and reduce the time spent searching for a parking spot.
2. Commercial vehicle owners
Commercial vehicle owners, including taxi and delivery truck owners, and companies that own vehicles that require parking spaces during operational hours, benefit from GoPark's real-time parking information. This allows them to optimize their routes and reduce the time spent searching for parking spaces, which can increase their productivity and revenue.
3. Parking facility operators
Parking facility operators, such as companies and organizations that manage parking lots, garages, and on-street parking spaces, can benefit from GoPark's IoT service. By installing sensors and IoT devices, parking facility operators can connect their parking spaces to the GoPark platform, increasing the visibility of their parking spaces to users.
4. Government authorities
Government authorities, including local government authorities, aim to reduce traffic congestion, emissions, and overall parking issues within the city. GoPark's solution can provide them with valuable data on parking demand and usage, enabling them to make informed decisions on parking management and infrastructure development.

Specific Market Trends to the solution

1. Increase in smart city initiatives
As Hong Kong strives to become a smart city, increasing attention is being given to leveraging the Internet of Things and other digital technologies to enhance urban living conditions, particularly in regard to parking and transit.

- Under the Hong Kong smart city government blueprint (2.0), our solution would be promoted under the smart mobility plan and under the smart environment plan. Thus, promotion and aid from entities, such as the government, are highly expected.
 - Our solution is aimed at addressing initiatives 3, 4, and 5 from the smart mobility plan, with initiatives 4 and 5 being labeled as 'New Initiatives' and therefore receiving increased support from the Hong Kong government.
 - All of these smart initiatives are still ongoing, indicating a continued commitment to developing and implementing smart mobility solutions in Hong Kong.
 - The public sector has already taken steps to improve parking management by installing over 10,700 parking meters throughout the city. These meters could be directly integrated with our smart solution.
2. Growing demand for sustainability
- The city's commitment to environmental sustainability has led to a surge in interest in programs aimed at reducing energy consumption, traffic congestion, and car emissions.
- The Hong Kong government's Smart Environment Smart City Blueprint initiative includes a focus on promoting decarbonization efforts through the Climate Action Plan 2050 scheme.
 - Initiative 4 of the blueprint focuses on promoting energy efficiency, particularly within buildings. This is directly relevant to our energy-saving parking solution within the Green Deck.
 - Another key initiative outlined in the blueprint is to optimize the use of city resources. This highlights the importance of solutions like GoPark, as land is one of the most limited resources in Hong Kong.
3. Increasing cashless payment system
- The widespread adoption of cashless payment systems in Hong Kong has made it easier for customers to pay for parking services using mobile applications or digital wallets.
- According to a study conducted by the Hong Kong government, 95% of residents use Octopus and other cashless payment systems for transportation and other services.
 - Hong Kong is an extremely car-dense city, with an average of 373 licensed vehicles per kilometer of road. Our solution aims to reduce this number by decreasing total commute time by allowing users to easily and directly reach their parking spot.

Other market trends

The Hong Kong government has been actively promoting the development of such technologies and has launched several pilot projects in recent years to help promote solutions such as GoPark.

1. The Hong Kong government has set a target of reducing carbon emissions by 50% by 2025.
2. The smart city market is expected to reach HKD60 billion, with transportation being named as a key area of development.
3. In the transportation sector, there is growing interest in smart transportation solutions such as intelligent traffic management systems and real-time parking availability systems.
4. Hong Kong has an extremely low ratio of parking spaces to vehicles, with a downward trend.

Competitive Landscape

1. Parkxper

A US-based company that provides smartphone apps for drivers, as well as parking advice systems, license plate recognition, and other smart parking solutions.

- Strength: An established client-based and industry knowledge
- Weakness: Lack of interaction with other smart city technologies, limited local presence, copied innovation

2. Nedap Identification Systems

A business located in the Netherlands that provides parking management and vehicle identification solutions, such as long-range RFID and license plate recognition systems.

- Strength: Advanced technology, a global presence, and expertise in carrying out significant projects.
- Weakness: Limited local presence and the need to integrate with other IoT solutions.

Market Growth Opportunities

1. Integration with other smart city initiatives

Working with other smart city initiatives, such as the parking meter program offered by the Hong Kong government and the plan by the transport department to offer real-time parking vacancy information in both the private and public sectors, will enable us to offer a more complete solution that is robust and evolving.

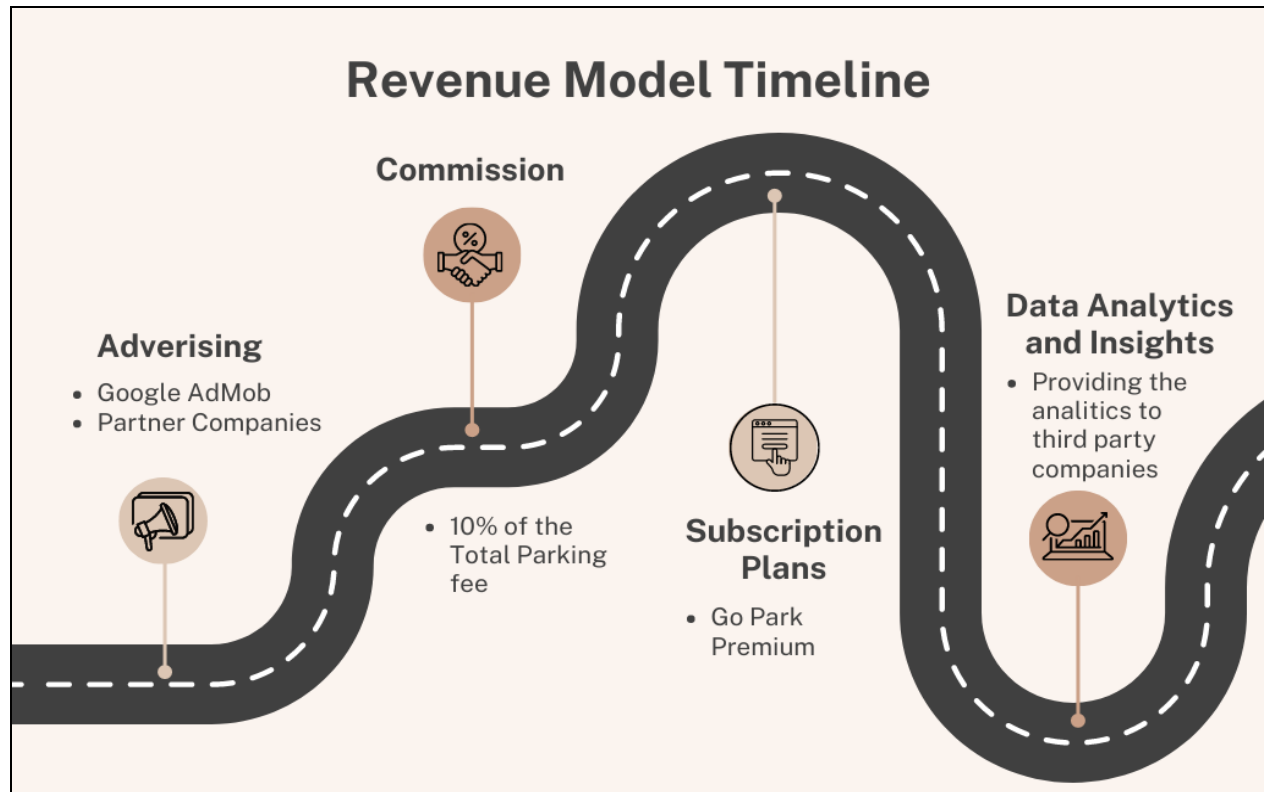
2. Stressing sustainability

GoPark can stand out in the market by providing ecologically friendly features such as automatic energy saving in parking spots, which will also attract additional support and investment from the public and private sectors.

3. Tapping unexplored markets

There are no established large or medium-sized companies in the Hong Kong market. This absence of any significant worldwide monopolies or conglomerates in the market provides an opportunity for GoPark to gain a foothold and establish itself as a leader in the market.

Revenue Model



Four key factors contribute to our revenue model.

1. Advertising

As the first step, we plan to run advertisements from Google AdMob. We also plan to partner with local businesses such as nearby restaurants, shopping malls, theaters, or cinemas so they can use our app as an advertising platform.

2. Subscription Plans

give customers additional benefits and features. We have included three subscription modes: GoBasic, GoSilver, and GoPremium. The benefits are as follows

Features	GoBasic	GoSilver	GoPremium
Basic Parking Search	✓	✓	✓
Real-Time updates	✓	✓	✓
Navigation Assistance	✓	✓	✓
User reviews	✓	✓	✓
Ad-Free Experience		✓	✓
Priority updates on parking availability		✓	✓
Can reserve parking slots in advance			✓

Offer discounts at partnering parking slots			✓
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GoSilver offers a 7-days free trial. In contrast, GoPremium provides a 14-day free trial.

3. Commision from transactions

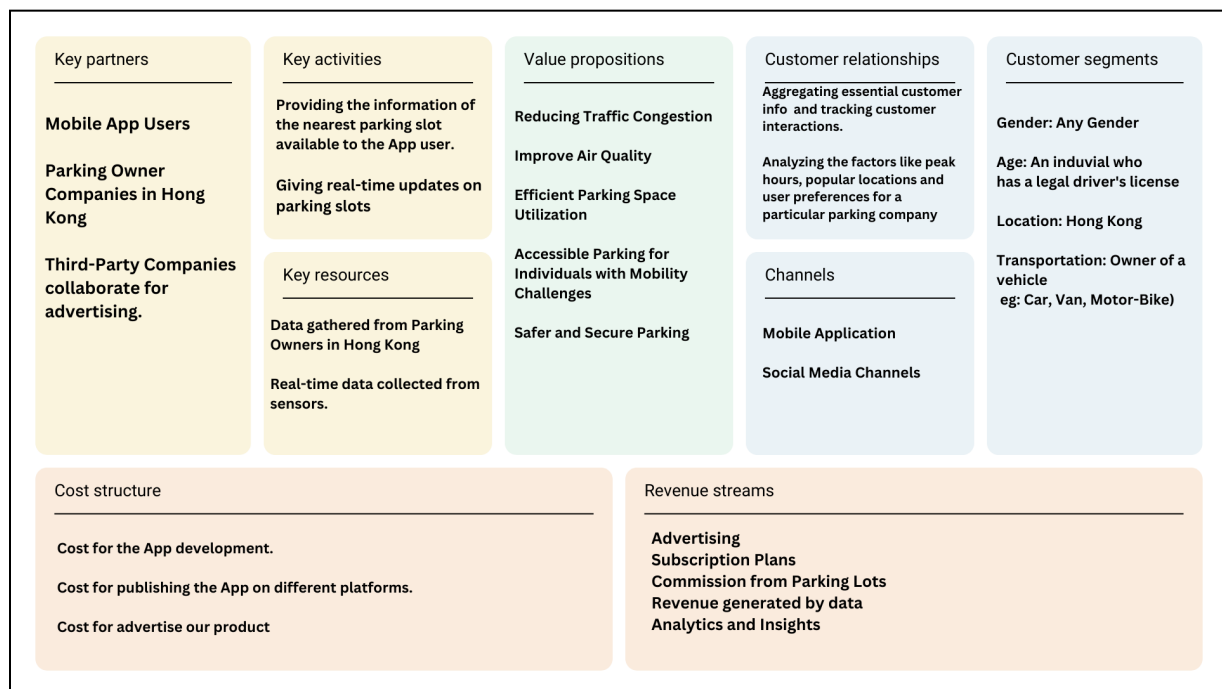
Since we are collaborating with parking lot owners, we plan to charge them a commission for each booking made through the app. This commission will be 10% of the total parking fee the user pays to a parking owner. Some parking companies in Hong Kong are as follows

- Wilson Parking (Hong Kong) Limited
- Sun Hung Kai Properties Limited
- The Link Management Limited
- New World First Parking Services Limited
- CP Park (Hong Kong) Limited

4. Data Analytics and Insights

GoPark can track analytics such as peak hours, popular locations, and user preferences. We plan to use these analytics to enhance city planning and transportation management. As a result, these analytics can be used by transportation agencies, city planners, and businesses, and we can charge a fee for providing the data.

Impact Assessment



GoPark provides several benefits and outcomes for the community. However, these positive impacts depend on user adoption, practical implementation, and collaboration with existing parking infrastructure. GoPark's main objective is to reduce traffic congestion in urban areas, which helps to save time and increase the convenience of searching for parking spots. We believe implementing GoPark will improve

users' quality of life and give Hong Kong a sustainable, user-friendly parking ecosystem. The key impacts and objectives of GoPark are as follows

1. Reducing Traffic Congestion

Hong Kong is known for its dense population and heavy traffic. GoPark aims to help drivers quickly locate the nearest available parking slot to reduce the time spent circling the city for parking slots. Consequently, the city achieves a smoother traffic flow and lessens the number of vehicles on the road network.

2. Improve Air Quality

As mentioned, GoPark will reduce traffic flow, decreasing vehicle emissions. By reducing CO₂ emissions and improving air quality, GoPark can help to reduce air pollution in Hong Kong.

3. Efficient Parking Space Utilization

Since Hong Kong has limited land availability, GoPark can help to maximize the utilization of existing parking facilities by guiding users to available parking slots, reducing the need for constructing new parking spaces. As a result, it preserves the green spaces in Hong Kong.

4. Accessible Parking for Individuals with Mobility Challenges

GoPark can provide information for people with mobility challenges and disabilities and prioritize their needs. It helps to promote inclusivity and support social groups with particular mobility needs.

5. Safer and Secure Parking

The app can inform the user about the security of parking slots so that customers can make decisions based on their safety. Hong Kong can benefit from this feature as a country where security and safety are critical.

REFERENCES

[1] Ben, C. Fischer, and Axel, "Hong Kong SAR Air Quality Index (AQI) and Hong Kong SAR Air Pollution | AirVisual," www.iqair.com, Jun. 2023.

[2] C. Lee, "Hong Kong's public space problem," www.bbc.com, Sep. 2020.

[3] M. Rowse, "Hong Kong can't bypass its biggest traffic problem: too many cars," *South China Morning Post*, Jan. 28, 2019.