Impact Assessment Report

License Plate Detector

system's phase: use

Section 1 INFORMATION ON THE SYSTEM'S USE AND TEAMS

1.1 **System's Use.**

Purpose. Streamlining and securing the parking allocation process by using image recognition.
Capability. Optical character recognition.
Domain. Retail and customer services.
AI User. Supermarket security managers and staff.
AI Subject. Customers of the supermarket.

1.2 **System Components.** The system uses a multi-model architecture to process:
(1) license plate images from a Pan-Tilt-Zoom CCTV camera,
(2) logs with the time of entry and exit of the vehicle from a loop sensor.

For real-time license plate image processing (1), the system uses two specialized Convolutional Neural Networks. CNN-Plate (version 3.1) is used to detect and isolate the license plate from the rest of the vehicle image. This involves recognizing the plate's shape and size. CNN-Digit (version 5.1) is used to segment the characters from the plate, including registration numbers, letters, and symbols.
For time log processing (2), the system uses an Autoregressive Integrated Moving Average (ARIMA) model, version 8.1.1. It identifies outliers and anomalies in the time log data, such as a vehicle taking an unusually long time to exit or enter, which could indicate a problem or an exception that needs attention. The system is equipped with an alert mechanism that triggers notifications to both the customer and store personnel whenever any of the models detect an anomaly.

1.3 **System Data.** The system utilizes a comprehensive training and testing dataset of 612 437 images, adhering to a 70/30 split. Captured under various conditions such as daylight and nighttime, and during different weather scenarios including rain, snow, and fog, these images are also taken from multiple angles, encompassing both the front and back of the vehicle. They feature varying levels of blur due to vehicle movement. Moreover, to ensure accurate character recognition, the dataset includes a wide range of license plates from different regions, showcasing variations in plate designs, fonts, and colors.
The dataset was obtained by combining the Chinese City Parking Dataset (300 000 images), the Vehicle Make and Model Recognition dataset (291 752 images), the Stanford Cars dataset (16 185 images), and the UFPR-ALPR Dataset (4 500 images). The dataset is updated twice a year to reflect new license plate formats and adapt to changes in vehicle registration designs, ensuring the system remains effective over time.
The system processes license plate images that contain personally identifiable information. It also records logs of vehicles' entry and exit times, which, while not classified as personally identifiable information, could potentially be used for purposes beyond their intended use. Future plans involve combining these logs with phone numbers from the customer database to offer personalized shopping discounts that are synchronized with the customer's typical shopping hours, providing them with special offers precisely when they are most likely to visit the store. To safeguard system data, stringent protocols are in place governing data access, storage, and processing. Access to this information is specifically limited to designated supermarket staff, including security managers and IT support personnel. These measures are designed to protect individual privacy and ensure the system's compliance with the General Data Protection Regulation (GDPR).

1.4 System Evaluation.

Evaluation at development stage. The evaluation of models for optical character recognition encompassed a variety of scenarios to ensure robustness and accuracy. Benchmarks included various conditions, including different vehicle types, license plate designs, and environmental settings like lighting and weather. The system's accuracy was tested by comparing its ability to correctly identify license plates against a pre-registered database under these varying conditions. License plate recognition achieved an accuracy rate of 97%, while digit recognition reached 94%. Additionally, the evaluation measured the system's response time from capturing the vehicle's entry and exit times via loop sensors to the moment the parking lot barrier goes up, aiming for a seamless and fast parking experience.
The evaluation of the model to identify outliers and anomalies within the time log data involved a combination of automated testing, manual verification, and real-world transaction simulation to ensure the system's robustness and accuracy. Simulated parking scenarios were conducted under various conditions, including peak hours, weekends, and adverse weather conditions, to gauge the system's accuracy and security in processing parking time information. Results indicated an accuracy rate of 75%, while instances where vehicles took unusually long durations to enter or exit were closely scrutinized to derive critical indicators of potential exceptions requiring personnel's attention.

Evaluation at deployment stage. The system was piloted in 50 supermarkets and evaluated in collaboration with 350 end users, including individuals in various positions such as security managers and customer service representatives, gathering vital feedback to refine usability and functionality in line with on-ground operational needs.

Evaluation at use stage. The system is consistently monitored for latency and downtime to maintain stable performance. Its accuracy is continually enhanced through the integration of new data, preserving relevance and precision. Moreover, the system is continually evaluated with feedback from supermarket security managers, staff, and customers.

1.5 **Teams.** The system's design involved a diverse team of professionals. Computer vision specialists focused on license plate recognition, and experts in privacy and data security to ensure the protection of customer information. Collaboration with parking management professionals ensured the system met operational needs for efficient parking management and security. Legal and ethical advisors provided compliance guidance, while input from supermarket staff and customers and was integrated to tailor the system towards user-centric functionality.

Section 2 RISKS

The system poses limited risk due to its processing of personally identifiable data within non-critical domains (EU AI Act, Annex III).

2.1 Capability Risks.

Accidentally capturing images of vehicle's surroundings. For customers, if the system captures images of drivers and passengers, this can lead to privacy concerns, potentially resulting in distrust and reluctance to use the supermarket's services. For stores, this could negatively impact their reputation and brand image. If customers perceive that their privacy is not adequately protected, they may opt to shop elsewhere, resulting in a loss of revenue. Additionally, non-compliance with data protection regulations could lead to legal penalties and fines, further damaging the store's reputation. Institutions, including regulatory bodies, are also at risk, as a privacy breaches would undermine their efforts to enforce data protection laws, leading to a loss of trust and credibility in their ability to safeguard customers' privacy rights. Moreover, improper handling of system's data could negatively imact the environment, contributing to electronic waste and carbon emissions through increased server usage and data storage.

Delays during power and network disruptions. For customers, such disturbances can create inconvenience, potentially affecting their satisfaction and loyalty. For stores, these disruptions result in missed sales opportunities, leading to direct financial losses and the potential for reputational harm.

2.2 Human Interaction Risks.

Information imbalance between staff and customers during parking conflicts. In situations where the system's data contradicts a customer's account of their parking activities, staff may face challenges in mediating disputes, impacting customer trust and satisfaction.

2.3 Systemic Impact.

Perpetuating the perception of constant surveillance. Although the system primarily targets license plates, its existence may engender a perception of perpetual surveillance, affecting the psychological well-being of customers, staff, and local residents. This constant surveillance impression could prompt heightened scrutiny from regulatory authorities, potentially triggering audits and investigations that disrupt institutional operations. Furthermore, the increased energy consumption needed to maintain the system's continuous functionality may worsen environmental degradation, undermining the long-term sustainability goals outlined in the ESG strategies of these stores.

Section 3 MITIGATION STRATEGIES

3.1 Mitigations of the Capability Risks

Accidentally capturing images of vehicle's surroundings. The system's operators can strategically position cameras to focus specifically on areas where license plates are expected. Additionally, installing physical shields around cameras can limit their field of view and prevent them from capturing extraneous surroundings. These measures help ensure that only relevant images containing license plates are collected, reducing the risk of privacy infringement.

Delays during power and network disruptions. Implementing manual backup systems like ticket booths or manual attendants can ensure parking operations continue smoothly. Additionally, installing backup power sources such as generators or UPS systems can keep the automated parking allocation system running during power outages, minimizing disruptions for customers. These measures provide resilience against unforeseen technical issues, ensuring efficient parking management even in adverse conditions.

3.2 Mitigations of the Human Interaction Risks

Information imbalance between staff and customers during parking conflicts. Installling interactive screens at prominent locations within the store, such as near parking entrances or payment kiosks, allows customers to easily access parking rules and check their current parking status. These screens can also display real-time information about available parking spots, time limits, and any special regulations, empowering customers to make informed decisions and reducing the likelihood of conflicts with staff.

3.3 Mitigations of the Systemic Impact Risks

Perpetuating the perception of constant surveillance. Implementing automatic deletion of captured license plate images after seven days can enhance privacy protection for individuals. This policy can be enforced through automated scripts or scheduled tasks integrated into the system's backend infrastructure. Exceptions can be made for law enforcement and court orders, with secure access controls ensuring that only authorized personnel can access retained images for legitimate legal purposes.

Section 4 BENEFITS

Reduction in parking time. For customers, shorter parking durations enhance convenience and efficiency, reducing the time spent searching for parking spots and waiting to exit the facility. This improved experience increases customer satisfaction and loyalty, encouraging repeat visits. For stores, the streamlined parking process increases turnover rates, allowing more customers to access the facility within a shorter timeframe. This leads to higher foot traffic, improved sales opportunities, and ultimately boosts revenue for the store.

Reliable calculation of parking time is essential. For customers, accurate parking time calculations ensure fair and transparent billing, preventing overcharges and disputes. For stores, reliable parking time calculations optimize parking space utilization and help ensure a smooth flow of traffic.

Improvement in the security of the parking area. For customers, enhanced security provides peace of mind, reducing the risk of theft, vandalism, or other criminal activities affecting their vehicles. For stores and institutions, heightened security measures deter criminal behavior, safeguarding assets and reducing potential liabilities. Additionally, a secure parking area contributes to community safety, enhancing the overall well-being of the neighborhood.

Reduction in the need for human labor at parking points. The model can monitor the performance of the parking system over time, helping the stores to identify periods of inefficiency or increased demand. The model's predictions can be used to optimize staff scheduling for peak times or plan maintenance work during predicted low usage periods

Reduction in the congestion and unauthorized parking. By understanding patterns of enter end exit logs, the system can optimize the allocation of parking spaces and potentially reduce wait times for the customers.