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Smart Stations – Willesden Green

WILLESDEN GREEN

EVERY JOURNEY MATTERS

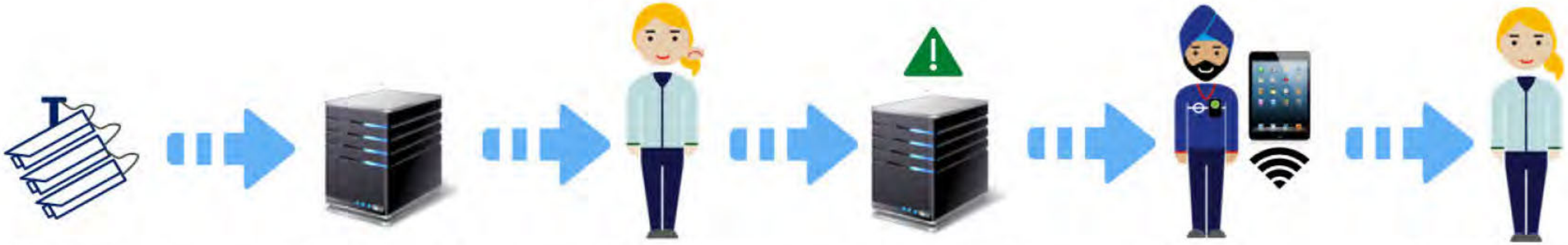
TfL RESTRICTED

What is a Smart Station?

Safety and security are paramount to Transport for London (TfL) and in 2021, TfL's Technology and Data department in collaboration with operational frontline colleagues and Virgin Media O2 began exploring the use of smart technology at Willesden Green Station. Smart Stations is an exciting proof of concept at Willesden Green station, which uses an enhanced video analytics platform, with the aim to provide station staff with real-time insights and notifications on customer movement and behaviour.

How does it work?

The smart technology uses existing CCTV images ([redacted] cameras in total), Artificial Intelligence (AI) algorithms and numerous detection models. Staff can receive notifications and insights related to incidents via a dashboard that visualises the information. Using image recognition and machine learning to identify trends and hazards, enables staff to respond to incidents that require their attention. Smart Stations does not make decisions for staff but equips them with comprehensive information about their station and customers.



[redacted] of our existing CCTV cameras at Willesden Green are watching for incidents in the station 24/7/365

The CCTV cameras are plugged into a processing device installed at Willesden Green that looks for specific types of incidents it's designed to spot

When an incident happens e.g. a Customer falls over....

...the processing unit recognises the incident and sends a notification to the on-duty CSS...

...who gets a notification on their iPad that has with details inc. an image to help them decide how to resolve the incident.

The CSS then attends to the Customer or radios to another staff member to help them, and closes the incident in the app

What does a Smart Station look for?

Our initial classification of **77** potential use cases, established **33** with a high and medium category. Following several prioritisation discussions with frontline staff from Willesden Green and subject matter experts, we agreed on the following **11** use cases:

- Hazards
- Unattended Items
- Person on Track
- Unauthorised Access
- Stranded Customers
- Safeguarding
- Crime & Anti-Social Behaviour
- Crowd Movement
- Injured/Unwell Person
- Mobility Assistance

Alerts sent

- Crowd Movement
- Fare Evasion
- Mobility Assistance

For intelligence purposes

The cameras WILL NOT be looking for…

- Facial Identification
- Specific people
- Most protected characteristics

The cameras will do this by identifying…

- Body language
- Movement
- Behaviour
- Some protected characteristics[1]

[1] This includes: disability, pregnancy/maternity for the purposes of the mobility assistance use case. All identification is performed in accordance with our data protection impact assessment and equality impact assessment.

Objectives:

- Help staff improve the passenger experience within stations
- Drive enhancements in station safety and security
- Test the viability of Smart Station technology in LU

Scoping & Design

Early engagement with Network Rail enabled us to learn lessons and gather important insights such as, selecting a large, central London station caused several issues for their engineering teams and installing new Smart Meraki cameras added huge cost to the project.

Following several design workshops led by T&D, which involved key stakeholders from specialist areas such as Customer Operations, SHE and Network Security etc. we agreed on the following design principles:

- The smart technology stores the image of the incident for 14 days (aligned with LU's CCTV retention policy and ALL faces are blurred).
- The analytics can tell the difference between staff and customers.
- NO facial recognition is performed.
- Smart Station technology will not be used in any disciplinary procedure.
- The Smart Stations dashboard will not be used as a tool to measure or manage the performance of station staff.
- No audio is analysed or recorded – our cameras have no microphones.
- Smart Station technology will not replace station staff, they are essential to decide how to resolve an identified incident.

An important output at this stage was to define our use cases and triggers. Our initial classification of 77 use cases, established 33 with a high and medium category. Following several prioritisation discussions with staff from Willesden Green and subject matter experts, we agreed on 11 use cases.

Use Case Triggers

[redacted]

Why Willesden Green?

Using the feedback and learnings from Network Rail, we selected a 'Local Station', as our focus was on helping a station that has high customer footfall and minimum staffing levels. Our Sponsor, Ray Adabra also wanted the project team to select a station on the Jubilee Line.

GATEWAY

DESTINATION

METRO

LOCAL

Reviewing all Local stations on the Jubilee Line, we assessed the station heritage, camera infrastructure and station characteristics e.g. number of gates, public help points, stairs, escalators, lifts etc. Following our assessment, we were left with 3 possible candidate stations and the Steering Group's decision was to select Willesden Green.

At this stage, T&D had been working collaboratively with colleagues in TfL Engineering and Asset Strategy. It was important to assess the existing CCTV infrastructure and at Willesden Green they use analogue cameras, which are circa 20 years old.

Our Telecoms Engineer was responsible for engaging and instructing our communication assets maintainer 'Telent' to work on the design and installation of hardware at Willesden Green station.

Station	Line	Type	Heritage	Camera Type	Camera Quantity	Gates	Step Free Access	Lifts	No. of Escalators	PHPs
Kilburn	Jubilee	Local - A	Not listed	Tecton Dalek	[redacted]	5	Y	1	0	7
Kingsbury	Jubilee	Local - A	Local listing pending	VisioWave	[redacted]	4	Y	2	0	12
Neasden	Jubilee	Local - A	Not listed	VisioWave	[redacted]	4	N	0	0	5
Stanmore	Jubilee	Local - A	Locally Listed	VisioWave	[redacted]	6	Y	0	0	11
West Hampstead	Jubilee	Local - A	Not listed	Liberator	[redacted]	6	Y	0	0	5
Willesden Green	Jubilee	Local - A	Grade II	VisioWave	[redacted]	8	N	0	0	8

Preferred stations

Listing unlikely to have an impact on installation of camera and connectivity technology. Further exploration to be done at chosen station

All cameras are analogue. TfL Engineering has a preference for VisioWave as this is newer technology, others are at end of life and due for replacement

Preference will be to have a station with stairs and/or lifts, to align with such use cases as stranded customers, vulnerable customers, customer/staff injuries etc.

Number of PHPs installed in stations, further investigation needed on how many are in operation

Camera Analysis

Our next step was to analyse and assess the [redacted] cameras in total at Willesden Green and select the cameras in scope for the PoC. Using the CCTV snapshots which TfL Engineering maintain for all stations across the network, we reviewed the station layout maps, CCTV images and agreed with staff from Willesden Green, which cameras we had to include and were aligned to the use cases in scope.

[redacted]

Installation & Architecture

[redacted]

[redacted]

Prior to install, architecture designs had to be produced and approved by TfL Engineering and T&D's Architecture Review Board. Telent installed and tested the hardware at their test site and following a successful test install, we arranged for Telent to install the kit at Willesden Green during non-operational hours.

[redacted]

Simulations

Prior to the launch of each use case trigger, we had to carry out extensive simulations at Willesden Green station. This required detailed planning and support from our operational colleagues. Due to the nature of some of the use case triggers e.g. weapons detection and person on track, we had to conduct the simulations during non-operational hours.

Simulations were required for machine learning e.g. many days at Willesden Green station simulating the exact behaviour we wanted the AI to detect and alert staff on. The more data and examples of the behaviour and movement we wanted detected, improved the AI models, and minimised the risk of alerting staff to false incidents.

[redacted]

[redacted]

Passenger Experience

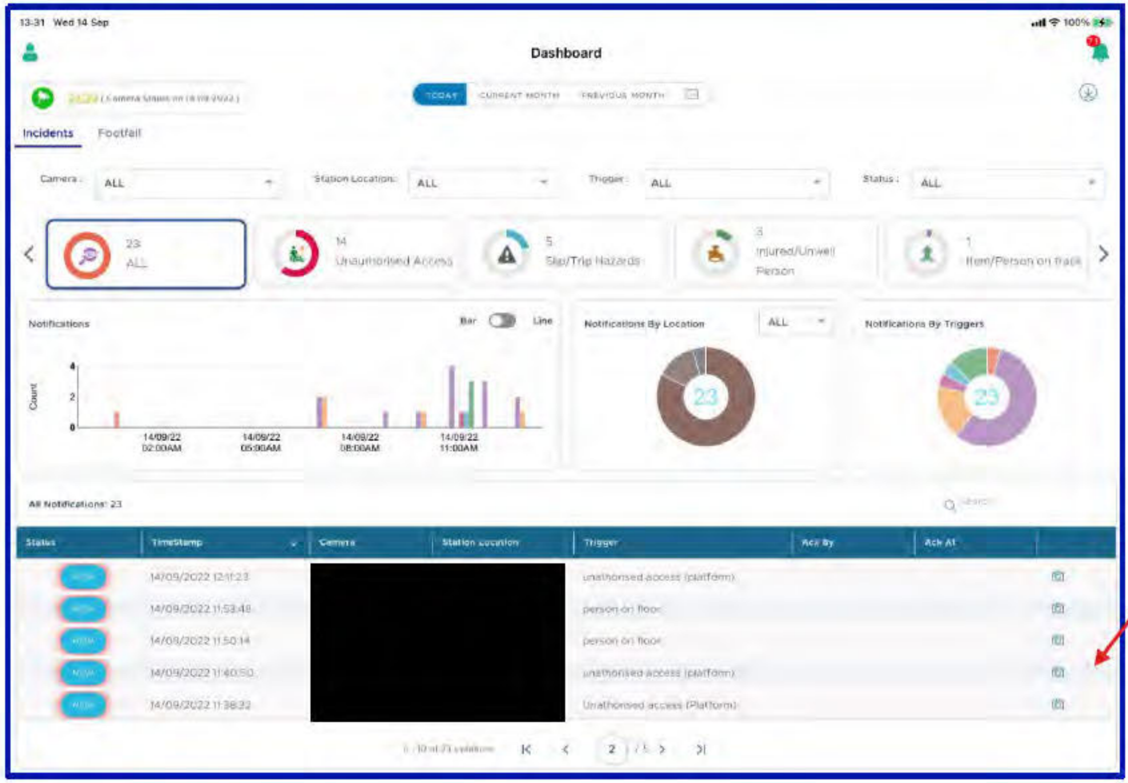
Safety & Security

Technology Viability

Smart Station Dashboard

There are two ways staff can access the dashboard, via a desktop or iPad. Both require the user to log-in with their credentials.

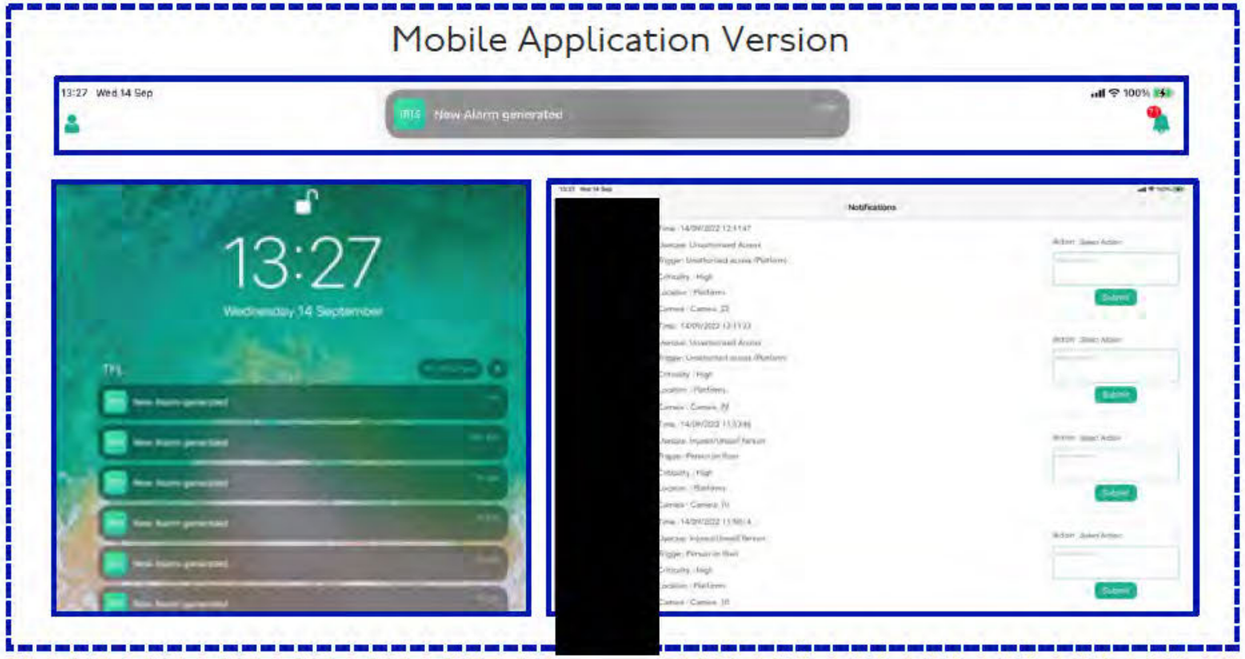
The mobile application includes popup notifications which is standard for many mobile applications. The notifications appear on the screen in real-time, alerting staff to incidents happening in the station.


13:31 Wed 14 Sep
100%
Dashboard
TODAY
CURRENT MONTH
PREVIOUS MONTH
Incidents
Footfall
Camera : ALL
Station Location: ALL
Trigger : ALL
Status : ALL
23
ALL
14
Unauthorised Access
5
Slip/Trip Hazards
3
Injured/Unwell Person
1
Item/Person on track
Notifications
Bar
Line
Count
4
2
0
14/09/22 02:00AM
14/09/22 05:00AM
14/09/22 08:00AM
14/09/22 11:00AM
Notifications By Location
ALL
23
Notifications By Triggers
23

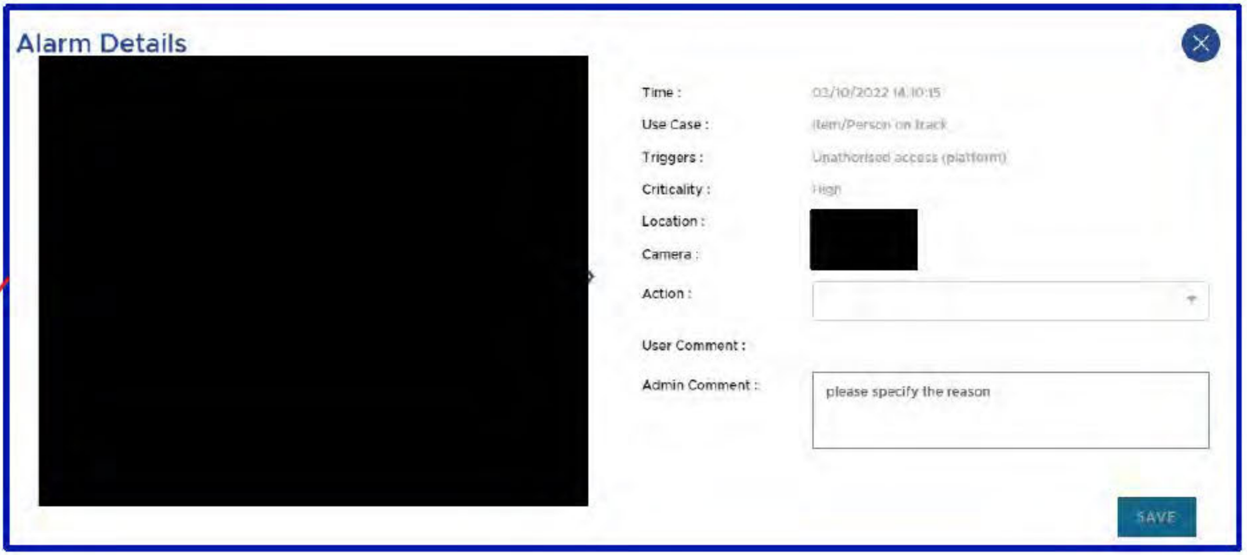
All Notifications: 23

Status	TimeStamp	Camera	Station Location	Trigger	Ack By	Ack At
NEW	14/09/2022 12:11:23	[redacted]	[redacted]	unathorised access (platform)		
NEW	14/09/2022 11:53:48	[redacted]	[redacted]	person on floor		
NEW	14/09/2022 11:50:14	[redacted]	[redacted]	person on floor		
NEW	14/09/2022 11:40:50	[redacted]	[redacted]	unathorised access (platform)		
NEW	14/09/2022 11:38:22	[redacted]	[redacted]	Unathorised access (Platform)		

Mobile Application Version


13:27 Wed 14 Sep
100%
IRIS
New Alarm generated
13:27
Wednesday 14 September
TfL
New Alarm generated
New Alarm generated
New Alarm generated
New Alarm generated
New Alarm generated
Notifications

[redacted]



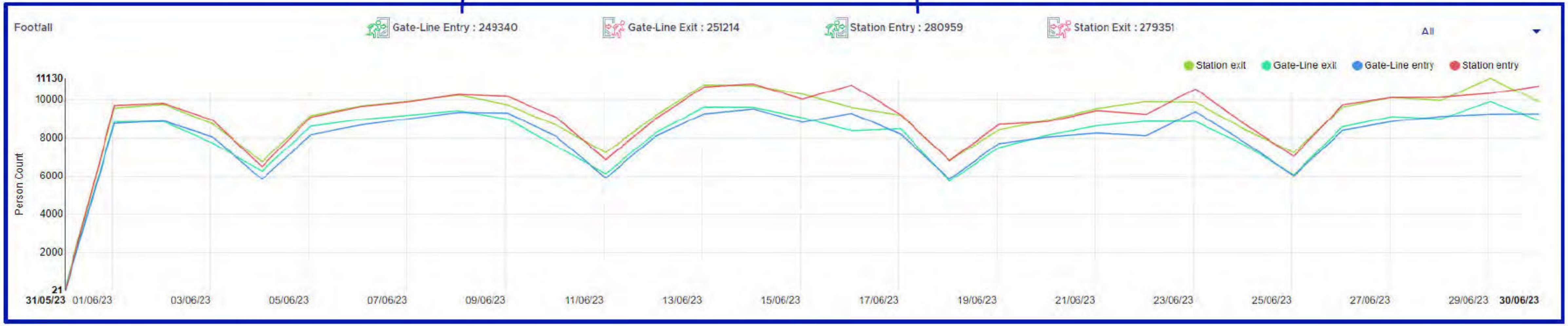
Alarm Details

[redacted]

Time : 03/10/2022 14:10:15
Use Case : Item/Person on track
Triggers : Unathorised access (platform)
Criticality : High
Location : [redacted]
Camera :
Action :
User Comment :
Admin Comment : please specify the reason

Analytics & Insights

31,619 – Insights for commercial planning



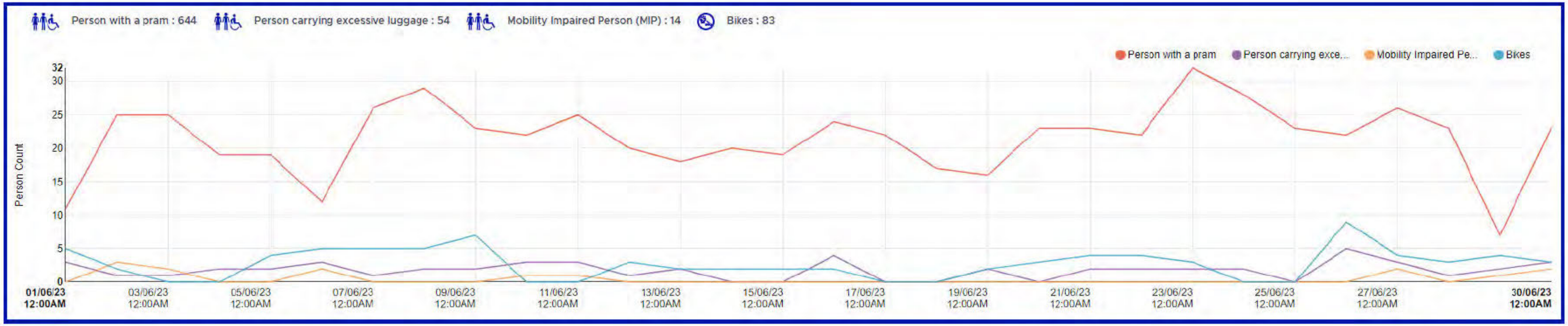
Footfall

Gate-Line Entry : 249340

Gate-Line Exit : 251214

Station Entry : 280959

Station Exit : 279351



Person with a pram : 644

Person carrying excessive luggage : 54

Mobility Impaired Person (MIP) : 14

Bikes : 83

Use Case Review

Unauthorised Access

At Willesden Green station they have two Boswick Gates in use, prohibiting non-personnel access to platforms 1 and 4. [redacted]

In scope was the platform end gates. Staff at Willesden Green wanted to be made aware of incidents when someone had opened and crossed the platform end gates.

The unauthorised access use case has proven to be extremely useful to staff, however following feedback from staff, we de-scoped one of the platform gates, as the system was accurately detecting a person i.e. the train operator, every time there was a de-trainment at the station.

[redacted]

Use Case Review

Safeguarding

During the design and scoping phase, we worked closely with our LU Safeguarding Leads and defined the thresholds and parameters for each trigger. Using the alerts as a preventive measure, allowed staff to act quickly and investigate matters further. As a result of the notifications, there was an increase in the number of public announcements made by staff, reminding customers to step away from the yellow line. For some triggers, we defined time parameters which reflected behaviour related to suicide attempts on our network.

[redacted]

[redacted]

Use Case Review

Mobility Assistance

Accessibility is extremely important to TfL, and a key use case trigger was to test if the system can correctly detect wheelchairs. Willesden Green is not a step free access station and with one main staircase leading to the platforms it is not safe for wheelchair users.

We also included two triggers which we believe can showcase how smart technology can assist with the decision making and analysis when it comes to deciding on future stations becoming step free. We are also conscious that Willesden Green station has one main staircase leading to Platforms 2 and 3, and the biggest contributor to customer injuries on stairs and escalators is excessive luggage e.g. large suitcases.

[redacted]

Use Case Review

Crime and Anti-Social Behaviour

Initially, we wanted to include 'acts of aggression', however due [redacted] insufficient training data needed for the detection model, we were unable to pursue. Although we were unable to successfully detect acts of aggression, we changed the trigger to 'arms raised', which is a common behaviour linked to acts of aggression.

Changing the trigger to arms raised, also provided staff with an additional safety precaution e.g. if a member of staff felt threatened and they were unable to use their radio, they could raise their arms and an alert would be sent to the Supervisor, who can then raise the alarm or request additional support. Thankfully, there have been no reported workplace violence incidents linked to this use case.

[redacted]

Use Case Review

Crime & Anti-Social Behaviour cont….

Although unfolded bikes and e-scooters were not initially raised as a concern by staff at Willesden Green, we wanted to assess if the smart technology can successfully detect bikes and e-scooters.

[redacted]

Following several months of staff feedback, testing and analysis of data, we eventually switched off the detection models for both, as the AI could not differentiate between an unfolded bike and normal bike and an e-scooter and children's scooter. This meant that the dashboard generated high numbers of false alerts which did not require the attention of staff.

Working closely with our colleagues in Network Security, we included a 'weapons detection' trigger. This required detailed planning and engagement with our policing partners, the British Transport Police (BTP).

A trained firearms officer was able to help with our simulations and we conducted several tests throughout the station during non-operational hours.

[redacted], we were pleased with the results and thankfully, there have been no reported alerts or incidents for weapons at Willesden Green station. In the images below, you will see the BTP officer holding a machete and handgun.

[redacted]

Use Case Review

Person on Track

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Use Case Review

Unattended Items

An objective for the project was to demonstrate how smart technology can to drive enhancements in safety and security and we recognised the security challenges we have across the network with regards to unattended items. We have seen promising results for this trigger which has resulted in staff carrying out further investigations when needed.

[redacted]

Litter and Debris

Station cleanliness and ambiance is very important, and our first trigger launched was the detection of litter. Although Willesden Green station has a regular cleaning schedule, the system generated many alerts which caused frustration amongst staff. The detection model was very accurate, detecting newspapers that customers had left, and unwanted paper cups. Following feedback from staff, we disabled the litter alert.

Use Case Review

Person on Floor

[redacted]

Another important trigger prioritised by staff at Willesden Green station. Throughout the trial we successfully detected several incidents where customers fell on the floor and required assistance.

We also received alerts, which highlights the challenging behaviour of a small minority group of customers who risk their safety when using our services.

We have also seen several alerts for rough sleepers and beggars at the entrance of the station. Alerting staff early, has enabled them to remotely monitor the situation and provide the necessary care and assistance.

[redacted]

Use Case Review

[redacted]

Stranded Customers

Staff at Willesden Green station raised the need to be alerted to when customers are stranded, either at the gateline or staircase. [redacted] Alerting staff enables them to quickly provide the assistance required.

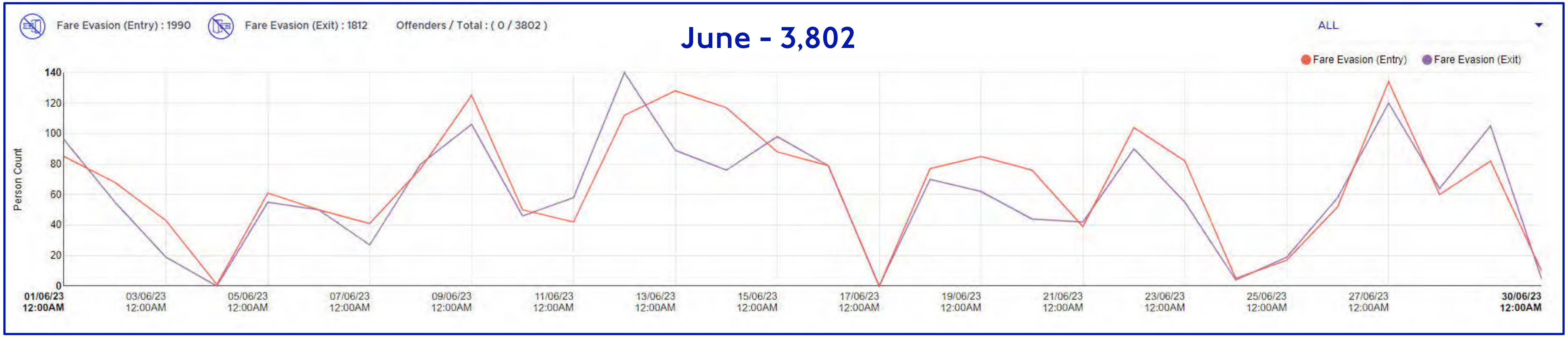
Fare Evasion

The triggers for fare evasion were the last to launch and it was agreed at the design phase and with our Trade Unions to not alert station staff due to concerns raised with workplace violence.

Following the launch of the fare evasion triggers, we made several enhancements to the detection models, this involved watching several hours of CCTV footage and recording the times of incidents that the AI detection model missed. Using the missed incidents data to machine learn and enhance the models resulted in a huge increase in fare evasion alerts.

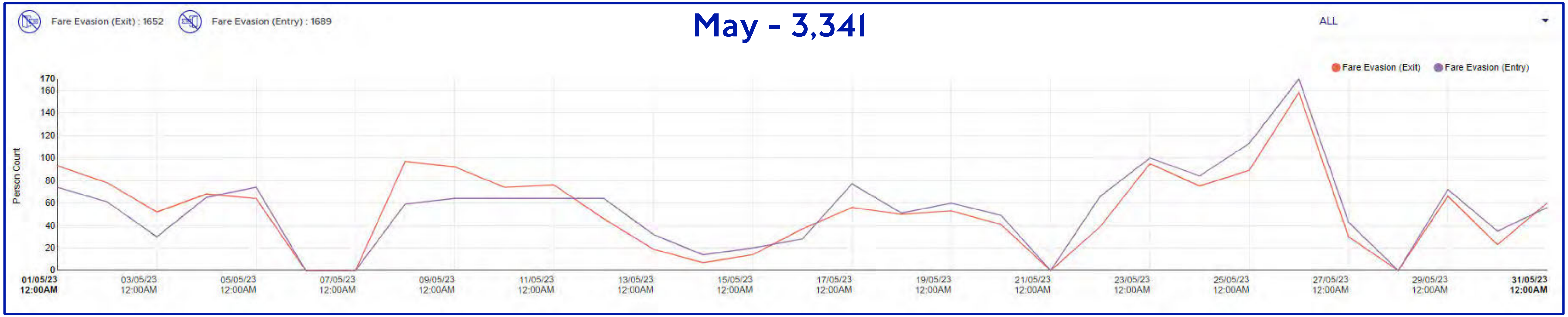
[redacted]

Smart Station Fare Evasion Alerts



Fare Evasion (Entry) : 1990 Fare Evasion (Exit) : 1812 Offenders / Total : (0 / 3802)

June - 3,802



Fare Evasion (Exit) : 1652 Fare Evasion (Entry) : 1689

May - 3,341

Smart Station Learnings

- Following a **12-month** period, the system detected over **44,000 triggers** which included real-time alerts (**19k**) and alerts for insights (**25k**) only. Smart Stations was designed by station staff and their continued feedback and collaboration with T&D, enabled an agile delivery to ongoing changes when required. On average, staff would receive **55 alerts** a day relating to the use cases.

- Following extensive Trade Union engagement it was agreed that the dashboard would be used voluntarily by Station Supervisors and therefore, staff were encouraged to use the dashboard when on shift. This resulted in over **60% of alerts** were acknowledged by station staff and only **1% was recorded as 'Invalid'** which is when the system has incorrectly detected the behaviour, movement or object as required.

- Early detections via the Smart Stations dashboard enabled staff to monitor and observe the situation, ensuring a speedy response is provided. Data shows that over **300 alerts** resulted in the Supervisor making an additional public address announcement, reminding customers to stand behind the yellow line.

- The dashboard alerted Station Supervisors to incidents when customers had accessed non-public areas and the track, resulting in the Station Supervisor sending staff to assist and prevent any major incident or risk to life.

- Feedback from staff suggests smart technology has a key role to play in the future, by helping and protecting our staff and improving the overall customer experience within stations.

Smart Station Learnings

There are several learnings from Smart Stations which we must consider if the decision is to extend the smart technology into other stations:

Support & Performance
Overall support was provided by the small T&D delivery team. As this was a PoC, we wanted to ensure we kept costs to a minimum and recognising that the system was voluntary to use. A mailbox was created and included within our briefing sessions and guidance material; we highlighted the need to submit any issues to the Smart Stations mailbox. The mailbox was monitored by the delivery team and would respond promptly.

Performance was monitored by the T&D delivery team. System outages would generate an email notification that would be sent to the delivery team. It was also the T&D delivery team who would conduct tests for each use case, to determine if the AI models were correctly identifying the desired behaviour and movement. This would involve the team conducting simulations on the station to see if the alerts would appear on the dashboard, and reviewing recordings from our CCTV to determine if the system had missed any use case incidents.

If the decision is to expand Smart Stations, we must consider the support arrangements, specifically if Smart Stations becomes an essential part of kit. Logging, tracking, and resolving issues will require the input and design from our service teams and supplier.

Networks

[redacted]

For future phases, the network design will need to adhere to existing project governance and be approved by T&D's Architecture Review Board.

Smart Station Learnings

Camera Limitations

We must consider the existing camera infrastructure and the enhanced accuracy of detections when using digital cameras versus analogue cameras. Camera position and the line of sight has a huge impact on the accuracy of detections and although our existing camera positions meet our safety and security standards, we may need to consider adding or moving cameras to increase the accuracy of detections.

Modern digital cameras are recommended to improve the detection accuracy and the range of accurate detections in each area. For the purposes of the PoC, we did not move or add any additional cameras at Willesden Green station. The existing analogue cameras are circa 20 years old and have been in the same position for circa 20 years. This has resulted in several learnings which we must consider if the decision is to expand smart technology into more stations.

For most of our use cases, we had to set regions of interest, this is a clearly defined area which requires the person or object to be present in. Within the region of interest, the trigger is active, if the movement or behaviour occurs outside of the region of interest, it is unlikely to be detected. Regions of interest had to be defined at Willesden Green due to the quality of images from our existing CCTV infrastructure.

[redacted]

Smart Station Learnings

Weather

Direct sunlight on the camera resulted in negative detections, and where extreme sunlight caused shadows over the benches, it did impact some use case detection models.

[redacted]

Simulations

Before the deployment of each use case trigger the T&D delivery team conducted extensive simulations at Willesden Green. This required careful planning to ensure all simulations were conducted in a safe environment. As mentioned previously, some simulations e.g. person on track had to be conducted during non-operational hours.

On occasions, it did require the help and support from operational colleagues to notify customers when simulations were happening on the stations. Nas Ali also conducted many simulations at times when the delivery team were unable to visit Willesden Green station.

It is likely that further simulations would be required if smart stations were to be extended into more stations. Conducting simulations will require people to support in the process and it will take time to complete, this must be considered when identifying project roles and responsibilities.

Smart Station Learnings

Human Factors

To improve the response rate to alerts, we must consider making Smart Stations an essential part of kit for Station Supervisors. Ensuring all alerts are acknowledged by staff will improve the situational awareness and response to incidents.

This may also result in future integration requirements into other existing applications, removing duplication and driving efficiencies.

Future phases must build on the existing guidance material and adopt a similar engagement model and conduct face to face briefings. This may prove a challenge if the station has high numbers of staff rostered at that station. Implementing Smart Stations at a larger station will take longer and will require more frequent engagement with staff.

Thanks