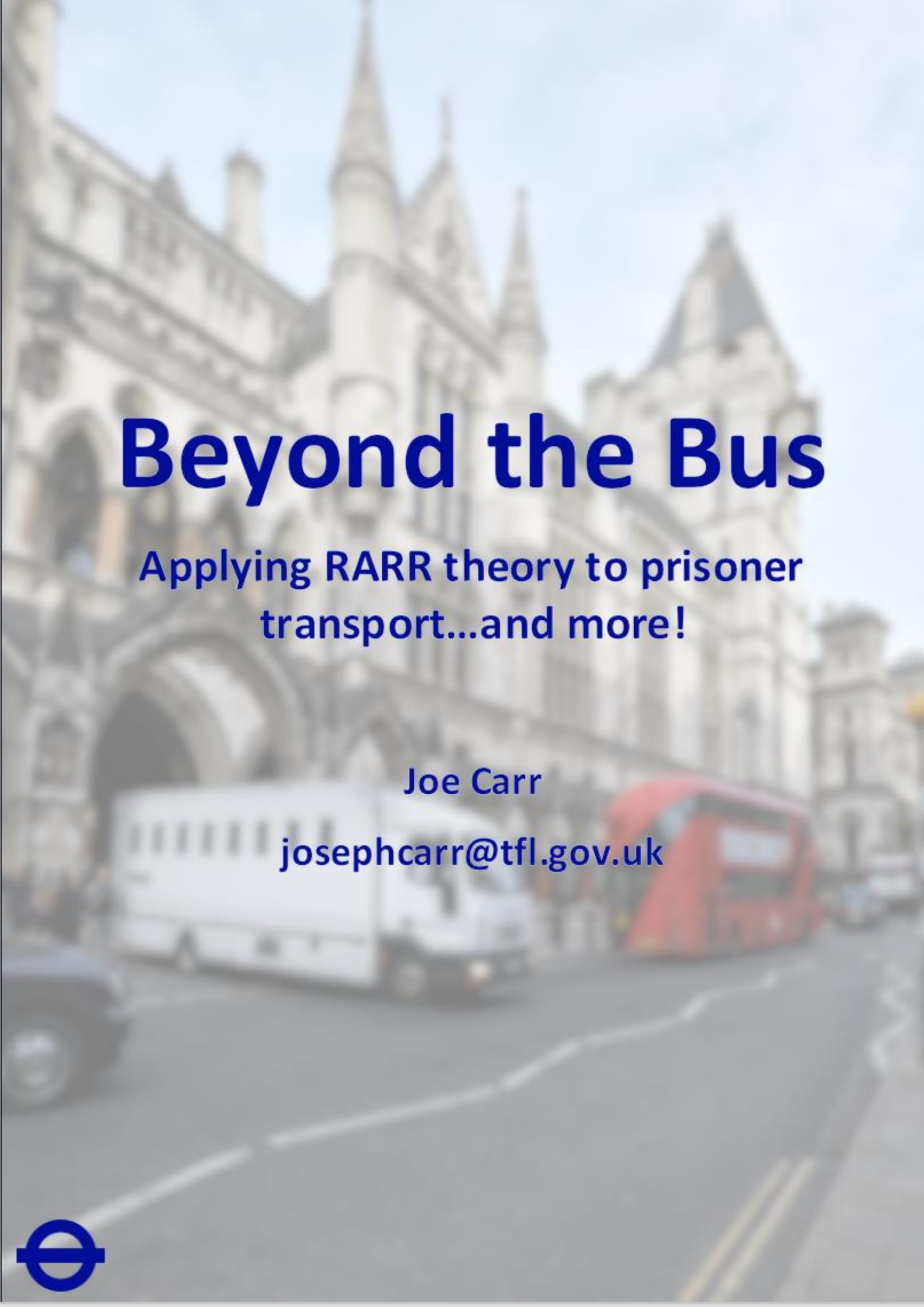


Beyond the Bus

Applying RARR theory to prisoner transport...and more!

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Background

What is a RARR?

The Route Analysis Recommendation Report (RARR) process is a structured, evidence-led approach developed by Transport for London (TfL) to improve the performance of bus routes. At its core, a RARR is a "total route analysis" that combines performance data, system data and on-the-ground observation to identify issues, optimise operations and deliver both immediate and longer-term improvements.

<u>The process typically follows three main stages:</u>

- **Start-up**, involving detailed investigation, stakeholder engagement and route-level analysis using operational and system data;
- **Implementation**, where identified actions—such as fixing faults, improving enforcement, optimising signal timings and introducing infrastructure changes—are progressed;
- **Close-out**, where measurable benefits are assessed, often in terms of time savings and improved service reliability.



Figure I: Sources of information gathered for a typical RARR review

A key strength of the RARR methodology lies in its holistic and pragmatic nature. It blends quantitative data with qualitative insights from route walks and operator knowledge, ensuring that both technical inefficiencies and real-world operational issues are captured. This allows for a mix of quick wins (e.g. resolving equipment faults) and more strategic enhancements (e.g. infrastructure schemes).

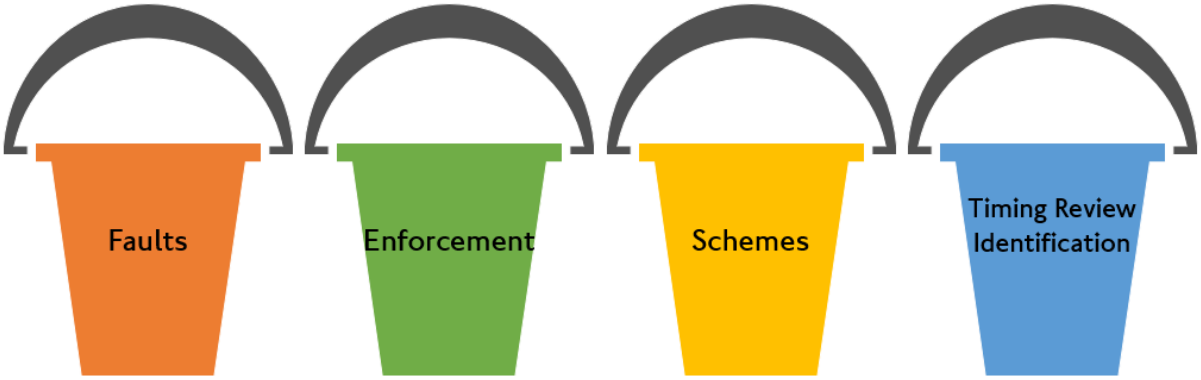


Figure 2: Demonstration of the 'buckets' observations are sorted into

While originally designed for bus networks, the principles underpinning RARR—systematic analysis, multi-source evidence, and targeted intervention—have the potential to be applied to other transport modes. For example, controlled and repeatable transport systems such as prison movements could benefit from a similar structured review process to identify delays, operational constraints and opportunities for efficiency improvements. Good thing we did just that!

Origin of project

The project started following an approach from the Prisoner Escort and Custody Service (PECS) team within His Majesty's Prison and Probation Service (HMPPS) to the Commissioner of Transport for London (TfL), seeking support to improve the efficiency and reliability of prisoner transport journeys across London. The request was subsequently directed through TfL's Director of Streets and Network Operations (SNO) to Network Performance Delivery (NPD) for consideration. Recognising the close alignment between the challenge and NPD's established route review capabilities, I volunteered to lead the project, drawing on my extensive experience of undertaking RARR reviews and identifying opportunities to improve journey time performance across the road network.

Adapting the RARR methodology for prison transport

Prison transport routes present a unique case study because they operate within far tighter constraints than typical public transport systems. Movements are strictly scheduled around court timetables and custody requirements, with limited ability to reroute or recover from delays. This means even small inefficiencies could have disproportionate impacts, such as missed court appearances or increased custody durations. As a result, applying a structured, evidence-led approach like RARR—combining data analysis with real-world observation—can prove valuable in identifying where delays occur and how they can be mitigated.

Additionally, prison transport is shaped by security-critical requirements that restrict operational flexibility, including controlled routing, secure handling procedures, and extended dwell times at key locations. These constraints limit the applicability of conventional transport solutions but also highlights the value of a holistic methodology like RARR, which considers systems, operations, and infrastructure together. In this context, the approach helps to identify both immediate operational improvements and longer-term changes, demonstrating how a process developed for buses can be successfully adapted to complex, security-sensitive transport environments.

The primary objective of this project is to improve journey times for prison transport movements, ensuring that prisoners consistently arrive at court on time. Given the fixed scheduling constraints of both courts and custodial facilities, there is very limited flexibility within the wider system to accommodate delays. As a result, the only viable means of creating additional resilience and "operational headroom" is to reduce the time spent in transit. By applying a structured, route-based review approach, the project seeks to identify and address sources of delay, enabling quicker, more reliable journeys and improving overall system performance.

Traffic Signal Review and Network Optimisation

This paper presents the findings from the first two of an initial three PECS route reviews undertaken as part of the programme. While the third route review remains ongoing, the interventions and outcomes presented here demonstrate the methodology adopted and the operational benefits achieved to date.

A detailed operational review of both routes was undertaken to identify opportunities to reduce journey times through targeted traffic signal interventions, infrastructure improvements and operational optimisation.

Route 1 – HMP Belmarsh to Central Criminal Court

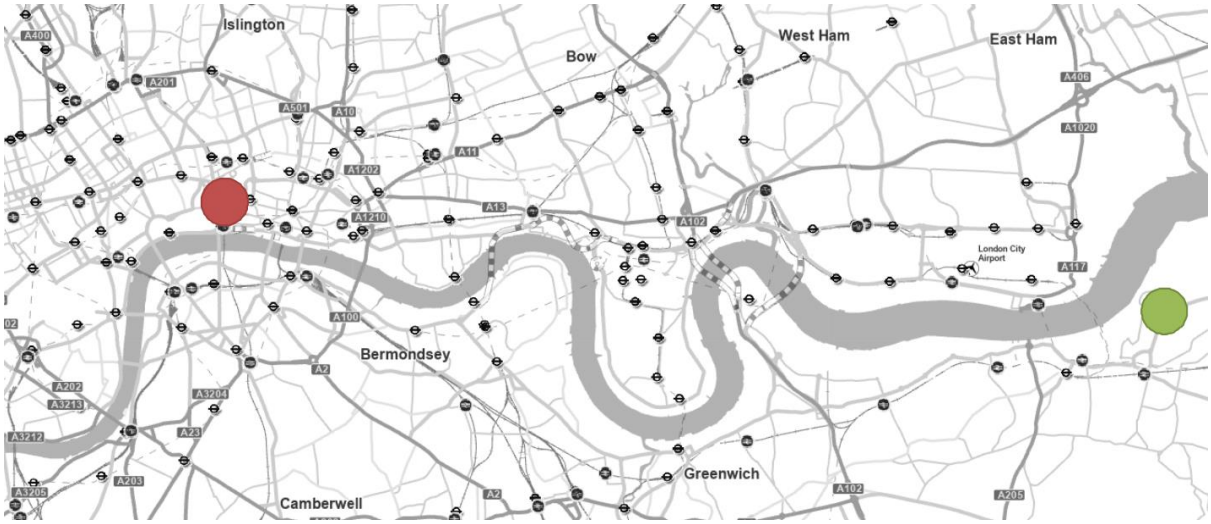


Figure 3: HMP Belmarsh (Green) & Central Criminal Court (Red) map

Route 1 focused on improving progression through signal-controlled corridors and reducing unnecessary delay. An initial feasibility assessment explored equipping prison escort vehicles with traffic signal priority using TfL's iBus system. Although deployment was not possible due to the legacy system being integrated into the ticketing machine and reaching end-of-life, the concept remains under consideration through the replacement iBus2 platform.

<u>Key actions undertaken included:</u>

- Collaborated with the London Borough to mitigate temporary congestion caused by major roadworks in Plumstead, including implementing signal timing adjustments to reduce queueing.
- Reviewed and optimised pedestrian crossing timings in Woolwich to balance high pedestrian demand during school peak periods with improved traffic progression.
- Revised signal timing plans at 12 junctions and pedestrian crossings across the corridor to improve progression and signal coordination, reducing the number of stops experienced by PECS vehicles.
- Commissioned engineering schemes at 5 pedestrian crossings to install pedestrian kerbside detection technology. This reduced unnecessary traffic interruptions at crossings by cancelling pedestrian demands from being satisfied if the user had already crossed or walked away.

Route 2 – HMP Wandsworth to Southwark Crown Court



Figure 4: HMP Wandsworth (Green) & Southwark Crown Court (Red) map

Route 2 combined fault rectification with operational optimisation. The route also benefited from an ongoing RARR review being undertaken by a colleague, which overlapped with sections of the corridor. This provided an opportunity to coordinate activities and implement additional signal and operational improvements beyond those identified through the PECS review alone.

<u>Key actions undertaken included:</u>

- Conducted site investigations to identify and rectify infrastructure defects along Route 2.
- Resolved a misaligned vehicle detector that was causing unnecessary right-turn stages and inefficiencies in signal operation.
- Addressed communications issues affecting bus priority operation.
- Repaired damaged signal equipment that was impacting vehicle progression.
- Undertook Bus Priority Optimisation (BPO) reviews at key locations to refine priority parameters and improve operational performance.
- Removed inefficient stage allocation through BPO reviews, improving progression for both buses and PECS vehicles.
- Completed corridor-wide timing plan audits to review signal controller performance and compliance.
- Updated 11 signal timing plans to address compliance issues and ensure controllers operated in accordance with current specifications.
- Commissioned engineering schemes at 2 junctions to install pedestrian kerbside detection technology. This reduced unnecessary traffic

interruptions at crossings by cancelling pedestrian demands from being satisfied if the user had already crossed or walked away.

Collectively, the first two route reviews resulted in a combination of immediate operational improvements, infrastructure schemes progressing through design and delivery, and longer-term opportunities for specialist vehicle priority. While the programme continues with a third route review, the work completed to date demonstrates how targeted, evidence-led interventions across an urban traffic signal network can deliver measurable improvements to journey time reliability for prison escort operations.

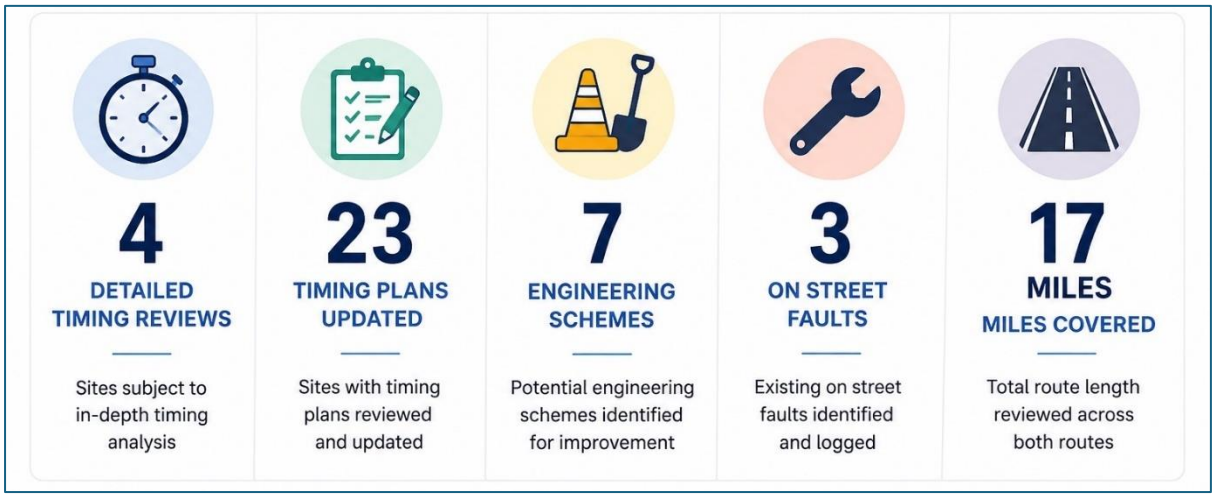


Figure 5: Key statistics from the 2x route reviews

Journey Time Analysis

Data methodology & validation

Journey time performance was assessed using four weeks of weekday GPS journey time data collected before and after implementation. The comparison periods were deliberately selected outside school holiday periods and reviewed to exclude the influence of major roadworks, planned diversions or other abnormal network conditions. This ensured that the results reflected typical operating conditions and provided a like-for-like comparison. While some day-to-day variability in traffic conditions is unavoidable, the consistency of the improvements observed across both routes provides confidence that the measured benefits are attributable to the interventions delivered.

The assessment was based on 20 weekdays of data before implementation and 20 weekdays following implementation, providing a sufficiently large sample to smooth the impact of unusual daily traffic conditions and improve confidence in the reported outcomes.

Results

The interventions delivered measurable improvements across both corridors. On Route 1, average journey times reduced from approximately **70 minutes** to **66 minutes** (approximately 6% improvement). Whilst the reduction in mean journey time was relatively modest, a more significant benefit was observed in journey time reliability, with the post-implementation data exhibiting substantially less variability and a much more consistent journey profile. This data is shown in Figure 6 (below).

On Route 2, average journey times reduced from approximately **56 minutes** to **50 minutes** (approximately 11% improvement). As with Route 1, the reduction in average journey time was accompanied by a marked improvement in reliability, with considerably less day-to-day variation following implementation. This data is shown in Figure 7 (below).

In summary, beyond the reduction in average journey times, the most significant outcome was the improvement in journey time reliability. Post-implementation data for both routes exhibited significantly lower variability, with a much flatter journey time profile indicating more predictable and consistent journey times. For prison escort operations, where punctual arrivals are critical to court scheduling and the efficient use of prison, court and escorting resources, this improvement in reliability is arguably as valuable as the reduction in average journey time itself.

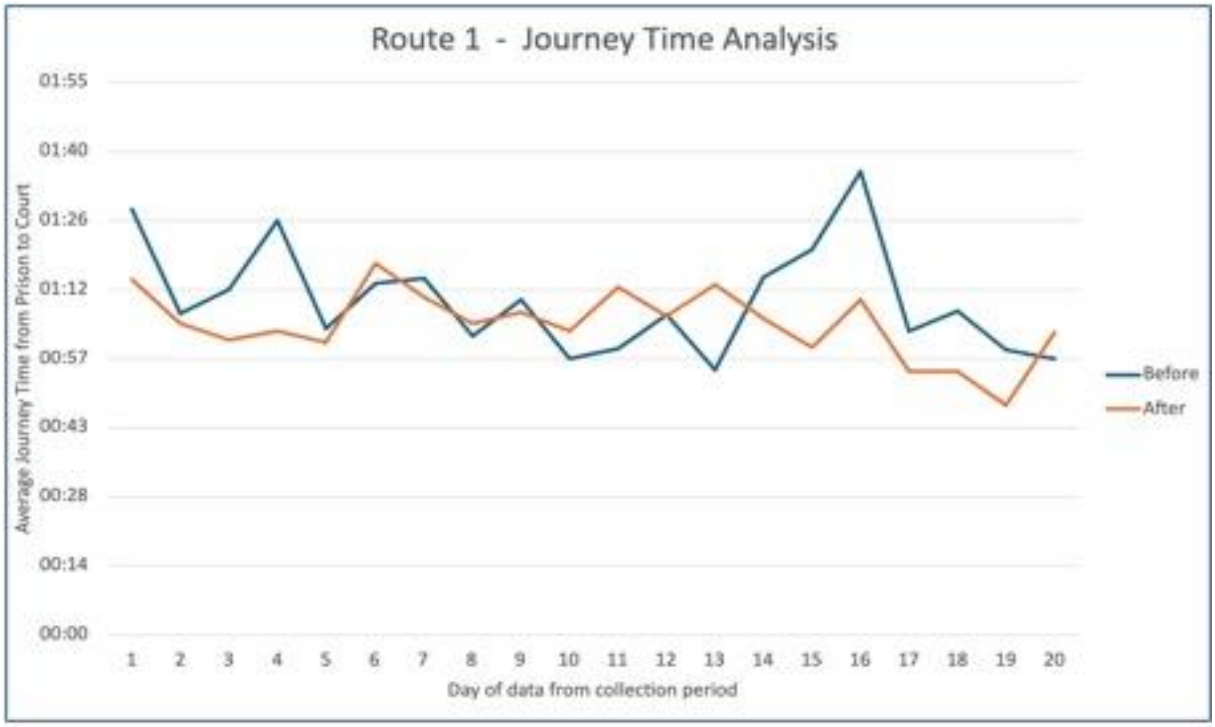


Figure 6: Route 1 Journey Time Analysis



Figure 7: Route 2 Journey Time Analysis

INRIX Journey Time Data

Alongside the PECS vehicle GPS analysis, INRIX data was used to assess changes in general traffic conditions across the route. INRIX uses aggregated floating vehicle data from connected vehicles and mobile devices to provide observed speeds across the road network, allowing changes in network performance to be considered independently of individual PECS journeys.

For route 1, the analysis was divided into seven segments - changes in average traffic speeds were compared between the before and after periods. The results show a mixed picture. Several sections recorded improved average speeds following targeted signal optimisation, while others experienced reductions due to major roadworks and wider network changes. In particular, significant cycle infrastructure works that started during the Route 1 review (Table 1, Section 2) and lane closures associated with nearby developments (Table 1, Section 6) have reduced overall route-level average speeds compared with the baseline period. This context is important when interpreting the results, as the PECS GPS analysis nevertheless identified an overall journey time improvement across the route.

	Average mph change	Reasoning for change in average speeds
1	+2.74%	Timing Review undertaken at the junction outside HMP Belmarsh to improve queuing and progression.
2	-7.38%	Major cycle scheme started along this section. Expected to complete Autumn 2026. Signal timings changed to mitigate in addition to reworking the build plan and traffic management to reduce the impact to PECS transports.
3	+0.86%	Signal timing adjustments made. Multiple detector faults fixed too to restore optimum performance
4	+9.06%	A new alternative route for traffic has reduced congestion on the existing PECS route, improving journey times and reliability. Nearby signals re-optimised.
5	-6.47%	Following the aforementioned changes to the nearby road network, congestion has increased in this area. Signal timings changed to mitigate.
6	-26.53%	A number of significant roadworks going on in this section of the City of London to support developments

7	+3.85%	Signal timing adjustments made and several on-street equipment faults resolved along this section.

Table 1: INRIX data analysis - Route 1

For Route 2, INRIX data shows a consistently positive outcome, with average speeds improving across all five analysed segments by between 4% and 13%. Unlike route 1, the corridor contained a greater concentration of signal-controlled junctions, providing significantly more opportunities for targeted signal timing interventions. These were complemented by the identification and resolution of physical faults and the development of potential engineering schemes.

The differing results also reflect the characteristics of the two routes. Route 1 contains relatively few signal-controlled junctions and a greater proportion of roundabouts and uninterrupted main road sections, limiting the opportunities for signal-based optimisation and increasing susceptibility to external disruption. By contrast, Route 2 contains a higher concentration of signal-controlled junctions, allowing a greater number of targeted interventions. The consistently improved speeds shown in Table 2 reflect the cumulative benefits of signal optimisation, fault rectification and complementary engineering schemes.

	Average journey time change	Reasoning for change in average journey time
1	+5.17%	Some on-street faults with detection were identified and repaired, reducing unnecessary demands for right turn arrows and kerbside detection for pedestrians
2	+13.06%	Significant signal timing adjustments made along this section using automated congestion-triggered strategies
3	+8.95%	Further detection faults identified, and timing reviews undertaken
4	+7.50%	Signal timing plans updated, making better use of advanced plan writing techniques, every second counts!
5	+4.08%	Engineering schemes commissioned to install kerbside detection, timings reviews undertaken, and faulty kerbside detection repaired.

Table 2: INRIX data analysis - Route 2

It should be noted that different INRIX measures were used for the two route reviews. Route 1 analysis was based on changes in average vehicle speeds across defined route sections, whereas Route 2 analysis used INRIX journey time data. This reflects a change in the INRIX datasets available from the traffic data team between the two review periods, necessitating a revised analytical approach. The results are therefore presented using the most appropriate measure available for each review and should not be compared directly.

Bus Lane Utilisation Trial

One of the principal recommendations arising from the Route 1 review was to permit smaller 3- and 6-cell prison escort vehicles to utilise TfL-operated bus lanes. Prior to this project, only larger 10- and 12-cell vehicles were authorised to use bus lanes under existing policy, despite the majority of daily PECS movements on Route 1 being undertaken by the smaller vehicle fleet.

Route analysis identified that approximately 25% of the corridor was served by TfL-operated bus lanes, presenting an opportunity to reduce journey times without requiring any physical highway interventions. Coinciding with the completion of the Route 1 review, Sir Brian Leveson's Independent Review of the Criminal Courts identified greater utilisation of bus lanes by prison escort vehicles as a key recommendation to improve the efficiency of the criminal justice system. This external endorsement provided additional impetus for progressing the proposal within TfL.

To simplify operational implementation, a detailed review of each bus lane along the corridor was undertaken to confirm TfL ownership, avoiding the need to engage individual London boroughs and ensuring a consistent operating environment for drivers. The proposal required close collaboration between multiple organisations, including TfL Surface Transport, the Traffic Signals team and His Majesty's Prison and Probation Service (HMPPS). Supporting technical analysis and operational evidence informed discussions between senior representatives, culminating in a formal agreement between TfL and HMPPS to undertake a live operational trial.

Following the first four weeks of operation, the trial demonstrated no measurable disbenefit to bus performance, whilst delivering a further reduction of **~4 minutes** in average PECS journey times along the route. This represented a significant additional improvement beyond that achieved through the traffic signal optimisation programme and demonstrated how evidence-led policy changes, alongside targeted network optimisation, can deliver substantial operational benefits for specialist transport operations.

Key Lessons Learned

- **Small operational interventions can collectively deliver significant benefits.**
    - While many of the measures implemented were relatively minor in isolation, their cumulative effect delivered meaningful improvements in both journey times and journey time reliability. This demonstrates the value of a corridor-wide approach that identifies and addresses multiple small inefficiencies rather than focusing solely on major capital schemes.
- **Reliability improvements are often as valuable as, or more valuable than, average journey time reductions.**
    - Although average journey time savings were achieved on both routes, the most significant benefit was the reduction in day-to-day variability. More predictable journey times allow prison escort operators to plan with greater confidence, improving punctuality and reducing the operational impacts of late arrivals at court facilities.
- **Multi-agency collaboration is critical to successful delivery.**
    - Close working with borough partners, operational stakeholders and other review programmes enabled issues to be identified and resolved more effectively. Collaborative working also helped align interventions across organisational boundaries and maximise the benefits delivered.
- **Many worthwhile improvements require little or no capital investment.**
    - A significant proportion of the benefits were achieved through signal timing optimisation, fault rectification and operational changes rather than major infrastructure works. This highlights the value of regularly reviewing existing assets and operations before considering more costly engineering interventions.
- **Structured route reviews can identify opportunities that isolated investigations may overlook.**
    - By considering the corridor as a whole, the review process was able to identify recurring issues, interactions between junctions and wider network impacts that would not necessarily have been apparent through individual site-based investigations. This supports the use of systematic route reviews as an effective tool for network performance improvement.
- **Combining planned reviews with ongoing programmes can maximise efficiency and outcomes.**
    - The overlap between the PECS review and the concurrent RARR workstream enabled findings and resources to be shared, helping to identify additional improvement opportunities and avoid

duplication of effort. Coordinated programmes can therefore provide greater value than standalone reviews.

- **Data-led monitoring is essential to demonstrating benefits and securing future support.**
    - The use of before-and-after journey time data provided a robust evidence base for assessing outcomes and demonstrating the effectiveness of the interventions. This helps build confidence in the approach and supports the case for wider application on other corridors.

Case Study Proposals: Other cities & authorities

A number of other transport and movement systems present strong opportunities for applying a RARR-style approach. These are not necessarily underperforming services, but rather complex, route-based operations where a structured, holistic review could unlock further benefits.

For example:

- **A town's Park and Ride network** could benefit from a review of operating hours, visibility and route performance to better align services with travel demand. This could include assessing signal operation, enforcement and priority measures to improve journey times and reliability. E.g. extending operating hours beyond the traditional commuter peak may encourage greater use for leisure and evening trips, reducing car journeys into town centres and associated congestion and emissions.
- **A University bus network** could benefit from a RARR-style assessment focused on journey time reliability, stop accessibility, service priority and campus connectivity. Improved reliability could enable students to travel from a wider catchment area while maintaining reasonable commute times, supporting both sustainable travel objectives and longer-term accommodation planning.
- **Cycling corridors** could benefit from a structured review to identify opportunities to improve route continuity, junction performance, signal operation, surface quality, signage and wayfinding, helping to create safer, more direct and attractive routes for cyclists.
- **Pedestrian areas**, such as high streets, town centres and recreational trails, could benefit from a corridor review to identify opportunities to improve crossing facilities, footway accessibility, pedestrian waiting times, wayfinding and the overall walking environment, helping to deliver safer, more reliable and more comfortable journeys on foot.

- **Key traffic corridors** could benefit from a holistic review of signal operation, junction performance, loading activity, parking controls, roadworks practices and network resilience. While individual issues may appear minor in isolation, a corridor-wide assessment can identify cumulative impacts on journey times and reliability, enabling targeted interventions that improve the efficiency of the route as a whole.

Beyond passenger transport, the approach also has potential application in **freight movements**, where key distribution routes—such as those serving major logistics hubs—could be reviewed in detail to identify delay points, operational inefficiencies and opportunities for targeted interventions. In each case, the intention is not to replace existing local expertise, but to complement it with a proven methodology that combines data, observation and user experience to identify practical, deliverable improvements.

A key benefit of applying a RARR-style review across different transport systems is its potential to deliver wider policy outcomes beyond simple journey time improvements. By identifying and addressing delay points, improving reliability, and enhancing the overall user experience, these reviews can make public transport and other shared modes more attractive relative to private car use. This, in turn, supports reduced congestion, lower emissions, and improved air quality. Improving the performance and appeal of existing transport networks can offer a more incremental and publicly acceptable pathway to achieving similar environmental outcomes.

An important aspect of this is the role of information and user confidence. Services that are poorly understood or lack clear, reliable information—particularly around arrival times and service patterns—are less likely to be used, regardless of their underlying quality. London's iBus system demonstrates how accurate, real-time tracking can improve passenger confidence and usability, allowing users to better plan their journeys and reducing perceived waiting times. Applying similar principles in other areas—whether through improved real-time information, clearer route communication, or better on-street visibility—could help unlock latent demand. When combined with operational improvements identified through a RARR-style review, this creates a strong foundation for encouraging modal shift away from private vehicles and towards more sustainable transport options.

Key recommendations & Implementation framework

Best Practice for Other Authorities

The application of a RARR-style approach should be positioned as a structured enhancement to existing transport planning and operational practices, rather than a replacement. Best practice is to adopt a holistic, evidence-led methodology that combines three core elements: data analysis (journey times, speeds, turning count surveys etc), stakeholder insight (area managers, bus operators etc), and on-the-ground observation (route walks/site visits). This ensures that both technical issues (e.g. signal timings, routing inefficiencies) and real-world user experience (e.g. accessibility, clarity, dwell times) are captured. Authorities should also prioritise high-impact routes or movements—those with high demand, strategic importance, or known reliability challenges—to maximise the benefit of interventions.

Importantly, maintaining strong engagement with operators, enforcement teams and local stakeholders is key. The success of the RARR process is underpinned by collaboration, ensuring that local knowledge is incorporated and that proposed actions are practical and deliverable.

Step-by-Step Approach

A simple implementation framework, aligned to the established RARR model, can be summarised as follows:

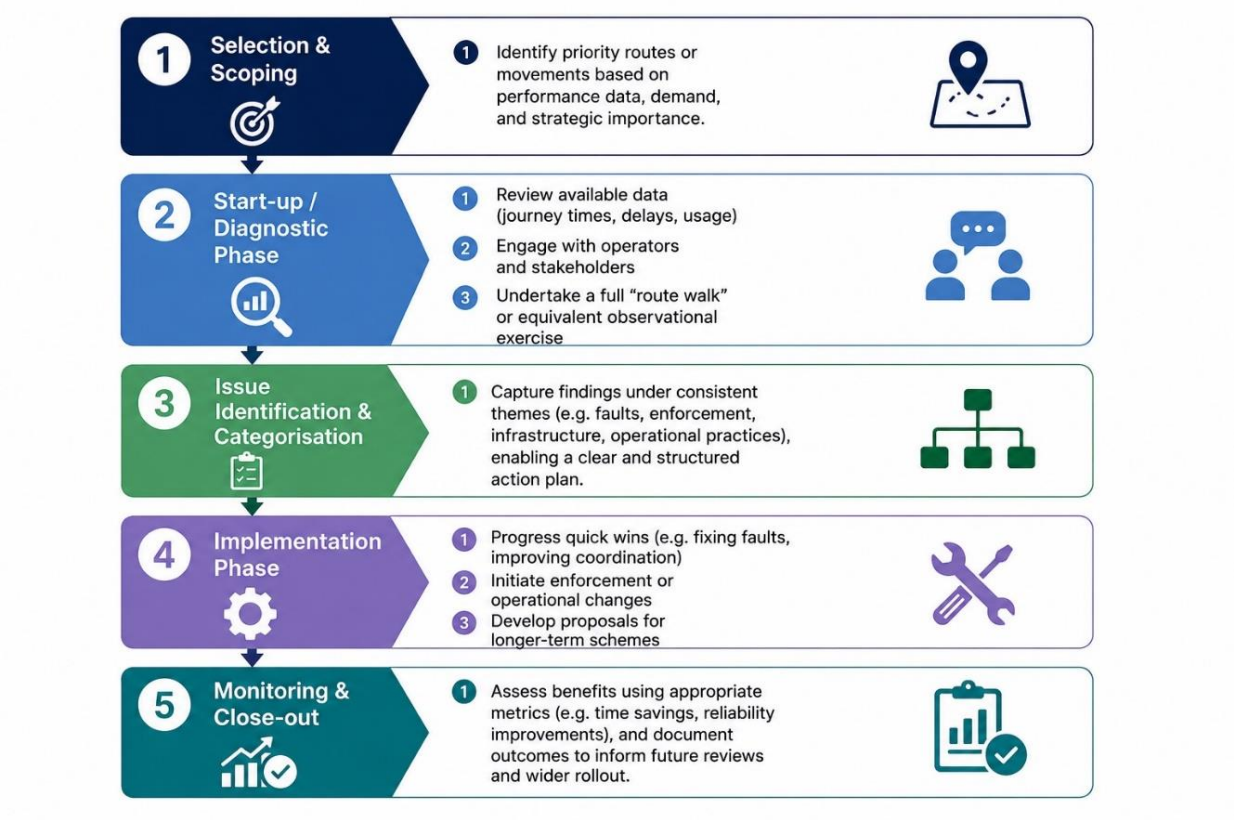


Figure 8: Implementation framework

This phased approach allows for both immediate improvements and longer-term strategic change, reflecting the strengths of the original RARR methodology.

Resource Requirements and Timelines

A typical RARR-style review can be delivered over a 12–16 week period, with clear "swimlanes" across different functions (e.g. operations, engineering, enforcement, data analysis).

Key resource requirements include:

- **Project Lead / Analyst** – to coordinate the review, analyse data and manage outputs
- **Operational Stakeholders** – including operators and local network teams
- **Engineering / Delivery Teams** – to develop and implement infrastructure or signal changes

- **Enforcement & Compliance Teams** – to address behavioural and regulatory issues

Using a structured programme approach (such as PECS-style swimlanes), tasks can run in parallel—e.g. data analysis alongside stakeholder engagement—helping to accelerate delivery while maintaining clarity on responsibilities and dependencies.

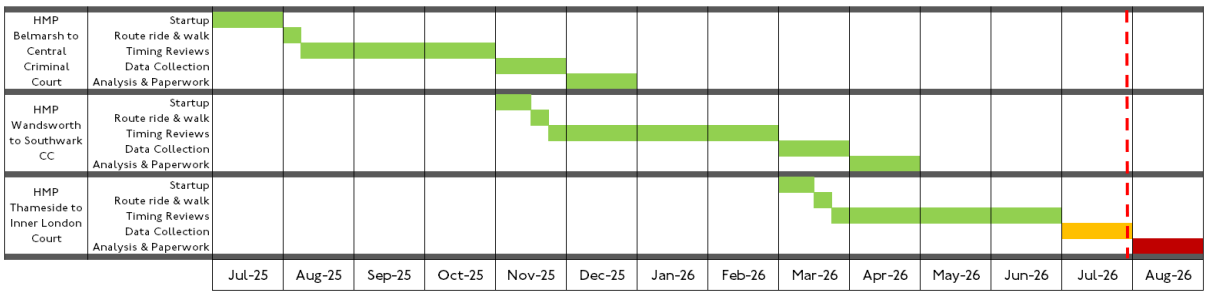


Figure 9: Project timeline example

Potential Barriers and Solutions

- Data limitations
  - Barrier: Incomplete or inconsistent performance data may hinder analysis.
  - Solution: Supplement quantitative data with observational work and stakeholder insight, mirroring the RARR "route walk" approach.
- Resource constraints
  - Barrier: Limited staff or funding capacity to undertake detailed reviews.
  - Solution: Focus on a small number of high-impact routes and prioritise low-cost, high-benefit interventions.
- Stakeholder alignment
  - Barrier: Multiple organisations with differing priorities can slow progress.
  - Solution: Engage stakeholders early and position the review as a collaborative, outcome-focused exercise.
- Deliverability of schemes
  - Barrier: Some identified improvements may require longer-term investment or approvals.
  - Solution: Balance the programme with a mix of quick wins and longer-term proposals to ensure early visible benefits while building the case for future schemes.

Conclusion

This paper has demonstrated that the Route Analysis Recommendation Report (RARR) methodology, originally developed to improve bus network performance, can be successfully adapted to specialist prison escort operations. By combining detailed data analysis, stakeholder engagement and targeted operational reviews, the project identified a series of practical interventions that delivered measurable improvements in both journey times and journey time reliability.

Across the first two completed route reviews, targeted traffic signal optimisation, fault rectification, infrastructure improvements and operational policy changes collectively reduced average journey times by approximately 6% and 11% respectively, whilst significantly improving journey time consistency. The subsequent bus lane utilisation trial demonstrated that further benefits could be achieved through evidence-led policy change, delivering additional journey time savings without adversely affecting bus performance.

Perhaps more importantly than the individual interventions, the project demonstrates the value of adopting a structured, corridor-wide review methodology. Rather than considering individual issues in isolation, the RARR process identifies multiple small improvements whose cumulative effect produces meaningful operational gains. This systems-based approach provides a repeatable framework for improving performance across complex transport operations.

Whilst the third prison escort route review remains ongoing, the outcomes achieved to date provide a strong evidence base for wider application of the methodology. The principles demonstrated throughout this project are not unique to prison transport and have the potential to benefit a wide range of transport systems where journey time reliability, operational efficiency and multi-agency collaboration are critical. As transport authorities continue to seek cost-effective ways of improving network performance, a structured, evidence-led route review process offers a practical and scalable means of delivering measurable operational benefits.