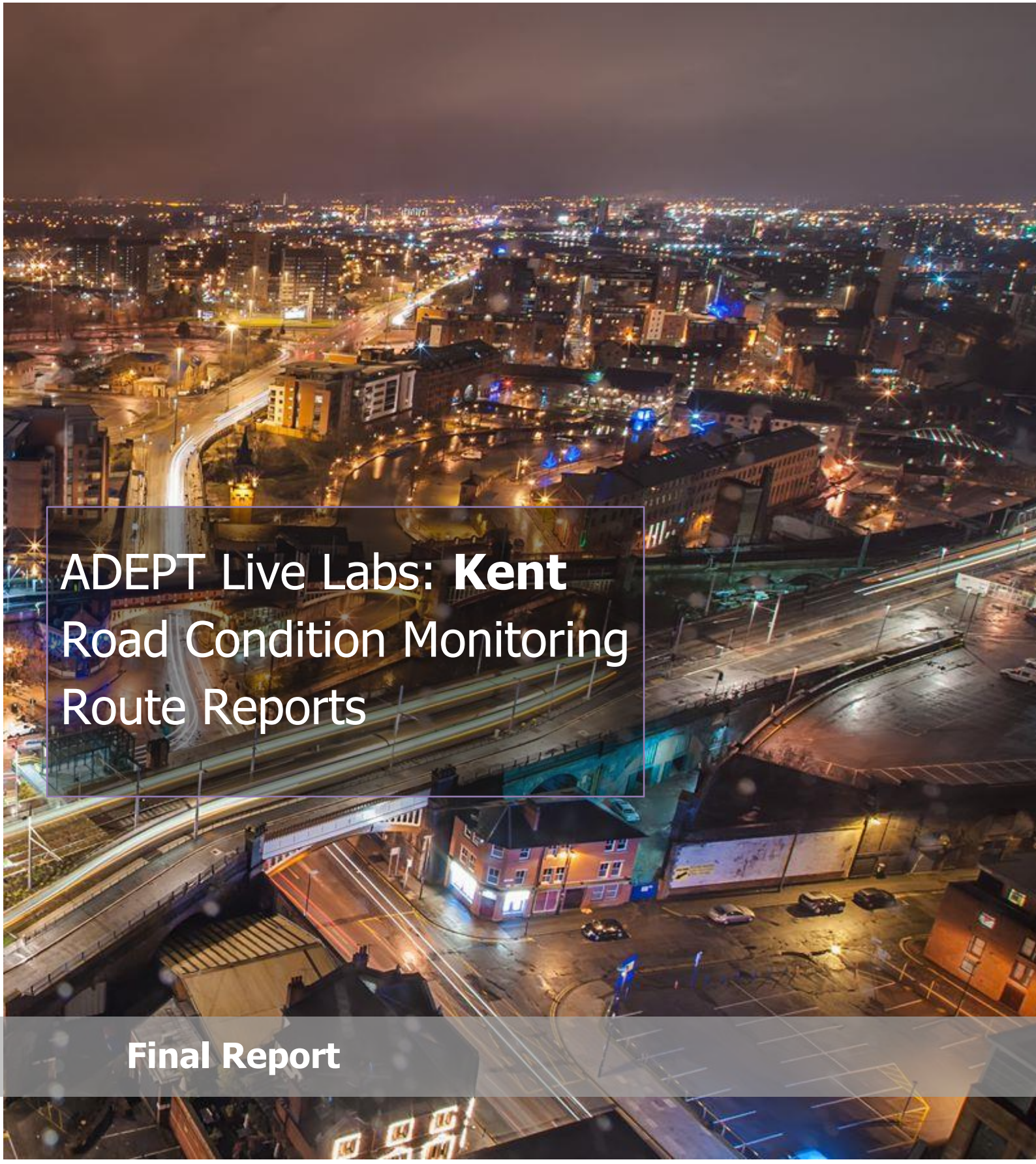


ADEPT Live Labs: **Kent** Road Condition Monitoring Route Reports

Final Report

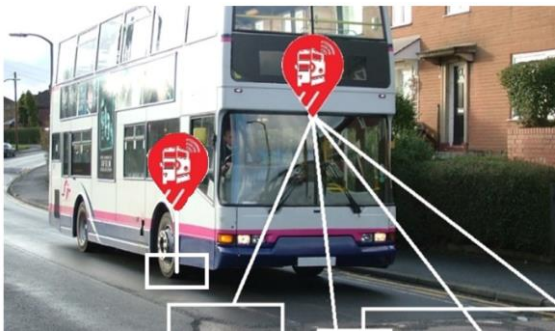
ADEPT LIVELABS

Kent County Council kent.gov.uk

In partnership with amey

1. Executive Summary

Approach



Between 2020 and 2021, Kent County Council (KCC) and Amey installed 20 road condition monitoring systems from *Route Reports,* in Arriva buses and KCC pool cars. The innovation involved the installation of bespoke front-facing cameras in vehicles' windscreens and telemetry sensors on the dashboards of the chosen vehicles. An on-board GPU combines this data with GPS information, using immediate edge-computing to generate a holistic view of road condition within a geospatial dashboard.

The cameras scan the road to identify defect locations and provide spatial information. The telemetry sensors detect vibration as the vehicle drives over a defect (ie pothole).

Numerous technologies are available that use AI and computer vision to survey the road, however *Route Reports* are unique in that they go further by pairing with the vibration-sensing telemetry devices to provide defect depth and a 3D representation of the defect.

Findings

The system was found to be effective at detecting defects, logging them by severity and providing video imagery of the defect within the user interface/dashboard.

Continual passes by the sensors over carriageway defects began to build up profiles of individual defects over time and the system then began to model the trajectory of degredation. In further stages of the trial, this information can be used to support maintenance programmes and asset management approaches to ensure end-of-life carriageway repairs are delivered effectively.

Business Case

Some of the potential benefits of using Route Reports include:

Using Route Reports as an inspection tool - could lead to increased service efficiency through a reduction in manual inspections and if being used on existing vehicles travelling on the network e.g. buses / waste vehicles, an associated carbon saving from reduced driven inspections.

Using the Route reports system to collect data on location and dimensions of road defects will reduce Kent's need for a second inspector as a passenger to identify and notate defects.

Predicting End of life carriageways - Using an iterative process of continually assessing defects' degradation over time, enables modelling and analysis of end-of-life carriageways to better inform operational maintenance decisions.

Using the Route Reports system would replace the need to carry out annual Scanner surveys, presenting a potential saving of approx. £20,000 per annum.

Improved highways condition - Using real time information to identify defects more quickly and reporting them instantly to the highways maintenance teams to fix will lead to an improved highway condition for road users and less damage to road users' vehicles

Having a fuller defect inventory will enable to us to identify defects sooner, batch our repairs better and more efficiently and restore road condition quicker, leading to less damage to vehicles over time.

Cost for the installation in 20* vehicles and development of the system in Kent - £160,000

*Remains an estimate for coverage

Recommendation

The project has seen very good technical results with Route Reports in terms of data quality and consistency, but we are still yet to compare against the current industry standard 'Vaisala' to understand whether the information collected through Route Reports (and the pairing of telemetry data) is superior to that provided by the mobile-phone-collected data through Vaisala. We recommend that interested parties await the publishing of the results of whether Route Reports' bespoke system can provide a superior and more comprehensive service than the currently more-widely-used Vaisala system.

Strategic case

- National, regional and local policy fit: What are the policies that this intervention addresses (key sources – DfT policies, local transport plan, economic plans etc.)?
In the DfT's position paper, entitled "Road condition data and technology review: position paper", the DfT state that "Local highway authorities will have flexibility to choose whichever surveying technology best supports their asset management strategy, providing the technology aligns to this new data standard. This will open the market, driving choice and technological innovation while still ensuring that data will be sufficiently comparable for us to maintain a national view of the condition of the highways network."

- The case for the intervention that meets those policy needs and priorities : How did the intervention address the policies identified?
The research and development project with Route Reports presents a different way of collecting road condition data and offers another potential solution in the marketplace for this developing set of solutions.

- The national, regional, and local set of background needs and challenges: What were the background challenges that led to the intervention, linking back to the original pitch?

Against a backdrop of worsening road conditions in the UK and an inherent lag between carriageway defects developing, councils discovering them and contractors repairing them, there is a developing-need to discover, identify, and record potholes faster, so that they can be repaired more quickly.

Modern surfacing programmes need to be continually fed with consistent data to be efficient and appropriate, with an optimal level of spend in the right areas of the network.

- The wider case for the intervention in meeting specific local needs and challenges: How did the intervention address those local needs and challenges, what have the successes been in doing so, what have been the failures?

Route Reports road monitoring solution uses a combination of sensors and computer vision to identify road defects and derive their width, length, and depth. The signals from the sensors on the device track vertical and horizontal movement of the vehicle; examining the vehicle's motion over the road surface as the vehicle travels. Analysing the vehicle's data makes it possible to identify different categories of potholes by estimating pothole size and differentiate potholes from speed bumps, brick/cobbled roads, or utility hole covers. Moreover, these sensor values provide the ability to determine a defect's profile and rate of deterioration.

In addition to sensors, the solution uses the RR GPU's computational capabilities and vehicle cameras to identify potholes. Through computer vision, it is possible to locate defects outside the wheel path, other observable road defects such as cracking and capture visual evidence of a defect's location and severity. Furthermore, it enables other 'use cases' with the same technology, such as identifying faded white line-markings and identifying street furniture.

Once installed, devices require no human intervention whatsoever. As such, they do not impact the operation or safety of the vehicles in any way. The devices' wireless connectivity capabilities allow Route Reports to update devices remotely without having to access

vehicles after fitment. This serves to make the implementation and use of Route Reports' solution as straightforward and safe as possible.

Route Reports has successfully installed 20 devices and successfully detected and categorised potholes, displaying the data on its user-friendly dashboard.

The only unexpected obstacle for the project occurred halfway through the trial period when technical engineers working for Arriva discovered the Route Reports devices and proceeded to remove the hardware, not knowing where it was from. Subsequently they determined that the technology went against their circuitry policies, and it became clear that the Arriva project team had not considered these policies when agreeing to help and granting us access to their buses. Since this occurred, we have re-installed those sensor systems into additional KCC pool cars to continue surveying the network.

Economic case

- The public value of the benefit of the intervention and associated investment: What are the wider benefits realised from the intervention? These can be tangible benefits (such as availability of an asset) or intangible (public confidence)

Using sensors and computer vision to identify road defects means it is possible to build a real-time database of road defects. This allows Amey and Kent County Council to implement proactive maintenance schedules and group roadworks. By knowing where and how severe road defects on Kent's road network are will enable Amey to repair them proactively before they become costly to fix or cause the council to pay excessive compensation for vehicle damage. Moreover, by knowing where defects are, Amey can group nearby defects into a single set of roadworks to minimise disruption and repair costs.

This is beneficial to the public as there will be a reduction in roadworks disruption, vehicles damage and repair costs (hence tax money can be better used). This will also increase the public confidence in the roads network.

The product could also lead to service efficiency through a reduction in manual inspections and if being used on existing vehicles travelling on the network, e.g., buses / waste vehicles, and associated carbon saving from reduced driven inspections.

- Public costs and benefits analysis: What were the broad costs of the intervention (this does not need to break any commercial confidences and can be broad brush) and what direct benefits did they bring?

The development of the Route Reports system and the deployment of sensors cost approximately £160,000. This was comprised of costs for the hardware (devices fitted on 20 vehicles), the cloud data pipeline, the data integration, the dashboard development and the application of pothole identification technology.

Annual scanner surveys are carried out which give point information on the quality of the roads, these would no longer be needed as the RR system would replace this

The potential savings through staff reduction and reducing the annual scanner surveys amounts to approximately £285,000

- Demonstration of benefits through qualitative and quantitative analysis: What are the measurable benefits associated with the intervention that you have observed and measured – this can be qualitative (perceptions, views etc.) and / or quantitative (cost savings, time savings etc.)

The intervention could lead to qualitative benefits, such as better maintained roads and proactive repairs, better efficiency of the road maintenance service with fewer required inspections. Furthermore, Route Reports is continuously developing features - including:

- Route View: A complete digital twin of the road network (included with solution as a free update)
- Stereoscopic Cameras: Using new hardware and computer vision techniques to improve accuracy significantly
- Repair Price - Estimates and Predictions: Estimating how much it would cost to repair a defect as it degrades

- Key metrics: What are the wider key metrics – jobs created, people upskilled etc.

There are further suggested savings through defects being identified and repaired more quickly, leading to better road quality, ride quality and a range of benefits for road users, including less damage to vehicles and tyres, less damage to cyclists' bicycles and reduced risk of injury.

Commercial case

- Demonstrating that the intervention will result in a viable procurement and attractive deal for the market: What was your procurement journey for the intervention – from specification to deployment?

Upon initially learning of the challenges experienced by KCC inspectors and stewards – and defining the problem statement – Amey began a market analysis project to understand the technology available to improve defect identification and monitor road condition in a smarter way.

Having carried out a supplier comparison, Amey and KCC determined that the Route Reports solution provided the best opportunity for development.

A bid was placed for funding under the Kent Lane Rental Scheme and the team was successful in securing £160,000 for the development of the Route Reports system

- How did the market respond to the opportunity?

Vaisala are seen as the next best alternative and are more widely established in this market, with various other council clients. Vaisala were keen to demonstrate their product off the back of Route Reports securing their development funding. We agreed that after the trial and development stages were complete, the project team would trial the Vaisala and Route Reports systems side by side and carry out a second supplier comparison.

- What lessons have been learned through delivery?

The primary lesson learned by the project team is that the GDPR requirements are onerous and specific. The Data Protection Impact Assessment required by the council's Data Protection office was extremely thorough and took several weeks to complete a first draft, with lots of input from a variety of parties and lots of deep email threads with correspondence back and forth. The lesson learned was that a workshop session with all

involved parties lasting 3-4 hours was a very effective way of collaborating and pulling together a comprehensive set of responses.

Furthermore, this should be carried out early in the process as there are a number of repeat sessions required with comments from Legal and DPO representatives.

Financial case

- If deploying again, how might you consider a structuring an at-scale package which could be attractive to the market

If deploying again with an at-scale package, the following steps could be taken:

- Route Reports and Kent County Council could expand the level of service, fitting more cameras to other vehicles and if possible, collaborating with district councils to fit them on waste collection vehicles. This would reduce the carbon footprint and further costs. Route Reports has fitted bin lorries in other projects to great success, doing so would facilitate frequent inspections of minor roads.
- Route Reports could scale operations in Kent with local councils and nationally with Amey

- Financial model: If you were implementing again, what considerations would you make in developing your financial model for an at scale set of similar interventions?

For an at-scale set of similar interventions, early adoptions discounts would be available:

- The existing device leasing costs will be waived for the duration of the contract. Additional device costs would be at a discounted 50% per device and camera set.
- Analysis required with Kent County Council and Amey to determine whether more devices would need to be deployed.
- Free camera upgrades and fittings to the newest versions at the start of the new contract.
- Software updates to the current solution and customer support would continue to be included under costs.

- Funding sources: Besides Live Labs funding have you levered any other funding sources (this can include contributions in kind as well as capital / revenue funds)

The project was primarily funded by the Kent Lane Rental fund, with £160,000 funding tendered for and secured. Live labs budget enabled the funding of discovery, market analysis, solution selection and project management of the trial and development project.

Furthermore, Route Reports has developed the innovation further with other councils and so some revenue funding was used to contribute to development costs.

Management case

- The intervention can be implemented using best practices in programme and project management: What did you do with regards to project management programming, practices and skills?

The project was run in an agile manner, using Prince2 methodology, resourced by a team of capable and dedicated project managers. A programme was defined at the outset of the project within the PID and the trial and evaluation dates were kept to.

- In retrospect, what would you do differently?

In retrospect the project team would have carried out the DPIA responses earlier in the project and with a more collaborative workshop approach.

- Delivery plan: Thinking back to your original pitch, how did your delivery plan differ from what you planned?

The project began by investigating road condition monitoring and carriageway defects, but since the project inception, the scope increased to identify signs, vegetation, and road markings.

Due to delays and complications in finalising the Data Protection Impact Assessment and aligning the trials with Vaisala, the comparative analysis that was due to be carried out between Vaisala and Route Reports is still outstanding and is due to be carried out throughout July 2022

- Project management team and qualifications: In retrospect, what roles, skills and qualifications would a deliver team need to deliver this intervention at scale elsewhere?
The core requirements of the PM task are largely non-technical and not too onerous, however some knowledge and understanding of Artificial Intelligence and electronics would be preferrable.

- Benefit realisation and contract management plan: With regards to this intervention what have you done to realise benefits (internally and externally)?
There has been limited benefit realised to date, due to the lack of supplier comparison, wider scale adoption and completion of the trial process. However, a number of inspectors surveyed the routes that they had driven and agreed that they could see benefit in reviewing video footage of their routes and the defects.

- What would you do differently if delivering a similar package of at-scale interventions again?
If Route Reports emerge from the supplier comparison as the supplier and system of choice, then it would make sense to install further Route Reports systems in multiple additional vehicles, including more buses, waste collection vehicles, KCC pool cars and within the Amey operational fleet.

- Ex-ante evaluation strategy: Did you undertake an evaluation of alternatives to the intervention?
During the market analysis stage, a number of other suppliers were identified, and service offerings studied, these included proposals from Roadbotics, Mobile Eye, Gaist, Vaisala, TrakM8 and TRL. However, through our preliminary scoring system we considered that the offering from Route Reports had the most promising ultimate potential.