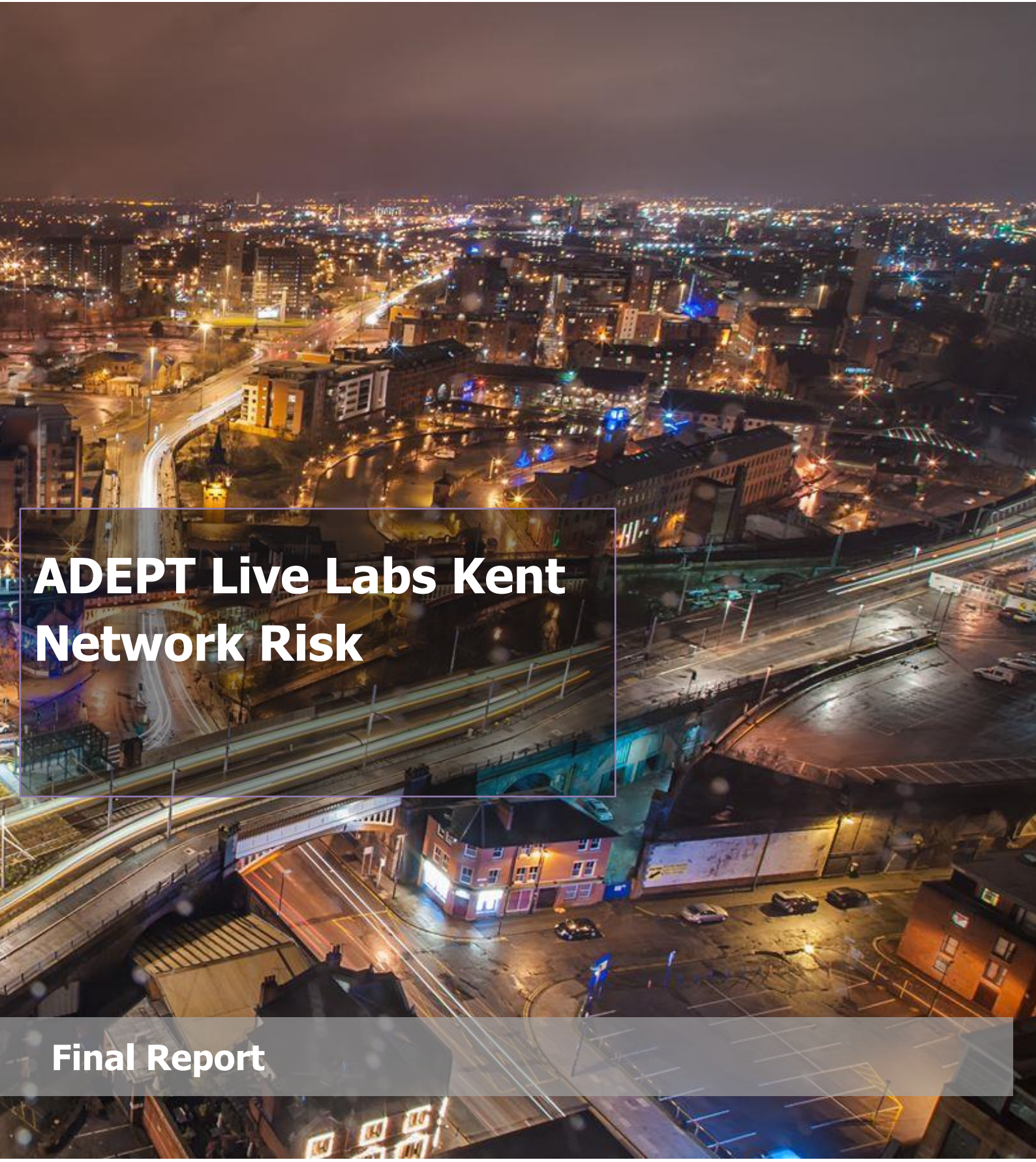


ADEPT Live Labs Kent Network Risk

Final Report

ADEPT LIVELABS

Kent County Council kent.gov.uk

In partnership with amey

Executive Overview

Introduction

Kent County Council (KCC) has a due care and responsibility to minimise risk and incidents on its local highway network. Previously this has been addressed through a generalised annual analysis of incident data as provided by the police service (known as Stats-19), followed by focus studies of identified incident hot spot locations in to formulate possible remedial and preventative measures, including schemes for re-engineering the network to mitigate identified risks

There is recognised value in providing more continuous access to these incident data sets and enabling a more contextual and intelligence-based view of incidents and associated factors. This will improve responsiveness and efficiency (through ready access to data) and effectiveness (through improved risk profiling and decision intelligence).

The above objectives are aligned with emerging areas of data science and innovation, particularly in the realm of machine learning, that may further augment this capability.

Approach

Despite the increasing prevalence of data analytics and AI in the marketplace, KCC recognised the challenges in achieving a 'model' of risk that can be relied upon to support critical decision making. Accordingly, the decision was made that the main focus of this Workstream should, at least initially, be upon facilitating improved access to, and visualisation of, source data to support KCC's existing analysis processes.

Our approach is centred upon decision support – and bringing all available relevant source statistical data to a central insights platform in order to enhance decision speed and quality – and particularly to provide this on a more continuous basis updated throughout the year. The platform itself forms part of the wider HADMS (Highways Asset Data-Led Management Solution) data eco-system. As an overarching objective of the Live Lab, hosting all Live Lab Workstreams on this same platform ensures that all data sets acquired through the various innovation streams can also be shared and integrated, thereby bolstering the potential scope of each Workstream. This risk data can be of particular use across other HADMS workstream – for example in helping to prioritise works

Although the decision to focus on integration and insights was made fairly early on, the potential future benefit of risk modelling was also worthy of initial investigation. Therefore, in parallel to HADMS platforming, time was also invested in assessing available risk data services, for possible integration into HADMS.

Later KCC also opted to further investigate the risk modelling that underpins these data services, as an associated initiative. Third part risk modelling technologies were assessed alongside Amey Digital Consulting's own machine learning approach. No model has yet been integrated with the solution, but the findings have been important in guiding KCC's future path.

Business Objective

There are five overarching aims for this Workstream :

1) Enable more effective and continuous monitoring of network outcomes (collision and incidents) in order to improve the responsiveness of KCC to emerging hot spots on the network (and thus maximise and improve safety)

2) Provide an improved contextual view of this outcome data that will equip KCC engineers and operators to make better informed assessments of network design factors that are aligned with road user outcomes, leading to better strategic decision making

3) Provide a more statistical intelligence-based approach to presenting historical data on the network, in the form of new derived route-based metrics that ensure more accurate and evidence-based planning and investigations into locational crash risk

4) Ensure KCC are better equipped to provide accurate data on request both internally to support other projects and initiatives, and externally to defend any public claims or FOI requests.

5) Provision all the above in an efficient automated form that eliminates the manual data processing otherwise required to produce such insights. This will improve KCC's overall resource efficiency, by reducing the current administrative overhead involved in scheme analysis and design.

The above objectives are each fulfilled through functional features provided on the HADMS digital interface, as set out in the Solution overview section to follow

Solution

Here we outline the main architectural components and source data feeds of the delivered digital solution:

<u>HADMS Platform</u>
The HADMS cloud architecture provides the foundation for the solution. As well as the underlying structural and functional components (PostGres SQL database, with Flask and React front end) and AWS cloud services used to host and deploy the solution, HADMS also provides the standard design pattern for the solution, whereby this Network Risk solution forms part of a wider platform ecosystem. This ensures that the user experience and functionality is consistent with other workstreams on HADMS, to promote familiarity and minimise the need for specific training.

<u>Mapbox</u>
All HADMS pages are centred around a geospatial view of the KCC estate, to ensure a practical oriented view of the data can be facilitated. This map view is provisioned by the Mapbox Open source package

<u>Incident Data Feeds</u>
Data feeds are supplied on a quarterly basis (via digital upload) and imported using a built semi-automated routine. These include Stats-19 injury collisions and Police (damage-only) reports

<u>Confirm (WAMS) Oracle Warehouse</u>
Data from KCC's Confirm Enterprise Asset Management system is sourced via data loaders that run at a set frequency (currently 6 hourly) to extract and import data into the HADMS SQL database. For this Network risk workstream, this covers principally WAMS enquiries data that are indicative of (as arising from) associated incidents

<u>Jacobs Traffic Model</u>
Static data sets of traffic volume provisioned by Jacobs as output from their annual modelling cycle. This data is supplied on an annual basis (via digital upload) and imported into the HADMS SQL database

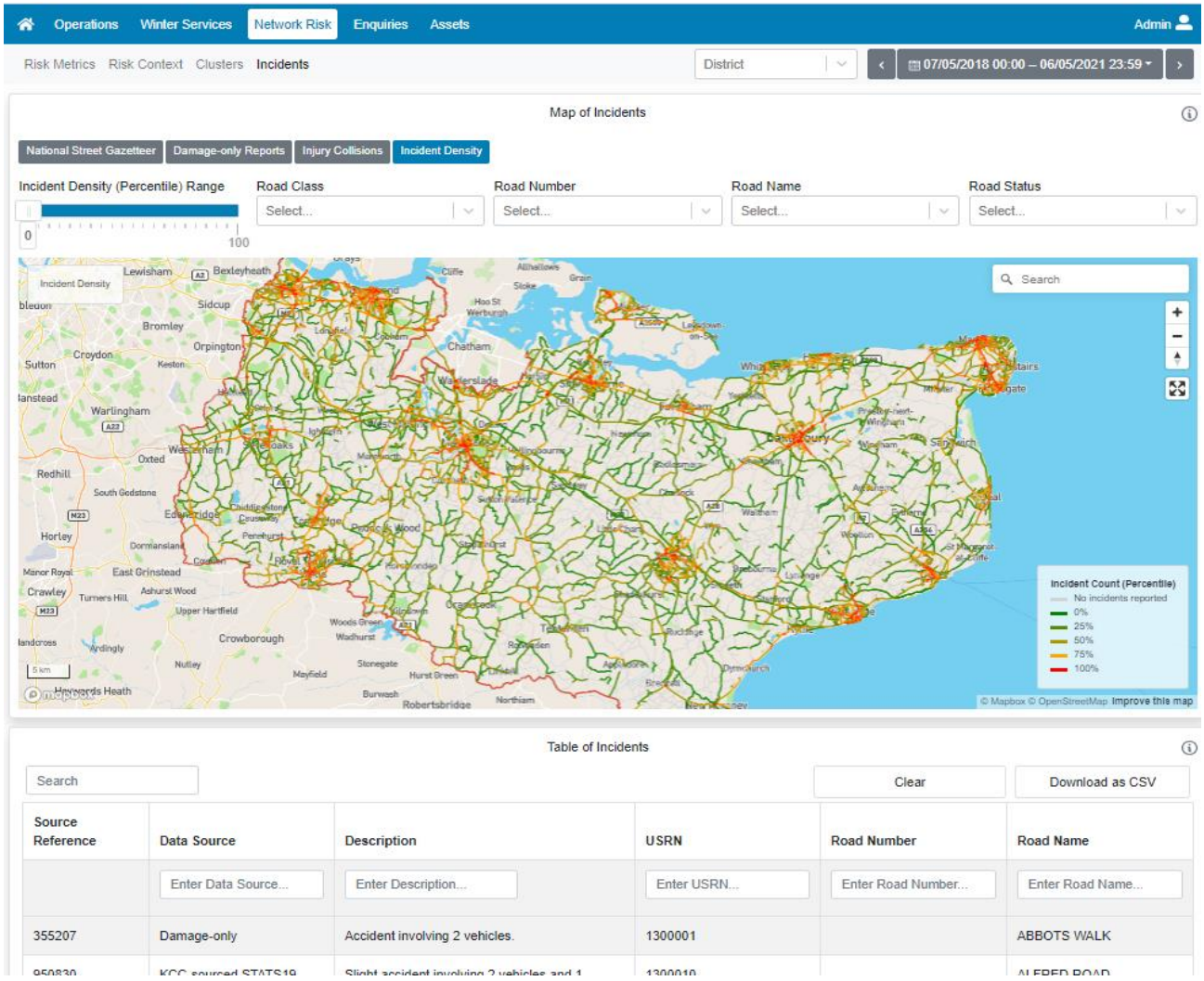
<u>Ordnance Survey Data</u>
Traffic speed (and speed limits) as modelled by Ordnance Survey is supplied on an annual basis (via digital upload) and imported into the HADMS SQL database

NSG (national street Gazeteer) layers
Official route classifications (status and class) are updated on an annual basis, provisioned by NSG traffic volumes (as modelled by Jacobs), traffic speed (ordnance survey) and road condition (RCI surveys)

KCC survey data
Road Condition (RCI) data and Traffic count Surveys

KCC – cluster sites
Annual hot spot analysis as provided by the authority

Below we outline the core functional features of delivered digital solution, as shown in the attached live visual of the built platform. This visual shows the 'Incident' page as example of the HADMS platform interface design, which is representative of the approach that is consistent across other pages.



Spatial & Temporal Navigation
All functional features are accessed via a standard map-based interface and accompanying date-time control whereby the user can select any desired historical time window. This general interface is consistent with other workstreams on HADMS to provide a uniform consistent experience. All pages provide access to data from 2010 up to the current/latest date.

Map Layers
Data sets are generally visualised on a layered basis, whereby the user can select to activate one or more layers of their choosing, with a dedicated reference colour key provided for each layer. The overall geographic view can also be optionally restricted to a single District if desired. Additionally, a search function is provided to enable rapid navigation to a specific location of interest.

Incident Outcomes
All outcome data, from all sources (Stats-19, Police reports, WAMS etc.) are presented on a single 'Incidents' page view. Accessing all these recorded statistics in one page enables KCC operators to easily view alignments and consistencies across the different sources without needing to consult multiple files.

Route Risk Metrics
A range of route-based risk metrics are provided, to support analysis – including collision rate (by traffic volume), collision density (by road length) and risk score (based on casualty outcomes). Crucially these metrics are not based on any modelling or interpretation, they are algorithmic only to ensure they are reflective of the source data only, to augment the above raw outcomes data

Risk Context
A further risk context view is also provided, which allows different physical network factors that are generally accepted as contributing to risk to be viewed as layers. Currently these context layers do not contribute to the risk metrics or score, as there is not any current industry accepted 'formulation' for risk. It is important that any 'dependency' on these risk factors is interpreted by the user, and the platform is thus only intended to convey their statistical alignment with risk measures and outcomes

Business Case

The ongoing cost for maintaining and supporting the HADMS platform is minimal – estimated in the region of £7K to £15K per month as the platform is progressively expanded into the KCC operation. This is also a central cost pooled across the various workstreams - accordingly, this Network Risk workstream will constitute only a component of this monthly maintenance fee.

Based on this minimal cost footprint, the following direct and in-direct benefits more than justify its ongoing usage. Although these are estimations only, based upon KCC's current operating costs, even allowing for a healthy margin for error the benefits will readily exceed the cost of maintaining the solution:

Benefits in Safety – Derived Risk-based metrics will aid with interpretation and analysis of risk on the network, rather than having to rely solely on historical collision data outcomes. This more expressive view of network risk improves the quality and impact of locations identified for schemes and intervention, increasing safety for road users on the network

Engineers can also more easily assess the resulting impact of completed schemes and interventions by inspecting before and after metrics directly on the HADMS platform. Engineers can thus develop a more robust understanding of what types and schemes are suitable under different scenarios, to inform and improve the efficacy of future schemes in preventing casualties on the network.

Together the above both serve to mitigate casualties through improved scheme decision making

Estimated at ~1% x £40M economic cost of KSI casualties = ~**£400K** per annum

Benefits in Efficiency – Network usage and outcome data is now much more readily accessible, saving time and effort spent gathering data for analysis purposes (such as offline studies) and for evidential purposes (for example in face of legal claims of FOI requests) against KCC. For example, colleagues can now self-serve the data they may require, directly on HADMS, without any need to submit a request to the Schemes team

Overall this provides much greater velocity in provisioning the data and measures needed to facilitate regular inspection and analysis, largely eliminating this overhead

~5% x £1.5M total FTE cost of Scheme Planning & Delivery= ~**£75K** per annum

Conclusion & Recommendation

The core benefit driving this solution has been in the provision of ready centralised incident and risk data to bring new efficiency to existing processes supporting schemes analysis and planning. The solution has taken a first step in starting to formulate more expressive measures of risk, by factoring against traffic usage and route characteristics.

These risk metrics are currently fairly formulaic, and any further dependency with wider external and intrinsic context (such weather, pavement condition, route geometry and traffic speed) is currently left to user judgement. By applying data science (machine learning), it is possible to model and hence visualise these dependencies, and it is recommended as a next phase of work that effort is made to build this further intelligence into the platform. A big benefit of doing this will be the ability to expand coverage to other routes where there is a sparsity of collision history, and to remove sample bias.

A further benefit is the usage of risk metrics on other workstreams on the HADMS platform and beyond. For example, as an input in prioritising services such as road maintenance and gritting.

The risk platform is now in regular operating use by KCC, whole team (20) users, 10 frequently - accessing speed / traffic surveys - supporting its current schemes planning cycle. KCC also undertook separate assessment of risk modelling services for potential expansion of the solution.

The five cases Live Labs considerations

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.)?

This innovation fits with the objective of the DfT 2021-22 Outcome Delivery plan to "Build confidence in the transport network… and improve transport users' experience, ensuring that the network is safe, reliable, and inclusive", particularly with a focus on safety and the public confidence that a strong safety record will elicit.

The case for the intervention that meets those policy needs and priorities: How did the intervention address the policies identified?

Through more robust and comprehensive assessment of network incidents and their alignment with associated risk factors on the network, scheme managers and engineers are able to identify and enact more effective interventions that will improve network outcomes.

By using the digital platform Engineers can readily evaluate the impact of previous schemes on traffic usage and outcomes, and thus develop a better appreciation for what types of schemes are suitable under different scenarios.

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?

Incident and outcome data sets can already be accessed on a variety of providers, but most currently provided in an offline file format. The challenge for scheme designers and engineers is the time and resource required to access, process and assemble this data on a network wide basis; They are therefore forced to rely on an initial clustering process to first prioritise areas where data can then be analysed within a more manageable contained area.

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?

By converging all these sources onto HADMS, operators now have a single point of entry, and a platform which further integrates other contextual data (such as traffic usage) to provide a comprehensive view of outcomes and risk across the entire Network. It also puts operators in control to take an intelligence-led approach to identifying areas of interest on the network and maintaining continued oversight of this network view throughout the year as source data sets are each updated.

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)

The core value to the public is through improved safety outcomes that arise from better informed and more timely interventions based on a consistent and comprehensive view of the network.

The public will also benefit from a more robust and informative response in the event that they wish to raise a concern or claim with the Authority in relation to road safety. This in turn will raise public confidence in their Local Authority, making claims less prevalent.

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 HADMS platform delivery under Live Labs comprised of multiple workstreams, including Network Risk, Winter Services and a range of Operations Management functions. The platform was implemented as a unified programme of works, at a total delivery cost of ~£870K over a 16-month period, inclusive of all initial discovery and engagement, project management, data exploration and technical solution delivery.

Although there is no explicit division of costs, a fair attributable estimate for the Network Risk workstream is ~15% of this effort, or approximately £130K, in addition to the further funding sources acquired during delivery. This is also a one-off solution development cost. It does not require to be repeated for further uptake by other Authorities.

The ongoing cost for maintaining and supporting the HADMS platform is minimal – estimated in the region of £7K to £15K per month as the platform is progressively expanded into the KCC operation. This is also a central cost pooled across the various workstreams including this Network Risk workstream.

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.)

Please refer to the earlier **Business Case** section for a detailed coverage of the envisaged benefits. These benefits will need to be measured over an extended period, by assessing the productivity of KCC's schemes planning team over time, and the quantity of KSI injuries, claims and negative outcome claims arising over time.

Although these direct and in-direct benefits have only been estimated at this stage, based upon KCC's current operating costs, even allowing for a healthy margin for error these benefits will readily justify its delivery and ongoing usage

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

These measures are as detailed in the Business Case section :

- Reduced KSI casualties, reduced negative outcome claims.
- Reduced overhead – operators freed up to focus on their core value-add activities through a more efficient data support service and analysis process, ultimately improving job satisfaction

Indirect and induced impacts: What have the indirect impacts been of the intervention – unexpected consequences, knock on effects etc.

There have been no unexpected consequences or knock-on effects

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?

This innovation was always envisaged as a core component of the wider HADMS digital platform offering. It does not involve any procurement channels, other than the choice of Cloud service provider in AWS (Amazon Web Services) – however this service cost is minimal (under £1,000/month) and the choice of provider largely incidental. Had another provider, such as Google, been utilised this would have had essentially zero impact on the nature or scope of the solution and will have minimal impact on cost.

Rather than other Authorities needing to repeat or emulate our entire solution implementation, which would require software consultancy costs, the premise is that HADMS can simply be offered on a ready built basis, enabling LHAs to gain benefit from the solution with minimal entry costs other than initial integration and minor adaptation if needed.

How did the market respond to the opportunity?

Not applicable. The solution was designed and implemented in-house by Amey Digital Consulting in partnership with KCC.

Implementation efficiency: How did you deliver the intervention?

The project was delivered using a standard agile adaptive methodology involving frequent progressive releases of HADMS as the solution evolved over time. This allowed KCC engineers and managers to provide regular feedback to actively guide the solution, thus ensuring the end product is fit for practical operating use and meets the expectations of the business.

What lessons have been learned through delivery?

As part of the wider HADMS digital innovation programme, there was a desire from early on to deliver more advanced analytical insights and machine learning, based on the contextual data sets available. While this remains an important future ambition, it was crucial to first succeed in platforming the base data services. Over the course of the Live Lab it became evident that just handling and visualising the vast array of data sets required was a challenge in itself.

Handling segmentation of the network was a particular challenge, especially in relation to attributing collisions to the appropriate road segment. There are many approaches to route segmentation, so this required a fair degree of trial and error. An additional 'macro' view of both incidents and risk was created to help alleviate the anomalies that can arise in the detailed representation of this data.

Procurement strategy and delivery schedule: What lessons have been learnt with regards to procurement and market reaction?

Early on in the project, a fair portion of effort was assigned to engaging with potential supply partners, with a view to incorporating their emerging data services. This market sector is in its infancy, however, and potential suppliers struggled to position their offering in a way that would fit KCC's aims and budget and be viable for future Live Labs partners. Over the course of this engagement we gained a lot of learnings about market readiness and contextual data, and we do still see future potential for integration with additional data services once products have matured

Aside from the above, the solution was designed and implemented in-house by Amey Digital Consulting in partnership with KCC, so there are no other particular lessons in relation to procurement.

Financial case

The intervention is affordable for the public sector and can be funded through a viable financial agreement: In retrospect do you deem the interventions to be affordable, if so why, if not why?

The built digital solution was designed with guidance from KCC to ensure its suitability for general use cases across the wider Authority market. The architecture has been designed to facilitate easy configuration and deployment into other LHAs, with minimum need for customisation and development

Therefore, in terms of future implementations for other Authorities, these should be deliverable at significantly smaller cost, with costs mainly covering integration (adapting to different APIs). Any functional enhancements are anticipated to be minor, and will be carefully vetted to ensure that any new features or processes are suitable for general use by wider Authorities

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

As already explained, a principal purpose of this workstream, and the HADMS platform generally, is to facilitate subsequent extensibility to other LHAs in the wider UK market. It was important to validate and pilot the new functionality within one Authority first, to minimise risk. So even with hindsight, this was the correct approach, which sets the foundation for reliable expansion.

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?

Now that we have completed this initial build phase, positioning the risk data service for other LHAs will be fairly straightforward, as it can be structured at a smaller cost limited to configuration and integration into whatever data service environment that LHA happens to occupy

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)

An additional £117K was provisioned by KCC through its Kent Lane Rental funding mechanism to augment the core HADMS workstream delivery, and to facilitate market research and development.

A further £32K was also commissioned by KCC for Amey Digital Consulting to implement an evaluative machine learning approach to modelling risk on the KCC network. This initiative was delivered in conjunction with third party suppliers to allow KCC to make a comparative assessment of multiple risk model propositions. Based on the outputs of this project, KCC have not identified sufficient immediate business

benefit in additional risk modelling data, mainly due to the current intrinsic challenges in engineering contextual risk factor data sets of sufficient density and coverage to support effective modelling – although noting that this is a peripheral initiative only, connected with Live Labs whereby this risk modelling was trained using data sets platformed on HADMS.

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 using a hybrid of Prince2 methodology, on top of an agile software delivery framework making use of Azure DevOps functionality. A stage objective delivery programme was set out early on, to guide the overarching delivery, with 2 weekly agile sprints employed to iteratively progress the solution in regular consultation with KCC stakeholders. The end solution was deployed as a pilot initially in order to validate its fit for usage prior to incorporating into KCC's schemes planning function.

In retrospect, what would you do differently?

A fair portion of effort went into developing supply chain engagements, with specialist risk data suppliers in particular. This was also complicated further by a change of stance to trial internal development of risk analysis in house, which changed the relationship with engaged partners due to concerns over sharing Intellectual Property. The authority did take a lot of learning from this collaboration, mainly in understanding the readiness of the market. However commercial terms could not be agreed with the authority, and we could have benefited from withdrawing from the engagement earlier on that basis.

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

We originally planned to generate 'risk profiles' based upon physical road characteristics (such as curvature, gradient, intersection), and their concurrence with historical incidents and collisions. The intention had been that these profiles can then be extrapolated to estimate risk at other equivalent network locations where less incident history is available. Machine Learning was identified as the best way to achieve this objective.

Over the course of the project it became clear that the extensive data-sets required to train such a model to a sufficient granularity of route segmentation will require significant engineering effort, that is beyond the capacity of the project. This has not impaired the project at all, as just being able to visualise the array of source incident and contextual data sets has been a big benefit to schemes planning

What lessons have been learnt?

As explained above, the key lesson learnt is to better manage expectations and all partners' roles around supply chain engagements. Data suppliers anticipated much greater profitability from the collaboration than KCC and Live Labs were able to offer, Had this been established earlier, time and effort could have been saved rather than trying to progress a relationship that was not commercially viable. IP concerns raised part way through the engagement also led to a more complex dialogue between parties, which could have been mitigated through earlier decisions as to whether to develop inhouse alternative solutions or not.

Project management team and qualifications: In retrospect, what roles, skills and qualifications would a deliver team need to deliver this intervention at scale elsewhere?

To repeat or emulate our entire solution implementation will require skilled IT/software consultancy capability. Our particular choices of framework (in SQL, React and Bootstrap) and cloud platform (AWS) are arbitrary – whatever framework is chosen, competent database and application developers will be required. However, the whole premise of implementing HADMS, is that this platform can now simply be offered on a ready built basis, enabling LHAs to avoid such implementation effort, and gain benefit from the solution with minimal entry costs other than initial integration and minor adaptation if needed.

Ex-ante evaluation strategy: Did you undertake an evaluation of alternatives to the intervention?

We did undertake desktop research into available data solutions and services, which instigated our engagements with risk data suppliers. It was noticeably clear that these companies sit at the forefront of risk modelling, and we were thus quite comfortable that we had a strong awareness of current industry offerings in this domain.

Based on this research and collaboration, there is no other ready risk and incident visualisation platform available in the market at this time, and especially none that offers the customisation needed to incorporate into KCC's clustering-based assessment process.

If undertaking a similar programme at scale, what alternatives would you consider, what scenarios might you consider them within?

We would consider positioning a greater budget up-front to accommodate the anticipated scope of data engineering required. Data (coverage and quality) is absolutely essential to providing comprehensive information intelligence and to enable effective AI modelling.