ADEPT Live Labs Kent
Asset Estate Management

Final Report

ADEPT LIVELABS

Kent County Council kent.gov.uk

In partnership with amey

Executive Overview

Background and Context

Local Highway Authorities like Kent County Council (KCC) are responsible for provisioning a range of different classes of assets on their highway estate. Each of these asset classes brings its own unique challenges in establishing an effective regime of maintenance and renewals that will minimise overall asset cost. This Live Lab workstream addresses two of KCC's largest asset estates that, following a review of potential innovation options, were identified as those where data and digitalisation can offer the most tangible benefits to the Council's asset management practices.

The first of these is the Council's streetlighting estate; As this estate has recently been upgraded to a full LED connected network, it offers an abundant source of data that can be leveraged for integration and analysis. The second initiative applied to KCC's vegetation estate, mainly due to its visual prominence to the customer and its increasing relevance in relation to environment and climate, but also due to the availability of data in terms of a well catalogued urban tree estate, and relevant external sources such as satellite.

For both these asset estates, a range of different innovation options were conceptualised based upon the available data. These options were then vetted to identify the most practical and beneficial solution to suit Live Labs implementation, taking into account their potential for leveraging the data convergence and analysis capabilities offered by the HADMS (Highways Asset Data-led Management Solution) platform, and considering any integration and commercial requirements based on the Council's current contractual arrangements.

For street lighting, maintenance of the LED network is currently contracted out to Bouygues. The LED luminaires have a central management system (CMS) which controls the lights and automatically reports faults via Streetlight Vision (SLV) software. The solution selected was to use HADMS to integrate this external network with KCC's works management system (Confirm WAMS), to enable better oversight of fault response and remediations. For vegetation, a similar approach was taken in utilising HADMS to visualise and align Confirm tree assets with wider contextual information integrated from external big data sources such as canopy coverage, air quality, demographics and flood risk in order to support KCC asset planning and funding applications.

Accordingly, the overarching objective of this asset management workstream is to provide a new digitalised and connective view of these asset estates, with accompanying insights and tooling that will enable both KCC and its contract partners to manage the estates more intelligently and proactively. By using HADMS, a further benefit is in providing a view to external stakeholders and customer, particularly in the case of natural assets which are of increasing public interest.

Approach

Our approach is based around bringing all asset and associated operating data to a centralised platform where it can be converged with other relevant internal and external data sets to provide a single unified view of service performance and dependencies impacting this performance. 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 be shared and integrated, thereby bolstering the potential scope of each Workstream.

The usage of HADMS as the foundation platform is also intended to facilitate easy extension to other Authorities in future, whereby the operations management functionality can be readily configured and deployed into a new Authority with minimum re-work. Based on this design principal, all features and functionality have been carefully vetted by KCC to ensure it is standardised enough to suit general use across local authorities.

Integral to creating this digitalised view, is connectivity with KCC's Confirm Asset Management System. In general terms, achieving this oversight of the asset estates involved a range of integrations with third party systems and services, including Confirm as well as the SLV lighting network managed by Bouygues. HADMS is a natural fit for facilitating this integrated view of the service.

Business Objective

KCC Asset Management teams are responsible for managing the overall work response, including any supply chain dependencies. For the lighting estate, due to sheer size of the estate (123,000 lamps), the biggest challenge is in fault handling (response and remediation); As even a small fault rate equates to a large number of potential issues. Accordingly, lighting technicians assess active faults reported by the SLV estate, and then raise work orders for any faults that cannot be resolved remotely by Bouygues (i.e. that require in-field attendance). This process currently involves a degree of manual effort in terms of first searching to verify whether jobs have already been raised (for a given fault), and keying in new jobs where needed.

For the urban tree estate, the challenge is more around general governance of the estate in terms of managing its renewal and expansion (ie. tree felling and planting) and maintaining its health and biodiversity. This requires strategic consideration of many factors such as current canopy coverage, demography, air quality and flood risk.

Accordingly, there are four overarching aims for these Workstreams :

1) Enable more intelligence-led management of the urban tree estate, to ensure effective decision making around tree planting and felling that will maximise future social and environmental benefits.

2) Provide improved data evidence and context around the usage, environment and condition of the urban tree estate to equip more persuasive applications for funding (such as the urban tree challenge fund)

3) By providing a connective view of all street lighting faults, enable more efficient logging and tracking of job response that will reduce the current administrative overhead involved in maintenance management.

4) Enable greater oversight of street lighting maintenance performance and productivity and provide actionable insights into the response history that can improve this performance, and will equip KCC managers to provide more effective coordination and guidance to maintenance operatives.

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 Operations Management 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

Confirm (WAMS) Oracle Warehouse
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 Asset Management workstream, this covers principally assets, asset surveys, jobs and all associated status logs.

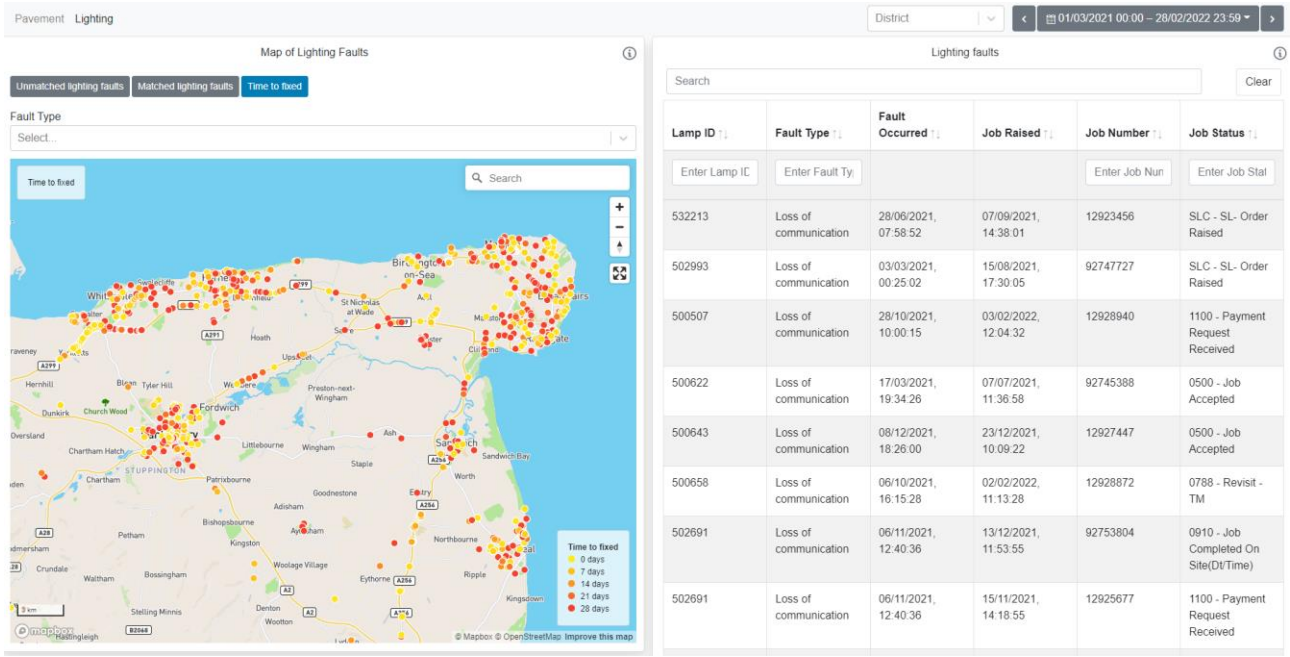
SLV lighting API
The platform is integrated with the API of Bouygues current lighting estate network provider (SLV) which is updated on a 4-hourly basis. This API can be easily re-pointed at any alternative provider, to suit the service environment, which is an important design factor to ensure extensibility to other local authorities.

Blue Sky aerial survey data
KCC have purchased aerial canopy surveys from the suppler, Blue Sky. This data survey output is refreshed using a semi-automated process, each time it is update (generally annually) and is included as contextual layer within HADMS.

Contextual GIS Layers
A variety of geographic data sets including air quality and flood plains are supplied on an annual basis (via digital upload) and imported into the HADMS SQL database

Public reference data-sets
A variety of open data sets are integrated including amenities (hospitals, schools), ONS deprivation index, air quality and flood plains are supplied on an annual basis (via digital upload) and imported into the HADMS SQL database

Below we outline the core functional features of the delivered digital solution, as shown in the attached live visuals of the built platform. The visuals below show the 'Fault duration' page for the Lighting estate, and the 'Priority Heatmap' for the Urban Tree estate, both as examples of the HADMS platform interface design, which is representative of the approach that is consistent across other pages.

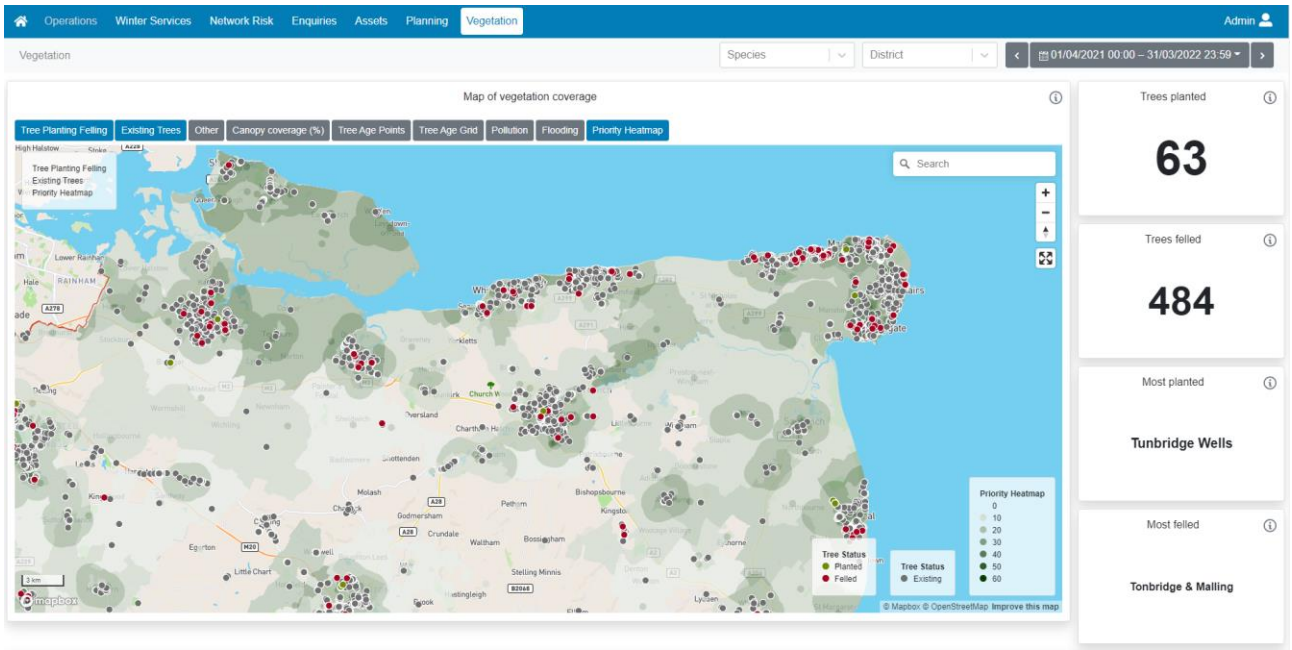


Spatial & Temporal Navigation
All functional features are accessed via a standard map-based interface and accompanying date-time control whereby the user can select any desired historical time window. This general interface is consistent with other workstreams on HADMS to provide a uniform consistent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

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.

Lighting fault monitoring
The total lighting estate is presented geospatially for the selected location and date-range, with a RAG-style encoding to visualise asset fault status (indicating presence of a fault, and if so the stage of response through to remediation). An accompanying tabular presentation of the faults is also shown, to provide more detail on each Lamp and its assigned Job (if any), as mapped from Confirm based on a proximity algorithm. This can be filtered to show all faults not yet assigned a job, to facilitate the initiation of new jobs.

Fault response performance
Provides an aggregated view of fault response performance over the date-range duration selected, to support periodic reviews. This performance is shown geospatially to indicate the point performance for each individual lamp, and is also shown graphically as an aggregated trend over the period.



Tree Estate Monitoring and Insights
The total urban tree estate is presented geospatially for the selected location and date-range, with a RAG-style encoding to visualise asset transitions (plantings and fellings) over the selected period, with options to view accompanying contextual map layers if desired

Locational priority scoring
Scoring metrics are devised to represent the context-driven priority of each location across the estate geography, to aid with decision support. An example is provided in the above 'priority heatmap' for the urban tree estate

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 Asset Management 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 Kent'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 Performance & Productivity - Improved strategic management of the urban tree estate leads to greater asset resilience. This in turn reduces the reactive component of tree maintenance, improving asset reliability, and benefiting KCC in terms of improved overall productivity

Estimated at ~5% x £0.5M total cost of tree maintenance operations = ~**£25K** per annum

Benefits in Efficiency – Ready visualisation of the connected street lighting fault response provides significantly greater velocity in generating the data and reports needed to monitor and manage maintenance performance

~25% x £40K total current FTE cost of Asset estate monitoring = ~**£10K**

Benefits to Customer – More contextual view of the soft asset estate improves the quality and impact of locations identified for planting schemes and interventions, leading to improved overall environmental and societal outcomes, including improved safety for users of the network

As this customer benefit is more qualitative, it is not estimated financially

Conclusion & Recommendation

The main benefit of this workstream is in the geospatial digitalisation of the asset estates and workload, enabling managers to more rapidly gain and sustain oversight of the operation, and obtain the performance information and measures needed to support maintenance management and strategic decision making without the need for manual data processing. For the urban tree estate in particular, being able to view this information directly alongside associated contextual data sets also enables greater insight into the factors that should guide this decision making. Accordingly, a further key benefit lies in this convergence of data between disparate systems.

The enduring effectiveness of the delivered solution will be dependent upon the reliability of these data feeds (SLV in particular) – however even where data feed issues arise, the tool itself enables these data service issues to be identified and mitigated much more rapidly. Thus, in general the solution facilitates much greater awareness and responsiveness by the business to maintain a viable asset management footing.

While these various context factors (such as flooding, air quality etc.) are useful to guide decision making in terms of customer and environmental benefit, attention should also be focussed on tree asset outcomes, such as health, longevity and the risk to the public in the event a tree should fail. Accordingly, it is recommended as a next phase of work that other locational data (such as planting density, traffic volumes, and exposure) be additionally applied to further inform asset decision making (particularly, where to optimally plant to maximise lifespan). Ultimately it may then be feasible to apply data science techniques to model and predict this health outlook for trees, to provide more intelligence to this decision making, however care should be taken to explore and evaluate machine learning approaches, as they will be dependent on the coverage and quality of the data sets available.

Finally, a further benefit to the wider KCC operation, is the usage of these asset data, and contextual data sets acquired to benefit other workstreams on the HADMS platform and beyond. For example, factoring the influence of tree locations and health within insights into drainage gulley locations and performance.

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 the road user environment and the public confidence that a consistent positive experience will elicit.

It also, if more in-directly, supports the DfT objective to "Tackle climate change and improve air quality by decarbonising transport"

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 monitoring and assessment of the asset estate, and its alignment with associated impact factors on the network, asset managers are able to identify and enact more effective installations, renewals and interventions that will improve overall network and environmental outcomes.

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?

Asset and works data can already be accessed within Confirm, and Confirm also provides a basic level of activity and performance reporting. The challenge for managers was being able to view this information on a network wide basis, and in general terms it was felt there is significant opportunity for better targeted insights to be provided, particularly in aligning these assets with other contextual data sets which, although already available through other services (such as Blue Sky mapping) are time consuming to access, process and assemble into any useful form to support analysis.

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, asset managers now have a single point of entry, and a platform which further integrates other contextual data (such as ONS and Forestry Commission) to provide a cohesive view of the asset environment across the operation. As well as general monitoring and decision support, importantly it also enables operators to access relevant targeted data quickly and efficiently when needed, reducing the overhead involved in responding to information needs and requests.

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 reliability and safety outcomes that arise from more effective maintenance management of the assets on which they rely day to day. In the case of natural asset estates such as urban through improved environmental outcomes and public spaces.

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, Asset Management as well as this Operations Management function. 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 Operations Management workstream is ~25% of this effort, or approximately £220K. 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 Operations Management 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 comparatively assessing trends in asset lifespan and reactive job frequency; And in the case of the street lighting estate, this will include evaluating fault response productivity and performance over time.

Although these direct and in-direct benefits have only been estimated at this stage, based upon Kent'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 reactive job rate (as proportion of workload)
- Reduced public claims and complaints, including reduced negative outcome claims
- Increased rate of success in public funding applications for natural asset initiatives
- Reduced overhead of fault response monitoring – operators and managers freed up to focus on their core value-add activities, 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 operatives 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?

Confirm business alignment – has evolved over the course of the Live Lab, including a number of acquisitions of the Confirm business which has made this alignment particularly challenging due to significant changes in their business strategy. It is important that we maintained a regular dialogue with these integration partners to ensure HADMS is effectively complementing Kent's solution landscape.

This is particularly true for the lighting estate, as Confirm have more recently introduced new integration with the SLV system, such that new faults can now be identified within Confirm, so that jobs can be raised directly within the Confirm Asset Management system. This functionality does not extend, however, to oversight of all fault responses and response history, which remains an exclusive benefit of this Live Labs workstream. Consequently, HADMS can now be used to monitor the performance of this new Confirm job initiation process.

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

The solution was designed and implemented in-house by Amey Digital Consulting in partnership with KCC, so there are no particular lessons in relation to procurement. However, it is useful to note that KCC through their partnership with Cantium have already invested to an extent into the Microsoft Azure cloud service for various other KCC initiatives, so from a procurement standpoint this Live Labs would have benefited from standing up HADMS on Azure, rather than Amazon (AWS). This is not a major issue as it will be fairly straightforward to re-platform the solution, but it is worth noting as a learning to try and align these technology and CTO roadmaps early on.

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 asset management package 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 £20K was provisioned by KCC to augment the core HADMS workstream delivery, primarily to cover the incorporation of the further externally-sourced context layers and associated formulated metrics to support decision making.

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 has been deployed as a pilot initially in order to validate its fit for usage prior to incorporating into KCC's operations management functions.

In retrospect, what would you do differently?

We could have benefited from tighter collaboration with KCC's supply chain partners – particularly those responsible for managing the SLV lighting estate. Ultimately, we did not have any issues with generally sourcing and integrating data as the project progressed, however its possible this collaboration could have benefited from more strategic buy-in by the contractor, facilitated by KCC.

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

Based on the premise of HADMS as principally a data convergence, insights and analytics platform, our original scope had included a component of data analytics in the form of modelling tree condition as a function of tree attributes (such as species, age and height) and local environmental factors (such as traffic volume and density of planting). The intention was that this model's outputs and feature weightings could yield additional context layers that can contribute further to asset decision making.

A small trial was undertaken early in the project to assess the viability of this modelling approach. Although it showed promise it was clear that asset condition is predominated by the tree's physical attributes which are already available within the asset history, and that there is a high correlation between species and environment whereby asset managers are already adept at selecting species to suit different planting conditions and scenarios. As experienced asset managers are already aware of these factors, it was uncertain as to how much further tangible benefit can be gained through modelling, and it is considered likely that separate models will need to be applied specific to each species, which will require significant more effort. Given the budgetary timescales of Live Labs, the decision was taken not to proceed beyond the trial phase on this project.

What lessons have been learnt?

The HADMS platform was originally envisaged as primarily an insights platform, to enable data-led decision making and management. While this remains the core capability of the platform, upon piloting of the platform in KCC district management it became clear that there is also a strong appetite for using HADMS for active monitoring of the operation, particularly due to the increasing resource challenges and budget constraints which has limited the capacity for operators to move beyond their immediate reactive workload. Tackling this direct incoming workload as efficiently as possible is therefore a critical priority.

For asset estates, this responsiveness is especially required under emergency conditions (for example, following a severe weather event). In this scenario, the ability to plan reactive maintenance response geo-spatially is a strong potential benefit. Accordingly, more focus is now being applied to tightening HADMS integration with data sources, particularly with the Confirm enterprise asset management system, in order to expand the scope of HADMS to address these more immediate operating use cases.

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 took steps to ensure that this solution will complement KCC's existing and emerging solution landscape, particularly in terms of the Confirm integration which is a core pivotal component of the solution. At the time of project inception, it was clear that there was no equivalent geospatial insights platform offering connected with the Confirm platform.

Additionally, we undertook a thorough review of KCC's existing GIS solutions, which are particularly prevalent in respect to asset management. In the case of its natural asset estate, KCC employ Esra for maintaining GIS data for both assets and programmed works, however this GIS system currently covers

other soft landscape assets, such as grass and hedgerows. It therefore did not offer any solution for the urban tree estate, but it was noted as being essential for any further expansion of the HADMS solution to other natural assets.

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

We are working in a fast-moving industry, with a complex and dynamic supply chain that is increasingly adapting to new technology and software capabilities. If we were to repeat this project again, we would need to undertake a significant phase of industry engagement to carefully position our solution within the current environment. We are confident that the solution, as currently delivered, is still a unique offering for Local Authorities, but in any event we would look to incorporate additional data services into HADMS to further augment its positioning in the Market.