Industry Insights Report

The Weather Ledger

July 2020

Digital Catapult is providing distributed ledger technology (DLT) and internet of things (IoT) expertise and creating a framework of standards for the Weather Ledger.

Contents

Executive summary

This Industry Insights report will provide a snapshot of:

1. the UK's construction sector;
2. its largest challenges, and how the sector may benefit from digitalisation, and;
3. the vast potential that digitalisation of weather compensation events can offer in light of the sector's need to modernise and keep healthy profit margins.

This pertinent contextual analysis explains the Weather Ledger project and its objectives, and ultimately aims to inform and drive the impact of utilising advanced digital technologies for this particular use case. The report findings uncover the potential and need for the digitalisation of weather compensation events for the construction sector, demonstrates savings gained through productivity enhancements and the reduced time to complete construction projects, as well as streamlining legal proceedings.

Key findings

1. It is common for construction projects to experience a lack of accurate, relevant weather data
2. Even with correct weather data, the process can be arduous and litigious
3. Current industry standard of 'one-in-ten year[1] weather event' is suboptimal
4. The digitalisation of this process would provide a number of benefits: reduction of back-office burden in onerous documentation and administrative tasks, as well as streamlining legal disputes

While compensation events for adverse weather conditions should in theory be a straightforward, binary question, (for example, rainfall either exceeded X or it did not); this research has indicated that in practice, the reality is very different. The projects which enjoy more straightforward weather compensation event claims are those which have a considerable amount of local, accurate, reliable weather data.

Locations such as Heathrow airport, which out of necessity for example, due to aircraft safety, have vast amounts of weather data, are a stark contrast to many construction sites where the nearest Met Office weather data can be over 100 miles away, does not adequately reflect weather on-site, and has historically missed a critical measurement indicating that there was a one-in-ten year weather event. This lack of onsite information creates many difficulties, frictions and misuse of resources for the contracted party.

There are a significant number of hours delegated to project managers, commercial managers and quantity surveyors in collating the relevant data, building the compelling evidence base and liaising with the client to apply for this compensation event. The research indicates that, even at this stage, when the relevant data is highlighted, there are still litigious disputes on settling which party is owed compensation, which distracts from other activities.

Finally, the findings from this report highlight a general perception that the industry standard of a one-in-ten year weather event is suboptimal. While this may be outside the scope of this particular pilot, this backdrop can better frame the benefits of the Weather Ledger project.

Ultimately, the need and value that the Weather Ledger project proposes is clear: the opportunity for weather related compensation events to be streamlined, and significant potential for cost savings via the reduction of project management overheads and back-office tasks.

Research methodology

This report and research has been authored by Digital Catapult as part of the Weather Ledger project. This insights report was developed through primary and secondary research: a comprehensive literature review of white papers, reports, and articles issued from governments, top tier business firms, construction expert groups was conducted, and was combined with insights from semi-structured interviews with multiple experts. The interviews were carried out by Digital Catapult in May 2020. When referring to 'experts' throughout this paper, it is in reference to these specific interviews. The interview questions asked can be found in the Appendix.

An introduction to the Weather Ledger project

Digital Catapult is providing distributed ledger technology (DLT) and internet of things (IoT) expertise and creating a framework of standards for the Weather Ledger, an Innovate UK project.

Climate change is making it increasingly difficult to predict weather patterns. Combined with the general increase in more extreme weather, this has made planning and operations more difficult for the construction industry, impacting on weather-related contract disputes, the costs of which can run into billions globally each year.

This 12-month project will develop and demonstrate a real-world DLT solution for automated evidence collection, information exchange, and contract administration relating to adverse weather events at two real-world construction sites.

Internet of things devices (IoT)

Using internet of things devices (IoT) on-site, construction companies can collect accurate and highly localised weather information. This feeds into smart contracts running on a distributed ledger shared by all parties to a worksite. This immutable shared data is both transparent and auditable. Automation of contract clauses based on this trusted shared data will save time and reduce, or even eliminate, costly and wasteful disputes.

The Weather Ledger is exploring the applicability of this model, including the user experience it would provide:

- Simple governance rules, no GDPR-sensitive data, no sensitive company data
- Verification replaces trust, through visible smart contract execution, immutable data and total auditability
- Simultaneous smart contract execution by all stakeholders, according to the weather data collected by IoT devices, enabling rapid alerts and swift allocation of compensation

Smart contracts

It is hoped that this project will set a precedent for further application of distributed systems in the construction industry

- Time can be better used for tasks that will help projects to complete more effectively and on time
- Lowering the risk of dispute will enable better collaboration within the industry
- Better data in general could help with more effective scheduling, to improve project delivery times
- This data may be used to add value for other industries

Product development will be undertaken with participation from all partners, maximising the value of available expertise.

Testing and iteration will be subject to detailed feedback from construction staff, on-site and office-based.

IoT devices used on a construction site are still novel, and for them to be used to collect weather data and then for the data to be used for smart contracts is entirely new and innovative.

Smart contracts and 'legal engineering' are both highly exciting emerging fields. The Weather Ledger is a world first in commercially-applicable smart contract technology, and certainly a first for construction.

Smart contracts are intended to automate the burdensome administrative work associated with disputes, which should also reduce any friction which would otherwise arise between parties. Smart contracting frees up legal experts to address more complex issues.

The Weather Ledger is an Innovate UK funded project led by consortium partners EHABITATION (EHAB) Limited and supported by Clyde & Co, Connected Places Catapult, Digital Catapult, Ferrovial Corporation UK and BAM Nuttall.

State of the UK construction industry

In 2018, the construction industry represented 6% of the UK's economy, at £117 billion, with 7% of jobs in the UK pertaining to the construction sector as of 2019. Interestingly, the proportion of construction workers in each region of the UK was comparable.[2] 13% of registered businesses in the UK are in construction - amounting to 343,000 businesses.[3]

The UK Government has specific policy focuses in modernising and optimising the sector: these include reducing the overall time from inception to completion of certain projects by 50%; as well as reducing the cost of construction by one third - both by 2025.[4] The UK Government has also identified some structural challenges to the sector, including labour shortages coupled with a widening skills gap. The UK Government plans to supplement education and training of construction workers.

While profit margins have remained relatively static within the UK construction sector, there has been a marked decrease in sales growth.[5] On the whole, there has been a reported downward trend in sectoral growth. The rising complexity in building structures, coupled with supply chain constraints, causes pressure to be profitable, especially with regards to minimising inefficiencies and streamlining the management of projects. Indeed, Deloitte has identified smart project management, using real-time data, leveraged for forward looking insights, with digitally optimised operations as a conduit to fostering economic sustainability and growth for the sector.[6]

Globally, 2019 experienced the continued advancement of digital transformation projects, with engineering and construction firms deploying advanced technology to modernise cities. City planners and local governments are increasingly, especially in light of COVID-19, considering how to make urban planning more sustainable, equitable and resilient, and in turn, are relying more on smart technologies to support this. More cities nationally, and globally, are looking to build smart infrastructure that better serves their residents. Building solid digital roadmaps will foster better responses to operational challenges, while offering a competitive advantage for early adopters.[7] This presents the landscape of a sector eager to reform and innovate, with growing motivation, though this does not come without its potential barriers.

Key challenges within the construction industry and the importance of digitalisation

This section highlights some of the key challenges within the construction industry, and the sector's historic inertia to innovate, while pinpointing the clear need for digitalisation. The core items discussed include: current state of digitalisation; lower profit margins; payments processing and delays; and finally, the evolving nature of client expectations.

Construction remains one of the least digitalised industry sectors in the UK.[8] A number of issues contribute to the sector's trepidation to adopt innovation, despite a number of government and industry led initiatives to enhance productivity. Notoriously low margins, an ageing workforce and an inability to free up resources to invest in new technologies are all part of the challenge. While digital evolution can be perceived as a threat, especially if not implemented or approached properly, the opportunities it can offer in both cost efficiency and client experience should be a top priority.[9]

The top 10 UK contractors had a combined turnover of £32 billion according to figures published in the past year, however, collectively these businesses had a pre-tax profit margin of -0.5%. Among the top 100 contractors, the average profit margin was just 1.5%.[10] These low profit margins may drive this reluctance, and restrict the ability to invest into digital innovation, even though these digital enhancements will ultimately drive profit margins up: 54% of companies which have adopted integrated digital practices have seen an increase in workforce productivity.[11] In a different survey, over 50% of construction industry respondents stated that digitalisation has contributed to attracting and retaining new talent. When considered in the context of an ageing workforce, with widespread skills shortages, effective digitalisation would appear to be critical to the future of the sector.

Key findings in this research suggest that a core challenge within the industry was payment processing and delays, both internal and external. This includes, for example, the process of receiving payments for compensation events. Six out of ten construction professionals responding to a survey stated that invoicing issues were one of their "biggest challenges". 50% of firms that implemented reforms to these processes managed to accumulate 20% savings on project management costs.[12] This is especially pertinent in the context of compensation events - contracting can be very litigious, with long legal disputes, going back and forth between parties as to who is or is not owed financial reimbursement or extended deadlines.[13] These payment delays disproportionately affect small and medium enterprise contractors. Further, given the UK Government is a major construction client, it is a top priority to ensure that the public purse is leveraged in the most efficient manner - making sure that each pound is spent on impactful work.

Furthermore, broad brush stroke findings of the construction sector indicate that, much like many other industries, top firms will need to improve client experience to keep winning new business with novel, innovative offerings. Client centred operations and project management is a continual upward trend for this sector, with many clients looking for a hybrid "product and services package", that includes performance tracking and support in financing and legal tasks.[14] It is evident that clients are no longer looking at just the final 'product' but at the end to end process of the project: completed with efficiency and minimal disruption.

These core areas paint the landscape around the need and potential for digitalisation in the sector - with compensation events cutting across some of the most pertinent challenges for the industry.

Framing the current process for weather compensation events

This section will outline the thresholds for qualification of a weather Compensation events (CE), as well as the work that is currently required to file a claim. Contextualising this process in detail will help to better understand the scope, potential and impact that digitalisation can have in this space. While this section specifically outlines weather CEs, it is important to recognise that this process is not dissimilar to filing for other CEs, which in turn will pave the way for future use cases and digitalisation in the process.

CE are extremely common considerations within the new engineering contracts (NECs), with about 20 standard CEs that appear for any given NEC. When events occur during the course of a project, which cause the completion of the project to be delayed, these may result in a compensation event, which allows the contractor to a) receive monetary compensation and b) have timelines reviewed. While weather compensation events are not the most common of the CEs, with interviewed participants stating three to five percent of disputes include a weather component, the process remains arduous and lengthy for something that would appear to be binary.

Weather compensation events

If a building project is delayed as a result of severe weather, the contractor might be eligible for a weather compensation event. There are many considerations that affect any potential compensation. While precise compensation details, including whether compensation is applicable, is contingent on what the contract states, general considerations focus on whether the contractor is entitled to additional time and/or money.[15]

The consequences of a contract overrunning normally include a financial penalty on the builder. Therefore, it is paramount to apply for a compensation event to avoid this penalty, and claim for an extension of time, on the basis that the delay and impact due to severe weather could not have been prevented. Additional challenges can occur if the parties to a contract cannot agree on the effect the weather has had, leading to the referral of the dispute to adjudication, incurring further costs and delays.[16]

Compensation criteria can include:

- Severity of weather conditions
- Impact on the project progress
- Contractor's entitlement to relief under provision of the contract
- Contractor providing sufficient notice

Contractual clauses for compensation events

The position of such unexpected events in common-law (for example, in the absence of specific provisions within a contract) is that a contractor is assumed to have contemplated the possibility of severe weather as part of the deliverables. However, exceptionally severe weather that could not be reasonably anticipated may be suitable for compensation.

Under the JCT (Joint Contracts Tribunal) suite of contracts, it is only weather which is 'exceptionally inclement' for the time of the year and the location of the project that would entitle the contractor to an extension of time (but no additional money). Consequently, the contractor is unlikely to be entitled to compensation under JCT for any loss and expense incurred as a result of stopping work.

As stated in the NEC3, rather than rely on the subjective generalisations about 'exceptionally inclement weather' sometimes included in standard forms of contract, the engineering and construction contract (ECC) includes a more objective and measurable approach.[17] This research has assumed the Met Office will provide appropriate data (as per the NEC) and is basing severe weather on a one-in-ten year event. The Met Office provides this service for a fee for every weather station in the UK and includes monthly weather reports highlighting "Red Flags" where weather is outside of NEC clause tolerances.

Process to apply for a compensation event

In order to receive compensation the contractor must file an application for it. This process can become extremely time consuming where data capture, exchange of information and contract administration between parties are all reasonably manual processes that take time.

Key activities that must be undertaken to ensure a compensation claim is valid are:

1 **A measurement of the actual weather conditions stated in the contract usually using nearby weather station:**

- Before the completion date for the whole of the works
- Showing to occur on average less frequently than once in ten years
- Reporting as an "early warning notice" (including "defined costs") to the client within 30 days of the event

2 **An early warning notice is the indication to the client / employer that sets out the impact of the event and mitigation measures and defined costs, in which the contractor is reimbursed the actual costs they incur in carrying out the works.**

Weather Ledger driving impact for weather compensation events

The purpose of the Weather Ledger project is to create a pilot system which demonstrates the potential benefit of digital data streams and algorithms to streamline weather compensation events. Given the binary nature of weather conditions, (for example, rainfall either exceeded Xmm or it didn't), the digitalisation of this process is in theory straightforward to manage.

However, in practice, it is an arduous process which causes delays and friction between the contracting parties. These two key items allow digitalisation of weather related compensation events to drive a lot of impact.

1. The potential for automation and digitalisation within specifically weather clauses may be more straightforward than other CEs to begin with

2. It offers clear value add in its use case by reducing frictions and minimising tasks within commonplace disputes

This section will outline the key value propositions for The Weather Ledger:

1. IoT sensors and radio technologies will complement existing digital weather reports from official sources, and add highly accurate and localised context to streamline and facilitate the process of identifying weather CEs

2. Creating a seamless digital user experience to overcome a key industry-wide obstacle to innovation. This is of great importance in the context of lower levels of digital literacy and ageing workforce in the sector

3. Current industry standard of one-in-ten year weather events deemed suboptimal

4. Utilising distributed ledger (DLT)/blockchain-based smart contracts improves contractual compliance, adherence to contracts, and reduces dispute resolution

Difficulty in collecting the correct evidence to qualify for a weather compensation event

The core problem is that one-in-ten year weather conditions happen surprisingly often, but contractors and subcontractors do not have the necessary evidence to prove that they are eligible for a compensation event. An expert interviewee outlined how in one instance, the construction site was visibly flooded, and resembled a 'lake', but the nearest trusted and authorised data sources for rainfall were too far away and did not accurately reflect that a one-in-ten year weather event had indeed occurred. As a knock on event, it took the project manager, commercial manager and quantity surveyors involved in the project on site level to build the evidence base and the overall case that a one-in-ten year adverse weather event had occurred. While this evidence is anecdotal, the research undertaken for this report with a number of construction professionals from different companies indicates that it is a common occurrence, and that this extra work disrupts and affects the activities that back-office and onsite staff are otherwise trying to perform.

At present, the majority of NECs stipulate that weather information must come from the Met Office, which typically charges £300 per report. Typically a project manager will request weather reports retrospectively, as no early warning weather signals are provided in the UK.[18] It is also not uncommon for monthly reports to be requested in retrospect from project and commercial managers - sometimes if there have been delays, there might be a more ad-hoc investigation and request for Met Office data - to see if weather contributed to delays, and consequently file for an weather-related CE event.

This delay in obtaining weather data, often in retrospect, and without any live warnings, is a major hindrance to efficient on-site work and rightfully receiving compensation for weather CEs. Regarding the £300 charge per Met Office report, some

interviewees have called this negligible, others have described it as a frustrating cost. What cannot be ignored is that the cumulation of these costs is better spent elsewhere, ideally in innovation or digitalisation.

The case for utilising validated onsite IoT weather data, and using a localised weather station and site wide LPWAN (low power wide area network) is therefore clear - the retrospective investigative process is turned on its head, and onsite staff are given access to real time weather insights on an hourly or daily basis. This can allow project managers to plan accordingly, deciding if weather conditions sit within contractual thresholds, and also eliminating any reliance on an intermediary to provide reliable data.

Weather Ledger creates 'beneficiaries' as opposed to traditional 'end users'

Throughout the primary research phase of this insights report, the majority of experts involved on NECs at site level were found to have low levels of awareness and knowledge about the use of advanced digital technologies and how these technologies could ultimately benefit their processes. Equally, expert interviewees were candid about having less experience in the tech space, with some participants even highlighting a level of discomfort with technologies such as building information modeling (BIM), which is more common within the industry. Having said this, there was a marked attitude of acceptance, and of welcome for such technology - in part due to the recognition of the difficulty in current process, and that the utilisation of new technologies could be a conduit to freeing more time for other project management or site activities (and in turn, potentially boosting profit margins). While the response was on the whole very positive, it is important to be cognizant of the widespread lack of experience or knowledge when using digital technologies within the industry, to ensure the building and deployment of a user-centric digital tool which delivers positive impact.

In this particular case, the relationship between how the user, the process and the technology interact is pertinent to explore. The development of the technology, at its most successful, would be developed in a seamless manner, whereby it eliminates the need for a number of stakeholders[19] within the process: particularly onsite staff, project managers and commercial managers. In this sense, they are not 'users' but 'beneficiaries'. It is framed as such because they are enabled to spend more time on other activities, thereby 'benefiting' from the technology instead of directly 'using' or interacting with it.

To this end, the Weather Ledger pilot is a considerable value add to construction companies as it enables staff to spend less time on applying for compensation events, and simultaneously, the contracted company does not need to invest in training its staff how to use the devices and increase digital literacy. Considering the broad landscape of construction professionals who, generally speaking, are less experienced in using technologies, this pilot offers a quick win for construction projects.

Current standard of 'one-in-ten year' weather event insufficient

While looking at industry standards might be outside of the immediate scope of this report, it is worth exploring briefly, to better frame and contextualize the crucial challenge that weather related events pose for construction professionals. It was expressed that the current process of a weather CE necessarily being a one-in-ten year weather event is suboptimal. One-in-ten year weather events may not be a suitable threshold for highlighting potential weather related delays and problems. One interviewee expressed that while not optimal, it is important to have a defined threshold for where the contracted party should be taking on risk.

Areas of future legal research might include creating hybrid contracts which combine elements of both the JCTs and NECs; with JCTs not necessarily including one-in-ten year weather event thresholds, but offering no compensation (and NECs the opposite). While it has not been possible to create different standards until now, this may be an interesting avenue for future exploration within the industry, given how advanced technologies may empower different contracts through real time data insights and advanced ways of working.

Furthermore, it is important to note that 'one-in-ten year' weather events do not encompass all weather conditions. There are a few aspects of weather which are currently not accounted for within this clause, such as fog. This report's findings indicate that ten year averages for such events either do not exist or are not useful. Fog will bring construction sites to a standstill for days unexpectedly, even if it is below a one-in-ten year average. For this reason, fog is not included as part of the contract. There might be value to be added through digitalisation by using devices to capture and denote adverse weather conditions relating to fog. This is included here as a potential area of future research, despite potentially being outside the immediate scope of the Weather Ledger project.

Core benefits of automation utilising distributed ledger technology (DLT)

Process automation using 'smart contracts' and shared transparency through DLT offers a compelling method of streamlining and better managing weather compensation events. Stakeholders will benefit from improved contractual compliance, adherence to contracts, with early warning timelines, automating audit trails and reducing dispute resolution. Overheads are also minimised with automated 'smart contracts' assessing event based compensation, reducing the burdens in the back-office, and eliminating the risk of manual mistakes or duplication of effort (for example double checking data and varying sources). Furthermore, this streamlined process has beneficial knock on effects for the wider supply chain such as no longer disproportionately impacting small and medium enterprise contractors, which is particularly important to 'leveling the playing field' in the sector.

Looking ahead, digitalising processes and providing open documented APIs to access data sources leads to greater interoperability with future versions of BIM, data analytics tools and project management systems. This also better opens up firms to future possibilities utilising other advanced digital technologies, such as machine learning, which require vast amounts of relevant and usable data (in specific formats).

Impact potential and future compensation automation

This section reiterates the potential of the Weather Ledger project, how policy initiatives may accelerate the widespread adoption and use of such a solution, and the potential groundwork to utilise a host of other advanced technologies.

In future, it is hoped that this successful use case can pave the way for further digitalisation in compensation events, potentially many more of the 20 standard compensation events which exist. It is evident that the impacts of digitalisation are clear: from both primary and secondary research: 68% of firms saved between 6-15% on operational reporting processes through the introduction of a digital solution.[20]

The UK construction industry faces clear challenges in both its desire, and its difficulty, in innovating. The potential of the Weather Ledger project highlights the need to encourage a policy driven approach to promote and accelerate the adoption of these new and useful standards. It is advised for there to be a top-down impetus to invest (potentially subsidised) to create new efficient protocols - and indeed this aligns with current UK government policy objectives to optimise and reform the sector.

This approach could be especially relevant given the UK Government is one of NECs biggest clients, as it is paramount to maximise the value of each pound spent from the public purse. Initiatives and deployments such as Weather Ledger pave the way for other types of advanced digital technologies to be more easily used and implemented. For example, in order to leverage other advanced digital technologies, such as artificial intelligence and machine learning, it is important to ensure that the digital systems in place can collect relevant and useful data, and at a large scale.[21] This will contribute to the long term road map in optimisations for the sector.

Concluding remarks

Weather Ledger offers an innovative, valuable solution to a very specific problem within the UK construction industry. This insights report highlights the evident problems that weather compensation events draw to the surface, as well as the vast potential that the digitalisation of this process has for on-site staff, and facilitating the end to end cycle and completion of NEC projects. The successful pilot of this compensation event will pave the way for future digitalisation and automation within the sector's standard processes, laying the groundwork for the potential of the sector to become more innovative, efficient and client centric.

Appendix

In total, we conducted 11 expert interviews, those who have agreed to be included are listed below:

BAM Nuttall

Adam Walker
Colin Evison
David Mitcheson

Clyde and Co.

Lee Bacon

List of questions asked in the expert interviews

Industry insights report: key questions

1. What are the key challenges facing construction at the moment? (clustering of categories)
2. Have they changed over the past few years?
3. What technologies do you currently use within construction? Are there subsets which are highly digitised or is it widespread across?
4. Do these solutions serve the challenges that you have aptly?
5. How many compensation events (CE) happen in a year on average?
6. How many of these CEs are related to weather conditions?
7. Have you considered or used other methods to calculate weather related CEs? If so, what are they?
8. What impact do adverse weather conditions have on efficiency / productivity. Do you know how much it has impacted ROI and other important KPIs?
9. Is the process to deal with adverse weather conditions straightforward? Who is involved in the process of dealing with the dispute resolution for this?
10. What could improve the process for dealing with adverse weather conditions within construction?
11. Ideally, what would be implemented to resolve this issue? Would you consider compensation automation?
12. What does 'trust' mean within the industry? Where does trust come from - existing relationships with other companies, particular people you've worked with in the past, or trust in the contracts you've drawn up between each other?
13. How well are DLT/IoT understood within your company and within industry? Are you aware of the benefits that these solutions can bring?
14. Would you consider a solution utilising DLT and IoT?
15. Would there be an impetus to invest in the implementation of these solutions. What are the barriers? Why have solutions been explored / not explored?

User insights report questions

1. How many contractors/subcontractors are involved in a typical NEC?
2. What is the average duration of a NEC project?
3. What is the formula to calculate weather related CE? (there seems to be some ambiguity on how the calculation is done, any precise guidance will be useful)?
4. Who is involved in a weather compensation event and when? Project managers? Workers on site? Legal office? Etc.
5. What impact do adverse weather conditions have on your supply chain (subcontractors)? For example on revenues, cash flows, scheduling etc?"
6. "Which tasks in weather disputes take up the majority of your time / cost? What kind of scale of effort is required from you on these, e.g. percentage of your time, or days per year etc"
7. where does trust/mistrust come from in the current process. What are the chief areas and causes of contention. Where does the process get too heavy/mired in legal review. What are the worst
and best-case scenarios?
8. Route to adoption for digital technology within construction, key decision makers within large companies - who controls budgets?
9. What do you understand as a weather related compensation event?
10. Describe the early warning notice sequence
11. Describe the compensation event sequence
12. How frequently do you get involved with this?
13. Understand their day to day activities around this
14. When do you get notified about a compensation event? How does it happen?
15. If an early warning occurs what do you do? Could you walk us step by step?
16. If a CE occurs what do you do? Could you walk us step by step?
17. Understand pain points
18. What admin do you have to do? Could you walk us step by step?
19. Where / when do arguments occur?
20. Understand high return x low cost opportunities
21. Where do you think the quick wins are?
22. Vision of ideal scenario
23. Which steps could be improved? What would you automate?
24. What do you think is an ambitious vision of the future for this system?
25. What would be the barriers to this?
26. Validate our flow
27. Does this look right?

Wider industry:

28. How painful are compensation events for your organisation?
29. Do you already, or, aspire to, use technology to solve this problem?
30. How could we educate your organisation and the wider industry about this?
31. Who or what could block this from being used?
32. Who would give the green flag for this being used?
33. What proof do you want to see before this can become something you would adopt?

Appendix II - A word on LPWAN

LPWAN capabilities

LPWAN (low power wide area network) technology is uniquely suited to address the construction industry's monitoring challenges as it provides wide-area coverage, is fast to deploy and requires limited infrastructure therefore minimising set up costs. One of the key attributes of LPWAN technology is the fact that devices and sensors require very little power and can therefore be run from batteries for a long period of time, which if optimised, can be many years. This makes the technology ideal for scenarios where the use case requires remote sensors that do not intrinsically have a constant and reliable power source. The frequencies and transmission protocols utilised by LPWAN solutions are well suited for deep in-building and underground coverage and operate effectively over long distances and through challenging radio conditions.

LoRaWAN technology

LoRaWAN (long range wide area network) technology has been selected for this project (alternatives include: SigFox, NBIoT and 5G). The LoRaWAN open specification is a low power wide area networking (LPWAN) protocol based on LoRa technology. Designed to wirelessly connect battery operated things to the Internet in regional, national or global networks, the LoRaWAN protocol leverages the unlicensed radio spectrum in the Industrial, Scientific and Medical (ISM) band. The specification defines the device-to-infrastructure of LoRa physical layer parameters and the LoRaWAN protocol, and provides seamless interoperability between devices.

Key features of LoRa technology

Long range - connects devices up to 10 miles apart in rural areas (up to 3-5 miles in urban areas) and penetrates dense urban or deep indoor environments.

Low power - requires minimal energy, with prolonged battery lifetime of up to 10 years, minimising battery replacement costs. If other sources of energy such as light, wind or moment are available devices can operate indefinitely.

Secure - features end-to-end AES128 encryption, mutual authentication, integrity protection, and confidentiality.

Standardised - offers device interoperability and global availability of LoRaWAN networks for speedy deployment of IoT applications anywhere.

Geolocation - enables GPS-free tracking applications, offering unique low power benefits untouched by other technologies. This is possible when the transmitting device can be seen by 3+ gateways (base stations). An accuracy of plus or minus 150 is possible. (If precise location is required a GPS receiver can be added to the device and the co-ordinates can be added to the payload).

Mobile - maintains communication with devices in motion without strain on power consumption.

High capacity - supports millions of messages per base station, meeting the needs of public network operators serving large markets.

Low bandwidth - the technology is ideal for low bandwidth applications such as measurement and telemetry.

Low cost - reduces infrastructure investment, battery replacement expense, and ultimately operating expenses.

The LoRaWAN ecosystem is growing rapidly with some major software, telecoms and hardware vendors (such as: ARM, IBM, Google and Cisco to name but a few) driving the initiative via the LoRa Alliance.

More details may be found here:
https://lora-alliance.org/member-directory

Endnotes

1 Weather conditions showing to occur, on average, less frequently than once in ten years. This is an industry standard measurement which appears on most New Engineering and Construction Contracts.

2 http://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf

3 With an annual turnover above £85,000.

4 http://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf

5 https://www.larking-gowen.co.uk/media/2536/mha-cre-report-2019-web-singles.pdf

6 https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-2020-engineering-construction-outlook.pdf

7 https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-2020-engineering-construction-outlook.pdf

8 https://www.constructionnews.co.uk/agenda/opinion/2020-year-construction-turns-corner-digitisation-11-10-2019/

9 https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2018/july/OliverWyman_Digitalization_in_the_construction_industry_web_final.PDF

10 https://www.causeway.com/hubfs/assets/documents/Front-Line-CDF19.pdf?utm_campaign=FY19H2-CDF19-Construction%27s%20Digital%20Front%20Line&utm_source=hs_automation&utm_medium=email&utm_content=75865673&_hsenc=p2ANqtz-86nHK9OmZqfQoGRpwcr5Xdr8udg9Vbv96XgwdpZ6EB-VfuvbFjD68wb2sJ-9Btj1-zbPeiA5j6alafqmFUUSYoaVh6Sw&_hsmi=75865673

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13 Expert interviews conducted by Digital Catapult, May 2020

14 https://www.oliverwyman.com/content/dam/oliver-wyman/v2/publications/2018/july/OliverWyman_Digitalization_in_the_construction_industry_web_final.PDF

15 http://www.stevencevans.com/whether-the-weather-is-fine-or-whether-the-weather-is-a-compensation-event-under-nec3/

16 http://www.stevencevans.com/whether-the-weather-is-fine-or-whether-the-weather-is-a-compensation-event-under-nec3/

17 Further details on NEC3 Guidance Notes can be found here: http://www.stevencevans.com/whether-the-weather-is-fine-or-whether-the-weather-is-a-compensation-event-under-nec3/

18 Currently deemed unnecessary, due to on the whole, mild weather. Unlike places such as the United States with more destructive and severe weather conditions.

19 Albeit not all stakeholders; there would still need to be an end user at the payments stage if the compensation event was successful.

20 https://www.causeway.com/hubfs/assets/documents/Front-Line-CDF19.pdf?utm_campaign=FY19H2-CDF19-Construction%27s%20Digital%20Front%20Line&utm_source=hs_automation&utm_medium=email&utm_content=75865673&_hsenc=p2ANqtz-86nHK9OmZqfQoGRpwcr5Xdr8udg9Vbv96XgwdpZ6EB-VfuvbFjD68wb2sJ-9Btj1-zbPeiA5j6alafqmFUUSYoaVh6Sw&_hsmi=75865673

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Digital Catapult is the UK's leading advanced digital technology innovation centre, driving early adoption of technologies to make UK businesses more competitive and productive and grow the country's economy.

We connect large established companies, startup and scaleup businesses and researchers to discover new ways to solve big challenges in the manufacturing and creative industries. Through this collaboration businesses are supported to develop the right technologies to solve problems, increase productivity and open up new markets faster.

As well as breaking down barriers to technology adoption for startups and scaleups, our work de-risks innovation for large enterprises and uncovers new commercial applications in immersive, future networks, and artificial intelligence technologies.

Digital Catapult provides physical and digital facilities for experimentation and testing that would otherwise not be accessible for smaller companies.

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