Thinks
Insight & Strategy

Connected Places: Rail and Aviation Sectors Research

Report prepared for the Department for Science, Innovation and Technology (DSIT)

Table of Contents

1. Introduction

1.1 Background and objectives

To support policy development, the Secure Connected Places Team within the Department for Science, Innovation and Technology commissioned Thinks Insight & Strategy to conduct qualitative research with professionals in the rail and aviation sectors responsible for the procurement, deployment, and management of connected places technologies.

The objective of the research was to provide insight into approaches to connected places and cyber security, specifically:

- How do professionals working in rail and aviation organisations understand connected places?
- How, if at all, is connected places technology currently being deployed by organisations in the rail and aviation sectors?
- What are the drivers and barriers to uptake of connected places technology?
- What approaches are being taken to cyber security?
- What is the role of cyber security guidance, if any?
- Are there any future trends for connected places technology in these sectors?

This summary report forms part of a wider series of research into approaches to connected places in non-local authority sectors. Further detail can be found in the overarching thematic report, education sector summary report, and sports and culture sector summary report.

1.2 Method and sample

Thinks conducted 14 x 60-minute in-depth qualitative interviews, nine with professionals in the rail sector, and five with those in the aviation sector. All interviewees were employed by a rail or aviation organisation, either directly or as a consultant. All had responsibility for at least one of the following:

- Designing and procuring connected places technology,
- Deploying and managing connected places technology,
- Cyber security associated with connected places.

Participation in the research was on an anonymous basis, but some example job titles in the sample included: Chief Technology Officer, Head of Innovation and Intelligent Automation, Digital Transformation Leader, and Head of Strategy Operational Delivery.

Greater detail on the methodological approach can be found in the technical report.

2. Executive summary

2.1 Audience breakdown

The key distinctions between audiences in this report are those between **airports and railway stations**, and between **larger and smaller** organisations. At a high-level:

Professionals working at airports more immediately feel that airports are suited to developing connected places, compared to the views of rail professionals towards stations.

- Aviation professionals perceive **the culture of the aviation sector** to be **future facing and technology oriented**. On the other hand, rail professionals feel their sector is relatively traditional and averse to change.
    - Some stakeholders in the rail sector present this as a barrier to implementing connected technology (see Section 4).
- Secondly, with respect to connected places, **airports are more obviously governed and utilised as 'places'** than stations are.
    - On the one hand, airport companies are typically distinct entities from the airlines who operate aeroplane fleets. Meanwhile, operators in the rail sector are more likely to manage both stations *and* fleets; therefore, their thinking about connected technology relates to improvements to the railway network as a whole, rather than simply to station spaces.
    - On the other hand, the customer journey is also different between stations and airports. Passengers are likely to spend more time (per journey) at an airport compared to a station, and to navigate it as a complex space in its own right (e.g., containing passport control, security, baggage claim, retail areas etc.).
- Lastly, airports typically have **larger budgets** than stations, with more private investment.

The size of both airports *and* stations influences how likely they are to have implemented connected places technology.

- Larger organisations have a **greater scale and complexity of space** (e.g., larger capacity and flows of people, more security, more retail spaces etc.), meaning they can see **more obvious benefits** to pulling together large amounts of data, for example to better manage staff resources or the flow of customers.
- Larger organisations are also more likely to have **greater budget and resource** to pilot and rollout new technologies than smaller organisations.

2.2 Understanding of connected places

- Consistent with other sectors, **rail and aviation professionals think about connected places technology as a means to achieving operational goals**, rather than an end in and of itself.
- **Understanding is often limited to the extent to which the technology is used within professionals' own organisation,** with larger organisations therefore more likely to see value in 'being connected'.
- **There is no term used consistently by rail and aviation professionals to refer to 'connected places'.** When prompted, professionals are most likely to use sector specific terms such as 'smart airport'.

2.3 Aims, facilitators and barriers to deploying connected places

2.3.1 Aims

- **Operating with a sustainable profit margin is the underlying driver for organisations in the rail and aviation sectors.** Organisations primarily look to achieve this by maximising their number of customers.
- **Two key aims of connected places technology therefore include improving customer experience (leading to more customers) and operational efficiency.**

2.3.2 Facilitators

- **No organisation in our sample has a dedicated connected places strategy.** Instead, deployment tends to be ad hoc in response to particular business needs or as part of associated strategies, e.g., technology or operations.

2.3.3 Barriers

- **Demonstrating the value added by connected technology is the largest barrier to implementation, particularly in the rail sector.**
- The following factors all make it more difficult for professionals to make a case for the value added by proposed connected place projects:
    - Emphasis on **cost-saving**
    - Resourcing and **lack of necessary skills**
    - **Procurement** and a perceived abundance of bureaucracy
    - **Risk averse culture**

2.4 Operating connected places technology

- **Rail and aviation organisations most commonly use IoT devices connected to the network via Wi-Fi** to deliver connected places projects.
- **At the moment, connected place projects are deployed in isolation.** They do not ladder up to a whole 'smart station' or 'smart airport'.

2.5 Future trends of connected places

- **Professionals feel that, while the technology itself remains fairly static, uptake of connected technologies will increase over the next 5-10 years.**
- **The key perceived drivers continue to be facilitating smoother customer journeys, and passenger safety and security.** Greater interoperability of connected technologies, allowing more accurate and holistic predictive modelling, is expected to play a large role in this.
- **Some consider AI to be the next disruptive technology, which has the potential to facilitate the move towards 'connected' decision making.**

2.6 Cyber security and connected places

- **Professionals are aware of the key cyber security risks associated with connected places technology**, namely hacking, data breaches and operational failure.
- **However, they perceive connected technology to be different from standard technology in degree, rather than type, of risk.**
- **In that context, professionals do not feel connected places projects require a bespoke cyber security approach.** Instead, they manage the risks in the same way as other technology projects.
- **While professionals from larger organisations benefit from established processes and structures to mitigate risk, they can also relinquish a sense of personal accountability for cyber security as a result.** Most who are not themselves cyber security experts will rely on a dedicated internal teams, such as risk management, IT or cyber security, when unsure on cyber security matters, rather than turning to information and guidance from external sources, such as Government.

3. Understanding of connected places

Key findings:

- Consistent with other sectors, **rail and aviation professionals think about connected places technology as a means to achieving operational goals**, rather than an end in and of itself.
- **Understanding is often limited to the extent to which the technology is used within professionals' own organisation,** with larger organisations therefore more likely to see value in 'being connected'.
- **There is no term used consistently by rail and aviation professionals to refer to 'connected places'.** When prompted, professionals are most likely to use sector specific terms such as 'smart airport'.

3.1 Familiarity with connected places

Most professionals are familiar with connected places technology and projects; those who are more senior or employed by larger organisations (either directly or as a consultant) are more likely to be aware of particular strategic use cases.

Larger airports and stations are more likely they are to have implemented connected places technology, because of:

- **Greater scale and complexity of space** (e.g., larger capacity and flows of people, more security, more retail spaces etc.), meaning there are clearer benefits to pulling together large amounts of data, for example to better manage staff resources or the flow of customers,
- **Greater budget and resource** to pilot and rollout new technologies.

> *"My teams are very much focused on getting things from X-ray machines... all the way down to ANPR cameras in the car parks. Getting all that information, pulling it into a central location, storing it in our data lake, and then making that information available." - Aviation*

There is no single 'connected places' leader in the rail and aviation sectors.

Instead, professionals cite a wide range of sources where they might look for inspiration regarding connected places, including:

- **Conferences and industry events**

- **Suppliers** of physical, digital or financial/professional services, including:
    - Large, global suppliers, e.g., Worldline, Nexus Alpha, Siemens, Alstom, SITA, AWS
    - Niche suppliers, e.g., Azinq, Airport Labs
- **Industry bodies**, e.g., Rail Safety and Standards Board
- **Large transport organisations**, e.g., Transport for London, Uber
- **Thought leaders**, e.g., Connected Places Catapult
- **Trade associations and membership organisations**, e.g., International Air Transport Association (IATA) or Airports Council International (ACI)
- **Local or partner universities**
- **Local authorities**
- **Venues for large-scale cultural events**, e.g., Olympic stadiums, World Expo centres

"I still haven't seen any 'leaders' that I think are brilliant [at connected places]. You know, aviation normally leads the way, but it may be that they're not very good at publicising it, because obviously a lot of the data sets that I'm talking about wouldn't be customer facing." - Rail

The Covid-19 pandemic has impacted on timelines for some connected place projects.

Since rail and aviation industries were severely affected by the pandemic financially, cost saving has become a top priority, and it is more difficult for professionals to evidence the possible value added by connected places projects.

"I've been trying to pitch a smart station concept for some time, and it was quite high up on the agenda at one point, but back then we had funding pots available. When Covid hit, that got kicked into the long grass, and to my knowledge I think it's still there." - Rail

"Pre-Covid, we did have a digital twin project. The ultimate version of a connected thing is to have a digital twin, so you can see everything that goes on and do 'what if?' scenarios and all of that kind of stuff. But that's stopped and it hasn't come back." - Aviation

This being said, the shift to online ways of working did mean that a minority of organisations were able to use the pandemic to re-evaluate how effectively their technology was being used.

"Covid was like an electric shock. For 6 months, we were meeting online every Monday and just going through a brainstorm of what the airport of the future will look like,

because there wasn't much else to do. There weren't any passengers. So I think there was an element where we were all able to sit back and think, 'Well, hang on, we've got enabling technologies here. Are we using them effectively?'" - Consultant, Aviation

3.2 Understanding of connected places

Consistent with other sectors, rail and aviation professionals think about 'connected places' technology as a means of achieving operational goals, rather than an end in its own right.

This is with the exception of the largest organisations, who have operated connected technology for a long time (relative to competitors) and are therefore more likely to see the value of 'being connected'.

"We did a piece where we integrated control systems with crew and stock systems, and it was the biggest step forward in decision making. If we had a block on the train between Reading and London, that has an impact on when train crews move through the respective stations, so it allowed us to forecast the impacts on capacity and crew in real time." - Rail

While there isn't a term that is used universally, professionals are more likely to use sector specific terms such as 'smart airport' instead of the broader term 'connected places'.

Other names include 'digital railway' and 'open airport', but these are used idiosyncratically.

"So, there was a time when Industry 4.0 was the thing I called it, Airport 4.0, which a few people have done. But some airports have called it 'smart airport'. Other places have broken elements of it down about 'wanting to be more data-driven' and that type of thing." - Aviation

"We're starting to look at [what] we're calling an 'open airport', similar to open banking. You can get authorisation and we'll start giving out information, and we get information back and it all comes together." - Aviation

The term 'connected place' feels less relevant to some rail organisations in particular.

Airports typically have large and well defined indoor spaces, within which there is a clear need to connect many parts of a complex ecosystem. This also applies to larger railway stations.

In other cases, however, professionals in the rail sector describe the connected technology that has added value in recent years as relating to the overall train network, rather than the station environment. For example, developments in automatic route signalling and remote condition monitoring for fleets have had a large impact on operational efficiency, while e-ticketing and automatic fare collection have facilitated smoother customer journeys.

4. Aims, facilitators and barriers to deploying connected places technology

Key findings:

- **Operating with a sustainable profit margin is the underlying driver for organisations in the rail and aviation sectors,** who primarily look to achieve this by maximising their number of customers.
- **Two key functions of connected places technology therefore include improving customer experience (leading to more customers) and operational efficiency.**
- **No organisations in our sample have a dedicated connected places strategy.** Instead, deployment tends to be ad hoc in response to particular business needs or as part of associated strategies, e.g., technology or operations.
- **Demonstrating the value added by connected technology is the largest barrier to implementation, particularly in the rail sector.** The following factors all make it more difficult for professionals to make a case for the value added by proposed connected place projects:
    - Emphasis on **cost-saving**
    - Resourcing and **lack of necessary skills**
    - **Procurement** and a perceived abundance of bureaucracy
    - **Risk averse culture**

4.1 Aims of deploying connected places technology

Operating with a sustainable profit margin is the underlying driver for organisations in both the rail and aviation sectors.

Organisations primarily look to achieve this by maximising their 'throughput' and 'output', i.e., the number of customers who can move through stations and airports, and the number of journeys that can be safely and effectively delivered for passengers.

Additional strategic goals, aiming to drive uptake from customers, include:

- [In the rail sector] **Modal shift**, i.e., incentivising the public to use trains rather than other modes of transport such as cars or buses;
- [In the aviation sector] **Connecting to surrounding transport infrastructure**, e.g., providing a 'linked up' service with train and bus stations, taxi services and car parks etc.

These organisational goals can all be positively impacted by two areas where connected places technology can serve a key role:

- **Improving customer experience**. Making decisions based off real-time data can facilitate smoother journeys for customers by minimising disruption, and providing more accurate and targeted information to customers at an appropriate stage in their journey.

> *"The early identification of customer behaviour is really important. A lot of the impacts to other customers while travelling can come from customer behaviour, for example loading and trespassing. And there's a lot to be said for what can be detected ahead of time, so that we can then predict future impacts on service." - Rail*

- **Improving operational efficiency**. Given the size of many airports and stations, professionals want to make sure they are being managed efficiently. This includes making sure that spaces are being lit and heated in a 'smart way', that flows of passengers are managed effectively (e.g., to avoid overcrowding and understaffing) and that assets are well maintained.

Better operational management is felt to facilitate the following benefits (in order of perceived importance):

- **Lowering costs and risks.**

> *"If you put machine technology in places where humans don't need to be, it costs less and is much lower risk; the human cost is lower." - Rail*

- **Improving resourcing.**

> *"You're talking about a suite of data sets that can help get staff into the right place at the right time." - Rail*

- **Pre-emptive and data-driven decision making, e.g., maintenance of fleets.**

> *"Some people will make decisions on anecdote and not insight. They may say it makes sense to change a part on a train because it's rattling, but actually, if you're being told ahead of time by a sensor that it needs it or doesn't need it, that's really good validation." - Rail*

- **Improving sustainability.**

> *"I guess we're learning towards the sustainability element. If you can identify where you should and should not be using energy in certain places, it not only reduces the cost of business, but also it doesn't look too bad when you're talking about your sustainability pledges." - Rail*

4.2 Facilitators to deploying connected places technology

No organisation in our sample has a dedicated connected places strategy.

Instead, deployment tends to be ad hoc in response to particular business needs or as part of associated strategies, e.g., technology or operations.

> *"Do we have a joined up strategy on this kind of stuff? The answer's probably no. We piecemeal try and provide value add by technological advancement." - Rail*

However, in some organisations connected places technology is driven by being part of an adjacent or broader strategy.

In line with understanding connected places technology as a tool to achieve other goals, its usage in some organisations is driven by its inclusion within:

- Technology or Digital strategies
- Operational and Safety strategies

Even when driven by strategies, some professionals feel that their organisations can lack a long-term approach to connected technology projects.

> *"We have an Operation and Safety Systems Strategy. We know that we need to replace some systems on the basis that they're end of life, but people talk about 'strategy' to mean the next 1-year plan, as opposed to what do we want our estates to look like in 20 years." - Rail*

4.3 Barriers to deploying connected places technology

Demonstrating the value added by connected technology is the largest barrier to implementation, particularly in the rail sector. In the aviation sector, procurement is one of the largest barriers.

The following factors all make it more difficult for professionals in both sectors to make a case for the value added by proposed connected place projects:

- **Cost-saving:** Many connected projects are high cost, both to implement and maintain, which can make investment unappealing:

> *"We're being pushed to keep costs flat if we can, if not reduce; that has been the focus for the last year or two. So, it's just a 'yes that's great,' but the general answer from senior management is, 'no, not at the minute.' You can revisit it in the future, but if it involves investment in anything, no." - Rail*

"Funding, you know, money. The government doesn't give you anywhere near enough." - Rail

- This investment can be even greater because of the need to retrofit technology onto old buildings:

"You might need to invest in improving the station first before you're able to deploy the technology, and that could often take some time, and some additional investment." - Rail

- **Skills and resourcing:** Organisations of all sizes say they struggle to have the number of staff with sufficient skills to be able to process and effectively make use of the data being collected via connected technologies. Without this, the value generated by connected place projects does not feel worth the investment.

"Sitting there, looking at the data, trends, translating the data into useful information, that's a service in itself. If we have to do it in-house, then that is a bit of a blocker as well, sometimes we don't have the resources." - Consultant, Rail

- **Procurement:** Both rail and aviation organisations note the large number of players and regulations that must be consulted to get connected places projects off the ground; some feel disincentivised by the length of time and amount of effort projects will take to be authorised.

"If it's a case of 'we can't build that ourselves', then going through the procurement measures to do it and making sure we follow all the right rules, there's a lot of red tape that slows it down. [...] I don't think it's a tech problem, I think it's a business problem." - Aviation

"It needs to be accepted by DfT and meet certain regulatory standards, so the RSSB, the ORR, even HSE. Then you've got people fighting over the budget internally. […] There's a lot of people to convince, and you almost have to convince yourself it's worth it, because the effort that goes in to getting it over the line is probably one of the biggest barriers." - Rail

- **Culture:** Some stakeholders in the rail industry feel that the sector is particularly averse to technological change, because of the railway's long history and tradition in the UK.

"It's a very traditional industry. A very basic barrier is, 'we've always done it this way, so why would we want to do something else?' It sounds silly, but it's just people being unaware of the potential benefits, so your business case has to be even stronger." - Rail

- Meanwhile, professions in aviation also describe their sector as risk averse in places, but from a perspective of safety and security.

> *"Aviation generally is risk averse because moving a huge aircraft safely has an inherent risk, so we approach everything in a very risk managed profile. That level and approach to risk is embedded in the culture, so it can be very difficult to overcome that with new stuff. One of the difficulties with any innovation in aviation is that culture; it's almost like, 'No" before you've even asked the question because it's the easiest thing from a risk aversion perspective." - Aviation*

- **Competing drivers:** Having strategic priorities in tension with one another can make it more difficult for connected places technology to 'tick every box', e.g., a project might allow an organisation to deliver operational efficiency in the long-term, but require more investment in terms of upfront costs or resourcing.

> *"I think you have competing drivers. As a public railway, there's a pressure to reduce costs and at the same time deliver better customer service and better operations. At some point, you can't do all three." - Rail*

5. Operating connected places technology

Key findings:

- **Rail and aviation organisations most commonly use sensors and IoT** to deliver connected places projects.
- **At the moment, connected place use cases are deployed in isolation.** They do not ladder up to a whole 'smart station' or 'smart airport'.

Professionals are aware of a range of technologies used within their organisation to deliver connected places projects. The technologies most frequently mentioned by professionals include:

Rail	Infrared sensors or measuring average weight on trains for the purpose of understanding occupancy and footfall Remote condition monitoring for trains Apps and machines relating to ticketing and on-board seat reservation Control systems / automated route signalling (e.g., measuring speed and location of trains, via sensors and GPS tracking)
Aviation	Tracking mobile phone data or Bluetooth for the purpose of understanding occupancy and footfall Interactive screens / dashboards (for staff or customers) Security machines, e.g., body scanners ANPR
Both	Wi-Fi / 5G connectivity (in stations and on board vehicles) Cloud data storage AI overlay on CCTV footage IoT – e.g., smart lighting, heating, air conditioning, water quality

However, professionals tend not to think about connected places in terms of devices and instead focus on how it's used.

Since the technology is seen to be an enabler of wider strategic aims, professionals typically do not think about particular specifications at the procurement stage, with factors such as costs and certifications impacting on the particular models used.

"I'm not a deep technology person and some people get obsessed with certain bits of technology and they think that blockchain is going to be the answer to everything, or everything's going to be IOT or everything's going to be artificial intelligence. In a way, I don't really care what the underlying technology is, I just want to know what business outcomes it's going to achieve." - Aviation

At the moment, connected place use cases are deployed in isolation. They do not ladder up to a whole 'smart station' or 'smart airport'.

For smaller organisations, a combination of operational barriers (e.g., costs, resourcing) and lack of tangible benefits means that they add connected technologies on an individual basis rather than at scale.

Meanwhile, the more advanced organisations have been able to implement much connected place technology over the last decade, but much of this has been in silo. For these organisations, connecting data to inform and automate decisions is seen to be the next piece of the puzzle, that can add value going forward.

"For over 10 years, we've had computer vision to give queue time, and used Bluetooth and Wi-Fi on phones to detect queues; the intelligent devices, we've had for a long time. What we haven't been really good at is bringing them all together to make an informed decision based on different things. The plans now are to start pulling all these things together into centralised dashboards, and to not just give people information but a recommendation." - Aviation

Case studies

Case Study: Rail

This rail provider views connected places technologies as a means of **empowering staff to optimise their decision making** and provide the best level of customer service possible. The technologies employed in the support of this are predominantly **sensors which provide data on station conditions** to support more dynamic staff deployment. They include:

- Sensors measuring **platform surface temperature** to guide gritting efforts in the winter.
- Sensors in toilets to give up to date information as to **when cleaning is required.**
- **Occupancy sensors** measuring dwell time to flag any potential overcrowding or **anti-social behaviour.**

The primary barriers to the further implementation of connected places technologies are issues of **cost and data processing capacity**. There is a concern around front-loading the implementation of this technology, investing in these kinds of sensors while lacking the capacity to process the data that they produce into an actionable form. Plans for a more coherent smart station strategy were also set back by the disruption to the industry caused by Covid.

Case Study: Aviation

This airport has **extensive and sophisticated connected places technologies,** implemented with the aim of optimising their operations. This is achieved by **pulling data from devices across the airport into a central repository**, where it can be analysed holistically in support of the effective and efficient working of the **airport as a whole**. This is the case in terms of providing insights to support staff decision making, such as:

- **Monitoring footfall** across the airport to predict periods of high and low demand at choke points such as security and border control, and to pre-emptively adjust staffing levels accordingly.
- **The use of geolocation technology** to track equipment across the airport to minimise staff time spent finding it.

As well as empowering connected places systems to take automated actions, such as:

- **Turning off lighting and HVAC systems** at terminals not in use, and automatically turning them back on when a plane is scheduled to arrive there.

The key barriers to the further implementation of this technology have been the **difficulties of carrying out research and development** activities in such a capital expenditure heavy industry, and the significant **security and regulatory requirements** of employing these kinds of technologies within **critical national infrastructure.**

All organisations have an official procurement process for new technology.

When considering new connected place projects, professionals first specify a need and business case for the technology. Once this has been defined, they will then look at the right types of technology for the project and suppliers who they think may be well suited to deliver it. Organisations will then decide on suppliers through an official tender process, which typically includes multiple rounds of pitching, ethics assessments and risk and security assessments.

Professionals often collaborate in this process with other teams across their organisation, particularly at larger organisations and for larger connected place projects.

Once a contract with a supplier has been agreed, most organisations then pilot the technology before rolling it out. During this time, they monitor the performance and value added of the technology over a defined period of time.

There are occasions where this process is less formal, for example where the desired technology providers are existing suppliers, or where the particular project or team is smaller.

"We look at the business case, then the funding mechanisms. Then it would be, 'we know who is good in this space, let's go out to tender' and then we'd go out through that formal tender process." - Rail

6. Future of connected places

Key findings:

- **Professionals feel that, while the technology itself remains fairly static, uptake of connected technologies will increase over the next 5-10 years.**
- **The key perceived drivers continue to be facilitating smoother customer journeys, and passenger safety and security.** Greater interoperability of connected technologies, allowing more accurate and holistic predictive modelling, is expected to play a large role in this.
- **Some consider AI to be the next disruptive technology, which has the potential to facilitate the move towards 'connected' decision making.**

Some professionals feel that improvements to the hardware available to organisations are likely to be fairly slow. For example, they consider certain connected technologies, such as 5G or infrared sensors, to be as developed and efficient as they need to be to adequately perform their role.

"We've taken the technology of 5G to the max, the only thing is maintenances and upgrades and updates." - Consultant, Rail

"The past 10 years since I've been in the industry. The sensors have remained almost the same. The way they interact with the aircraft and on the ground have remained almost exactly the same." - Consultant, Aviation

Where professionals see value is in system interoperability and the ability to make more informed – and in some cases, automated – decisions.

Consistent with other sectors in this research, this view is heightened among larger organisations, who already have a large amount of connected place technology implemented.

"Every step of the way now we're not creating services and applications in silo, we're creating an essential data repository, so that we can make informed decisions based on the information that all those services provide us. I think it's all about interconnected airports, really." - Aviation

Some consider AI to be the next disruptive technology, which has the potential to facilitate the move towards 'connected' decision making.

In comparison to hardware such as sensors, AI is understood to be a new development with a huge amount of potential, to let organisations move from

the status quo to fully connected and predictive modelling. In particular, the amount of data that AI can process, as well as its versatility, make it an attractive proposition.

However, while some organisations currently overlay AI software onto CCTV footage, for example to measure footfall or detect anti-social behaviour, none had concrete plans to implement connected place projects involving AI in the near future.

"I hope that, you know, AI comes into play even more and the whole, for example, station could have predictive maintenance more widely used." - Rail

"In terms of the next step change it is going to be only AI, and if AI then drives data process and data management." - Consultant, Rail

"I see that we're already thinking about artificial intelligence for plane turnarounds, to start impacting and understanding what the impacts are, and then what changes we need to make throughout the airport." - Aviation

Overall, professionals expect uptake of connected technologies to increase over the next 5-10 years. The key perceived drivers for this are facilitating smoother customer journeys, as well as passenger safety and security.

Smooth service delivery incorporates managing delays, providing accurate and relevant information to customers, and managing features such as catering and ticketing which impact on customer experience.

"In terms of rail, how can we reduce delays? And where there are delays, how can we pack that information to passengers? Also making the station itself a pleasant part of the journey. If you go in somewhere and the catering proposition is great, the ticket purchasing process is super smooth..." - Rail

"I think it will move forward at quite a pace, so then we will have more optimisation around seamless processes, and I think it should also then have more embedded safety and stuff like that." - Aviation

"I hope there is more utilisation of the technology, and I hope that it really helps to enhance the customer experience. In 5 years' time, I would expect the journey to be more seamless than what it is today." - Rail

A key perceived challenge relates to making changes to physical as well as digital infrastructure.

While professionals perceiving technology to always be advancing, and software updates to be relatively quick to install, changes to physical infrastructure are perceived to take much longer and require more resource. This is particularly the case for railway stations whose buildings are often tens or hundreds of years old, and not built with connected technology in mind.

> *"The biggest challenge is going to be the physical infrastructure. It takes a long time to change physical infrastructure. And in a safety-critical business, changing trackside or station infrastructure is, by definition, going to take a while." - Rail*

7. Cyber security and connected places

Key findings:

- **Professionals are aware of the key cyber security risks associated with connected places technology**, namely hacking, data breaches and operational failure.
- **However, they perceive connected technology to be different in degree, rather than type, of risk.** This is consistent with findings in the Education and Culture and Sports sector reports.
- **In that context, professionals do not feel connected places projects require a bespoke cyber security approach.** Instead, they manage the risks in the same way as other technology projects.
- **While professionals from larger organisations benefit from established processes and structures to mitigate risk, they can also relinquish a sense of personal accountability for cyber security as a result.** Most who are not themselves cyber security experts will rely on a dedicated internal teams, such as risk management, IT or cyber security, when unsure on cyber security matters, rather than turning to information and guidance from external sources, such as Government.

7.1 Understanding of the cyber security risks

All professionals in the sample are aware of the key cyber security risks associated with connected places technology.

Professionals acknowledge there are risks associated with an increasingly connected place. Their primary concerns are hacking and data breaches, and the potential for rogue or unauthorised actors to access commercially sensitive information or to force operations to cease.

This is particularly front of mind for larger organisations, who either constitute critical national infrastructure, or who have heard about increasing data breaches at large organisations over the past few years.

Professionals also understand that human error by employees is a vulnerability for a connected system.

> *"The number of attempted hacks we get every single day [are] just absolutely ridiculous. Ok, the vast majority of them are turned away but there's some issues in some of our really old legacy systems. We are on critical national infrastructure and so we're a target for all kinds of things." - Aviation*

"I think if you look at the amount of information that we hold on customers… then we have 3000 frontline colleagues inputting into phones. It only takes one of those to be stolen and not to be encrypted and then people have an entry point." - Rail

"Any kind of connected device, especially if it's open to the wider internet, is open to hacking and GDPR concerns. As soon as you collect any form of data, there's major GDPR concerns. It could even be, if you're taking people's Wi-Fi or Bluetooth devices, that they're open to be hacked and things like that." - Aviation

The **enhanced capabilities** that connected technology provides mean that some professionals are even more concerned at the power it could afford bad actors.

"The biggest risk there being if someone could get connection to signals. Ultimately you could put every signal on green and just allow every trained crash into each other." - Rail

Furthermore, some are wary that increased **reliance** on technology will lead to greater operational failure – and ultimately, cancelling services – when things go wrong.

"So the more that you rely on the systems to be able to deliver any of these functions, [the more] any vulnerability accessed by third party can compromise how you have designed your systems." - Consultant, Rail

7.2 Management of the cyber security

Despite these concerns, stakeholders perceive connected technology to be different in degree (rather than type) of risk, compared to standard, operational technologies.

In that context, professionals do not feel connected places projects require a bespoke cyber security approach. Instead, they manage the risks in the same way as other technology projects, which often includes considering risks from the design and procurement stages of a project. If professionals cannot be sure of technology or suppliers' cyber security credentials at this stage, they are unlikely to go through with the project.

"It's no different [for connected technology] to what it is right now, because when you go for new companies, there are minimum tolerances that you have got to have: x amount of trading years of service, x amount of Companies House

representatives, x amount of certification. We've got processes in place [to manage risk]." - Consultant, Rail

"It's just a question of, 'how have you designed your systems to make sure that the risk from any of these vulnerabilities has been either removed, completely eliminated, or mitigated?" - Consultant, Rail

All are fairly confident in their organisation to manage the security risks of connected places projects in theory.

They point out internal measures and training for example, segregating authorisation and access to networks, or internal phishing training.

"I think we're in a good place, we've got a good cyber security team, I think they are on the ball, we have a good working relationship with them, I think we have a decent understanding of proportionality when it comes to it. I feel reasonably confident at the moment." - Rail

Some larger organisations make use of internal and external teams to prove themselves against simulated attacks.

"We've gone through a lot. We have our own internal audits done, like security audits. We work with external red teams and with NCSC for them to come in and do organised attacks on us. And we've always come out fairly strong. So, I'd say a high 90% that I'm confident we can survive these things." - Aviation

While professionals from larger organisations benefit from established processes and structures to mitigate risk, they can also relinquish a sense of personal accountability for cyber security as a result.

Most who are not themselves cyber security experts will rely on dedicated internal teams, such as risk management, IT or cyber security, when unsure on cyber security matters, rather than turning to information and guidance from external sources, such as Government.

"So we do quite a bit of internal training on that stuff as well. That's a mix of our internal security team and also external partners that they bring in sometimes to do various training on different areas. But it is quite segregated by tower. So most of us stick to our lane and it's generally a case of you bring in subject matter expert in whatever area to put together a service." - Rail