



From smart possibilities to smart investments

MUFG EMEA: SMART INFRASTRUCTURE REPORT 2018

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About MUFG

MUFG is a global financial services group with a network spanning more than 50 countries. The world's fifth largest bank by total assets, our financial strength, stability and expertise equip us to offer a wide range of complementary products and services, stretching from commercial banking to securities services. We pride ourselves on exceeding client expectations and building long-term relationships.



MUFG's Structured Finance team

MUFG's structured finance team offers comprehensive advisory and debt arrangement for the nonrecourse and limited recourse financing of long-term, capital intensive projects. Our specialist teams focus on a range of sectors, including power and renewables, infrastructure, natural resources, and housing finance.

The infrastructure and transportation team structures, advises on and arranges complex debt finance solutions for greenfield infrastructure projects, refinancing and the purchase of existing infrastructure assets and aviation financing.

Based on asset and sector expertise, we offer tailor made debt solutions to our customer base for the development and acquisition of assets in transportation, public services, environmental services, telecommunications and housing finance.

We are a market leader in renewables, thermal power and regulated transmission and distribution assets.

Our global renewables portfolio covers offshore and onshore wind, solar photovoltaics (PV), concentrated solar power projects, hydro geothermal and biomass. We have financed more than 350 transactions representing approximately 60GW of renewables generation capacity and our renewable energy project finance portfolio was recently measured at over \$13bn.

The natural resources team work across the entire value chain – upstream, midstream and downstream with core focus on pipelines, regulated assets, vessel financing and large scale refineries and petchem facilities.

Our advisory service is product neutral in structuring the most competitive and deliverable funding solutions for our client base evaluating all available funding sources in the market. These funding sources include commercial or multilateral banks, institutional investors, private placements or public bond finance or a combination thereof.

Foreword

Smart infrastructure has the potential to transform the infrastructure environment, making existing assets more useful and more cost-effective, and revolutionising aspects of the new build environment. Enabled by data and analytics, these digital enhancements to physical infrastructure bring better performance and lower cost.

Whilst there have been numerous studies into the technological potential of smart infrastructure, little has been done to gauge investor appetite, or to seek the investment community's views on how the business of funding may need to adapt to this challenge.

In commissioning the research outlined in this report, we sought to explore how the changing nature of infrastructure is being perceived by investors from both the private and public sectors, and whether, and to what extent, the rise of smart infrastructure is beginning to affect the realities of funding and investment decision-making. Our investigations covered how projects are assessed, as well as what can be done to overcome challenges such as obsolescence risk as technology rapidly evolves, the blurring of boundaries between transportation, energy and technology and the need to collaborate in new ways. There is a growing recognition that as the impact of technology increases, so will the need to add complementary technology skill sets to existing infrastructure teams.

We deliberately canvassed several groups within the infrastructure community upon whom effective infrastructure funding depends; including government funders from both central and specialist departments, as well as private sector funders such as institutional investors, infrastructure funds and corporate investors from contractors, technology firms, and telecommunications companies.

As one of the commentators in our study succinctly put it, change cannot happen in isolation. Delivering on the social, financial and environmental promise of smart infrastructure means incentivising diverse interest groups, sharing risk as well as reward and finding effective ways to collaborate. What's more, it involves turning smart possibilities into investable opportunities if industry enthusiasm and consumer usefulness are to be matched with funding. Access

to diverse sources of private capital will be key to making the rollout of smart infrastructure a success on a meaningful scale. In the current environment of budgetary pressures felt by governments and procuring authorities everywhere, there are a number of discussions to be had about how this technology could be leveraged to the benefit of both the public and private sector. Our research shows that there is more to be done to ensure interests and expectations are aligned in a way that fosters the necessary collaboration to make this a success.

Our research has also indicated that there are concerns around the pace of change and how obsolescence risk can be managed, and consequently whether or not the current risk models need to adapt or change to cater for this evolution. In our work at MUFG, we can see the potential this has for the infrastructure market and how important this may become for our clients. As a result, we are now investing in understanding these developments in a way that has the ability to add value for our clients. We bring many parties together when structuring project finance transactions, and are acutely aware that the fourth industrial revolution will affect the funding ecosystem that our infrastructure clients rely on.

We think there is real potential in this growing sector, but there needs to be more examples of how this translates into a concrete financial benefit for both the public and private side before it is really embraced.

I would like to thank all the participants of this research for their time and candid views. Smart infrastructure is at the beginning of a journey that requires thought, discussion and pragmatism; in many cases between groups who are not used to working with one other. Building connections across geographical and industrial boundaries is central to our work at MUFG and we're keen to hear from those with an interest in this fast-emerging area.



A handwritten signature in black ink, appearing to read "Phil Roberts".

PHIL ROBERTS
Head of Investment Banking
Division for EMEA, MUFG

Executive summary

WHAT IS SMART INFRASTRUCTURE?

We have seen a number of definitions, but the one that best encapsulates it is the following from Cambridge University:

"The result of combining physical infrastructure with digital infrastructure, providing improved information to enable better decision making, faster and cheaper."

Our research was focused on gauging both the private and public infrastructure investment community's views on the impact of smart infrastructure. Having consulted with 300 investors, there are a number of interesting findings coming out of the report:

Investor appetite for infrastructure remains strong

Despite challenging conditions in the broader infrastructure market (which include macroeconomic volatility, an undersupply of core infrastructure investment opportunities, and a compressing of investor returns), investor appetite for the sector remains strong. Sixty two per cent of EMEA investors describe current demand for the infrastructure asset class as high, while a further 34% consider it moderate. Seventy per cent predict demand will increase still further throughout 2018 and 2019.

Difficulty assessing long-term asset value

Perhaps not unsurprisingly, investors see challenges relating to how to value the specific impact of technology. This ranks alongside more established concerns such as high asset prices and dry powder. In an evolving smart infrastructure market, there is likely to be an evolutionary rather than revolutionary approach in relation to this, as investors become more comfortable with how to assess its impact based on their experiences. We think that this is part of a much wider discussion to be had around aligning incentives for sponsors and authorities in a way that could provide more certainty and opportunities around this.



Divided views on smart technology's ability to increase returns

Our research indicates there are two distinct views on smart infrastructure within the market. One camp of investors is embracing the impact of digital technology and exploring how it might be used to optimise performance across a portfolio or a specific asset. A similar proportion are adopting a wait and see approach. The reluctance to engage is being driven in part by concerns over obsolescence, while individual remits and accompanying risk appetites also play their part.

In a mark of broad support, 72% of EMEA infrastructure investors across both private and public funding sources recognise that smart technology gives a project an edge when assessing potential investments.



Airports



Bridges & Tunnels



Energy



Pipelines



Ports



Rail



Roads



Social

Obsolescence is a concern

Eighty four per cent of Private Investors think obsolescence is a risk given the rate at which technology is moving. While smart infrastructure clearly has the potential to enhance asset portfolios, there is always a concern that the pace of technological change can lead to solutions that are obsolete before the end of their operational lifecycle. This is particularly the case where the operational cycle tends to be very long for traditional infrastructure – so we can understand why that is a key concern.

This of course will depend on what is being contemplated and there may be other ways of assessing this risk. In response, 80% of Private Investors would consider reducing their asset recycling timeframes. In other words, the greater the risk of obsolescence the more likely investors would see a need to recycle their investments over a reduced time horizon. This drives an interesting debate around the investment horizons of different types of investors, who may view things differently. For example, owners of economic infrastructure such as ports and airports may be more finely attuned to the benefits smart technology can play in optimising their asset base – where small incremental benefits can generate a meaningful return (with an investment horizon measured over the short to medium term), versus owners of long term PPPs who have a different investment and return model and may have a slightly different approach as to how to benefit from this type of technology.

A new breed of infrastructure demands an evolution of risk analysis

Seventy seven per cent of investors recognise that current risk models need to change to properly assess the impact of smart infrastructure. This report makes some initial suggestions for how to achieve this through a shift in perspective, and an evolution of proven processes, rather than a wholesale shift in approach. All projects are different, and there is always scope for looking at certain risks in a more nuanced and collaborative way.

METHODOLOGY

This report is informed by 300 interviews with investors across EMEA infrastructure, conducted in the first half of 2018.

200 of these participants are private sector investors deliberately selected from a blend of institutional investors, investment funds and non-financial companies which also invest in infrastructure as part of their corporate strategy, primarily technology firms, telecommunication businesses and contractors (we refer to this category of respondents as the Private Funders or Private Investors). The other 100 research participants are responsible for public investment decisions in relevant central government departments or specialist transport departments and ports authorities (we refer to this category of respondents as the Public Funders or Public Investors). All are leading decision makers involved in choosing which infrastructure projects to invest in within their organisation.

We also undertook qualitative interviews with a number of our clients and contacts, many of whom kindly shared quotes and case studies featured in this report.

Countries we surveyed as part of this research included France, Germany, the Netherlands, Saudi Arabia, the UAE, and the United Kingdom.

The smart landscape

Up to £4.8 trillion: the estimated size of the global opportunity for smart infrastructure*.

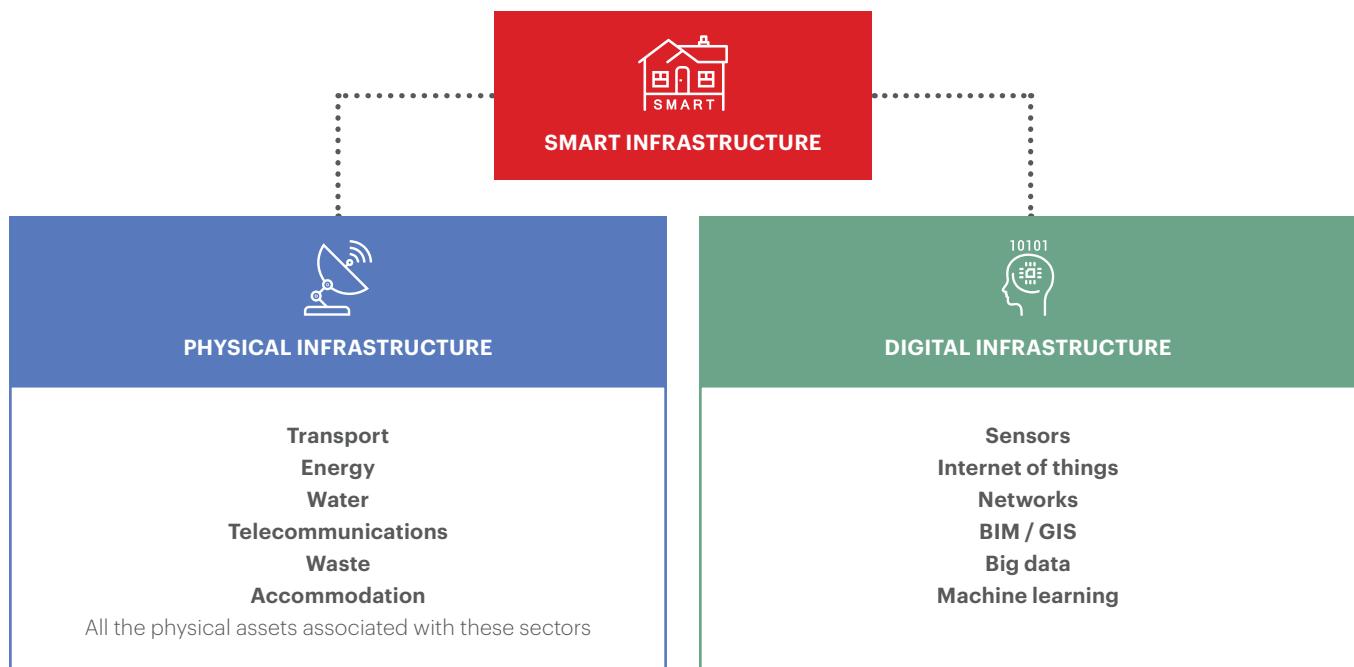
Smart infrastructure is about taking the benefits of the digital world to enhance the physical world. We believe that greater understanding of the performance of existing infrastructure will allow further value to be realised from that infrastructure both in terms of whole life costing and efficiency and will allow new infrastructure to be designed and delivered more efficiently in a way that provides better value.

What this revolution will drive is a tremendous increase in the amount of data that assets generate. The ownership, understanding, analysis and action we take as a result of the data generated has the potential to have a transformative effect on the infrastructure landscape. It could revolutionise how infrastructure projects are delivered, managed and controlled. It will change and better inform how future strategic investments are made by both government and industry and it will allow us to extract more capacity from our assets.

There are a number of consequential changes that this may drive over time in relation to traditional roles, business models and measures of value.

Whilst infrastructure is on its own journey of transformation in this regard, some of the benefits are on the critical path in terms of needing realisation. For example, the rail industry needs to find solutions to cater for c.40% more traffic on the railway. It is difficult to cater for that in the current signalling environment, but digital solutions offer the potential to solve parts of this conundrum. Smart motorways also offer similar potential for the strategic road network. The construction sector as a whole is also beginning to embrace the use of technology in order to drive efficiencies and lower cost by operating on a more digital basis.

WHAT IS SMART INFRASTRUCTURE?



What's the value for the Infrastructure Investor?

What benefit does smart infrastructure hold for the Infrastructure Investor?

There are a number of different answers to this depending on where you sit in the value chain, which range from (i) enhanced customer experiences; (ii) meeting the mounting challenges from population growth in rapidly urbanising areas in an environment of tighter budgets and finite natural resources to; (iii) providing a broader spectrum of investment opportunities.

Fundamentally, however, smart infrastructure will allow owners and operators to get more out of what they already have by increasing capacity, efficiency, reliability and resilience.

By extracting more from existing assets, owners and operators will be able to enhance service provision despite constraints on finance, resources and greenfield sites. Better understanding of the performance of their infrastructure will allow new infrastructure to be designed and delivered more efficiently, and to provide better whole-life value.

Why now?

Part of this is driven by a natural saturation point in the market having been reached (at least in EMEA). Traditional infrastructure investment has reached a point where the value of 'infrastructure in use' is

substantially greater than the value of 'infrastructure in development'. In a number of maturing markets, the addition of new assets adds less than 0.5% each year to the value of existing infrastructure. So, whilst new infrastructure can be built "smarter", it will not lead to the wholesale transformation of the infrastructure industry over the short or medium-term horizon. The way to address this is clearly through the existing operational asset base where opportunities exist to provide enhancements. This may also prove to be a way of unlocking existing latent capacity.

We are generating more data than ever before, largely thanks to the ongoing reduction in the costs of collecting, analysing and storing of data – but making sense of that data, and the value it holds is another challenge in itself, something we explore further in this report.

Take transport as an example – what happens with this data has never been more important. Roads, rails, bridges and ports are the circulatory system of an active city. Optimising that system in a way that improves efficiency and the customer experience is good business for all parties. Technology, data, and data analysis has an important role to play in how that is achieved. Government is clearly plugged into the benefits that this may bring, and a good example is the National Infrastructure Commission report on Data for the Public Good which for the first time creates a framework around how some of this could be realised.

WHY MUFG?

Increasing urbanisation, ballooning populations and climate change all add up to the pressing need for infrastructure that is smarter, more sustainable and more reliable. At MUFG we see the potential smart infrastructure brings to the built environment. How it is implemented and financed is not yet clear, but with unparalleled expertise in delivering integrated multi-product services combining the ability to advise, structure and lend, we are an important part of that conversation.

We have the ability to connect the right people in a way that allows for more creative solutions and potentially facilitates discussion around risk alignment and incentives for sponsors and authorities to deliver these changes.

Over the last decade we have financed over 130 projects across EMEA, drawing on insights from across our global network to break new ground, manage risk and structure finance that helps make complicated projects bankable.

Investor appetite and smart potential

The infrastructure market has been very attractive to investors and this has led to a significant increase in the breadth and depth of investors. In turn, this has inevitably led to a compression of returns. However, the sector continues to enjoy a broad base of investor interest across EMEA. Sixty two per cent of investors describe current demand for the infrastructure asset class as high. Only 4% consider it to be low.

Investment performance is holding steady under this intense interest and notwithstanding some challenging market conditions from macroeconomic volatility to an undersupply of core infrastructure investment opportunities. Fifty eight per cent say their infrastructure investments have met expectations over the last 12 months, 24% have seen returns below expectations, and 19% above.

The investment community overwhelmingly predicts that interest in the infrastructure asset class will continue to grow, with 70% expecting a further rise in demand over 2018/19. Only 1% think interest in the sector is likely to retreat.

As ever in a competitive environment, the market continues to evolve, and private investors adapt. As our graphic below shows, there is a recognition and acceptance of returns coming under pressure and an increased desire to collaborate. An increase in M&A activity comes out at the bottom of the table, but it's worth noting that the spread between the bottom three choices is a relatively modest 4% with investors looking keenly at new markets or being prepared to accept more risk.

In terms of overall market challenges, EMEA infrastructure investors support conventional wisdom in reporting that (i) political uncertainty tops their list of concerns, closely followed by (ii) difficulties sourcing

opportunities that will deliver strong returns and (iii) slow deal flow. However, the difficulty of assessing long term asset value due to technological change is noted as an equally pressing concern to well-established challenges such as high asset prices and dry powder. This is an interesting development that shows that investors are switching on to the potential impact of technology in infrastructure, and that is presenting a practical challenge when it comes to asset valuations.

Against this backdrop of liquidity and recognition that infrastructure remains a strong asset class to be in, investors' current views on smart technology make for interesting reading.



TRENDS IN INVESTOR APPETITE



Acceptance of reduced returns



Increased collaboration



Requirement to accept a higher degree of risk



Increased demand for lower cost opportunities in less established markets



Increased mergers and acquisitions activity

72% of EMEA infrastructure investors across both private and public funding sources think smart technology gives a project an edge when assessing potential investments. What's more 74% say that smart technology's future effect on the overall investment has to be considered when making investments with an investment horizon of 10 years or longer.

Cost, however, remains a major sticking point. Public Funders are naturally cautious with 89% saying the upfront cost is unappealing at a time of high asset prices. This is only slightly less of a deciding factor among the private sector with 74% voicing this reluctance. On reflection this would seem to indicate that there is a practical uncertainty around identifying the real cost of technological impacts, and the Public Funders are reluctant to factor that in as an upfront cost. The corollary of that position is that if the Private Funders were to look to make technological enhancements and improvements to a project over time, it would presumably not want to share the benefit of that investment with the public side.

Indeed, 82% of Public Funders think that Private Investors are willing to pay a premium for smart technology's ability to control costs and increase operation efficiency. However, many Private Investors have concerns over recouping investments in upgrading existing assets with 71% stating it's too early to say whether this can improve investment returns. This we think is a key point, there is real potential in this growing sector, but until there are more concrete examples of how it translates into a financial benefit, there will be some reticence from the private side.

PUBLIC SECTOR VIEW

"Smart technology deserves more attention, but the challenge lies in the fact that investors usually want proven technology. Someone needs to take the risk. How can we be flexible and build projects for the future if we don't? We've seen some incentives which have made improvements along the way, but many banks are reluctant to accommodate change which doesn't make the structure very flexible."

MARC BOLLEN

Smart Mobility Manager, Rijkswaterstaat Environment, Dutch Ministry of Infrastructure and Environment

PRIVATE INVESTOR VIEW

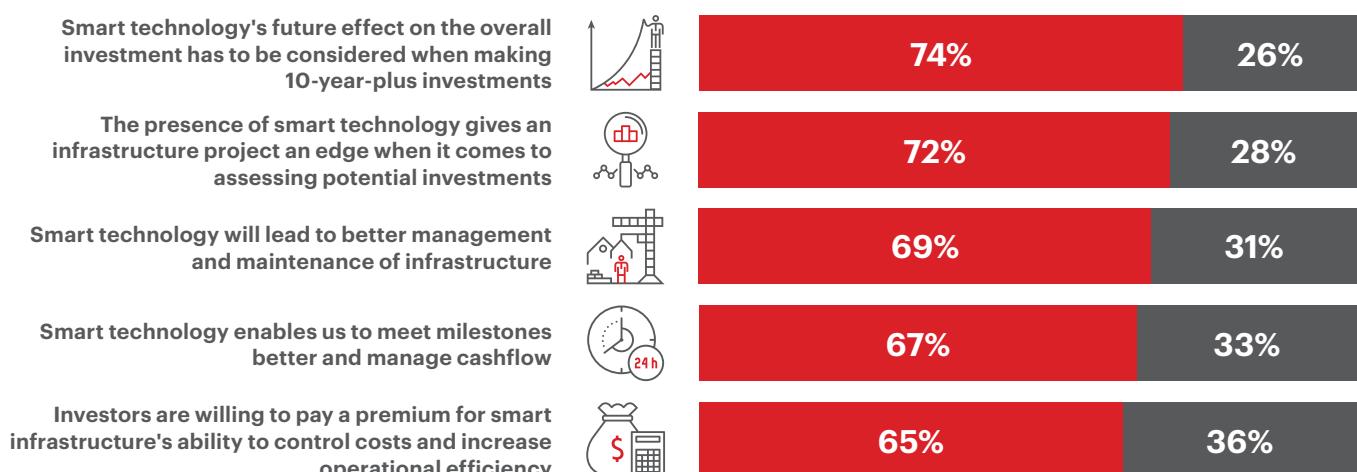
"We get paid based on the availability of the asset, so smart technology is interesting for us. It inherently reduces an element of risk due to the ability to carry out predictive maintenance. Right now I wouldn't say it's changing decision-making in any dramatic way, but I can see it becoming essential for infrastructure investments in future."

ADRIAN PEACOCK

Head of Acquisitions, Dalmore Capital

KEY MARKET CHALLENGES

■ Agree ■ Disagree



These divided views perhaps reflect the natural evolution of something new, and is also a reflection of the remits, investment timescales and motivations of those within the funding ecosystem. Those Private Investors with shorter horizons may not be incentivised to invest heavily in technology that delivers a return over a longer time scale – that is not to say that there are not short-term benefits to be obtained as well. Longer-term investors may well invest in innovations which can deliver financial returns over a longer timeframe commensurate with the underlying asset life. Our consultation panel interviews revealed that these benefits are not to be underestimated. If they can deliver small incremental gains over a long-term period they can be significantly IRR enhancing given the length of some of these asset lives – particularly if amplified with a portfolio effect. This is where the broader discussion around aligning incentives really provides some food for thought. For example, sponsors in long term availability-based road

PPPs may not be sufficiently incentivised to invest in smart technology that allows traffic to flow more efficiently (which may be a key feature for transport authorities), as they are paid on an availability basis. There may certainly be a benefit in understanding better how that impacts their long-term maintenance and operation but is there a discussion to be had around how to align these interests more closely. Some of these points could be picked up as variations to existing agreements that enable the risk and benefit to be shared appropriately.

The opportunity to make an evolutionary impact on the efficient use of existing infrastructure and new build has been reported to [add up to a global opportunity worth £4.8trn](#). Parties will need to work together to share risk and reward in ways that fit their differing motivations if the potential social, environmental and financial benefits of smart infrastructure are to be realised.



ACCELERATING EFFICIENCIES AND SPARKING NEW REVENUE STREAMS

"Across the board, investors are looking for ways to get more out of their assets. Enabled by data and analytics, smart technology that reduces downtime, lowers maintenance costs and keeps assets running at maximum efficiency is increasingly attractive. There are numerous ways in which this can be built into existing projects. For example, the increased use of sensors to report on an asset's health and integrity to ensure lifecycle maintenance is being performed against an actual asset condition; rather than an anticipated condition, energy efficiency and subsector innovations such as equipment that monitors road condition to give operators a reliable data set on which to base maintenance decisions. In the waste sector for the first time, we are seeing tech solutions being employed to optimise plant performance. A small spend for unrealised gain."

"Beyond the obvious advantages of lowering costs much of this data has the potential to be monetised. This gives rise to interesting dynamics in terms of how information could be shared or exchanged. It will also require a higher degree of collaboration across different parts of the infrastructure sector."

"In terms of capital investment allocation, we can see two different approaches as to how to smart infrastructure may be implemented:

- Either iterative investments that create noticeable efficiency savings in relatively subtle ways, by overlaying data and analytics onto existing infrastructure systems; or
- Significant standalone digital infrastructure systems, such as a digital signalling system across the railways.

"The benefit of the iterative approach is that there is an incremental risk / reward approach that allows pilot projects to be tested and bedded in before being rolled out across a portfolio."

"There is no doubt that the growth and pace of technological change has the ability to make a significant impact. An example of this (albeit not strictly smart infrastructure) is blockchain. The easiest way to think of blockchain is a secure distributed ledger that allows people to update it simultaneously in real time across the world. AP Moller Maersk is investing with IBM to create an independent platform for the shipping industry (using blockchain technology) that would simplify and speed up the way cargo is processed across the whole of the shipping industry. Shipping has one of the most convoluted paper trails, and this could be a really effective and clever way of reducing that burden. However, it requires collaboration to be successful and for the industry as a whole to buy into the potential benefit. We can see a number of similarities in that to how the infrastructure world can evolve using and sharing data to improve performance and ultimately improve the experience of the end user."

STEFAN BARROW

Director, Structured Finance, MUFG



Opportunities across the region

One of the really interesting ways that the EMEA market has developed – as opposed to the US, Australia and Asia, is that concessions and funding horizons have traditionally been considerably longer (with PPPs and PFIIs going out 25–30 years and funding tenors to match). Whilst the appetite for long term funding for the bank market has changed in recent years, the focus on long term investment horizons has not. This allows private investors to take a much longer-term view on return and the whole life performance of any asset.

We see some of this being repeated in the Middle East, which has slowly begun to evolve from government driven funding to off balance sheet project finance solutions. Saudi Arabia in particular presents a fascinating case study in opening up to infrastructure development, and has the opportunity to develop it using the lessons learned from other countries. It means they are ideally placed to take advantage of some of these changes in procurement models as they plan for their future – the potential of which could be significant.

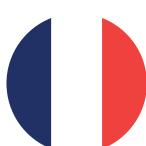
Africa also presents interesting potential opportunities. The one key element around smart infrastructure is that it could present an opportunity to leap-frog forward, by moving forward with new innovations that are not built or retrofitted onto legacy infrastructure. Good examples of this include how mobile telephony has transformed the continent, and how follow on services – like mobile banking in Kenya – which has provided huge support to the previously unbanked can take advantage of technological innovation free from legacy constraints.



TOP 10 COUNTRIES PERCEIVED TO BE THE MOST ACTIVE IN SMART INFRASTRUCTURE



01
Germany



02
France



03
United Kingdom



04
Netherlands



05
United Arab Emirates



06
Spain



07
Italy



08
South Africa



09
Belgium



10
Ireland

Obsolescence and asset recycling

We live in a highly connected age with rapid advancements in technology, automation and data capture. While many will talk about industry being on the brink of the forth industrial revolution, people are already starting to look at the fifth. Businesses can be run with minimal human intervention and more reliance on intelligent, connected devices to run industrial systems.

The consequence of this is that technological innovations are always at risk of becoming obsolete.

It therefore comes as little surprise that 84% of Private Investors think obsolescence is a risk at the rate at which technology is moving. Interestingly this is considerably lower among government funders – with 64% considering obsolescence a risk in infrastructure projects.

In response to this risk, 80% of private investors are considering recycling assets within shorter timeframes due to the pace of technological change.

PREDICTED TIMEFRAMES FOR ASSET RECYCLING

Assets will typically be recycled
less than every

5 YEARS



Assets will typically be recycled
closer to every

5 YEARS

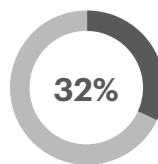
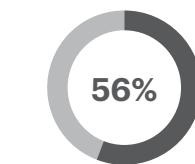


Assets will typically be recycled
between every

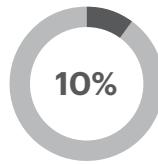
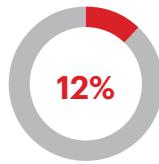
5-10 YEARS



INSTITUTIONAL INVESTORS



INVESTMENT FUNDS



CORPORATE INVESTORS

UNCERTAINTY AROUND THE PACE OF TECHNOLOGY IMPROVEMENT LEANS SECTOR TOWARDS ITERATIVE INNOVATION

"If there's one thing that turns infrastructure investors' blood cold it's the fear that what they've invested in may no longer be relevant.

"Much of this comes down to the scale of the investment and whether stranded assets have any alternative uses/value. Tactical additions to existing infrastructure are an easier argument, such as adding sensors to tunnels or machine learning to an airport to find ways to move planes around an apron more efficiently.

"Massive revolutionary investments are often stalled by the shadow of obsolescence. Some of this will be obviated by the type and size of investment made, one of the real potential benefits is that a modest investment may yield a tangible benefit. One observation we heard recently, is that if you take the construction sector as whole it is probably the least digitalised industry in the world. That means even modest investments are likely to drive benefits, which is why you are seeing an increase in Building Information Models (BIM).

"Macro trends in technology and consumer behaviour are transforming the way in which even traditional infrastructure assets need to function and the definition of infrastructure is subtly changing all the time. Twenty years ago, people thought PPP was the most exotic financing approach in the universe and yet it became a simple, standardised approach to procuring large infrastructure projects and its commoditisation led to wafer thin debt and equity returns. In the same way ten or fifteen years ago nobody would have thought of motorway services as an infra asset worthy of investment, and yet these have come to market regularly in the past three years. Our sense is that much of the technological innovation to come will be viewed in a similar way by future generations of infrastructure practitioners.

"The point is we are at an exciting juncture in the infra world where the market is broadening out into new sectors (towers, broadband, data centres, smart metering, batteries) whilst at the same time technology is going to have a real impact on our built environment. As this grows in both directions so will the opportunities for taking well-calculated risks (for both Sponsors and Funders alike)."

RISHI NIHALANI

Head of Advisory, EMEA, MUFG



Risk approach

Our research reveals the approach to risk analysis for this developing sector needs some thought and consideration.

"We all recognise the potential of smart technology. The knowledge of how assets perform will undoubtedly reduce risk, but every investor must look at the bottom line and some are financially scarred from previous projects, so it will take someone brave to take the risk right now. For many, we're still building for today, rather than looking to tomorrow, but you have to look at the delivery of the service and its long-term implications and there's where smart technology will help."

YVONNE JONES
General Manager, BAM PPP B.V.

EVOLVING RISK MODELS

This is probably the most interesting part of the debate. The point here is that you always have projects that by virtue of their evolution in the development cycle are not yet suited to attracting senior debt (and that is why there is venture capital and private equity to plug the gaps).

However, in terms of looking at risk models we think there is a lot to be said for adapting the existing approach. In looking at new areas when we break down the risk, so much of it can be boxed into categories we know and understand (e.g. does it have high barriers to entry, create a quasi-monopoly, benefit from a strong regulatory framework, are there long-term sticky cash flows, captive market etc.). The gap that is left is the part that really needs to be understood (be that because it has demand risk or technology risk attached to it).

It is that gap that requires collaboration between sponsors, lenders, government and technical expertise in terms of understanding and breaking it down, so that it can be understood, assessed and then allocated to the party best able to bear it (and be priced accordingly).

ROBERT BARTLETT
Head of Infrastructure, EMEA, MUFG



Data Management

Data is at the heart of all smart technology. As smart infrastructure is rolled out into different areas of our society, there will be a vast explosion of data generated – data ownership and management of that data becomes increasingly important. The National Infrastructure Commission in the UK is also looking to focus on this aspect with its report on *Data for the Public Good*. They quite rightly identify that data is a critical part of the puzzle that needs to be addressed.

"The challenge will be if someone else has collected the data from an asset – can you put your faith in it? You can't always trust what is being presented, and if you do, you need a benchmark against something else to compare. If someone else is providing data to you, it needs some form of indemnity, a fail-safe mechanism."

YVONNE JONES
General Manager, BAM PPP B.V.

"Smart technology and the data it offers to enable predictive maintenance is allowing us to significantly reduce risk when it comes to infrastructure investment."

ADRIAN PEACOCK
Head of Acquisitions, Dalmore Capital

There are going to be some interesting debates around how that information is used, who controls it, who accesses it and if it is being used for the benefit of the end user or the companies in between.

The quality of data, and the analysis of that data is key.

There is no doubt we are moving to a world where infrastructure assets are interconnected to each other and to all other information sources in a way that enhances both the user experience and the performance of the asset itself.

Despite a varying degree in sophistication of smart, the basic principles remain: most smart systems use a feedback loop of data, which provides evidence for informed decision-making. The system can monitor, measure, analyse, communicate and act, based on information captured from sensors and other sources.

This has huge implications on future infrastructure investments where this data can help future designers to produce the next, more efficient version; collect data, process it and present information to help a human operator to take decisions (for example, traffic systems that detect congestion and inform drivers); and use collected data to take action without human intervention.

As well as making existing assets more valuable, this is also creating new economies: data exchanges – a new kind of asset that enables private and public organisations to evolve into a new way of delivering value – whether that's to shareholders or citizens.

Take the road traffic example again – an organisation like Highway England collects a huge amount of data on the road networks across England – thereby informing them of which parts of the motorway are likely to suffer the longest tailbacks in adverse conditions (for example), which roads will need maintenance, and when, and the likely impact this can have on different cars.

If you compare that with the likes of data a car manufacturer collects on an individual car (25GBs an hour on everything from its route, its speed, the wear and tear on components and so on), there's huge potential for a data exchange that can take place to make investments even more attractive in transport infrastructure projects. There are many market participants who would be interested in sharing, using, or exchanging that data.

Collaboration

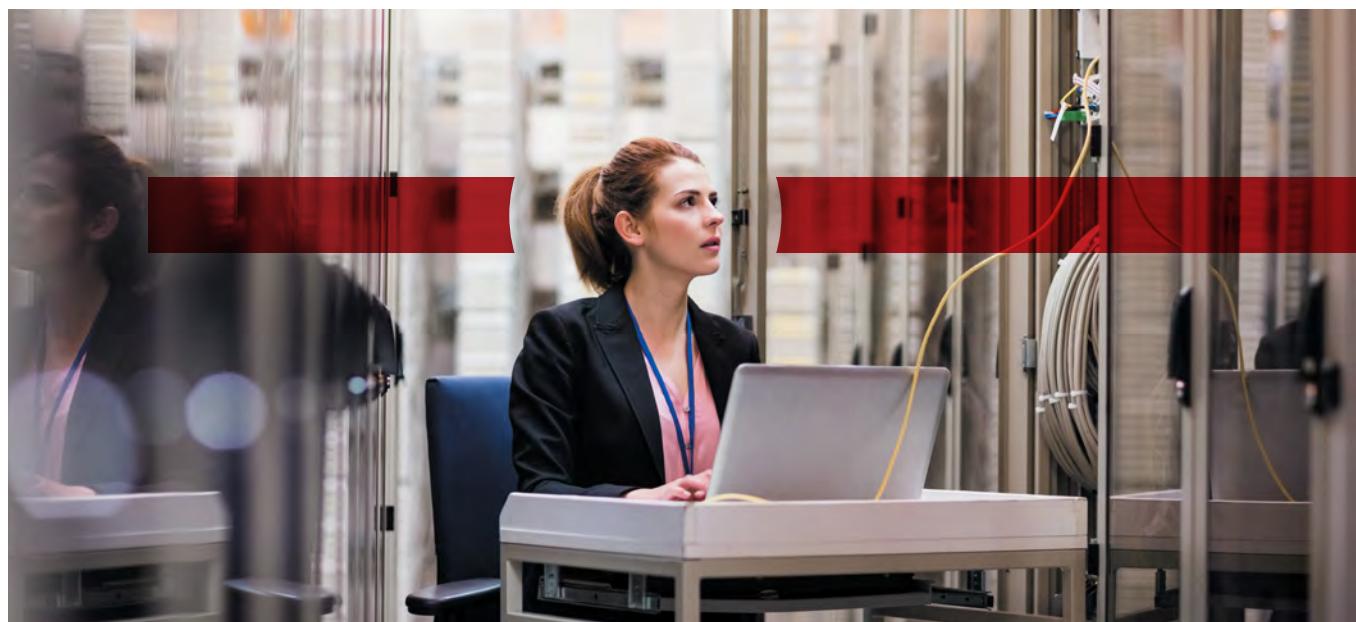
All of this is going to require collaboration. Diverse communities make up this new interconnected infrastructure world, and each holds a piece of the data puzzle that may help solve another's problem.

How this is brought together in a meaningful and efficient way is going to be one of the really interesting areas of development. It may be that Private Investors are more adept at working out how to realise efficiencies or opportunities from this collaboration or it might require government to take a macro view in encouraging information sharing.

The very different views and motivations of Public and Private Investors when approaching smart infrastructure can be seen in the results of this research. For example, Public Investors are naturally more concerned about cost, with 89% saying the increased upfront cost of developing smart infrastructure is unappealing at a time of high asset prices, compared to 66% of Private Investors who expressed an opinion on this question. These divergent concerns and motivations need to be considered if these equally crucial groups are to be motivated to invest in smart technology and bring about its social and environmental potential, alongside efficiency benefits for the taxpayer.

"One of the common threads among the nations leading on smart infrastructure is the public sector's approach to maintaining a sustainable pipeline of projects and a predictable procurement schedule. The French government's success in attracting digital infrastructure investment such as fibre optics and Holland's work in transportation stand as examples that other countries could emulate. In both cases the government created a strong pipeline and operated a tightly controlled procurement timetable from inception to conclusion. This predictability has won investors' confidence and capital is flowing in as a result."

YANN OTTENWAELDER
Concession infrastructure lead for continental Europe,
Aberdeen Standard Investments



SHARING RISK AND DATA

ALONGSIDE THE BENEFITS OF DEPOLITICISING INFRASTRUCTURE

"All partners in a project ecosystem need to take responsibility for ensuring each party takes their fair share and no one ends up overloaded. By the same token effective collaboration only works when every group gets something in return."

"The private sector needs a return, while government needs well-managed quality infrastructure that will stand the test of time. Efficiency is essential, but that doesn't always mean going for the cheapest price and a race to the bottom benefits no one."

"As the taxpayer is a major investor in most infrastructure projects public sector investments are often terrifically politicised. This can backfire, with excessive focus on upfront cost and less so on long term efficiencies which often have a greater impact on overall cost efficiency of infrastructure. The infrastructure achievements of the Dutch government is a prime example of what can be done with a more pragmatic approach that simply prioritises the best solution – from whatever source it comes from and regardless of whether it's seen as to the right or the left of the political spectrum."

"One of the many challenges about effective collaboration relates to sharing of data. The arrival of smart technology further pushes these challenges – effective application to infrastructure goes beyond the sector's usual triple collaboration between providers, government and investors, to require working with various technology firms, regulators and communications networks as well. Groups need to get used to working with each other and figuring out how to incentivise all parties and fairly share rewards as well as risk."

PHILLIP HALL
Head of Structured Finance Office, EMEA, MUFG

Creating a new roadmap

There has been a real growth of interest in this developing area. The question is how to set out a road map for this new world. In short, there isn't one road to travel. Much of this will be driven by innovators who understand the benefit that technology can bring to existing infrastructure, and they will start to lay a foundation for others to follow.

We want to play a central role in the development of this sector, and help facilitate the discussions, analysis and debate that creates an environment in which senior debt can support smart infrastructure projects and innovations. We think we offer a unique insight having supported both sides of the table (private and public) across the globe.

We don't believe this is going to happen overnight, but we do believe the market and our clients are plugged into the potential that this could yield. Together we can play an important role in helping unlock that value and be part of delivering infrastructure fit for the 21st century.



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