Rethinking Infrastructure and Cities for a Covid-19 World: A UKCRIC Prospectus

UKCRIC

UK COLLABORATORIUM FOR RESEARCH ON INFRASTRUCTURE & CITIES

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Before we begin

This prospectus has its genesis in a workshop held during the early stages of the 2020 Covid-19[1] lockdown in the UK. At that point, the realisation was still dawning that the changes to our lives brought about by the pandemic were not, as had initially been assumed, merely temporary. The purpose of the workshop was to surface and explore the short-, medium- and long-term impacts of Covid-19 on the UK's infrastructure and its cities.

Following the workshop, the editors drew together the narrative and distilled the principles that had emerged, which form the backbone of this prospectus. Domain specialists expanded the thinking on the influence of the pandemic on cities and buildings, people and their environments, transport and mobility, energy, water, resources and waste, and construction. UKCRIC's international Advisory Board then reflected on an early draft to provide additional, invaluable insights.

The editors are grateful to all who gave their time and expertise in the creation of this prospectus. They are recognised in the contributors section, towards the end of the document.

1. Throughout this prospectus we use the term Covid-19 to refer to the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) pandemic, which first came to light in Wuhan, China in late 2019 and swept comprehensively across the globe in early 2020.

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Introduction

It is easier to make the future than to predict it. There is still much about Covid-19 that we do not know. Now the immediate crisis has passed, it seems obvious that the strategies and plans for addressing the challenges presented by the pandemic should reinforce the things we should be doing – and in some cases were already doing – to address the global threats of climate change, resource security, loss of biodiversity, and global poverty and inequality.

The OECD's Covid-19 recovery strategy advocates 'building back better'[2], but better means different things to different people. Sustainability, inclusivity, resilience, equity, liveability and so on might all be considered to be 'good', but they can come into conflict with each other. When this happens, how do we decide what is best? Despite our good intentions, we are working within systems that are, for the most part, degenerative. We need to create *restorative systems*, which 'do more good' rather than 'do less bad'.

In this prospectus, we tension this need against the recognition that we too often focus on building new at the expense of looking after what we already have. 'Building back' needs to be for a purpose, not just to create a temporary economic stimulus. While not wishing to add to the existing plethora of Covid-19-related slogans, a more apposite one might be "make things better for all", where, ironically, achieving better may not require the 'making' of anything. Making things better does, however, require planning, organisation, commonality of vision, buy-in and resources.

How much infrastructure, new or otherwise, and what density and configuration of the built environment will a Covid-19 society need? Is there an ideal 'peak infrastructure' and have we already reached it? Our existing infrastructure and cities certainly are not cost-free, but come with the burden of maintenance and the sunk cost of their embedded carbon. It is already accepted that we need to think carefully about properly maintaining, repairing and enhancing the infrastructure and cities we have, but we stop short of mandating that the construction of new infrastructure and urban developments must focus upon repurposing and replacement. For example, could a high speed rail network enable the closure of motorways? Layered onto this is the need for the services provided by infrastructure and cities (the water we drink, energy we use, roads we travel, culture we imbibe and so on) to be equitably accessible and affordable. Covid-19 has the potential to set back such ambitions and to mask their importance by focusing attention on more immediate health concerns. At the same time, Covid-19 may force us to revalue these services. For example, we might come to view motorised travel as the luxury it really is, and organise our lives in a way that needs less of it.

In this prospectus, we explore the opportunities afforded by the Covid-19 pandemic. We don't mean our approach to downplay in any way the tragedy that has befallen us. It is a tragedy irretrievably interlinked with others – climate change, resource depletion, species loss, inequality and poverty. It is our greatest responsibility to ensure that we do not turn tragedy into catastrophe, and that we continually strive to make things better.

2. http://www.oecd.org/coronavirus/policy-responses/building-back-better-a-sustainable-resilient-recovery-after-covid-19-52b869f5/

Guiding principles for transitioning to a Covid-19 world

What follows is the outcome of UKCRIC's efforts to bring into focus the impacts of the Covid-19 pandemic on the UK's infrastructure and its cities, and to begin to understand how we might use our reaction to the pandemic to do things better. Three principles encapsulate positive action for transitioning to a world with Covid-19:

1. **Create systems-level benefits and resilience**
2. **Strengthen existing priorities**
3. **Plan the transition**

The principles are followed by a set of seven 'spotlights', which expand on the principles within the given context, demonstrate the scale and complexity of the challenges we face, and provide guidance on the way forward.

1. **Water**
2. **Energy**
3. **Waste management**
4. **Transport and travel**
5. **Buildings**
6. **Construction**
7. **Demand and supply chains**

Principle 1: Create systems-level benefits and resilience

National prosperity depends on, amongst other things, a national system of infrastructure networks. Sustained, long-term national prosperity requires all of the complementary enabling systems (including infrastructure) to be mutually reinforcing and resilient to the disruptive impacts of current and future strategic challenges[3]. Covid-19 is one example of a strategic challenge.

Strategic challenges include:

- **Climate change as a driver of long-term change to ambient operating conditions and/or changes in the frequency, intensity, duration, clustering and predictability of extreme events and natural hazards**
- **Malicious acts, such as terrorism and sabotage**
- **Accidental disruption, including human error**
- **Digital or any technology-driven systemic transformation**
- **Demographic transition, such as urbanisation or regional population growth, or any form of societal change that changes demand for infrastructure services**
- **Greater demands that threaten to exceed existing capacity**
- **Aging or stressed infrastructure components**
- **Global trends that affect the demand for, availability and price of scarce resources**
- **All risks included on a national risk register**

3. A strategic challenge is any event, decision or trend that has the potential to disrupt the normal operations of national infrastructure and thus undermine the realisation of the strategic outcomes it helps to enable.

Covid-19 has exposed latent vulnerabilities to strategic challenges. It is a powerful illustration that if a nation as a whole is to be systemically resilient to the disruptive impacts of future strategic challenges, resilience must be present across all levels of society. National and local infrastructure, households, communities and businesses are complementary and essential aspects of a resilient economy and society.

To date, national infrastructure systems appear to be performing incredibly resiliently in the face of sudden and sustained changes to:

- **Pattern, scale, type and location of demand for infrastructure products and services**
- **Logistics and supply networks**
- **Working patterns, such as reduced hours on sites, more hours at home**
- **Operational capacity**

This has been achieved, in part, by redeploying available resources (including skilled staff) to where they are most urgently needed. The unintentional side effects of this are delays to non-urgent activities such as routine maintenance.

Some national infrastructure systems are operating closer to, or even beyond, their design thresholds (for example, telecommunications as a result of the rapid increase in the use of teleconferencing), and new latent vulnerabilities are being created. This increases the likelihood of systemic disruption (for example, cascade failures, interdependence-related disruptions and accidents) and their likely scale, intensity and duration.

Principle 2: Strengthen existing priorities

Covid-19 has not changed the global challenges related to sustaining 9 billion people on one planet. We must see Covid-19 in the context of larger-scale environmental and social priorities, and ensure our response to the pandemic strengthens our approaches to these challenges. Here we consider the global priorities of:

- **Climate change and Net Zero**
- **Circular economies and resource efficiency**

Climate change and Net Zero

We must not become deflected from the existential threat of climate change or our Net Zero commitments. It will be difficult to resist making compromises through the adoption of ‘quick fixes’, such as new construction, or some other general activity to stimulate the economy at the cost of carbon reduction targets. Global challenges, including Covid-19, must be addressed without trading them off against each other.

Circular economies and resource efficiency

The disruption caused by the pandemic created unprecedented stress on global supply chains and just-in-time delivery models. We don’t fully understand the material aspects of global resource

flows, have a sense of how materials ultimately become 'things', or appreciate the vulnerabilities and bottlenecks in these systems. A rapid and comprehensive analysis of the resource sector, business models and the impact of market disruption is needed to understand key vulnerabilities, build resilience, and support future growth.

Pre-Covid-19, Defra estimated that UK businesses could benefit by up to £23 billion/year[4] through low-cost circular economy improvements such as lean production, reducing waste, and moving from purchasing goods to purchasing services (e.g., through leasing)[5]. Policies should accelerate the transition to a circular economy to support society and the economy, reduce pollution and the impacts of climate change, reduce greenhouse gas emissions and regenerate natural systems.

Credit: Chloe Evans/Unsplash

4. https://www.wrap.org.uk/content/wraps-vision-uk-circular-economy-2020#:~:text=The%20adoption%20of%20a%20circular%20economy%20offers%20considerable,efficiency%20could%20eventually%20reach%20%243.7%20trillion%20per%20year

5. https://www.wrap.org.uk/sites/files/wrap/FULL%20REPORT%20v2.pdf

Principle 3: Plan the transition

The Covid-19 pandemic, and government responses to it, have created many unknowns. We face multiple uncertainties at multiple scales, from the individual to the global. The past is of limited use in predicting the future and is an inappropriate model to which to return. We are not going to get back to the old normal.

The highly-interdependent nature of infrastructure and urban systems and the multiple dimensions of changes to people, places and their modes of operation make transitioning both complex and dynamic. Predictions, projections and models cannot be used with any confidence. We are only able to advance by learning, and to learn we must monitor, measure and analyse our actions.

In such a situation, we must take care not to be impulsively reactive, or to implement unconsidered remedial interventions. Equally, doing the same thing we have always done won't work. We must be proactive, innovative, pre-emptive and, ultimately, we must plan the transition.

It is, of course, difficult to plan when there are so many unknowns. The following areas of focus are particularly relevant to UK infrastructure and urban environments.

1. **Repurpose the physical environment, redistribute demand and create flexibility of use**
2. **Make density and distance allies**
3. **Develop new urban business models**

Repurpose the physical environment, redistribute demand and create flexibility of use

Lockdown has shown us that everything is linked, such that changes in one thing (e.g., our ability to congregate and travel) can affect almost every area of life. In cities, for example, we've seen how high-density living can quickly become intolerable and even hazardous to human health and wellbeing. We must therefore rethink everything about the way in which we plan, build and use our environment, how our infrastructure systems can support life in this changed environment and how everything fits together as a system.

Now, more than ever, engineering and design must be able to adapt quickly as more knowledge becomes available. How do we reconfigure the spaces we have? How do we share amenities better? Although our understanding of Covid-19 changes on a weekly basis, it is becoming clearer that Covid-19 is airborne and that the suspension of small droplets in the air can remain and deliver a viable viral particle for several hours. Hence proper air circulation renders the virus less transmissible. Distancing requirements need to take this into account when enabling people to be in public spaces. Rethinking places on the basis of spacing between people in an appropriate environment is now a priority.

We are already redistributing urban activities to facilitate physical distancing. Work does not have to be done at the employer's premises. Covid-19 has shown that work can often be done at home, but it could also be done in other places. Incentivising the offer of timed workspaces around the city could enable people to choose where to work, thereby distributing the economic activity around the city, changing travel patterns and generally equalising passenger density and activity in both time and space.

Make density and distance allies

If we are to continue to create healthy places, we need to make density and distance allies, not enemies. We must to plan for people being physically isolated and distanced with high levels of physical and mental wellbeing. Health and social cohesion are vital aspects of urban planning at the neighbourhood level. This is because premature death and disability are often a result of environmental and social factors, rather than of health care or genetics. Urban design should provide what people need to be healthy and happy; we are having to re-evaluate what that means in a world where high-density, city living is no longer fully viable.

Urban planning processes, practices, and how we understand, define, and control urban density need sharpening up. We can already see how precarious communal spaces are becoming. What can their role be? What configurations will work? How will they be financed in a Covid-19 world? Public spaces need to be attractive for people to use in physically distanced situations. If people need to remain a certain distance apart, then setting out communal space in a way that makes it easier to meet requirements will make the requirements more likely to be observed and easier to enforce.

We mustn't, however, confuse social distancing with physical distancing. Proxemics theory is concerned with the spacing between people. The distances that people choose to separate themselves from others in public situations are physical expressions of social spacing. For example, we like to be close to people we are speaking to or walking with. We inherently want social spacing that is considerably less than the physical distance considered the minimum to prevent viral transmission. In a Covid-19 world, we are having to recalibrate what feels comfortable. Desired social spacing will drive the physical spacing that people will accept; if this is not taken into account, physical distancing requirements will fail.

Develop new urban business models

There is now a clear need to leverage investment streams to support economic growth and job creation in cities. We need to create the institutional infrastructure to enable investment in cities to support change and resilient systems. Place-based approaches may be needed to encourage investment, and evidence is needed to enable planning. Covid-19 has broken accepted views on city density, but that provides an unprecedented opportunity to deliver urban change. Density is key to mass transit infrastructure, but density must be constructed in such a way that city users have ready access to local facilities, services, blue and green space; in essence, the 15-minute walkable city.

How do we develop and use new business models to support adaptations that provide healthy cities for all? For example, if council taxes are higher for those closer to green spaces, can the money go directly to pay for the maintenance of green space? Does this reinforce the value of the green space? Does it lead to inequity and gentrification? If retail is declining, how do we raise revenue to repurpose the space?

Covid-19 has rapidly accelerated established trends in UK cities, tipping sectors that were already struggling to crisis point. Bricks and mortar retailers, in particular, are challenged by the inherent

Credit: Julie Ann Gylaitis/Unsplash

financial advantage of internet retailers. Covid-19 has thrown into sharp relief the fact that traditional retailers are burdened with expensive, oversized sites no longer fit for purpose. There have been myriad failures across dining, entertainment and retail, which means that city centres will fundamentally change as a result of the pandemic. British Property Federation chief Melanie Leech predicted that there will be a 50% reduction in shops on the average British high street within two years[6]. In parallel, the forced transition to home working has accelerated a much hyped, but to date almost imperceptible trend. Two trends in the UK of bricks and mortar retail shrinkage and office footprint contraction will free up unprecedented areas within cities. This is a once in a generation opportunity that must be grasped positively and used for good.

6. https://www.theguardian.com/business/2020/apr/30/pandemic-will-vastly-accelerate-decline-of-uk-high-street-mps-told#:~:text=The%20chief%20executive%20of%20the,place%20over%20a%20shorter%20timeframe.

Spotlights

In this section we expand upon the scale and complexity of the challenges and changes brought about by Covid-19 through a closer inspection of seven infrastructure and cities sectors.

Spotlight 1: Water

Although on the whole the UK's infrastructure has coped well with the initial impacts of the Covid-19 pandemic, measures taken to control the spread of Covid-19 have triggered a set of unprecedented challenges for the water sector. In parallel, the sector is playing an important role in protecting public health by implementing sampling regimes to support epidemiological modelling and decisions about local lockdowns.

The UK is part of globally interconnected supply chains that all rely on global water security. Investment in overseas development assistance to increase global water security is vital to the UK's water security. "The world's health system is only as strong as its least water-secure region."[7]

Clean water is fundamental to public health

- **It is a crucial part of our hygiene response to diseases**
- **Shared wet spaces, such as toilets and kitchens, provide places for diseases to become aerosolized and linger, and hence need to be more readily cleaned**
- **Sewage can be monitored for evidence of diseases in the population, including Covid-19**

At the beginning of the pandemic the focus was on short-term operational priorities designed to maintain the flow of water and the sewerage system. Increased home occupancy resulted in major spatial shifts in the demand patterns for drinking water, as well as significant increases in the volume of wet wipes and other inappropriate materials being flushed down the toilet (thereby increasing sewer blockage incidents). Physical distancing requirements saw water companies having to restructure their call centre arrangements, delay meter installation programmes and postpone some construction and maintenance work. As the wider economic impacts of the crisis become evident, water service companies are anticipating a sharp rise in customers struggling to pay their bills.

As the longer-term impacts of Covid-19 come into focus, water companies are working to identify what role the sector can play in helping the country recover and rebuild. Sector leaders have made progressive statements in recent months about the need to sharpen the focus on achieving Net Zero, enhance resilience, and realise circular economy aspirations. Practical steps might include bringing forward significant capital projects, exploiting improved understandings of customer behaviour, creating smarter water systems and making more use of novel funding mechanisms such as the direct procurement for customers (DPC) programme. Both the impacts of Covid-19 and renewed objectives for the future suggest that asset maintenance plans might need to be adjusted, perhaps requiring additional discussions with regulators to facilitate remedial or new ambitious initiatives.

7. https://www.nature.com/articles/d41586-020-02085-y

The water system needs to be reconfigured for sustainability including wastewater reuse, energy recovery, nutrient recovery, greywater use and replacing bottled water with safe and sustainable alternatives. It also needs to be better at handling flexibility in water usage patterns, such as those caused by the pandemic, which saw a shift to higher demand in residential areas and lower demand in commercial areas.

The capacity of the UK's water sector to meet these ambitions will, in part, depend on the readiness of others in allied sectors to work with them. A water sector that is more resilient, lower carbon, greener and contributes to the circular economy will necessarily be more tightly collaborative, welcoming co-dependencies as opportunities rather than fearing them as risks. The fundamental challenges that have shaped the sector's strategic planning for the past decade have not changed: growing demand, climate change and an aging asset base continue to provide an urgent backdrop to solution development and investment. More extensive use of nature-based solutions and resource recovery techniques, improved sensing, monitoring and control, demand management, and realisation of the digital promise will continue to be prominent themes. The differences between the past and future will be twofold; a deeper appreciation of the interdependencies that characterise our infrastructure systems and the communities they serve, and a sense that the Covid-19 crisis should be used as a launchpad for change, driving a collective intent to re-intensify our efforts.

Spotlight 2: Energy

Energy efficiency measures are the backbone of our Net Zero ambitions. Covid-19 provides opportunities to transition to low-carbon living through focusing investment on the sustainable delivery of energy and its efficient use. Energy systems should be redesigned to adapt to new patterns of work, life and energy use, increasing resilience and ensuring that fuel poverty is reduced. Existing green and climate regulations should be reinvigorated; for example, many cities have already declared a climate emergency and have green city charters. Cities need to be supported to achieve their climate energy targets with the necessary resources and know-how to accomplish these at scale.

In a Covid-19 world, we must invest in sustainable energy solutions and innovations that are designed to be holistic and provide protection to vulnerable populations. We must accelerate the decarbonisation of our energy systems with universal and equitable energy access at the core. Investment streams need to be leveraged, while recognising the significant threat to these resulting from the economic shock caused by Covid-19. Geographical coordination (e.g., cities and regions) could help combat economic downturn and provide test beds for future energy systems and investment, with modelling and monitoring providing the necessary evidence.

Spotlight 3: Waste management

The pandemic has revealed how fragile our resources and waste management systems are. During lockdown, 46% of recycling facilities reduced service or stopped operating and many collection services for recyclates such as glass and garden waste were suspended[8]. All household waste recycling centres closed, charity shops closed, and a 300% increase in fly-tipping was reported[9]. Collection and processing services were reduced because of staff absences and the rapid introduction of changes to working practices to allow safe physical distancing.

8. https://www.letsrecycle.com/news/latest-news/council-waste-survey-coronavirus/
9. https://www.countryside-alliance.org/news/2020/4/don-t-be-a-twit-and-fly-tip

We need to be better at spotting and responding to trends that have a negative impact on resources and waste. This goes beyond planning for possibilities (which we are relatively good at) and it is particularly challenging when dealing with things that are slow and long-term. To support the circular economy, we need to ensure that resource recovery systems continue during a pandemic or other shock. Research is needed to understand the infection risk associated with waste management working practices. Automated or semi-automated waste collection vehicles[10] or vacuum systems[11] are options which could be used to improve worker safety. Advanced automation of sorting and processing could increase the amount and purity of recovered resources while protecting the workforce. Ensuring the availability of recyclates may provide resilience going forward and enable a circular economy to be supported during future disruptions.

There is a risk that recycling rates may slip as household waste management behaviour changes in response to Covid-19. During lockdown in the UK, the amount of household waste increased while commercial waste dropped. Recent progress on the reduction of single-use plastic has suffered a setback with wrapped goods and single use cups being preferred for hygiene reasons[12]. These impacts are hopefully short-term, but a return to unwrapped goods and reusable cups will need to be actively managed.

Spotlight 4: Transport and travel

Safe physical distancing means some things are getting worse. Across the world we have seen people reverting to the private car as the perceived safest means of transport in a Covid-19 world. Operators of mass transit systems are reducing the number of people able to use public transport at any one time, further pushing people to travel independently. Recent evidence suggests that initial increases in walking and cycling are being replaced by a reversion to travelling by car; and the space that had been carved out from roads and elsewhere to facilitate walking and cycling is reverting to its original purpose in spite of the initial good intentions to keep it.

Clearly such trends are detrimental to the long-term climate change risk being mitigated by carbon reduction. The climate emergency is still the primary threat to the future existence of human societies, meaning that a resurgence in the use of petrol and diesel vehicles could have catastrophic impacts. 'Zero-emission' vehicles will not solve most of the problems associated with motorised road traffic (such as traffic congestion, impoverishment of the environment and air pollution[13]). There is a significant risk of a rebound in transport-related oil use when countries end lockdowns[14]. We therefore need to actively reduce the need to travel, discourage high-carbon transport, encourage and plan for increased low-carbon and active transport, and find ways to effectively 'Covid-proof' public transport.

Spotlight 5: Buildings

Covid-19 is changing our way of working and living, and a vast repurposing of buildings now seems inevitable. Repurposing buildings rather than demolition is a sustainable, cost and carbon efficient way to address the problem of buildings standing vacant, but will require thorough understanding and resolution of many scientific, technological, planning and business issues. For new buildings, the

10. https://schaeferwaste.com/improve-worker-safety-with-automated-waste-collection/
11. https://www.envacgroup.com/waste-collection-reimagined/envac-in-the-city/
12. https://www.theguardian.com/environment/2020/jun/22/reusable-containers-safe-during-covid-19-pandemic-say-experts
13. Timmers RJH & Achten PAJ (2016) 'Non-exhaust PM emissions from electric vehicles', Atmospheric Environment 134:10-17
14. https://www.iea.org/articles/changes-in-transport-behaviour-during-the-covid-19-crisis

pandemic has revealed that we must be better at 'designing in' adaptability and flexibility, including a contribution to resilience – for example, what might buildings be used for in an emergency?

In the UK the market for repairs, refurbishment and repurposing has historically been of a similar scale to new-build. It is more agile as a vehicle for economic stimulus and is more suited to address changes in the use of buildings. In the short term, new infrastructure investments in cities will likely be a low priority. It may be that we need to refurbish and repurpose in the most efficient and affordable possible way for maximum benefit rather than focussing on large-scale investments. The Nightingale hospitals, created by converting existing buildings, are a good example. They were created in a short space of time and were designed as impermanent places – qualities that needn't be solely reserved for existing buildings. For this way of thinking to become embedded, land ownership, a barrier to such regeneration, will have to be addressed.

We mustn't underestimate the importance of interior environments that are not only safe but are believed to be safe. Safe and healthy working and living environments will become a differentiator in a Covid-19 world. We know that we need to sort out the ventilation systems in buildings (and other public spaces and transport). This means setting the appropriate number of air changes per hour and determining the appropriate direction of air flow and circulation to reduce transmission as much as possible, while retaining comfortable levels for the people in the space. But buildings are more than physical spaces. How can organisations encourage loyalty and commitment in an online world with fewer offices and face to face meetings? How will new staff acquire the organisational ethos and culture that binds people together without regular social contact? What will be the glue that holds communities together?

Credit: Etienne Godiard/Unsplash

Spotlight 6: Construction

It is crucial for the construction sector to develop new working systems and practices that ensure our infrastructure and cities can successfully transition to a Covid-19 world. The construction industry operates at low margins and comprises a high proportion of small- and medium-sized enterprises (SMEs), which are less likely to be able to survive the Covid-19 storm. The industry needs a flourishing SME sector for competitive tension and innovation. SMEs may need short-term bridging support such as rates relief on underused facilities. Even Tier 1 contractors, already reeling from recent high profile collapses or near-collapses, will continue to be fragile until (and unless) markets recover. Strategic interventions may be required to maintain a competitive market for the long term.

The construction sector needs to improve the robustness of its modelling of whole life costs in financial and carbon accounting. Decisions on whether and what to build should be informed by the best available forecasts of cost and carbon across the whole life of assets, to assess net benefits or disbenefits. Future reuse and repurposing must be built into the design process. Approvals for new build should be strengthened with obligations to plan for re-use of components, materials and the repurposing of entire assets using circular economy principles.

Construction is a team endeavour. Many routine operations require 'buddies' to ensure safe working methods. If proximity creates an unacceptable safety hazard due to the risk of infection transmission, traditional methods of working must be changed. Modern construction sites with strong safety cultures have a workforce whose members look out for each other. In a Covid-19 world, this needs to operate at a heightened level. The concept of PPE (Personal Protective Equipment) needs to transition to CPE (Communal Protective Equipment), that protects groups of people. Sites may need to be open for longer (hours in the day and days in the week), with shift work patterns to allow fewer people on site at any one time – carefully mitigating the potential downsides of such changes on nearby communities (for example, using quieter vehicles to reduce noise pollution and minimising vehicle movements). Existing good practice should be augmented, such as increasing the use of off-site fabrication to improve quality, reducing waste and reducing the negative impact of longer working hours.

In the short term, construction projects may have to be re-phased to favour outdoor groundworks, substructure and landscaping work. There is an opportunity to increase the use of AI (Artificial Intelligence) and robotics for routine tasks; but, the more robotics, the less employment is required for the displaced tasks. In a healthy economy, this releases people to do other tasks, but when economies are in recession (as the UK now is), such alternative employment opportunities are diminished.

Spotlight 7: Demand and supply chains

In the short term, there are legitimate questions about how we restart supply chains in a Covid-19 world. Manufacturing procedures also need to change. Is there sufficient confidence that there will be a market for what is being produced? Revitalising UK production and supply chains would reduce reliance on imports using long distance transport. The security of supply issues at the start of the pandemic highlighted the risk of being reliant on too few sources, especially if these are not within the user country. The "global just-in-time" marketplace may need to change to a "local,

just-in-case" approach. Research will be required into the availability of resources and the products most suited for regenerating local supply chains.

There is a need to research desirable future demand profiles, moving away from 'predict and provide' and towards 'decide and create'. Are high street retail and department stores and business offices now over-provided? Do we need more warehousing for a resilient system? Do schools need to be expanded to allow more space? Will universities need less space if online teaching becomes the norm? The National Infrastructure Commission has an important role to play here.

There is a very real chance that we are entering a period where access to capital is limited and public sector-funded projects are constrained by affordability. This demands an integrated approach that reflects creativity around pipeline and reuse, offers a different planning proposition and incentivises collaborative contracting arrangements.

Is Covid-19 just another shock?

The answer to this question depends upon who you are asking. Some hold the opinion that Covid-19 is transient; but whether that is true or not doesn't actually matter. What we do in response to Covid-19 should align with other priorities: climate change, Net Zero, circular economies, resource efficiency and security, loss of biodiversity and global poverty and inequality. In some cases, national responses to the pandemic have jump-started societal and economic changes that might otherwise have taken years; for example, the mass movement to vastly reduced travel, working from home, remote delivery of healthcare and other services, self-reliance and improved hygiene practices. It is now our responsibility to continue these trends, even if Covid-19 ceases to be a factor. But more than this, we must innovate. We must utilise new materials, processes and ideas to do things much better than before. We must improve our understanding of how our infrastructure and cities serve society, and invest to ensure they continue to do so into the future.

Transitioning requires flexibility and agility, but not random action. There will be many transition phases as new ways of doing things become embedded. In the beginning our focus was on health and transmission. Now we are thinking about rapid adoption and repurposing facilities and spaces. Democratic and transparent decision-making must not be trampled in the rush to act quickly. The balance of decision-making – the degree to which changes in behaviour and practices are in response to government regulations or personal choice – will, in part, determine who carries the associated risks.

Covid-19 has accelerated our need for systemic, complex problem solving, yet we continue to slice up cities into sectors (e.g., water, energy, waste, transport). What would happen if we moved away from a utility-centric perspective to a geographic-centric perspective (treating streets or neighbourhoods in the round) or even a human-centric perspective?

Health and wellbeing, economy and society, infrastructure and ecosystems, and leadership shape our everyday experience and Covid-19 has disrupted all of them. As we move beyond the initial shock we have a real opportunity to create systemic resilience, to strengthen existing sustainability priorities and to proactively co-design our infrastructure and cities.

Next steps

Although this prospectus casts backwards and forwards in its consideration of the impacts of Covid-19 on infrastructure and cities, it is inevitably a product of the knowledge available at the time of writing. That knowledge is changing rapidly, influencing our perceptions and perspectives.

It is not, therefore, our intention for this document to be static. We are already planning complementary activities that will generate new insights and change what is written here. We are also plugging into other, similar initiatives in order to influence and to be influenced. This document will, therefore, change – and change again – and we invite you to contribute by emailing us at **hello@ukcric.com.**

We cannot, however, let shifting sands make us impotent. We need to act to influence policy and regulation and to enable change. This won't be easy. We are acting on imperfect and incomplete information, but act we must, and so we are cultivating collaborative relationships with those in positions to make and to facilitate change. If you would like to find out more about our activities, please get in touch with us by emailing **hello@ukcric.com.**

Credit: Aleks Marinkovic/Unsplash

UKCRIC's role in meeting the challenge

Covid-19 has reinvigorated interest in rethinking infrastructure and cities. We now need structured ways to re-imagine and redesign places and spaces, to develop the underpinning science, and to test our thinking. UKCRIC's unique set of facilities are vital in establishing a comprehensive and rigorous evidence base.

One of the outcomes of the original workshop was the testing of the relevance of UKCRIC's missions in a world living with Covid-19. The clear conclusion was that UKCRIC's four missions, which relate to sustainability, resilience, affordability and productivity, and levelling up, are more relevant than ever. Covid-19 is a boundary condition adding urgency, but does not, in any sense, change UKCRIC's vision.

UKCRIC's four missions:

Infrastructure and urban systems for one planet living – sustainability. Empowering society to thrive within the capacity of the planet through responsible consumption, resource efficiency and sustainable growth. Lead academics: William Powrie and David Richards

Transformational infrastructure and urban systems for a changing world – resilience. Enabling infrastructure and urban systems to adapt to the challenges of climate change, changing patterns of use, societal expectations and emergent technologies. Lead academics: William Powrie and David Richards

Ownership, governance and business models for infrastructure and urban systems – affordability and productivity. Coping with greater system interdependencies, changing patterns of use and new, disruptive technologies whilst at the same time delivering social justice and affordability. Lead academic: Brian Collins

Infrastructure and urban systems as drivers of equity, inclusion and social justice – levelling up. Forging healthy, happy and productive lives for all through urban design, planning, policy and infrastructure. Lead academic: Chris Rogers

The principles described within this document add to UKCRIC's existing suite of approaches and methods to help the UK respond positively to the changes inflicted by Covid-19. UKCRIC adopts a systemic approach to understanding the consequences, positive and negative, of infrastructure and city system interventions. In order to deliver the outcomes from infrastructure and city investments that are so desperately needed from necessarily constrained budgets, three important processes are required:

1. **The case for change needs to draw selectively and creatively on the evidence base.**
2. **Alternative business models, deriving from an understanding of all of the infrastructure and city systems affected by the intervention in question, need to be formulated. These value frameworks balance and tension the positive and negative consequences of the intervention.**

3. **The formal and informal forms of governance that determine whether the business models are able to deliver fully their intended outcomes need to be identified and aligned, via changes where necessary and possible, with the intervention.**

Adopting these processes provides comprehensive and transparent information to decision-makers, enabling them to make decisions with confidence, understanding the full extent of the likely consequences of their decisions while also de-risking the decisions that they make. UKCRIC's guiding philosophy is that the above processes need to be considered while designing any intervention, whether for the short or long term.

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