

SHARING SOLUTIONS
TO COMMON URBAN
CHALLENGES IN BRAZILIAN
AND UK CITIES

CATAPULT
Future Cities

Solutions to common urban challenges like traffic congestion, overcrowding and road safety can be shared between cities around the world. This report by Future Cities Catapult identifies intelligent urban infrastructure in the UK that can help address real challenges in Brazilian cities.

BELO HORIZONTE

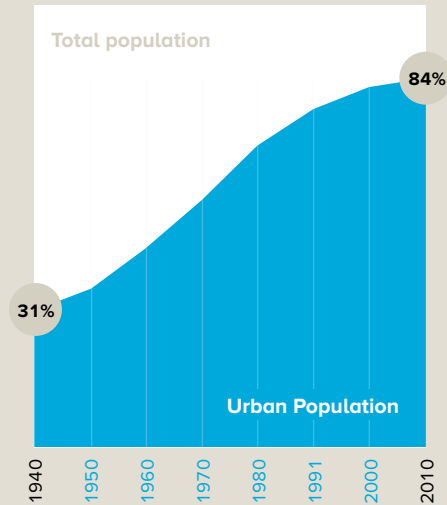
INTELLIGENT INFRASTRUCTURE

BRAZIL'S URBAN GROWTH

Brazil is an urban nation. The vast majority of its population now lives in cities. From coastal cities like Rio de Janeiro and Salvador, to rainforest cities like Manaus and the federal capital of Brasilia in the highlands, these diverse and vibrant metropolises provide a home for many of Brazil's 200 million people.

Like most countries across the world, Brazil's urban population is growing every year. In the past 50 years this prosperous nation has experienced an incredible population boom, almost tripling in size from 71 million to 200 million people, with most of that growth concentrated in urban areas across the country. Brazil's urban population has grown by a staggering 12% in the past decade alone.

The Metropolitan Region of São Paulo (Região Metropolitana de São Paulo), the largest metropolitan area in the country, now has over 20 million inhabitants and São Paulo is the largest city in the western and southern hemisphere. Rio de Janeiro is home to 6.5 million people while Belo Horizonte has 2.5 million inhabitants.



COMMON URBAN CHALLENGES

Urbanisation brings both opportunities and challenges. With more and more people living in cities, providing access to vital infrastructure like housing, food, energy, clean water, transport and health-care becomes increasingly difficult. Existing infrastructure becomes vulnerable to multiple pressures. Addressing these challenges whilst maintaining thriving, competitive local economies and providing sustainable livelihoods for inhabitants, remains a priority concern.

Cities across Brazil are facing problems as diverse as improving mobility, increasing citizen safety and better supporting local innovation. But these challenges are not unique to Brazilian cities, they are common to many cities all over the world. And with common challenges comes the opportunity for sharing solutions to address them.

INTELLIGENT INFRASTRUCTURE

Technology does not have all the answers, but it can help provide solutions to some of the most pressing urban challenges. Intelligent infrastructure is about identifying the right technology for the right challenge to make a real impact in cities. This could be applying new solutions to urban challenges, or using existing infrastructure in innovative new ways.

The United Kingdom is an urban nation with a legacy of world-leading innovation. Internationally regarded for its architecture, engineering and technology firms, city planners and universities, this melting pot of expertise has given rise to ground-breaking innovations that have real application in cities, both in the UK and elsewhere.

82%
of UK population
lives in cities



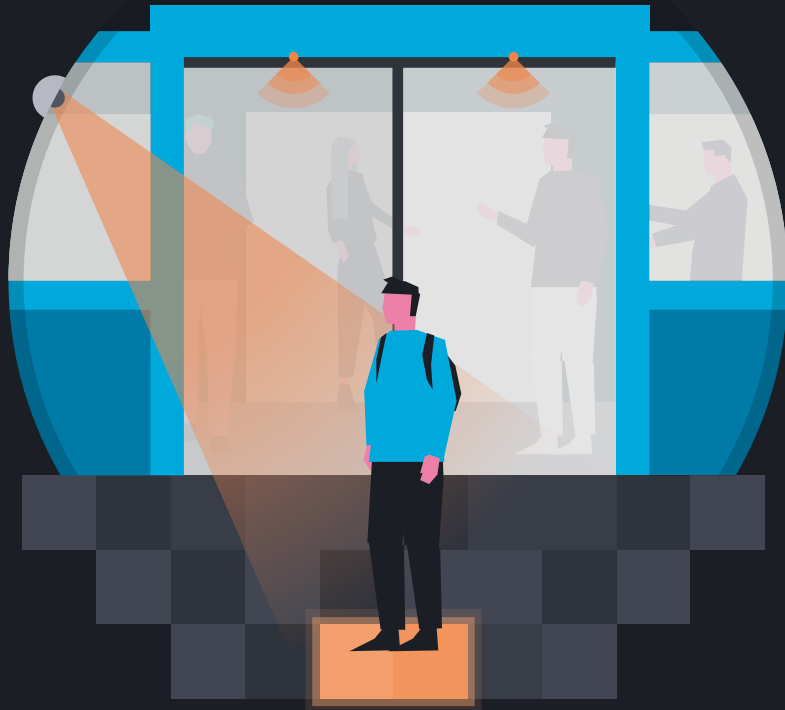
84%
of Brasil population
lives in cities



SHARING SOLUTIONS BETWEEN UK AND BRAZILIAN CITIES

This report aims to identify intelligent urban infrastructure in the UK that can help address real challenges in Brazilian cities, focusing on the city of Belo Horizonte, Brazil's third most populous metropolitan area.

Through a series of workshops and interviews, the partners have worked together to prioritise four key urban challenges in Belo Horizonte, to explore their root cause, and then to identify examples of technologies from the UK that can help tackle them. This will provide a model of best practice for cities across Brazil seeking similar solutions to some of the most common urban challenges.



CHALLENGE

OVERCROWDING ON PUBLIC TRANSPORT

The bus rapid transit system is the best way to travel in Belo Horizonte. Half a million people make 3.6 million journeys on it everyday, though this can often lead to overcrowding on buses, delays to the service and unhappy passengers. The public transport authority, BHTrans, does not currently have adequate information to monitor the problem or sufficient evidence to resolve it with the transport companies operating the services.

SOLUTION

USING TECHNOLOGY TO MONITOR OVERCROWDING

Technology can be used to monitor the level of overcrowding on buses in rapid transit systems. By measuring data on passenger numbers and bus occupancy, BHTrans will be able to collect the right information and take practical steps to address the problem. In some cases it might even be possible to use existing infrastructure to collect data, minimising additional costs and effort.

1. ONBOARD CCTV CAMERAS

On some bus routes in London, passenger occupancy is monitored using pre-existing onboard CCTV cameras. The video footage generated from the bus CCTV system is analysed to identify current seat occupancy and thereby the location of available seats. When new passengers get on the bus, they are guided to available seats and encouraged to make the most of the space. The information is also useful for transport operators to monitor user behaviour on board the buses and for future mobility service planning.

2. DATA-GENERATING FLOOR TILES

Innovative floor tiles can be used to measure how many people are getting on and off buses. Installed in strategic locations at stations, these tiles react to footfall to count the number of passengers going past. The data is then analysed to calculate the passenger occupancy of each bus. The floor tiles are also able to convert energy from footfall into electricity that powers the tiles (and even creates a surplus), making them ideal for bus stops where there may not be an existing energy supply. They have been successfully demonstrated in London Heathrow Airport as well as at West Ham Underground Station.

3. THERMAL IMAGING

Thermal sensors can detect the number of people passing by a specific location. Installed at alighting points of buses or station entrances/exits, these sensors can count passenger movement in two different directions at the same time. With sufficient coverage at stations along bus routes, the data can then be analysed to infer the passenger occupancy of each bus.

KEY STAKEHOLDERS

Target organisations:

Public transport authorities, e.g. BHTrans

Similar stakeholders in UK:

Organisations running bus services, including service providers contracted to Transport for London, Transport for Greater Manchester

IMPACTS

- Better passenger experience
- Fewer delays caused by overcrowded vehicles taking longer to load/unload passengers
- Fewer onboard accidents due to overcapacity buses
- Doesn't require installation of devices on buses themselves



CHALLENGE

LACK OF INFRASTRUCTURE TO SUPPORT INNOVATION

For Belo Horizonte to thrive in the long term it needs to nurture its culture of innovation. The city has a diverse local economy and is well regarded for its nascent wealth of IT and biotechnology firms, but for these and other service oriented companies to continue to grow, more investment is needed in smart information infrastructure to support innovators and early-stage firms. As of 2014, only 57.6% of Brazilian citizens have internet access, which is particularly lacking in more deprived parts of cities.

SOLUTION

BUILDING SMART CIVIC INFRASTRUCTURE

Investing in infrastructure is key to supporting technological innovation. Smart civic infrastructure includes digital infrastructure like public WiFi zones, data infrastructure to support new businesses, and even physical infrastructure that can manage itself more intelligently and also provide a platform for other civic technology.

1. OPEN DATA INFRASTRUCTURE UNLOCKING INNOVATION

Cities are increasingly realising the value of open data for stimulating innovation in their local economies. In Manchester, the city authorities are making urban data on a number of themes available to the public, and freely usable to public bodies, companies and citizens in that region and beyond. Data experts in city authorities work together to generate and share their data in a common format and store it in a central repository, meaning that data can be used quickly and reliably. A digital engagement programme is also run in parallel to engage the local community of innovators and support them in developing new smart products and services. After one such recent 'hackathon' an obesity-fighting software application called 'Light Raider' was developed and is now being commercialised.

KEY STAKEHOLDERS

Target organisations:

Municipality of Belo Horizonte, Centro de Operações da Prefeitura de Belo Horizonte

Similar stakeholders in UK:

Birmingham City Council, Birmingham Smart City Commission, Manchester City Council, Glasgow City Council

IMPACTS

- Digital infrastructure delivering new services for citizens:

Whilst still in its early days of delivering the programme, Birmingham City Council estimates that for every £1 it spends on broadband connectivity, nearly £16 is generated in additional value for the wider economy as a result of efficiency gains and business growth.

- Open data infrastructure unlocking innovation

Low-cost civic initiative with wide-ranging applications including cost savings from improved transparency in government, increased efficiency of public services, and avoiding procurement costs for bespoke IT services that are instead provided by grassroots developers

Direct economic returns of opening up and re-using public sector data estimated at £1.8 billion (~R\$10.5 billion) per year in the UK with cities being key drivers

Wider benefits from the programme include development of skills and capability in Manchester and the UK for open data infrastructure development, data analytics and software development.

2. DIGITAL INFRASTRUCTURE DELIVERING NEW SERVICES FOR CITIZENS

The English city of Birmingham is using digital technologies to deliver better public services for citizens. High-speed broadband and free public Wi-Fi networks are being installed across the city - particularly in more deprived areas - to provide essential infrastructure that can support a range of new, smarter services. These include smart parking sensors and connected digital signs that guide drivers to available spaces, real-time traffic monitoring systems to help reduce congestion, and online healthcare platforms to connect patients to doctors online and reduce the need for them to leave the house.

3. SMART CIVIC INFRASTRUCTURE SUPPORTING SAFETY AND CONNECTING CITIZENS WITH THEIR CITY

The Intelligent Street Lighting Demonstrator project in Glasgow, Scotland, was rolled out to address local crime issues, with 72,000 old fashioned street lights replaced with LEDs and sensors to measure footfall, lighting and climatic data such as air pollution. The intelligent street lights detect and respond to local activity, brightening in response to approaching pedestrians and cyclists, and dimming when nobody's around. By improving local light levels, these automated street lights are encouraging people to feel safe when out and about, whilst reducing costs of energy consumption by up to 60%.

The creation of this new connected platform of smart street lights has spurred on other innovations to improve the quality of life in Glasgow. As the lights are connected to the internet, they can also be used to coordinate more sophisticated responses to address crime in the city. Unusually high noise and footfall levels are often an early indicator of anti-social behaviour. In response, lighting automatically brightens to help calm disruptions before they escalate, and an alert is sent to the central Operations Centre where the information can be investigated alongside real-time, high-definition CCTV footage. This enables an appropriate response to be coordinated, such as deploying police services to the area.



1. SMART PEDESTRIAN CROSSINGS

The SCOOT (Split Cycle Offset Optimisation Technique) is a smart road crossing system that automatically gives priority to pedestrians crossing the road. Sensors installed at traffic lights can detect the number of pedestrians waiting. Depending on the size of the crowd, the system is able to adapt in real-time to extend the green signal and allow pedestrians more time to cross the road. Since the sensors are very low resolution they can be processed locally in real time, negating the need to store or transmit images off the device, avoiding many privacy issues.

2. SMART CYCLE LANES

Sensor technology can be installed on cycle lanes to detect the volume of cyclists waiting to cross the road at traffic lights. Two types of detection technology have been trialled in London: a radar-based system using sensors embedded in the road surface and a thermal-imaging system that detects the heat profile of riders as they approach a junction. Depending on the volume of cyclists, the information could be used to vary the green signal phase of the traffic lights to allow more cyclists through. As well as the road safety benefits, this would also improve the experience of cyclists, encouraging more people out of their cars and on to bicycles.

KEY STAKEHOLDERS

Target organisations:

Public transport authorities, e.g. BHTrans

Similar stakeholders in UK:

City and metropolitan area transport authorities for large cities include Transport for London, Transport for Greater Manchester, West Midlands ITA and others. National agencies include Highways England and Transport Scotland.

IMPACTS

The SCOOT system for pedestrian crossings has been deployed in many areas throughout the UK. In central London, around 90% have now been fitted with the technology and by 2018 virtually all junctions will have it. So far it has had real benefits for reducing congestion and improving safety, including:

- Reduced general traffic delays by up to 12%
- Average bus delay reduced by 7% to 13% and average bus delay variability decreased by 10% to 12% in the initial trial deployments
- Emergency services can request 'green waves' through the smart junctions, improving their response times to incidents

CHALLENGE

TOO MANY ROAD ACCIDENTS / POOR ROAD SAFETY

There are around 1.6 million vehicles on the roads of Belo Horizonte. Traffic congestion is a daily occurrence, leading to delays and road traffic accidents. Every year around 14,000 dangerous traffic accidents are reported in the city, which often affect vulnerable road users like pedestrians, cyclists and motorcyclists in particular. In Belo Horizonte over a third of people involved in fatal collisions are pedestrians.

SOLUTION

USING TECHNOLOGY TO HELP IMPROVE ROAD SAFETY

Technology can help to reduce congestion and improve road safety. When installed in high risk areas like road junctions and pedestrian crossings, sensor technology and other detection systems can help people to cross the road. In London 80% of serious or fatal collisions involved pedestrians and other vulnerable road users like cyclists. Technology has been successfully rolled out across the city to help address this.



SOLUTION

IMPROVING THE SAFETY OF HIGH ENVIRONMENTAL RISK AREAS WITH DATA

Technology can help to collect comprehensive, up-to-date geospatial information in areas most at risk of environmental disasters. In Rio de Janeiro kites have already been used to map informal settlements by collecting aerial photographs. Other technologies such as low cost drones are an affordable solution for collecting situational data easily, regularly and in a way that supports the existing data systems used by local civil defense authorities. The data that is generated can be used to diagnose and predict where and when incidents are likely to occur, giving advanced warning to authorities and enabling them to take appropriate action, minimising the negative impacts on people and buildings in the area. The information can also provide greater evidence to support investment in areas most at risk.

1. DRONES FOR LOW-COST INFORMAL DEVELOPMENT MAPPING

Drones, or unmanned aerial vehicles, are increasingly available devices that can be bought and operated for far less than traditional aircraft-based aerial photography. Typical examples weighing less than 1kg can generate photography covering 12 km² with a ground sample distance of 1.5cm per pixel, meaning high resolution 2D imagery, called orthomosaics, can be gathered as and when needed. This may be in the visible light spectrum, or extended to ultraviolet and infrared, useful for determining characteristics of surface soil. This imagery can then be transformed into a 3D representation of the area observed, that can be used to give Civil Defence organisations up-to-date GIS information.

The availability of this data means that pre-emptive efforts to identify and address informal development in high risk areas can be done more effectively by identifying changes in land use and building construction quickly.

3D geometry of neighbourhoods and districts can also be helpful when engaging with local communities out in the field. By 3D printing neighbourhood areas of the up-to-date digital 3D model, the plans of Civil Defence organisations can be more easily explained and contextualised out in community.

KEY STAKEHOLDERS

Target organisations:
Civil Defense of the Municipality of Belo Horizonte

Similar stakeholders in UK:
Environment Agency, MET Office, and their joint venture the Flood Forecasting Centre

IMPACTS

The combination of low-cost aerial imagery for generating both 2D and 3D data, along with sensing devices embedded in water systems and high-risk infrastructure allow for:

- Smarter approaches to flood mitigation strategies
- Greater responsiveness and more effective prioritisation by Civil Defense organisations
- Better engagement with local communities through scenario visualisation

2. ENVIRONMENTAL MONITORING OF WATER SYSTEMS FOR MORE EFFECTIVE FLOOD RESPONSE

The UK's Environment Agency has a network of 2,400+ river and sea level monitoring stations throughout England and Wales. These electronic stations generate readings every 15 minutes, store the data and then, once a day, relay them via telemetry systems (or even more frequently during flood events). This data is then published on the Internet.

In combination with meteorological information, this data is used by the national Flood Forecasting Centre to generate clear, consistent and targeted forecasts of flood events ensuring those that manage flood response have long lead times for more effective preparation. This helps better protect homes and business that are at risk from flooding.

In addition, as the water system monitoring information is published as Open Data online, individual citizens and entrepreneurs have created valuable products and services. From online websites allowing users to track individual gauge activity by Twitter, to tools to support farmers, fisherman and those extracting from the water network.

CHALLENGE

ILLEGAL OCCUPATION OF AREAS IN RISK

In Belo Horizonte some of the areas most at risk of environmental disasters are occupied illegally by people living in informal settlements. These people are very vulnerable to dangerous conditions, especially during flash floods, extreme weather and other emergencies. Gathering information on the number and location of people living in these areas, and the state of buildings within them, is currently expensive and time consuming for the city government, but important for them to be able to effectively prioritise their resources and protect these vulnerable communities.

DELIVERING INNOVATION IN INTELLIGENT URBAN INFRASTRUCTURE

This report outlines a number of examples of technologies and innovations from the UK that could help Brazilian cities address some of their most pressing challenges.

To take the next step, an organisation like the Future Cities Catapult can help. We accelerate urban ideas to market, to grow the economy and make cities better. We bring together businesses, universities and city leaders so that they can work with each other to solve the problems that cities face, now and in the future.

From our Urban Innovation Centre in London, we provide world-class facilities and expertise to support the development of new products and services, as well as opportunities to collaborate with others, test ideas and develop business models.

We help innovators turn ingenious ideas into working prototypes that can be tested in real urban settings. Then, once they're proven, we help spread them to cities across the world to improve quality of life, strengthen economies and protect the environment.

Our Cities Lab provides data analysis, modeling and visualisation capabilities to understand and elucidate city problems, while on-the-ground demonstrators in our network of collaborating cities provide opportunities for testing new approaches in-situ. Combined, they help us discover which new ideas can have the biggest impact on our urban environments.

RECOMMENDATIONS

To successfully deliver intelligent infrastructure in Brazilian cities:

Local stakeholders must be involved through a collaborative development process. This brings together the combinations of skills required for delivery, improves engagement with citizens improving adoption, supports the local economy and fosters local innovation networks

The state-of-the-art research in academia and the delivery capabilities of industrial partners must be brought together to iteratively prototype, test and evaluate potential interventions, before expanding to full-scale deployments

It should be recognised that technology alone is rarely the whole solution to urban challenges and that without the people, their training, sustainable underlying value models, good policy and supportive local governance, success is far more difficult.

There is no one-size-fits-all approach to solutions in cities. But by working together with local authorities and solution providers (and innovation agencies like Future Cities Catapult) they can:

- Identify high-potential emergent technologies and best practice
- Connect novel technological solutions to high priority urban challenges
- Share between cities an understanding of successes and the lessons learned from local experience

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FUTURE CITIES CATAPULT

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www.futurecities.catapult.org.uk

CITY OF FOCUS

Belo Horizonte is the capital city of the State of Minas Gerais and Brazil’s third most populous metropolitan area. A planned, modern city, it exemplifies the kinds of urban challenges common among many Brazilian cities, as well as the entrepreneurial spirit needed in order to tackle them. It continues to look for ways to bring the public sector, technological innovation and citizen engagement together to innovate.



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