The Business Case for Smart Cities

Executive Summary

Siemens Digital Cities Series

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Introduction

We have developed a smart cities methodology – put into practice across five cities – that enables cities around the world to build a business case for smarter urban environments.

The potential for cities to transform themselves for the better has never been greater, thanks to digital technologies that enable the exchange of data on a vast scale.

These tools create new possibilities to make cities safer, cleaner, greener and more responsive to the needs of their citizens, businesses and other organisations.

Connectivity & mobility
At the heart of this transformation will be the smartphone, alongside a profusion of ever-cheaper smart sensors that collect and transmit city data in real time. In one example, traffic flows could be monitored in real time to ease congestion.

Smarter, faster & safer
Cities can also share data among different agencies to speed up and improve collaboration while promoting innovative approaches to service delivery, helping to address challenges as diverse as environmental degradation and security.

Cleaner & greener
Smart cities will use data to better manage energy demand. Energy use can be optimised, minimising fossil fuel use while maximising efficiency savings and inputs from clean energy sources.

Building the business case

To achieve such advances cities must be sure of a strong and clear business case to justify capital investment. Funding proposed innovations is tough, since by definition there will be little or no historic evidence to demonstrate their worth.

The role of city hall
City governments are best placed to lead and co-ordinate such wide-ranging initiatives. However, the successful ones are acting in partnership with companies and other organisations to create an integrated value chain that benefits everyone.

Contents

This document summarises an 18-month research programme carried out in collaboration with five European cities to establish the returns available and ways to build a business case for investment in smart city infrastructure.

Capturing the potential of the digital revolution

A new methodology for cities to establish a robust financial case for implementing smart city measures, from energy to security. Our modelling supports cities with infrastructure planning through a new approach we call 'the digital value sphere'.

To develop and test our smart cities methodology, we worked with five cities on the use of smart approaches in their real-world aspirations, plans and challenges. The model used included over 350 inputs and was designed to provide a measurable business case, expressed in currency units.

Techno economic

Using city-specific data, alongside other research and technical expertise, we built and developed a unique techno-economic model to calculate the technical, financial and indirect benefits from digital infrastructure. This can be compared to a business-as-usual reference case and used to plan and prioritise infrastructure investments.

Cashflow projections

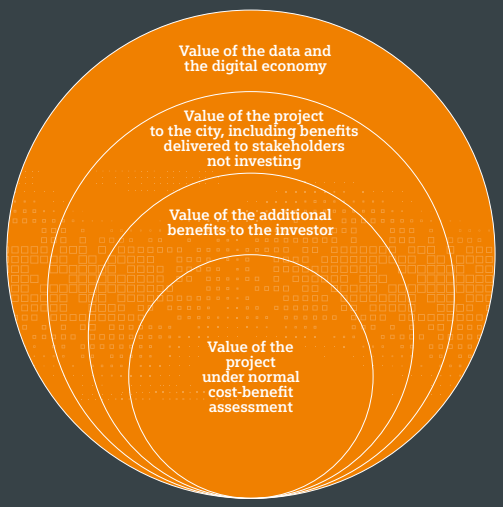
Cashflow graphs capture the results, showing the modelled investment and benefits on an annual basis over 35 years. Direct financial costs and benefits, alongside wider socio-economic benefits, are considered; therefore, while all figures are expressed in currency units (in euros), the figures represent a mix of 'cash' and 'non-cash' elements.

350 inputs

A combination of more than 350 city and technology-specific statistics are used in the modelling. These include economic value factors for wider benefits such as: carbon savings, crime reduction and improved air quality.

Digital value sphere

To capture the value opportunities from digital infrastructure, the cost-benefit assessment for a conventional investment appraisal is broadened to capture a wider field using a digital value sphere model. This approach takes a cross-stakeholder view.



Direct and indirect benefits

This model reflects an understanding that a viable smart city business case will be founded on a mix of real benefits which can be directly monetised (e.g. transport services and energy savings) and other real but indirect benefits which are more diffuse or which cannot be rationed (e.g. public health benefits from better air quality, lower crime rates and new amenities).

Delivering on investment

Our methodology helps any city explore different investment options and identify key uncertainties. This provides a way for cities to decide on the projects to invest in and develop approaches that can deliver positive returns on investment.

ENERGY TRANSPORT

Greener power grids & time-saving transport

Smarter digitalised city grids can drive transformational energy benefits, while digital technology can have some of the greatest impacts on transport in any city, speeding transit times and improving use of existing road space.

ENERGY

Each city is unique, each has its own growth pressures and energy demand profiles, but common to all of them is the potential for smarter grids to drive efficiencies and improve the lives of their citizens.

This technology can lead to substantial cost savings and greater resilience.

Our methodology looked at the many benefits afforded by smarter grids, including increased capacity, resilience and cost-effectiveness of the electricity system. This technology offers the ability to manage demand, for example, through dynamic response pricing and the integration of clean, low-carbon renewable energy generation.

Virtual power plants (VPPs) could replace use of some fossil or nuclear power; cities currently rely on these sources which may soon be retired. VPPs enabled by digitalization can minimise the need for new centralised baseload generation, by managing decentralised generation, large-scale battery storage and controlling energy loads. Where demand threatens to exceed the capacity of the grid, smart energy infrastructure measures, including enhanced measurement and verification of network operations, could cut significant amounts of electricity demand.

Another tool to help manage capacity constraints in any city is flexible AC transmission systems (FACTS), which help optimise existing electricity distribution infrastructure. This can increase grid capacity without any new investment in the grid itself.

Even relatively straightforward measures can yield dramatic savings. Smart meters are a useful tool for managing demand and offsetting the need for additional infrastructure; digitally connected city-wide LED street lighting is cutting electricity use dramatically in cities the world over.

TRANSPORT

It is said that digital information is the fuel of mobility. In the era of smart sensors, the internet and smartphones, cities can use valuable new tools to make moving around the city safer, faster and smoother.

In cities heavily reliant on privately owned passenger cars for transport, deploying integrated traffic control centres, with real-time network monitoring and communication systems, can cut both peak-hour congestion and accident rates. They can also manage congestion by introducing variable road-pricing programmes.

On-street smart parking management can help drive efficiencies in managing city parking assets while a better understanding of the condition of transport assets could reduce insurance premiums and defer unnecessary upgrades.

Our modelling shows that digital technologies can also drive passenger uptake of public transport through improved, often real-time transit information, increasing passenger trust. This can speed modal shift and cut congestion.

Where there is pressure on existing public transport services, other measures can drive modal shift: for example, digitally enabled rental e-bikes increase the range visitors and commuters can travel, replacing other forms of transport.

A digital future for transport could also create new opportunities for cities to develop or participate in revenue-earning activities based on the value of data collected around the city's transport networks.

€1.56bn
Average value of cumulative return – both direct and indirect benefits – from smart energy measures across five cities

4x
Average return on investment from energy measures across five cities

20 GWh
Average annual energy savings from smart street lighting

€110m
Average net direct benefit from smart street lighting, representing an average ROI of
5x

20x
Average return on investment from transport measures across four cities

€566m
Average value of total cumulative return from smart transport systems across four cities

74%
Of the benefits from transport measures come through reducing delays and time savings

7 years
Average payback time on investment in smart on-street parking (including full detection technology and payments system implementation)

Test bed: London's Arc of Opportunity

In East London, electricity demand will soon exceed existing grid capacity but smart digital tools can help fix this. Flexible AC transmission systems (FACTS) can optimise existing electricity distribution infrastructure, increasing grid capacity without any new investment and cutting annual transmission losses by 2.6 GWh. Smart grid technologies – such as dynamic-thermal circuit rating, line sensors and bulk storage – would reduce demand and grid inefficiencies by 11 GWh annually.

Smarter transport infrastructure in city zones with challenging geographies, such as London's Royal Docks, can add significant value. These could include better network management encompassing operational sensors providing real-time data on road, transport infrastructure and parking space use, easing congestion and fixing problems faster. Integrated ticketing and mobility-as-a-service applications, meanwhile, can promote smarter use of transport modes.

Value of energy savings

€304m Direct and indirect benefits

55% Of benefits are indirect, coming from new energy service delivery models, consumer behaviour change and carbon reduction

Transport connectivity

€251m Direct and indirect benefits of smarter transport measures in London's Royal Docks

Helping buildings learn and talk to us

BUILDINGS

Buildings consume one fifth of global energy, so smarter building management can yield rapid cost and emissions savings while making them safer too. Central to these improvements will be the smarter operation of buildings along with closer integration of renewable energy generation.

Integrating smart controls and sensors into a building operation system – optimising the services they provide at minimum energy cost – is now possible. This makes for more comfortable, safer places to live and work, while minimising energy use.

It's all driven by a digital overlay that makes high-quality data cheaply available, improving the accuracy of design and specification of efficiency measures, driving down the delivery cost. This is not just for new builds but can equally be applied to retrofit programmes where rich data collection could yield comparable benefits.

Data-enabled building management can also help integrate cleaner power use, for example integrating solar generation and combining it with battery storage. This lowers grid energy dependence, and helps mitigate the adverse effect that variable generation has on the city grid by minimising peak power demand.

Advanced power electronics and building management systems we analysed can ensure that the benefits of on-site generation are further enhanced by optimising the timing of power purchase from the grid based on energy demands, on-site generation capacity, available storage and load control capacity.

Smarter energy management in buildings also helps reduce electrical transmission losses and reduces the need for grid infrastructure upgrades.

14x

Average return on investment from smarter buildings across three cities

29%

Of the benefits from using smart technology in buildings are from carbon emissions reduction

€4.2bn

Average value of cumulative return – both direct and indirect benefits – from smart buildings measures across three cities

4.3 years

Average payback time on investment in commercial building energy management systems

Smarter, safer buildings: Kartal

In an active earthquake zone and with many buildings that don't meet modern safety standards, Istanbul's Kartal district has a great opportunity to rethink the fabric of its built environment, develop a modern new city district and embed smart technologies. Smart building sensors will not only help manage energy more efficiently, it will also help save lives, limit damage and speed recovery and repair efforts in the event of a quake.

Value of return from buildings investment

24:1
Cumulative net benefit to capital cost ratio

5 years
Payback period

Predictive policing, safer cities

32x
Return on investment in smart security infrastructure in one city

11%
Reduction in police costs through predictive policing and savings in responding to crime

86%
Of the benefits come from measures to avoid crime taking place

SECURITY

Targeting crime effectively while maintaining public trust and avoiding alienating affected communities during times when budgets are squeezed is a challenge for effective modern policing. Smart technologies can help detect and deter crime, making city police forces more responsive and effective.

The smart detection, control, prediction and prevention measures we modelled in the study can boost city security on a range of measures while achieving significant direct cost savings. For example, camera systems can pay back their cost in just one year.

Greater indirect savings are also achieved due to the substantial value associated with avoided crime, and the many economic and wellbeing benefits of a city free from the fear of crime.

This is already happening. Predictive policing measures have reduced aggregated crime by between 8% and 32% in various locations in the US. The principal security technologies considered in this research include security operations centres and advanced networked camera systems that help forces deter and also respond to crime in real time while cutting the need for manual surveillance.

Camera systems alone have reduced incidents of crime by 16% in the past and they repay their costs in less than one year. Operations centres can return their investment in only three years.

When used in concert with crime analytics, these digital overlays to policing can help forces develop analytics on police data to anticipate and prevent crime.

Preventing crime: Brussels

Greater operational effectiveness, safer citizens and significant cost savings are all on offer in Brussels, according to our modelling. Using data for predictive policing could save the city €30 million, 8% of police costs. Predictive analytics based on real-time traffic data feeds, could cut the impact of unplanned events, speed response times and save €14 million.

Security sector opportunities

€482m
Cost of investment

€16bn
Value of cumulative direct and indirect benefits

2 years
Payback on investment

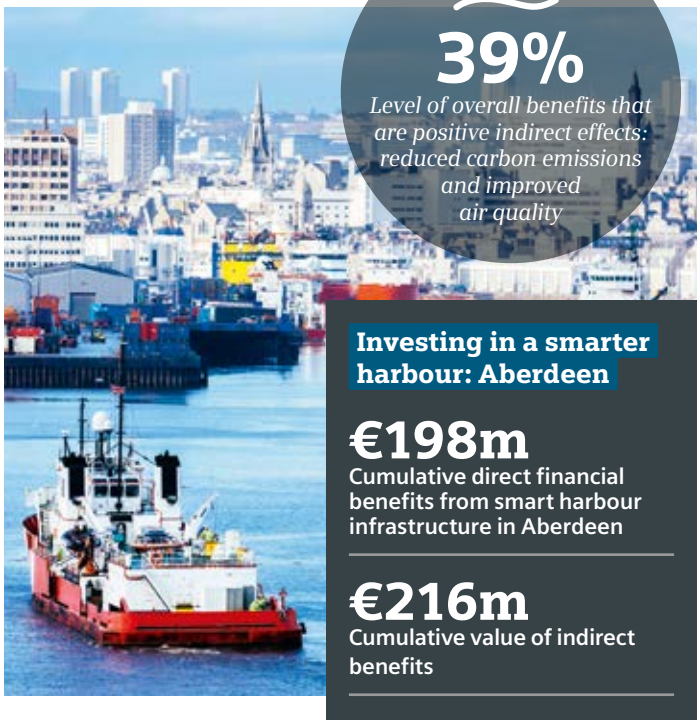
Lower impact harbours

Harbours are critical economic generators for cities; increasing efficiency and throughput delivers more shipping traffic. At the same time, clean and efficient shipping is critical if air quality is to improve around ports and any negative effects are to be minimised.

Our modelling shows that smart technologies can help port operators increase efficiency, optimise energy use and improve local air quality, where diesel pollution from vessels' on-board power systems can be a serious problem.

Automated / autonomous container yard and gantry crane operations can drive significant labour savings and optimise operational performance due to the removal of human error.

GPS tags for each shipping container allow better route analysis, tracking, tracing and container management. This can improve security and save time for operators, while reducing local road network congestion.



39%

Level of overall benefits that are positive indirect effects: reduced carbon emissions and improved air quality

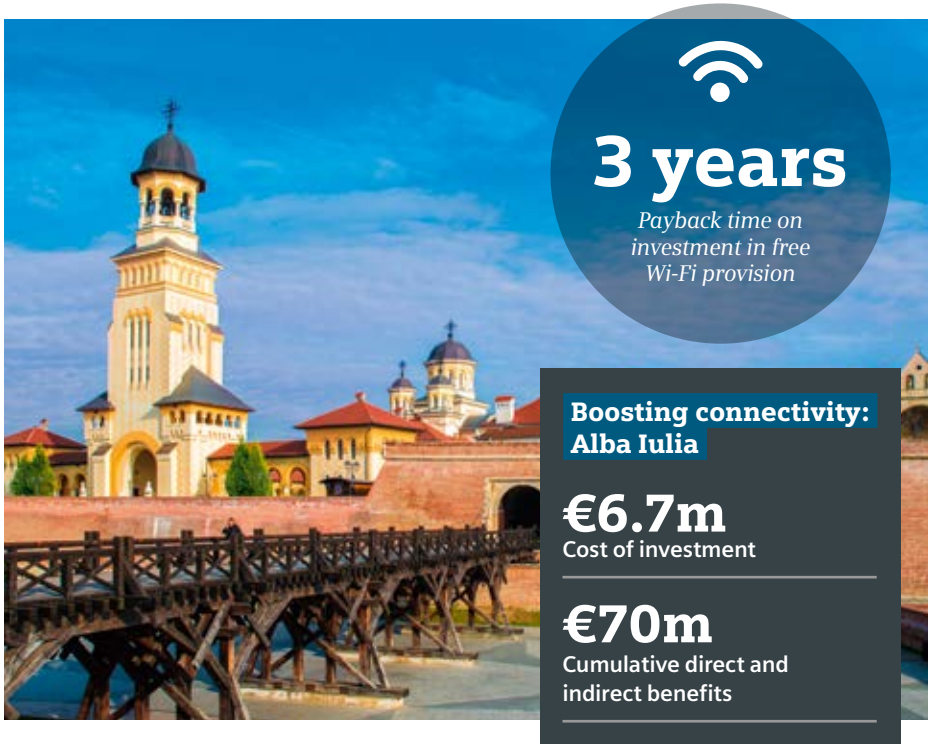
Investing in a smarter harbour: Aberdeen

€198m
Cumulative direct financial benefits from smart harbour infrastructure in Aberdeen

€216m
Cumulative value of indirect benefits

New connections

Half of the world's adult population is expected to own a smartphone by 2020. The greater ubiquity of mobile digital devices offers potential opportunities for cities through improving how people connect with the local environment.



3 years

Payback time on investment in free Wi-Fi provision

Boosting connectivity: Alba Iulia

€6.7m
Cost of investment

€70m
Cumulative direct and indirect benefits

Better connectivity measures we analysed help local businesses harness the power of the Internet in new ways, boosting local business growth and employment levels.

Good Wi-Fi connectivity also boosts the tourist industry by helping visitors connect more richly with the city. This can be through provision of free Wi-Fi points, geospatial beacons and tourism apps.

Cities can also harness the power of mobile phones, which act as distributed sensor networks. This enables greater understanding of where people travel, what their interests are and how to improve service provision through feedback.

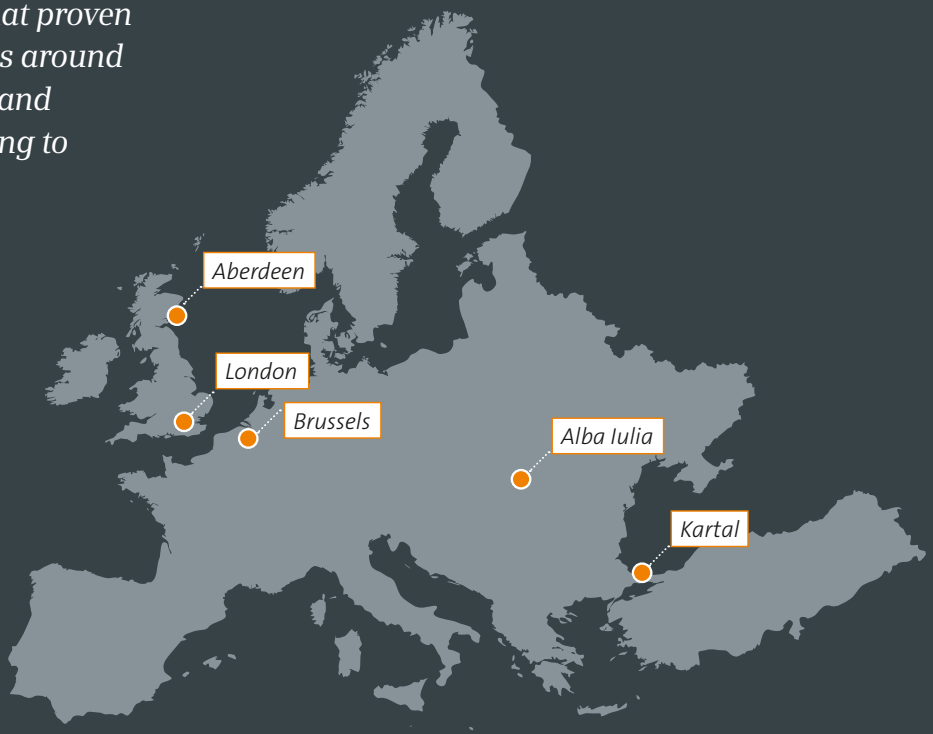
E-ticketing and digitally enabled bike rental schemes are further spin-offs from a more connected city.

Creating smarter cities

Our smart cities model shows that proven technologies can deliver for cities around the world, with delivery models and financing mechanisms developing to facilitate investment.

Cities can implement models for their local social and political context in the knowledge that investing in digital technologies can yield significant direct financial returns and wider social benefits.

The five city reports reveal how aspects such as data sharing and policy incentives can be used to not only effectively implement smart city infrastructure but also broaden the positive impacts.



The five cities chose their top three infrastructure priorities to be modelled in this research. Just some of the results are highlighted in this report. To access the full reports for each city, or other documents in the Siemens Digital Cities Series, please go to: www.siemens.com/intelligent-infrastructure

The five city reports

Aberdeen

The Granite City stands to benefit from smart automation and electrification of its busy harbour and responsive traffic solutions.

Brussels

Significant savings and rapid returns from joined-up investments in security measures can be realised.

London's Arc of Opportunity

In this emerging East London district, smart public transport and mobility solutions can provide an economic boost.

Alba Iulia

The capital of Alba County in Transylvania, Romania, can use connectivity to unlock economic benefits.

Kartal

This vibrant area of Istanbul is earmarked as a future business district. Digital tools can capture the benefits of new infrastructure.

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To access the full reports for each city, or other documents in the Siemens Digital Cities Series, please go to:
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