Cities that Work

PREPARED BY

IGC International Growth Centre

Assessment framework for measuring economic success in transport, land-use planning and resilience interventions

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IGC International Growth Centre Cities that Work

Assessment framework for measuring economic success

"I feel passionately about measurement - about how difficult it is, about how much theory and conceptualisation is involved in measurement and indeed, how much politics is involved"
Angus Deaton, Economist, Nobel Memorial Prize in Economic Sciences 2015

"Every line is the perfect length if you don't measure it."
Marty Rubin, Writer

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Preamble

Measuring Economic Success and the Global Future Cities Programme

The FCO Global Future Cities Programme aims to promote sustainable, inclusive, and economic growth in 19 cities across 10 countries worldwide including Turkey, Brazil, South Africa, Nigeria, Indonesia, Malaysia, Philippines, Vietnam, Myanmar and Thailand. It aims to support the development challenges that arise with increasing rapid urbanisation, climate change and urban inequality, which can lower long-term growth prospects of cities. By designing and implementing policy interventions in these cities to achieve the goals of urban policymakers, the Global Future Cities Programme aims to contribute significantly to achieving the Sustainable Development Goals (SDGs), in particular SDG 11 on Sustainable Cities and Communities, and implementation of the New Urban Agenda.

In response to a unique opportunity for a wider set of policy makers to learn from the Global Future Cities Programme, this Assessment framework for measuring economic success has been drafted. This paper seeks to **highlight key impact evaluation best practices and key gaps of cities research**, so that the programme can make strategic research investments. The results will allow low and middle income cities to learn and prosper from today's actions in years to come. In this way, the paper seeks to provide a framework for strengthening the evidence base for policy change in middle income cities.

1. Introduction

The Foreign and Commonwealth Office (FCO) Future Cities Programme is built around three key pillars: transport, urban planning and resilience. With the programme contributing a significant investment and lasting almost three years, ensuring the measurement of outcomes and future learning from these pillars is an important step to maximise the benefits and achieve ongoing prosperity in the future. Building an assessment framework for measuring economic success prior to the interventions taking place is an essential first step in understanding which potential benefits the cities receive from the interventions under this programme. The framework will also help to leverage cross-country learning such that similar benefits may be felt by an expanded network of low- and middle-income cities transitioning with similar challenges and problems to those faced by the nineteen FCO Future Cities.

Urban systems are relatively unique in the way in which impact measurement should be framed. Any changes to one part of the system reverberates and spills over to other parts of the system, making it difficult to isolate the true effect of the intervention. Whilst using simple experimental techniques are the 'Gold Standard' in common scientific and economic problems, they are often not capable of accounting for a city's complexity. This economic assessment framework attempts to provide some insight into rigorous techniques that effectively deal with this complexity and will ensure a useful review process of the FCO interventions.

The document is split into three sections. The first will unpack best practice for impact evaluation, drawing upon key examples of research where this has been done before. It includes subsections on the collection of historical and future data, methodologies for evaluating impact and designing the intervention to facilitate impact assessment. Section 2 summarises current key research gaps, with Section 3 outlining the potential role of some of the FCO funded programmes could play in alleviating these gaps.

2. Impact evaluation: best practice

Impact evaluation is a critical part of implementing and evaluating change. It helps us to understand which specific parts of the intervention worked and which didn't, how the intervention might be improved, and how it could potentially be implemented in other areas in the future. The term 'impact' should be used with caution. Assessing impact requires rigorous methods in order to isolate the portion of outcomes we observe that can be directly attributed to the intervention. Empirically based cross-city learning and evidence on best practices will allow a longer term virtuous cycle of benefits to be felt from the Prosperity Fund.

The perceived gold standard of impact assessment for many years in the field was that of a Randomised Control Trials (RCTs). This method has been widely used to analyse scientific and medical interventions, where the trial is designed to clearly impact one randomly chosen group (the treated group) but not another (the control group). Comparing the outcomes of interest in these two groups then provides us with a 'treatment effect' – i.e. the effect solely attributable to the intervention, whilst holding all else constant. The random assignment of groups is important because it ensures that the outcomes observed are not clouded by different baseline group characteristics.

RCT's, although useful, are not without fault - they are costly, time consuming, have ethical challenges, must be a-priori designed into the intervention. However, above all, they rarely work within the urban context. Cities are complex systems, and interventions involve a web of different interactions between actors with numerous spillover effects. Instead, in the city context the focus should be on cost-benefit analysis and other economic impact assessment methods that capture this complexity – outlined hereafter.

We can split most urban interventions into a direct effect on the outcome of interest, and indirect effects captured by employment and wages, local property values and a migration response. To illustrate using a transport example, an intervention on creation of a new Bus Rapid Transit (BRT) route may have the following impact effects:

1. Direct effect
    a. Speeds of travel – time from source to destination is reduced
2. Indirect impact
    a. Employment and wages – labour market has increased access to jobs
    b. Local property values – increased connectivity raises the values of surrounding property as it makes it a more attractive area to live.
    c. Migration response – increased attractiveness of destination causes people to move to that area.

Unlike simply testing the effectiveness of a vaccine, isolating any true impact of a city intervention requires rigorous theory and modelling. The methods outlined in the following section get us closer to this ideal.

There are three components that need to be considered in order to rigorously evaluate the impact of an intervention. These include, the availability of high quality historical and future data, an identification strategy or appropriate methodology to critically evaluate the impact and

designing the intervention in such a way that it facilitates impact assessment, which are expanded on below. It should be noted that many best practices for impact evaluation are cross cutting to all three themes, and therefore can apply generally across most of the interventions. However, the pillars of transport, urban planning and resilience also have their own nuances that should be considered and dealt with in specific ways. The following section draws upon best practices that are useful to incorporate into all intervention design and where appropriate, will highlight these unique aspects, showing where they have been usefully dealt with before.

a. Collection of historical and future data

For the FCO program, baseline data assessments have already been conducted with the local city consultants. To do this, the International Growth Centre at the outset outlined a number of key spatial and non spatial data useful to provide foundations for good economic research. Spatial data includes information on categories such as land plots, buildings, infrastructure, population, transport routes. Non spatial data looks at areas such as water and sanitation access, firms and employment, land ownership and property tax as well as governance and city finance. The local city specialists leveraged their networks in city to establish the following:

1. Whether this data existed
2. Whether the data was publically available
3. Which institution had access to the data
4. When the data was last collected

Although data availability varies across the cities which are part of this programme, the completed baseline data assessments provide a useful starting point in designing economic research. They also highlight the data gaps that ideally need to be rectified in order to provide more rigorous assessment. With the collection of historical and future data, assessment and research should be able to draw some useful conclusions regarding benefit from the interventions.

The table below details some of the salient variables required to evaluate each type of intervention. Although we have separated these by category, there may be many cases in which one intervention requires data specific to all three pillars. For example, Yangon's flood management and urban renewal intervention may require information on flooding frequency (to assess the risk), land and property values (to understand increases in neighbourhood values) as well as origin-destination matrices (to see where new visitors to renewed cultural buildings have come from).

Data structures are also important to consider for the types of methodologies that can be used. The two most important ones for the analysis of these interventions are cross-sectional, pooled cross sections and panel data:

- Cross sectional data is data that is collected once off to provide a snapshot view of the economy/demographics in a society.
- Pooled cross sections are a number of cross-sectional data sets collected at different times that are pooled together to enable some types of analysis of how the economy/demographics have changed. The observational units (for example individuals) that the data is collected on changes between the different cross-sections.

- Panel data is similar to pooled cross-sections in that the data is repeatedly collected over time, however the important difference is that with panel data, the same individuals are followed. This allows us to use some more rigorous methods as we will explore in the next section.

It is important that the data we use is collected in such a way that is it representative of the underlying population we are trying to study, and that we have enough data points to make convincing conclusions.

Key variables[1]

Cross-cutting	Transport	Urban planning	Resilience
Spatial data			
• Land ownership records • Administrative units/boundaries • Population density by area	• Infrastructure shapefiles • Road network • Transport Routes • Origin-destination matrices	• Land plot (location, size, use) • Building height data • Educational institutions and health facilities • Zoning allocations • Building regulations by area • Place-based regulations (SEZ's)	• Water sources • Sewer lines, electric lines, water pipes • Environmentally sensitive zones e.g. floodplains • City area under sea level • % area of city under flood each year. • Water basins and aquifers.
Non-spatial data			
• Income/Wages • Employment/ unemployment rates • Firm productivity (e.g. total factor productivity). • Firm types • Land and property values • Land and property tax payments	• Travel demand surveys • Fare prices • Commuting times • Vehicle replacement and maintenance costs • Traffic accidents • Fuel costs • Public transport costs. • Parking costs	• Health facilities type & status • Construction costs • Municipal service provision and usage (water, sanitation & electricity) • Municipal revenue information	• Rainfall level • GHG emissions • Air pollution levels • Number and monetary value of insurance claims each year. • Frequency of flooding • Number of residents living in a flood plain.

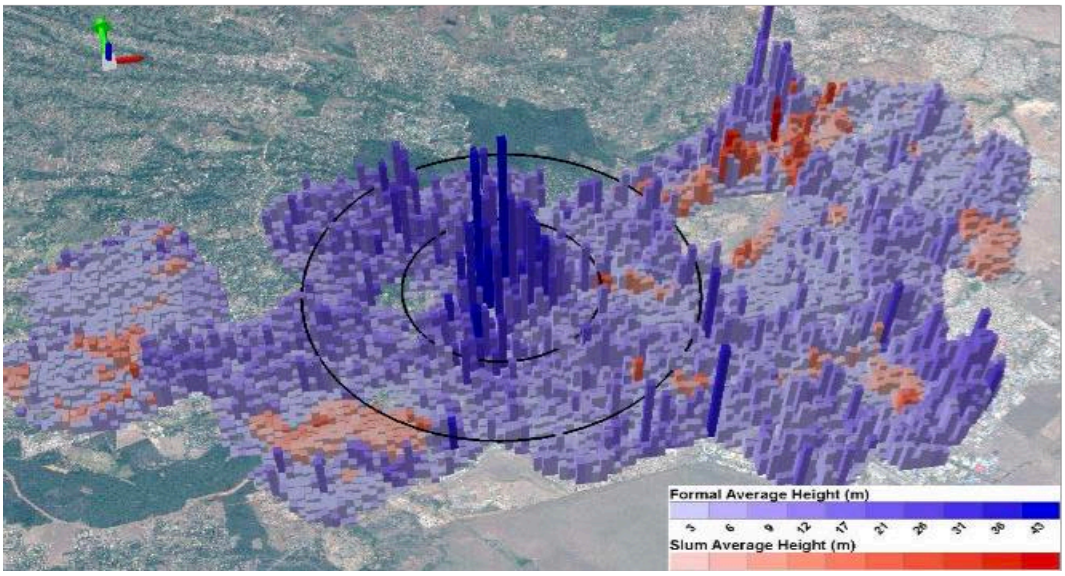
[1] The split between spatial and non-spatial data is indicative with spatial elements able to be added to much non-spatial data

21st century data sources

Satellite data:

Satellite imagery is increasingly used in economic analysis, particularly in developing countries where other data sources are limited. Satellite data is very useful because it covers all parts of the world in equal measure, unlike administrative data which differs between region in quality and availability. Some examples of where it has been used in practice include:

- Urban land use: Henderson et al. (2017)[2] combine satellite and aerial data on building footprints and heights to model the change in formal and informal neighbourhoods in Nairobi and some of the economic implications.
- Environmental impacts: Gendron-Carrier et al. (2017)[3] measure the impact of subways un decreasing air pollution in cities around the world.
- Night lights as a proxy for economic activity: Roughly 3000 studies have used night lights as a proxy for economic activity since 2000. Storeygard (2016)[4] uses it as a proxy for GDP in a large sample of African countries.



3-D average height of buildings by grid square in the formal and slum sectors. Source: Henderson et al. (2017)

Google maps street view:

- Street Bump is a project of the Boston Mayor's office. It is an app in which road condition data is collected by citizens while they drive. The mayors office uses the data to fix short term problems as well as to plan long run investments.

[2] Henderson, Regan and Venables. (2017) "Building the city: urban transition and institutional frictions" *Centre for Economic Policy Research Discussion Paper*, *11211*

[3] Gendron-Carrier, Gonzalez-Navarro, Polloni, and Turner. (2018). "Subways and urban air pollution" (No. w24183). *National Bureau of Economic Research.*

[4] Storeygard. (2016) "Farther on down the road: transport costs, trade and urban growth in sub-Saharan Africa." *The Review of economic studies*, *83*(3), pp1263-1295.

- Street Score is an algorithm that predicts how safe any street looks using machine learning methods. It can be used to study urban improvement and decay as well as the determinance of urban perceptions.

Mobile wifi data: Mobile wifi is often used to track the location and movements of individuals. And therefore has a number of urban mobility applications. Transport for London (TfL) has used this to optimise public transport planning in London.

Social network data: Social network data, such as data from facebook or twitter, can be used to understand peoples preferences and their valuation of certain goods and services.

Yelp: Glaeser et al. (2017)[5] show that researchers can use online review sites such as Yelp to measure economic activity at a granular level and at any geographic scale. They use changes in the number of businesses reviewed on Yelp to predict the number of overall establishments in US County Business Patterns.

[5] Glaeser, Kim, and Luca. (2017). "Nowcasting the Local Economy: Using Yelp Data to Measure Economic Activity" (No. w24010). *National Bureau of Economic Research.*

b. Methodologies for evaluating impact

There are two main ways to calculate impact: cost-benefit analysis and economic impact assessments. Cost-benefit analyses typically evaluates and places a monetary value on the direct benefits of a project, and compares it with the costs involved to evaluate whether a project is/was worth investing in. Economic impact assessment, on the other hand, evaluates the broader and often indirect impacts of a project such as the changes in wages and employment that arise from living closer to the city. It uses causal econometric analysis as well as the estimation of structural economic models to isolate how a change in variable x leads to a change in outcome *y*. These two overarching methodologies often overlap as one can use economic impact assessment to derive some of the values required in the cost-benefit analysis.

i. Cost-benefit analysis

Cost-benefit analysis compares the monetised benefits and costs of a project to assess its impact. This is distinct from financial analysis which specifically analyses revenues and costs to assess the profitability of a project. Cost-benefit is typically undertaken before deciding on a project. However, it can also be informative to carry out a cost-benefit calculation after the project to help assess whether it delivered value for money. The OECD describes value for money as striking the optimal balance between the three E's of economy, efficiency and effectiveness[6]

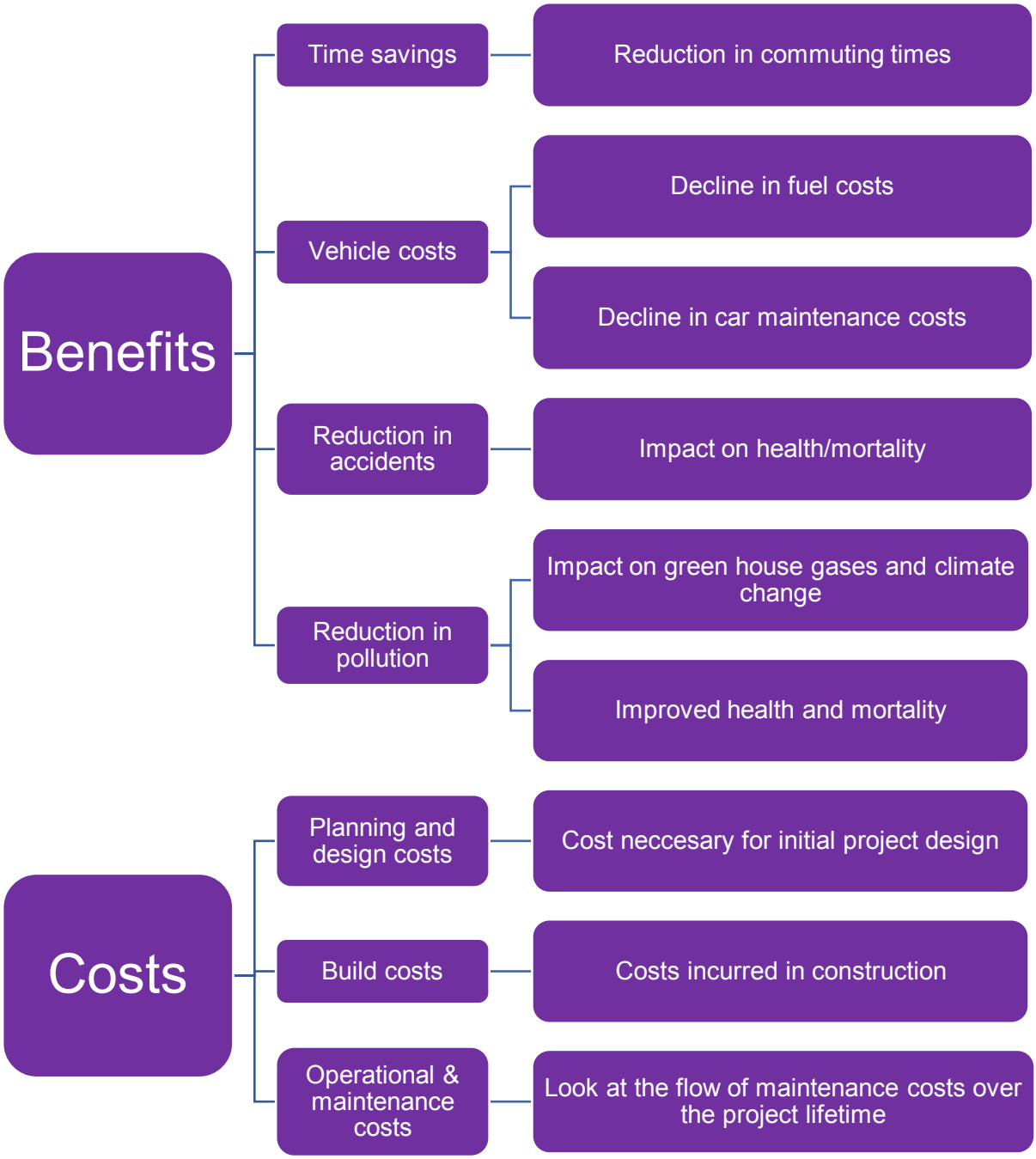
- **Economy:** Reducing the cost of resources used for an activity, whilst still ensuring a regard for quality.
- **Efficiency:** Increasing output for given inputs, or conversely minimising input for a given output, whilst maintaining quality.
- **Effectiveness:** Successfully achieving the activity's intended outcomes.

Some advocate the inclusion of equity, ensuring value for money accounts for the necessity of reaching different groups.[7] We advocate this approach for FCO's Prosperity Fund.

[6] OECD (2012) "Value for money and international development"
[7] ICAI (2011), Approach to effectiveness and value for money, Report No 1, ICAI.

Transport example

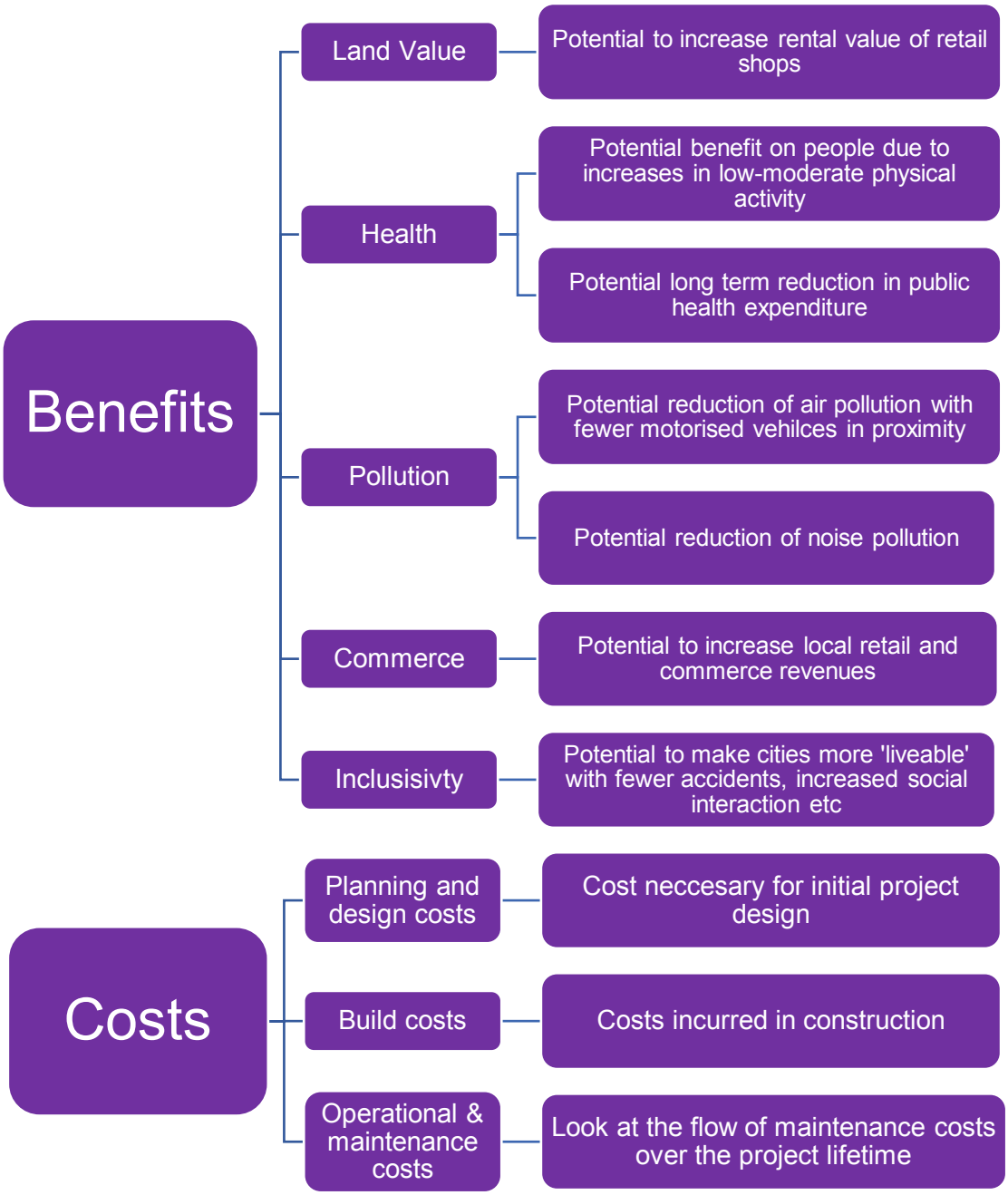
The diagram below summarises key components of a typical transport cost-benefit analysis[8]. A traditional cost-benefit analysis calculates costs as the present discounted values of all costs incurred in construction and maintenance. In terms of benefits, there are a wide variety from transport projects which can be monetised, but key benefits include a decline in commuting times, accidents, pollution and vehicle operation costs.



[8] More information is available at http://bca.transportationeconomics.org

Urban planning example

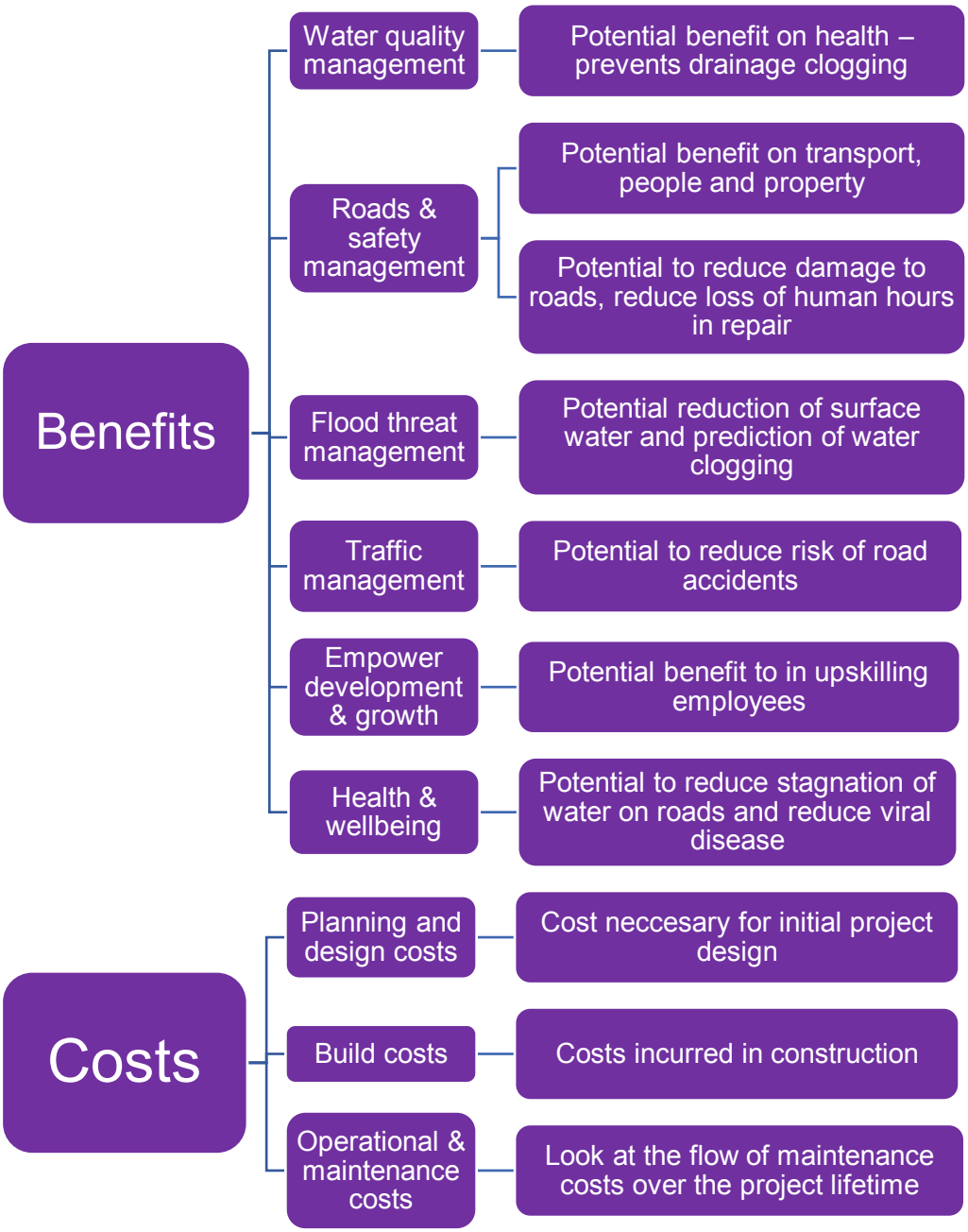
The costs of urban planning are similar construction and maintenance costs to transport interventions. However, it is also useful to think of opportunity cost, that is what the use the land could be to the community if not for the community. The benefits of urban planning projects include increased land values, improved access to economic opportunities, and enhanced productivity from economies of agglomeration. The diagram below summarises key components of a potential urban planning pedestrianisation of a neighbourhood cost-benefit analysis.[9]



[9] This has been influenced by Boarnet, Greenwalk and McMillan (2008) "Walking, Urban Design and Health" *Journal of Planning Education and Research 27* pp 341-258

Resilience example

In resilience projects, it is the opportunity costs that are key to consider. With most cities having scarce resources, how these can most effectively be deployed in either short term, medium term or long term to develop city resilience is critical. With numerous potential avenues for investment, cost benefit analysis is a useful tool for valuing resilience. The benefits that may be monetised include reduction in deaths & illness, reduced cost of disaster management, increased interest in living in the city, higher quality of life. The diagram below summarises key components of a potential resilience drainage cost-benefit analysis.



Further things to note on cost-benefit analysis

1. In many cases, the variables we are interested in do not hold monetary values, but rather represent a social or environmental 'good'. There are two main methods used to estimate the values of these:
    - Revealed prefereces – This method infers a monetary value for a non-market good through the prices of other market goods. For example, capturing the value of open public spaces by comparing houses with a view of the public space to those far away.
    - Contingent Valuation – Use of a survey to ask respondents about their willingness to pay for an environmental amenity, such as a park or clean air. The questionnaire should involve trade off's for what the money could be used for to elicit the implicit value.

2. The individual components of a cost-benefit analysis (e.g. reduction in commuting times as a result of the project) can also be estimated through more and less rigorous methods, depending on the extent to which these methods construct a counterfactual for what would have happened in the absence of the project. More rigorous methods to assess the impact of analysis are discussed in the next section, and can be used to identify the individual parts of the larger cost-benefit analysis. For example, (See Gendron-Carrier et al for details[10]) for use of a regression discontinuity approach to assess the impact of subway systems on air pollution in particular. Also see Picarelli et al (working paper) utilising spatial regressions to understand the impact of floods in urban areas in Dar es Salaam, Tanzania.[11]

3. In a traditional economic model, land-value appreciation is not included as a way of capturing benefits from transport, urban planning and resilience interventions. This is because of the problem of **'double-counting'.** To use a transport example, with perfectly competitive land markets and no externalities, the increase in land value in a newly connected area is precisely caused by the decline in commuting costs associated with that area. Counting the land-value appreciation *and* the monetised value of decreased commuting time would double-count the benefits of the project. In practice, imperfect markets and the existence of externalities in practice can mean that land-value appreciation is not exactly equal to decline in commuting costs, so to some extent land-value appreciation may be considered as well as decreased commuting costs in assessing benefits. See Wheaton 1977 for further details.[12]

[10] Gendron-Carrier, N., Gonzalez-Navarro, M., Polloni, S. and Turner, M. A. (2018) "Subways and air pollution", NBER Working paper
[11] Picarelli, N., Jaupart, P., Chen, Y., (2017) "Cholera in times of floods", IGC Working Paper, C-40404-TZA-1
[12] Wheaton, W. C. (1977) "Residential Decentralization, Land Rents, and the Benefits of Urban Transportation Investment" American Economic Review 67,2: 138-143.

ii. Economic impact assessment

Economic impact assessment can be further divided into two overarching arms of analysis. The first is causal estimation, which looks at a specific relationship between the intervention and an outcome of interest. The second is structural estimation, which models the economy as a whole and looks at the overall impact of an intervention. We will briefly describe both methods, but will focus on causal analysis as these are far more commonly used in practice.

1. Causal inference

In order to identify key impacts resulting from the interventions, both for use in cost-benefit analyses or for stand-alone use, econometric analysis is important to ensure the impacts identified are *causal* – i.e. they would not have happened in the absence of the project.

Identifying the causal impact of transport, urban planning and resilience interventions is challenging because there is no clear counterfactual for what would have happened in the absence of the intervention. As this paper has already mentioned, in the ideal scenario, one would be able to determine cause and effect by setting up an experiment in which every other element was held constant apart from a treatment group receiving the intervention and a control group not receiving it. Of course, in the real world, where people, communities and physical spaces are complex and multifaceted, this is not possible. However, using econometric techniques, outlined throughout this paper, there are still ways to try and find an identification strategy for the causal impact that best approximates this experimental ideal.

The most basic way to analyse the impact of the intervention econometrically would be to simply compare a variable of interest between the treatment and control group. For example, comparing the change in the employment rate in an area next to a newly implemented BRT station with direct links to the city, to one without it. However, one can quickly see how this might give an inaccurate view of the 'impact' of the project on employment; while it is true that a change in employment in this area could be attributed to having better access to employment opportunities in the city centre, it is also possible that more employed people may have moved into this area specifically to be closer to the new transport route in to their place of work. If this is the case we cannot conclude that it was solely the new transport link that caused the increase in employment, but rather this effect is confounded by migration.

Below we explore some econometric techniques that can be used to help researchers get closer to a causal interpretation of the impact of interventions on outcomes of interest. People that receive an intervention are referred to as the 'treatment' group, and those who do not as the 'control' group. We include examples of research from each of the three pillars to illustrate how these techniques have been used in practice before. We also try to highlight the circumstances under which these methods might be useful and the associated implications for planning the intervention.

a. Placebo lines

Using placebo lines is very similar technique to the basic case of simply comparing the outcomes between treatment and control. However instead of using any untreated area as a control, we rather use an area that was going to receive a similar intervention but, in the end, for reasons not relating to the success of the project, did not. This helps to rule out that the impact we observe being due to the intervention occurring in an area that was already increasing in prosperity. Comparing two areas that were equally good to receive an infrastructure investment makes our analysis more rigorous than comparing an area that was invested in because of its high potential with an area that is derelict and unfeasible. It should be re-emphasised that this method relies on the reason for the other project not going ahead being inconsequential to the success of the project, i.e. it should be as close to random as to which one received the intervention.

Transport Example: Donaldson (2018)[13] evaluates the impact of British railroads in India by comparing built lines with lines which reached advanced stages of costly surveying, but were not built for administrative reasons. He finds that railroads decreased trade costs and interregional price gaps. increased interregional and international trade and increased real income levels.

Urban Planning Example: Helmers and Overman (2016)[14] look at the impact of establishing a large scientific research facility in the UK on wider research and knowledge creation in the local area. This was the largest investment in research infrastructure in the modern history of the UK and urban location choice was controversial. To remove the possibility that the area that received the facility was on a long-term trend of increasing knowledge anyway, they compare the trajectory of that of the 'runner up' site or the 'placebo line'. Thus, the real impact the site had on local scientific inputs and outputs can be effectively proxied.

Resilience Example: Balboni (2016)[15] evaluates large infrastructure investments in hazardous coastal areas. Particularly to see whether they can be justified in current productivity and amenity advantages in light of climate change and sea level rise. It utilises counterfactual placebo lines, which in this case are alternative non-coastal investments for roads. The study shows that similar or higher aggregate welfare gains would have been seen by utilising alternative road investments that moved populations out of the hazardous regions, a benefit that is amplified when accounting for future changes in climate change.

Useful for: Placebo line methods are useful for evaluating hard infrastructure projects, where in the initial planning phase there are multiple options for implementation, but the final area(s) of implementation are chosen randomly. This can also be for projects where similar planned investments did not go through for reasons not relating to its level of impact.

[13] Donaldson, D. (2018) "Railroads of the Raj: Estimating the Impact of Transportation Infrastructure."American Economic Review, 108 (4-5): 899-934.
[14] Helmers and Overman (2016) "My Precious! The Location and Diffusion of Scientific Research: Evidence from the Synchrotron Diamond Light Source" *The Economic Journal, 127*(604) pp 2006 - 2040
[15] Balboni, C. (2016) "Living on the Edge:Infrastructure Investments and the Persistence of Coastal Cities" Working Paper

Implications for planning the intervention: To facilitate this methodology being used to evaluate any eventual investments, it is useful to collect data on any planned investments which did not ultimately get put into practice from the outset.

b. Fixed effects

Fixed effects methods compare the growth of variables between treatment and control groups, and are useful because they allow us to control for confounding factors that are constant over time. This is because the growth in variables that are constant is zero, and therefore they drop out of the analysis. The method relies on the availability of panel data, which follows the same unit of observation over time. Although this method enables causal impact evaluation where there are confounding, unobservable variables that are constant over time, it still requires that unobservables which vary over time to have the same trend in both treatment and control groups. Individual fixed effects are commonly used to understand the effects of city size or density on wages and productivity through agglomeration economies.

Transport example: Baum-Snow & Kahn (2000)[16] investigate the impacts of new rail transit investments in the 1980's on usage and housing values, using panel data from 5 cities. Whilst clear benefits are evident, they find that these are not uniformly distributed; different demographic groups receive different levels of benefit.

Urban planning example: White et al. (2013)[17] used fixed effects methods to look at the impact of urban green spaces on mental wellbeing. Controlling for individual and regional covariates, they find that, on average, individuals have both lower mental distress and higher well-being when living in urban areas with more green space. Although effects at the individual level were small, the potential cumulative benefit at the community level highlights the importance of policies to protect and promote urban green spaces for well-being.

Resilience example: Rodriguez-Oreggia et al (2013)[18] look at the effects of natural disasters on human development and poverty levels at the municipal level in Mexico. After controlling for fixed effects as well as other institutional, socio-economic and demographic pre-shock variables, they find that general shocks, especially from floods and droughts, lead to significant drops in both types of indicator.

Useful for: Analysing the impact of an intervention on people which have different static characteristics, such as academic ability, gender, race or geographic location but follow similar trends, such as changes in income, over time.

Implication for planning the intervention: The use of fixed effects methods usually requires the availability of panel data, i.e. data which is collected from the same observation unit over time, with observations both pre- and post-intervention, as well as potential intermediary interventions as well. This is usually the greatest challenge in using this method as it is expensive data to collect which is not always already available in many cities.

[16] Baum-Snow, N., & Kahn, M. E. (2000). The effects of new public projects to expand urban rail transit. *Journal of Public Economics*, *77*(2), 241-263.
[17] White, M. P., Alcock, I., Wheeler, B. W., & Depledge, M. H. (2013). Would you be happier living in a greener urban area? A fixed-effects analysis of panel data. *Psychological science*, *24*(6), 920-928.
[18] Rodriguez-Oreggia, E., De La Fuente, A., De La Torre, R., & Moreno, H. A. (2013). Natural disasters, human development and poverty at the municipal level in Mexico. *The Journal of Development Studies*, *49*(3), 442-455.

c. Difference-in-difference

Difference-in-difference (DD) is similar to fixed effects but deals with removing the group level, rather than individual level, confounding constant effects. A DD estimate of impact evaluates the difference in the growth of a variable (e.g. wages) between two areas after an intervention. This is to account for the fact that variables such as wages are likely to be rising across the city. Therefore, a relevant comparison is not whether wages have grown, but whether they have grown more in affected areas than in other areas. DD estimates rely on the counterfactual assumption that the growth path of the two compared areas would have been the same in the absence of any intervention. This can be verified by checking whether the two areas were on similar growth path before any intervention.

Transport examples: The DD technique has been used in Dar es Salaam, Tanzania to underpin a rigorous evaluation of the impact of their BRT, by Bryan et al (forthcoming)[19] There are six planned phases of this BRT. The first phase has been constructed and services are running. In the evaluation, areas around this first phase are designated as the treatment and all other areas around planned phases as control with respect to the centre point of the BRT system. The assumption made is that not that areas would have had similar growth paths in the absence of the BRT. It is that, in the absence of BRT phase 1 roll-out, the gradient of outcomes with respect to distance from the arterial ray would have evolved in the same way in the catchment area of the phase 1 as well as additional phase routes.

Urban planning example: Field (2007)[20] uses the DD method to look the effect of the Peruvian urban land titling program on labour market outcomes. The differences come from the staggered roll out of the intervention in different regions through time, as well as varied pre-ownership rights across the population of interest. The results show a significant increase in hours worked as well as a shift from household work to work in the market.

Resilience example: The DD approach was utilised to understand how weather shocks and insurance impact risky agricultural investment in Ethiopia. In this instance Hill and Viceisza (2011)[21] construct a game protocol to elicit decision making under varying degrees of risk. In reality such difference in difference studies may be trickier to construct. The results show that Insurance does have some positive effects on fertilizer purchases, and that depend on the realisation of weather in the previous round.

Useful for: any transport, urban planning or resilience intervention, particularly with hard infrastructure investments or regulatory changes, which can be applied to one area and not another, in an otherwise fairly homogeneous context. The DD method can be used where there is repeated cross-sectional data, does not necessarily have to be panel data. There can be time constant differences between the treatment and control groups, but there should be no time-varying differences between them.

[19] https://www.theigc.org/project/evaluating-the-impacts-of-the-dar-es-salaam-bus-rapid-transit-brt-system/
[20] Field (2007) “Enititled to Work: Urban Property Rights and Labour Supply in Peru”. *The Quarterly Journal of Economics*, *122* (4) pp 1561–1602
[21] Hill and Viceisza. (2011) “A field experiment on the impact of weather shocks and insurance on risky investment” *Experimental Economics 15,*2 pp341-371

Implications for planning the interventions:

- The use of a DD strategy can be facilitated by staggering the roll-out of the intervention across different areas, assuming that the chosen areas can be thought of as having certain similar trends relative to non-chosen areas. The areas which receive the intervention first form our treated sample, leaving the others as a counterfactual with which to compare.
- Data on the treatment group needs to be collected both before and after the intervention. This could be repeated cross sections or panel data if available.

d. Propensity score matching

In cases where we do not have data before an intervention took place, and receipt of the intervention in non-random, we can construct a counterfactual by using so-called propensity scores. Propensity scores use observable characteristics of a population to predict the probability of them receiving the intervention. For example, we might think that a affordable housing subsidy might be more likely to be given to lower income, female-headed households who live further out of the city centre. We can use these propensity scores to match similar people, one who benefits from the intervention and one who does not, and then compare them on outcomes of interest. The method assumes that the difference in outcomes between matched observations can be attributed as the impact of the intervention. The main issue with this is that the individuals that are matched may change depending on the variables used to construct the propensity score, thus changing our assessment of the impact.

Transport example: Gimenez-Nadal & Molina (2016)[22] use propensity score matching to examine the relationship between individual commuting behaviour and household responsibilities in the Netherlands, with a focus on gender differences in that relationship. They find that the effect of home production on commuting time for women is more than double that for men, while childcare time has an effect on women's commuting behaviour only.

Urban planning example: O'Keefe (2004)[23] use propensity score matching to evaluate the impact of Enterprise Zones in California on employment growth. She finds that Enterprise Zones experienced significantly more growth in employment than similar areas that did not receive business tax incentives. Estimates suggest that the Enterprise Zone designation raises employment 2 to 3 percent each year. The number of employees at each business in an Enterprise Zone also rises more than employment at businesses that do not have the same tax incentives.

Resilience example: Hudson et al (2014)[24] evaluate the effectiveness of flood damage mitigation measures along 3 major rivers in Germany using propensity score matching. The paper shows that the flood damage mitigation measures saved between EUR 6,700 and EUR 14,000 of flood damage per flood event.

[22] Gimenez-Nadal, J. I., & Molina, J. A. (2016). Commuting time and household responsibilities: Evidence using propensity score matching. *Journal of Regional Science*, *56*(2), 332-359.
[23] O'Keefe, S. (2004). Job creation in California's enterprise zones: a comparison utilizing a propensity score matching model. *Journal of Urban Economics*, *55*(1), 131-150.
[24] Hudson, P., Botzen, W. J. W., Kreibich, H., Bubeck, P., and Aerts, J. C. J. H.: Evaluating the effectiveness of flood damage mitigation measures by the application of propensity score matching, Nat. Hazards Earth Syst. Sci., 14, 1731-1747, https://doi.org/10.5194/nhess-14-1731-2014, 2014.

Useful for: Matching methods, such as propensity score matching, are used in cases in which there is no data available before the intervention is implemented. It can only be used when there is good reason to believe that, conditional on the observed characteristics being similar, treatment and control groups are similar in unobservables as well.

Implications for planning the intervention: The use of this method does not require any specific planning ahead of the intervention, other than ensuring the availability of comprehensive and good quality data.

e. Regression discontinuity

Regression discontinuity methods exploits situations where there is some arbitrary rule which determine whether someone is in the treatment group or not. For example, there may be a policy where below a certain level of income people are entitled to housing subsidies, and above which they are not. The people just above and below this chosen value are likely in a very similar position in many other ways, but are divided in terms of their receipt of the intervention. This allows us to compare the individuals on either side of the cut-off to see how receiving the intervention impacts the outcome of interest, getting us very close to random assignment in a non-experimental setting.

Transport Example: Kriendler (2016)[25] uses a regression discontinuity approach to assess the impact of Delhi, India's 'odd-even' restriction on driving behaviour and on congestion. This policy restricted the use of cars with a license plate ending in an even number and an odd number, on alternative days. In response to the policy, he finds that approximately one quarter of drivers cancel their trips, one quarter switch to using public transport, and one half switch to second cars with a different license plate or auto-rickshaws which the policy did not include. He also finds a significant reduction in traffic congestion.

Urban Planning Example: Baum-Snow and Marion (2009)[26] investigate the effects of Low Income Housing Tax Credit Developments on the neighbourhoods in which they are built using a regression discontinuity design. This was possible due to a discontinuity in the formula for of assigning tax credits based on the proportion of low-income earners in the neighbourhood. The paper finds that new low-income developments increase the turnover of homeowners, increase the value of property in declining areas and crowding out new rental construction in gentrifying areas. It does not displace construction in stable or declining areas.

Resilience Example: Sadiq and Noonan (2015)[27] use a regression discontinuity approach to assess the impact of a community rating systems on communities' responses to flood related subsidies and flood management activities. Looking into different characteristics of communities above and below the threshold, the study helps understand how to best build capacity to address flood risks and make certain communities more resilient to future flood disasters.

[25] Kriendler. (2016) "South African Airways: the 'debt-ridden' legacy carrier struggles to save a country's name, once again." *Airways. Sandpoint, Idaho.*
[26] Baum-Snow, Nathaniel, and Marion. (2009) "The effects of low income housing tax credit developments on neighborhoods." *Journal of Public Economics 93(*5-6) pp654-666.
[27] Sadiq, A., & Noonan, D. (2015) Local capacity and resilience to flooding: community responsiveness to the community ratings system program incentives. Natural Hazards 78: 1413. https://doi.org/10.1007/s11069-015-1776-9

Useful for:

- Interventions where there is an arbitrary rule deciding who is treated and who is not such as individuals below a certain income level or age, or areas beyond an arbitrary spatial boundary.
- It is also useful in contexts where there may be a lack of available data. This is because the arbitrary allocation of people to treatment and control groups, close to the cut-off value, means that it is unlikely that there are other confounding factors that determine treatment that need to be controlled for.
- Areas where there is no data available prior to the intervention.

Implications for planning the interventions: Regression discontinuity should be kept in mind when deciding on spatial or demographic coverage of the intervention. If there is an opportunity to choose one random value in a continuum of values as a cut-off point for who or which area receives the intervention then it would be helpful to use this method.

f. Instrumental variables

Whilst the placement of infrastructure is often not random and thus there is no clear counterfactual comparison for the area chosen, there are some things which are strongly correlated with the placement of infrastructure which are random. These can be used as instrumental variables (IV) to evaluate the impact of the infrastructure, thereby solving what is known as the endogeneity problem[28]. It is important to remember that although instrumental variables should be correlated with the intervention treatment, it should not be correlated with the outcome of interest. Good instrumental variables are difficult to find, but are assisted by good institutional knowledge and ideas about the process determining the variable of interest. Researchers can use multiple instruments to strengthen the effect.

Transport example: Tsivanidis (2018) uses the lowest cost way of constructing Bogota's BRT route to end-destinations, as an instrument for the actual route constructed. He uses this method to find significant impacts of the BRT on wages, land-values and output and further estimates these impacts more than outweighed the costs of the BRT.[29]

Urban planning example: Baum-Snow (2017)[30] use historical urban road and railway networks as an instrument for their modern counterparts to investigate their influence on the urban form of Chinese cities since 1990. Historic infrastructure is often correlated with modern replacements, as replacing or renovating old sites is usually cheaper than investing in a brand-new placement. Therefore, it is uncorrelated with the outcomes of interest as it is no longer in place to influence that outcome, making it an exogenous source of variation. The researcher finds that each radial highway displaces about 4 percent of central city population to surrounding regions and ring roads displace about an additional 20 percent, with stronger effects in the richer coastal and central regions. Each radial railroad reduces central city industrial GDP by about 20 percent, with ring roads displacing an additional 50 percent.

[28] An endogeneity problem can be described as a situation in which the variable of interest is correlated with unobservable factors, which confound our estimation of the true impact.
[29] Tsivanidis, N. (2018) "The Aggregate and Distributional Effects of Urban Transit Infrastructure: Evidence from Bogotá's TransMilenio" Job Market Paper
[30] Baum-Snow, Brandt, Henderson, Turner, and Zhang. (2017) "Roads, railroads, and decentralization of Chinese cities." *Review of Economics and Statistics 99*(3) pp435-448.

Resilience example: Balboni (2017) uses the length contained within each spatial unit of the North-South supply trail used in the Vietnam War, as an instrument for road upgrades between 2000 and 2010. The method is useful as the initial North-South supply trail was chosen to avoid US aerial bombing and was unrelated to factors such as economic or population growth other than through the area of interest - probability or road upgrades.

Useful for: In urban and regional economics literature, IV's are commonly used when the unit of observation is aggregate geographic area. It is useful for interventions which are not randomly allocated, as well as in cases where data has issues of measurement error.

Implications for planning the intervention: To facilitate this methodology being used to evaluate any interventions, it would be useful to begin thinking about potential IV's in advance such that one can ensure that adequate data on these IV's is collected.

g. Spatial Methods

Spatial methods take the typical form of analysis and bring in a spatial or geographic element, which is highly necessary for cities. These spatial elements not only look at how an intervention may impact on an area, but how this may spillover and interact with others. There is a level of spatial interdependence, where relative location matters, that is not picked up without explicitly using spatial methods. Disentangling this interaction from the intervention itself is important, but discerning how wide an unintentional impact the intervention may have either positive or negative effects, is of use. Spatial regressions are particularly beneficial to understanding the true nature of gains or losses. For instance, although the area may show growth, including the spatial regression of other areas, it might simply be that commerce moves from nearby neighbourhoods and overall city increases are minimal.

Transport example: Iimi et al. (2017)[31] look specifically at agricultural production and transport connectivity. This is particularly characterized through rail transport. By utilising spatial autocorrelation panel regression, the endogeneity of infrastructure placement is dealt with. The study finds that farmers in close locations share certain common production patterns. However external acute shocks such as flood and drought do in fact spillover to neighbouring areas.

Urban planning example: An interesting thematic cross cutting spatial regression study comes from Dai et al (2018)[32]. Analysing how land uses and parks can explain the urban heat island effect, the spatial regressions are used to account for spatial autocorrelation. This is the clustering of similar values across geographical space. For instance lower temperature values seen in and around parks or higher temperatures around buildings. The land surface temperature is understood with reference to these land uses and how the temperature spills over into neighbouring parts of the city.

[31] Iimi, You and Wood-Sichra (2017) "Spatial Autocorrelation Panel Regression: Agricultural Production and Transport Connectivity" *World Bank Group, Policy Research Working Paper 8089*
[32] Dai, Guldmann, Hu (2018) "Spatial regression models of park and land-use impacts on the urban heat island in central Beijing". *Science of The Total Environment, 626,* pp1136 - 1147

Resilience example: Picarelli et al (2017)[33] look at cholera incidence as a result of heavy rainfall and flooding. They specifically analyse how the provision of infrastructure differs in wards and therefore interacts with the spread of this disease. Disease does not respect ward boundaries with high incidence easily spilling over onto neighbouring areas. Therefore, the necessity to disentangle to what extent poor infrastructure in Ward A results in increased cholera incidence and to what extent poor infrastructure in Wards surrounding Ward A is due to the change is critical.

Useful for: When the intervention is expected to have positive or negative effects in surrounding neighbourhoods/wards/districts to the areas the intervention is taking place. It is particularly useful to see if any gains were generative or redistributive.

Implications for planning the intervention:
To facilitate this methodology being used, ensuring data availability at a detailed enough geographical scale is important. Also ensuring there is baseline data for both the area the intervention is directed at as well as the surrounding areas is important.

[33] Picarelli, N., Jaupart, P., Chen, Y., (2017) "Cholera in times of floods", IGC Working Paper, C-40404-TZA-1

2. *Structural estimation*

Structural estimation of the impact of an intervention is different to causal estimation in that instead of looking at how treatment affects a specific outcome, we model the economy as a whole to see the overall impact of a change in one of the variables. Structural estimation is also known as theory-based estimation as it is based on models developed through economic theory and tested to be roughly consistent with observed data.

The first step of structural estimation involves developing an economic mode. This could be a simple decision model or a complex general equilibrium model of how a city works. The second step is to estimate the model to identify the values of the various parameters included in the model. The third and final step is policy analysis. One can do retrospective and prospective policy analysis, as well as evaluating the likely impact of alternative policies.

The advantage of this approach is that it enables us to estimate parameters that could never be identified with observational data alone. Knowing the value of these parameters enable simulation of potential policy changes. On the down-side, structural estimation requires very strong assumptions and models can be misspecified leading to misleading results.

a. Urban models

Many research studies construct models of the city, which include variables such as market access or transport costs, as well as wages, land values and broader economic welfare. These models are useful in gaining a broader understanding of the effects of an intervention as it affects the city as whole. For example, they are useful in identifying knock-on consequences of transport projects in other areas of the city, and in understanding the often complex effects on markets which are one-step removed from the direct intervention, such as labour markets or land markets. One can also use these models to evaluate what might have happened to key variables if the intervention had been designed differently.

Transport example: Tsivanidis (2018) creates a model of a city incorporating a measure of market access, linked to wages, house prices, and with households facing the decision over whether to buy a car or not. He uses instrumental variables to assess the impact of the BRT on market access, and then uses this to estimate impacts on wages, house prices and welfare. He also estimates that welfare gains would have been 23% higher if land-use policy had allowed housing to be developed around BRT stations in line with market forces.[34]

Urban planning example: Bayer et al (2016) develop a dynamic model of neighbourhood choice that captures observed and unobserved preference heterogeneity across households and locations in a flexible way. The paper applies this model to housing transaction data in the San Francisco Bay Area from 1994 to 2004. The results provide the first estimates of marginal willingness to pay for a number of non-market amenities such as neighbourhood air pollution, violent crime, and racial composition.

[34] Tsivanidis, N. (2018) "The Aggregate and Distributional Effects of Urban Transit Infrastructure: Evidence from Bogotá's TransMilenio" Job Market Paper

Resilience example: Venables and Bird (2018)[35] have created a computable spatial general equilibrium model to concretely assess the urban development options for Dhaka, Bangladesh. The model addresses three major challenges to the city, that of flooding, congestion and messiness. By building bottom up from ward level data the approach can differentiate between high and low skilled households, by housing formality and by firm sector. This urban model can study the effects of varied urban development scenarios for the area of interest, in this case that of East Dhaka. Strategic interventions such as construction of the eastern embankment can be modelled and key variables such as productivity or liveability inferred.

Useful for: Assessing the intervention and its overarching potential benefits to the wider community. It is also helpful to compare the impact of alternative interventions on city growth, or another outcome of interest, in an effort to decide between them.

Implications for planning the intervention: Urban models require substantial data foundations to underpin with clarity the urban development options inferred from the models. Very comprehensive data therefore needs to be available. They also take more pre-emptive planning in order to construct and therefore make sense as part of a wider project.

[35] Bird, Li, Rahman, Rama, and Venables. (2018). "Toward Great Dhaka : A New Urban Development Paradigm Eastward. Directions in Development." *Washington, DC: World Bank. © World Bank.*

c. Designing the intervention to facilitate impact assessment

As we have described in the previous section, there are a number of issues that need to be overcome to get an accurate estimate of the impact the intervention has on an outcome of interest. The important thing is that we think about these issues in advance such that the correct data is collected, and the right methods used, to obtain the best estimates of the impact. We can also design the intervention to facilitate rigorous impact assessment. To recap some of the main ways are:

- Identify two equally suitable areas to receive an intervention and then choose one at random, and compare how this area develops to the non-chosen areas. As explained before, it is important to choose the area at random so as to avoid selection bias and the confounding factors that obscure our estimate of the true impact.
- Stagger the roll-out of a programme such that a researcher can use the areas that received the intervention first as the treatment group and the areas that have not yet received it as the control group.
- Compare interventions to proposed alternatives that were never actually implemented. The projects should have not been implemented because of reasons unrelated to the success of the project.

3. Key gaps in research

For the Global Future Cities Programme to add to the global stock of knowledge on successful urbanisation leading to global prosperity, it is important to first understand where the gaps in academic and policymaker's knowledge lie, such that the research can then be undertaken more strategically. Therefore, the following section provides a comprehensive overview of the literature and outlines areas that are currently lacking evidence. It also highlights
the potential interventions under the FCO's Global Future Cities Programme that could be used to provide supporting evidence are also detailed in the subsequent section. Any supporting evidence should draw upon the best practice previously outlined.

a. Transport

Building transport infrastructure

- The impact of high-capacity public transport investments on demand for informal transport services (especially feeder routes).
- The relative impact of infrastructure investments for motorised and non-motorised private transport on mobility in middle income cities.

Coordinating & restricting transport

- **The impact of regulating the schedules of informal minibus services on commuting times.**[36]
- A direct comparison of the impact of transport investments in areas with stringent vs non-stringent planning restrictions.
- The short and long run impact of restrictions on private transport, and the impact of combining these restrictions with investments in public transport.
- Impact of using big data to manage and coordinate transport flows.

Transport orientated development

- The relative effects of different types of transport interventions (e.g. roads vs BRTs vs LRTs) on surrounding land values, employment and ease of access to jobs and services.
- **The relative efficacy of different land-value capture instruments (e.g. property taxes vs development fees vs FAR sales) in funding transport interventions**.

b. Urban planning

Land use

- **Developing a deeper understanding of land-use in middle incomes setting would provide a broader narrative on how land-use decisions affect key economic outcomes in varying contexts.**
    - Most of the evidence in this area comes from American cities. Given the context in middle income cities today is very different, the lessons may not always be transferable.

[36] The areas highlighted in bold are ones that are being directly tackled through interventions under the FCO's Global Future Cities Programme.

- **Understanding the effects of changing technology on land use, including the how the location of firms and households depend on technologies as substitutes for travel.**
- Measuring the effects of relaxing counter-productive land-use policies such as building regulations or building height restrictions on land use and land prices as well as housing affordability.

Land value capture

- **Which land value capture instruments are most effective in places that have unclear land and property rights and how they need to be modified accordingly.**
- **Whether land value capture instruments can be used for smaller more localised interventions.**
    - Most of the current evidence comes from large infrastructure projects.

Network effects

- **Investigating neighbourhood and network effects, particularly for ethnic minorities.**
    - Very few studies look at both urban and social space in their analyses of economic outcomes such as productivity and migration, and thus it would be useful to disentangle their relative importance of each on economic outcomes.

Place-based policies

- Understanding the effect of urban enterprise zones, in particular, which features of these 'place-based' policies enhance or dilute their effectiveness, as well as who gains and who loses.
- Better understanding the impact of using zoning regulations to attract firms to particular areas, and where this is more efficient than broader local economic development initiatives.

c. Resilience

The human focus

- Detailed quantitative analysis that disaggregates the effects of resilience changes. Such changes may be building better i.e. improved infrastructure provision, or regularising better as well as improved zoning.
    - Particular interest between the heterogeneous effects upon urban and rural as well as poor and non-poor. The latter being at most vulnerable.
- The most effective and replicable current examples of adaptation to climatic acute shocks, particularly those that enhance resilience for the urban poor
- The future uncertainties associated with varying climate change models best planned for in order to mitigate negative implications for the urban vulnerable and marginalised.

The climatic focus

- How cities can better respond to acute shocks, i.e. short-term disasters, while also building resilience to chronic stresses, i.e. long-term climate change.
- How climate change and disaster risk reduction affects housing and sector specific provision of services as well as the effective methods in dealing with this.

- **The likely future impacts of both long term and gradual changes in weather that are induced by climate change e.g. the chronic stresses. How do these compare to acute shocks, such those that come from natural disasters.**
    - **Therefore, how should cities effectively deploy their scarce resources to tackle each one.**

The geographical focus

- **How do middle income cities, those with** higher capacity than low income cities but lower revenues than high income cities, **deal effectively with resilience challenges. and the associated funding and financing methods.**
- The difference between climatic resilience strategies between coastal and inland cities.

The financial focus

- **Effective financing and funding mechanisms for resilience.**

4. The FCO's Global Future Cities Programme's potential role in alleviating the research gaps

The Foreign and Commonwealth Office's Prosperity Fund and 'Future Cities' programme represents a unique opportunity to expand the knowledge base for middle income cities. Many of the outlined interventions represent solutions to problems seen by many other similar cities. The International Growth Centre and its affiliated network has highlighted some of the interventions under technical assistance as part of the Future Cities this programmes that could provide useful learning opportunities. We expect many low- and middle-income countries to be going through similar problems to those that these cities are facing. Through utilising the best practice methods, assessment of what the programme is doing in the 'Future Cities' today, will help inform the policy makers in cities of tomorrow. Therefore this potential research to also be used for cross-country learning.

The following examples, which are context specific, are only a selection of potential projects to help frame FCO's potential role. They do not represent the only opportunities for research under this programme. It should be emphasised that the nature of FCO's Future Cities technical assistance provision, which will mostly result in plans or strategies, make it difficult to measure potential impact at this stage. Much of the research needs to be set up now such that when the cities come to financing and enacting the plans and strategies the impact can be measured.

a. Transport

Bandung, Indonesia - integrated/multimodal transport and mobility systems

Bandung's technical assistance programme, focused on **regularising and regulating private minibuses**, or in this case the 'Angkot', is an area that many low- and middle-income cities suffer from difficulties with. These vehicles form a key part of the urban transport network, representing 98% of public transport journeys in Bandung, and are therefore critical to urban mobility. However, the also have significant challenges. Furthermore, poor integration into the wider city transport system and no link with long term transport planning they remain ineffectively deployed.

Many other middle-income cities such as Lagos, Nigeria and Georgetown, Guyana have similar problems with the congestion, poor regularisation and safety concerns such private minibuses are associated with. Therefore, undertaking research on the impact of regularization of informal transport on ridership patterns, congestion, and supply responses throughout the Future Cities programme in Bandung could be of critical benefit for other cities.

Bursa, Turkey - using data in transport planning

Knowledge information costs have decreased as a result of the second unbundling,[37] i.e. the ICT revolution radically lowering the cost of moving information and ideas. Data has become substantially easier and arguably cheaper to produce. As a result, utilising data for transport

[37] Baldwin (2016) "The great convergence." *Harvard University Press.*

in middle income cities has become a key interest. Almost 1 in 6 of the Future Cities proposed technical assistance is in this area.

One example area in which greater understanding into how data provision and real prosperity increases can be achieved is from Bursa. Bursa Smart City Strategy is looking at using smart city technology to improve public transportation, active transportation networks and urban mobility represents a useful cross city learning opportunity. Given the intervention is yet to take place, there is the opportunity to model current transport patterns with more reliable data, and to assess the impact of changes to transport policies, in part driven by these data improvements, on ridership changes, congestion, and other outcomes of policy interest. This may also include how marginal communities are brought into the public transport network.

b. Urban Planning

Recife, Brazil - Data systems for land management and urban planning

The proposed intervention in Recife will see multiple arms of government, other public agents and the private sector coming together through coordinated smart data systems to improve land management and urban planning. The Open Data Hub is proposed to be a both a catalyst for new digital solutions in social entrepreneurship, a tool for enhancing citizen engagement, and also drive knowledge-based businesses. This is a useful opportunity to assess how moving to integrated and open data systems in government can impact on the above mentioned outcomes. This could be achieved by initially collecting baseline data on indicators such as citizen input in planning applications or days required to process building permits. The increase and variety of such citizen engagement could then be measured post intervention. Information on the way technological innovations are shaping our cities is of vital importance in an age where data is becoming a central focus in many local government's future plans.

c. Resilience

Ho Chi Minh City, Vietnam - flood management systems

61% of Ho Chi Minh City will be exposed to regular flooding in 2050, with the city's flood management already at the edge of its capacity. The chronic stresses resulting from climate change and related to flooding is a threat that many cities are facing. Ho Chi Minh City is to benefit from drainage mapping and system intervention. This and the related action in weather forecasting and planning around the Urban Flood Control Centre (UFCC) in the city is particularly important to research and learn from. Under current climate change predictions many more cities will face similar flood strain both from fresh water and salt water. Understanding which areas of the intervention had greatest influence from an institutional perspective will be important to understand. At a later stage it is also important to examine how flooding was reduced as a result of the new drainage mapping represents a useful opportunity for learning. Research that will help set some best practices and key lessons for the next generation of future cities has the potential to expand prosperity.

Yangon, Myanmar - heritage and urban renewal

Most of the Future Cities Resilience interventions are focused on flood related interventions. Yangon's intervention integrates both flood resilience with urban planning and urban heritage renewal. Financially, strained municipalities have a plethora of issues, many of which may be higher up voter's agendas than maintenance of cultural assets.

Understanding how to incentivise and finance urban heritage renewal will be interesting for other cities in the world as well. For example, historical quarters of cities can be leveraged for wider local economic gain and development through tourism or other commercial undertakings. Lessons from the effectiveness of this capacity building, how it has changed both resident and visitor perspective of the cultural buildings as well as the economic changes could serve as a useful roadmap and framework for other cities to replicate. Measuring the social and economic returns to investment in heritage renewal, particularly from rises in tourism and associated sectors is also important, particularly when comparing the opportunity cost of utilising the land for city benefits.

d. Cross-cutting

New Clark City, Philippines - urban planning (with reference to green spaces)

Land value capture represents an interesting cross topic research gap that cuts across all three pillars of the FCO's work. General information on the relative efficacy of different land-value capture instruments is useful for any land increasing investment. This can be through transport, urban planning and resilience. There is evidence on the benefit of surrounding green space for land values, however this is not always translated into policy action. To date, much of the evidence in this area comes from the US. Therefore, there is the opportunity to improve the evidence base and also strengthen it in a middle-income context. Here weaker pre-emptive planning measures may result in less emphasis on public green space.

The New Clark City intervention of the design of the new central park, represents an interesting opportunity to look at land value changes. Particularly as surrounding investments for the South East Asian Games and government facilities represents an alternative effect on land values. If implemented properly their long term locally generated revenue and spending will be able to benefit from the technical assistance.

5. Conclusion

The Assessment Framework for Economic Success has shown where current key knowledge gaps are in the three pillars of transport, urban planning and resilience and how some of these may be addressed by the roll out of the interventions under the FCO's Global Future Cities Programme. Research on the key city interventions highlighted in Bandung, Bursa, New Clark City, Recife, Ho Chi Minh and Yangon are just examples of cities from which other cities could learn. The final section on the economic impact assessment methods outlined have been used before for similar interventions in transport, urban planning and resilience. By considering the data requirements for the intervention from the outset, as part of the strategic phase, the FCO can set up the interventions in such a way that they are conducive to research and thus line up further city learning and prosperity for years to come.

There are two things that are important to emphasize. Firstly, in order to truly understand and be able to attribute the impact of any of these interventions to future prosperity outcomes, a counterfactual is needed. This paper has noted different ways in this can be done. The second important point to note is the fact that there is no one size fits all assessment method; the various interventions will require different techniques of analysis. However, these assessment techniques are difficult to retroactively apply with clarity once interventions are underway. Therefore, to be able to do this properly, it will require conversations between the city, academia and implementing, strategic and knowledge partners before the interventions are carried out.

It is therefore recommended that specific meetings regarding the assessment framework for economic success are included in the kick off discussions with all framework partners. They can involve academics from the respective Future Cities country as well as drawing upon those in the IGC's network. This will ensure long term and cross city learning benefits, not only for the city where the research is taking place but much further afield, thus *"achieving inclusive prosperity and alleviating high levels of urban poverty"*[38] for years to come.

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