Integrated Programme for Better Air Quality in Asia (IBAQ Programme)

CITY SOLUTIONS TOOLKIT:

INTRODUCTION TO CONGESTION CHARGING BASICS IN DEVLOPING CITIES

THE SITUATION

Developing cities across Asia face significant air quality challenges linked to a variety of pollution sources. One of the top sources of PM2.5 is associated with the transport sector, driven by increased private car ownership among a growing middle class, and also by emissions linked to older truck and bus fleets. Small motorized vehicles and other pollutant sources, mainly the burning of biomass and stationary sources, are additional contributions to poor urban ambient air conditions.

In addition to the health impacts and costs definitively linked to poor air quality in cities, urban dwellers in major Asian metropolitan areas have grown accustomed to long commutes. Exacerbated by increasing traffic congestion, commuters' daily round trip journeys from home to work have grown longer, negatively impacting productivity and quality of life.

THE APPROACH

To address these challenges in a comprehensive way, a small number of cities in Asia and Europe have developed traffic charging systems designed to reduce air pollution and congestion, while also offering opportunities for significant reductions in associated climate pollutants.

Figure 1: Automatic tolling gantry of Singapore's Electronic Road Pricing system

Because these traffic charging systems, frequently referred to as "congestion charges", provide opportunities to direct collected revenue towards improvements in public transport and facilitate shifts away from motorized transport, they hold great promise in significantly reducing the environmental and health impacts in cities across Asia.

While only a few cities have implemented congestion charges globally, particularly cities in Europe, the concept holds significant promise to transform behavior though targeted economic signals. To date, the model has yet to be widely applied in a developing city context. In the region, Singapore is one of the early pioneers of this concept and is the first city to successfully implement the model, offering a strong link to the Asian context.

GUIDELINES ON CONGESTION CHARGING

Congestion charging systems operate on the principal that drivers, when required to pay a fee to access an urban center, will be influenced by this change and will assess the value of their trip against the cost of road access. Upon consideration of the value assigned to that trip, they may decide to delay or reschedule their trip to a time when the journey will cost less. By sending clear and consistent market signals to drivers through these systems, planners are able to ensure that roadways operate within their design capacity and do not experience vehicle overloading that would result in congestion, additional pollution, and travel delays.

With this basic understanding of congestion charge systems, it is also important to recognize that congestion charges will also have an impact on the entire transport network, and that not all of them lead to positive outcomes. Unsuccessful policy implementation is often the result of a focus on a specific area of a city or the specification of one set of technology, preventing an objective approach to overall system design. Sometimes the lack of clear policy objectives hinders the ability to evaluate alternative approaches. An example would be when the main objective is to raise revenue as opposed to improving transport systems or air quality. In both cases, gaining public acceptance will prove challenging.

The key components involved in the creation of a congestion charge system are outlined below:

1. Congestion charge policy development

The process begins with a **feasibility study** that helps policymakers identify the problems to be solved and potential solutions. At this stage, the risks and rewards will be assessed, as well as ways to address anticipated barriers. The legal basis for the system will be analyzed, and the study will also provide insights into the political realities that city leaders will need to contend with as they push forward with implementation. The feasibility study is also a useful tool to determine the best path forward, providing decision-makers with a sufficient overview of the likely challenges and returns on investment, allowing them to decide if and how to proceed.

Following this step comes the **functional design** stage. This is the step during which the congestion charge policy will be established. It is during this stage that insights will be provided into how traffic patterns in specific areas might be impacted by congestion charging; who will pay, when, and how much for access; and how will fees be collected. Many alternatives will need be assessed as part of this process, with the ultimate aim being to reach consensus on the best approach that satisfies both political and technical criteria.

Technical design is the next element of the planning phase. During this step, the details of the system are decided, including key elements such as how vehicles will be identified and how charges are determined and paid, as well as consideration of enforcement and customer service interface. This phase of planning will also identify the type of equipment used and the back-office systems required to support the proper functioning of the integrated system.

Many of the technical specifications will be determined by the **institutional and legal frameworks** governing the system's operations. This phase of assessment will highlight how vehicles are identified and the way and extent to which information can be gathered and stored. The need for new structures and institutions may be identified during this phase as needs are highlighted that can only be met by addressing gaps in existing organizational arrangements.

The **development of functional, technical and institutional/legal elements** is another decision milestone requiring political input. At this stage, a proper sequencing of events and actions will be important in order to minimize the risks associated with the development and approval of supporting legislation and the procurement of goods and services. The launch of the procurement phase is only recommended once a regulatory framework is in place. This will reduce the risks associated with potential changes in legislation or an implementation delay linked to a drawn-out approval process.

Typically, this entire process from concept to an operational system will take up to four years in a best-case scenario. As the tenure of many elected city officials also spans a similar timeframe, it is important to consider how best to time the launch of planning efforts so as to be in synch with regular electoral cycles.

The communications element rounds out the main considerations related to the development of congestion charge systems, and figures heavily into the likely success or failure of systems.
To ensure that the public is fully engaged on the topic, it is important to focus communications efforts on three key areas:

a. **Raising awareness**s and drawing attention to the need to address traffic congestion and its environmental and economic impacts.
b. Highlighting congestion charging as a **strategy to address broader environmental, health, and transport challenges**.
c. **Practical aspects** related to the functioning of the system.

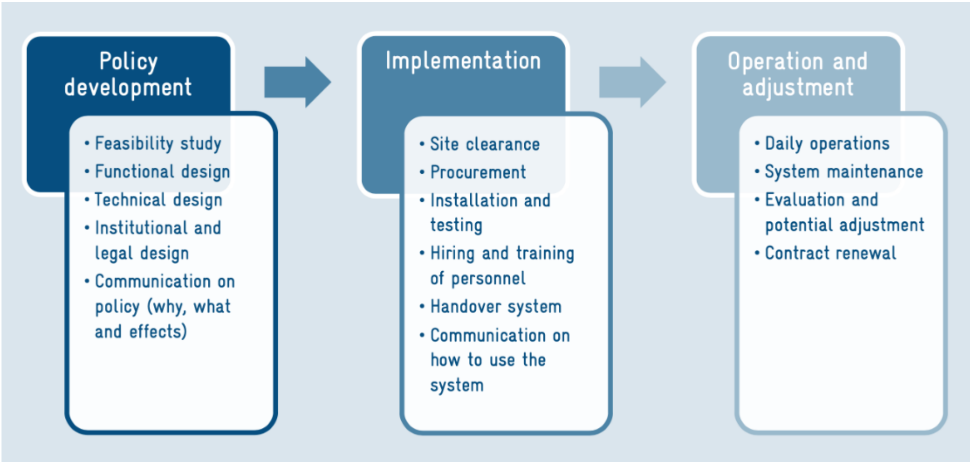

Figure 2: Components of policy development and operationalization for congestion charging.

Source: ADB, GIZ 2015.

2. Testing concepts

The most challenging aspect encountered during the development of a congestion charge system will be to identify the precise combination of functional and technical design elements that will satisfy the stated objectives and be politically acceptable.

To identify the optimal combination of elements, it will be important to adapt an iterative design process as part of the early stages of function design discussions. Through the adoption of a methodology that constantly circles back to consider how concepts can respond to objectives, the essential considerations will be maintained front and center.

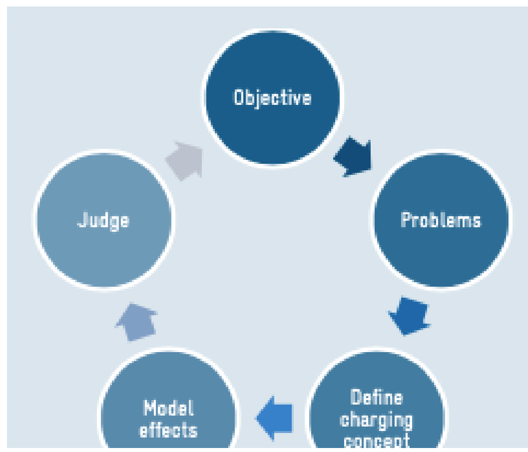

Figure 3: Iterative design methodology for congestion charging policy design

This will involve the repeated screening of different design and pricing scenarios that is designed to lead to the best outcomes for a city while also anticipating the need to modify approaches in accordance with local culture and preferences.

Another important aspect for consideration during this phase of conceptual evaluation will be to ensure the development of a structure that integrates the views and opinions of key stakeholders. During each phase of policy development, it is essential to ensure an unbroken link to senior political decision-makers while also integrating technical and institutional inputs from key members of the municipal bureaucracy who will eventually be charged with the operationalization of the system.

3. Transport model-based design for charging systems

In order to design a viable congestion charge system, a strong understanding of both the political and technical elements is required that correctly integrates both, resulting in a system that delivers the intended results. To achieve this outcome, much effort will go into the process of forecasting, the analysis of a variety of alternative systems involving options that present different geographical boundaries, and charging approaches and fees.

In order to successfully meet this challenge, it will be important to have a transportation model that is sufficiently robust to permit the testing of the various combinations and approaches being considered. While many transportation models exist, it is important that any model includes the following capabilities: Route choice, time of day, mode choice, destination choice, a trip generation model, and a car ownership model.

As modeling practices and capacities vary across the globe, a model's potential weaknesses should be identified and measures to mitigate them should be adapted. Additionally, the availability of local transport and demographic data will impact model outputs and should also be considered alongside other model operational characteristics in order to determine how outputs may be impacted and what adjustments may need to be made.

4. Geographical boundaries and charging approaches

Determining geographic boundaries that delimit a charging zone is a critical aspect in the establishment of a congestion charge system. In developing congestion charge boundaries, planners are advised to consider existing natural and institutional boundaries, as well as identifiable neighborhoods and zones, so as not to create divisive focal points that could drive resistance to overall system implementation.

There are several complex considerations involved in determining the charging approach used by congestion charge systems and different approaches to charging associated with each scheme. System approaches are typically modeled around two distinct but similar ways of assessing charges. These approaches include zone and area charging systems, where the **zone charge** is assessed for a vehicle upon entering or exiting the designated congestion charge area. The second category used to define charging system is **area charging**. Area charging is a concept associated with "once per 24 hour" charges, meaning that repassing through the charging zone does not incur an additional fee.

Each of the above approaches will have implications for the overall functioning of the system, as well as implications related to technology selection.

5. Charge levels and types of charges

Determining the appropriate charge for entry into a congestion zone is the second major design element in the establishment of a congestion charging system. Determining the "right price" involves consideration of policy objectives, political considerations, and the sensitivity of travelers to price. Identifying the price that corresponds to system, policy and political needs will involve the testing of various pricing levels. Methods used to arrive at the appropriate price may involve the use of elasticity estimates based on different costs in order to identify the charge level that results in the required demand reduction.

Another useful approach to determining charges involves an analysis of delays and the value-of-time to travelers in order to identify the times during the day during which a congestion charge would be higher than the value-of-delay for a given set of travelers.

Taken together, these tools can be used to determine how different charges should impact use and how to design a high-performing workable system.

Other key considerations related to charge level determination include:

- **Vehicle type:** Most congestion charging policies involve the assessment of different charges for different vehicle types. This is due to the various roles played by different vehicle types such as trucks, taxis and emergency vehicles. Motorcycles may also be assessed differently given that they contribute less to congestion, although they are sometimes associated with higher emissions.
- **Time of day:** This can be an additional differential in the determination of charge assessment, as different periods of the day are often defined by travelers having various motivations for travel. Commuter trips are common in the morning and afternoon, while business and shopping are prevalent between peak periods. Leisure trips are often associated with the evening period. Given that each of these motivations will have different sensitivities to charges, it is important to ensure that time-of-day charges reflect those sensitivities.
- **Place:** Place is a third charge assessment differential that can be valuable when specific areas of congestion are being targeted. This concept involves the application of different charges at different locations across the charging system. This could also imply an exemption for vehicles that are simply passing through a system in cases where the city center is not their ultimate destination.

6. Key indicators

Well-developed indicators provide planners with a sound tool to compare a range of congestion policy alternatives. Priority indicators will be determined by the hierarchy given to policy objectives, but will generally fall into the following three categories:

Traffic and transport: Congestion charging is generally focused first on reducing traffic congestion, which implies a need to identify the specific ways that alternative approaches will impact the flow of traffic across a city. To achieve this, planners need indicators that show how traffic speed and volume is affected, changes in mode shares, vehicle kilometers traveled, and changes in volumes across charging boundaries.

Environmental: This is another high-priority policy objective for city decision-makers, often driven by citizen demand for cleaner air and improved health, but also by an interest in making cities more climate-friendly. The indicators used to track environmental progress may be determined by national or city air quality regulations. This might result in tracking the number of kilometers of roads not meeting emissions norms, or the number of inhabitants exposed to emissions above the norm. In the case of a climate focus, an indicator would likely center on tonnes of emissions per year by vehicle type and traffic status.

Economic/social: In an ideal comparison of the economic costs and benefits of congestion charge implementation, an appraisal of system alternatives would be developed to include a full monetization of costs and benefits. As this is a process that may be beyond the means and capabilities of many city governments, a simpler approach involves calculating the benefits that accrue from each alternative being considered when compared with a business-as-usual scenario. This ideally considers the benefits to society as a whole, where benefits are directed to other productive uses, such as sustainable transport alternatives. Indicators helpful in this line of inquiry center around how the scheme meets policy objectives, traffic performance improvement, changes in consumer surplus, and cost-benefit analysis.

7. Revenue use

Decision-makers must understand that in order to build support for charging systems in the long term, revenue generated by these systems must be put to use in ways that have broad public support. It is also important to understand that this new source of revenue can be a powerful tool in addressing inequity in transport while also offering resources that can be directed to address any needed adjustments to the existing charging system.

Generally, revenues will be directed toward environmental protection, mitigating traffic problems compounded by the existing system, or providing increased access to alternative modes of transport for inhabitants. With regard to equity considerations, it is important to have a solid understanding of the way charging impacts specific users, and how it will help to mitigate impacts and develop viable transport alternatives that deliver benefits in an equitable fashion.

Other system modifications requiring resources may be required, particularly in the early phase of system operation. This is frequently related to zone boundary modifications. These complementary measures may involve the implementation of traffic management measures – road closures, one-way streets – to minimize rerouted traffic, or the introduction of restrictions on heavy-duty trucks. Parking regulations within zones peripheral to congestion charge boundaries can serve to limit undesired access by drivers parking on the edge of a zone who later access by another means.

8. Technologies

The technologies selected to operationalize a congestion charge system must permit a robust and accurate vehicle detection and identification system that has built in fraud-mitigation measures. Different systems and technologies exist, but all integrate mechanisms to capture number plates that can then be linked to vehicle type and owner. Other more technologically advanced systems, coming with additional costs for drivers, integrate communication systems permitting information-sharing between vehicle and system operator. These more advanced features are not required but can boost the accuracy of systems and overall operational efficiency, driving down costs and increasing the effectiveness of operations.

Payment, enforcement and back-office provisions are final but essential elements. Payment system selection will depend on factors that include the availability of banking access by drivers and local preferences. Initial payment channels may offer several options that include automated payments via banking systems, online payments, or payments by text message or post. Consistent enforcement is another important element as lapses in enforcement will lead to lax compliance and an overall disregard for system penalties. Enforcement will be rooted within an existing legal framework, one that offers the right to appeal in instances where it is merited. A back office underpins the operations of the integrated system, where vehicle identification, charging and payments are streamlined, supported by a public-facing customer service center operation.

CASE STUDIES

Two Asian city case studies are highlighted below to illustrate some of the concepts previously described.

SINGAPORE – ELECTRONIC ROAD PRICING (ERP) SYSTEM

Singapore launched its ERP system in 1998, becoming the first city in the world to implement a road pricing system based on congestion charges. Prior to the implementation of this system, the city had a manual road pricing system in operation since the 1970s. This system required the purchase and display of a windscreen license coded by color and shape for easy identification by enforcers. Violations of this system were noted and sent a fine by post. This system was expanded beyond the central business district in the 1990s to target congestion on three major expressways.

With the introduction of electronic toll-collection systems in the late 1980s, Singapore began preparations for the launch of the ERP system. As of 2010, Singapore had invested more than USD $140 million in the system, with annual operational costs of USD $18 million (2009) and total annual revenue of USD $107 million (2008-09).

Total km of road: 3,240
Total km of Expressway: 164
Total km of main road: 604
Rush Hours: 7:30 AM to 9:30 AM
Traffic Speeds (City): 25-30 kph
Traffic Speeds (Expressway): 45-60 kph
Vehicle Population: 917,000
Car Population: 560,000
Bus Population: 3,100 buses; 3.1 million trips per day
MRT & LRT: 139 km; 89 stations with 1 million trips per day
Daily Modal Split for Public Transport: 51%

Figure 4: Singapore transit overview.

Source: Electronic Road Pricing: Experience & Lessons from Singapore, Simple Interactive Models for Better Air Quality, January 2010.

Operationally, the system is structured around the installation of in-vehicle unit (IU) devices in all licensed vehicles, including motorcycles. Overhead gantries detect the passage of vehicles and charge set fees linked to time and vehicle type, which is deducted from an on-board CashCard that is available from banks, convenience stores, and petrol stations. Vehicles violating the terms of operation are captured on camera, as are those with faulty IUs. City officials have set a desired speed range for expressways of 45-65 kph, while other roads are set at 20-30 kph. ERP charges are reviewed every three months to adjust fees based on historical speed data to meet established targets. The city has invested heavily in public awareness efforts in order to inform drivers about the rules governing the system, as well as the functionality of the IUs, charges and payment mechanisms.

Some of the lessons learned from the Singapore ERP experience include:

- Systems should be tailored to local traffic conditions.
- System success depends on its perceived reliability.
- The fitting of IUs must be carefully planned and implemented to avoid unnecessary inconvenience for motorists.
- Motorists' feedback should be taken seriously, and mechanisms developed to respond to problems or confusion about the system.
- Ongoing traffic monitoring is important to understand how the system impacts on traffic conditions, and remedial measures to resolve problems.

BANGKOK – LOW EMISSION ZONE (LEZ) DEVELOPMENT

Spikes in air pollution in Bangkok in early 2019 led officials to focus attention on the development of comprehensive strategies to address the city's pressing air quality challenges. With 72% of PM2.5 emissions linked to transport, the city has recently embarked on the implementation of the Bangkok Clean Air Zone.

Working with international partners, the city, with support from the GIZ TRANSfer project, launched the Thai Clean Mobility Programme (TCMP). In collaboration with the Ministry of Transport's Office of Transport and Traffic Policy and Planning and the Bangkok City Administration, a roadmap for the development of the clean air zone was launched.

A key feature of this planning is the discussion of a congestion charge zone modeled on those of other cities in Asia and Europe. Preparatory work has involved analysis of optimal zone geography, charging methods, pricing, exemptions, and estimates related to the impacts on air quality and congestion. Discussions related to additional measures that could be funded from congestion charge revenues have included increasing the availability of public transport and reduced tariffs options designed to facilitate transport access for low-income groups.

In addition to the Congestion Charge Scheme, other efforts supported under the umbrella of the TCMP include the establishment of a Green Transport Fund and public transport improvement focused on electrification of the bus network.

Bangkok, together with its GIZ TRANSfer project partners, is in the process of finalizing a pre-feasibility study of a congestion charge system for Bangkok, a major early milestone in the development of a congestion charge system.

Links to other resources related to Bangkok's LEZ development process include:

https://www.connective-cities.net/en/events/documentation/expert-assignments/assignment-of-experts-and-workshop-on-the-first-low-emission-zone-lez-in-bangkok

https://www.changing-transport.org/bangkok-clean-air-zone/