Ex-Post Comprehensive Evaluation for Urban Public Transport Pricing Policy:

Case Studies of Singapore and Hong Kong

(都市公共交通プライシング政策における事後総合評価:

シンガポールと香港のケーススタディ)

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Abstract

Cities are the agglomeration of humans and goods. Urban transport serves a high-dense population and economy and supports the mobility of humans and goods. Considering constraints of limited land area and increasing travel demand, compared to private transport, the promotion of public transport would be the only solution for sustainable urban transport development.

Pricing as a direct and effective intervention instrument has long been emphasized by transport economics and gains more and more attention due to the necessity of dedicated soft system management when facing hard infrastructure constraints, as well as the development of ICT that makes complicated pricing management possible. Policy makers have tried to optimize pricing policy based on pricing theory and to customize and implement pricing policies under different urban contexts for diverse purposes. However, past research and practices have pointed out pricing policy-related problems impeding the sustainability of urban public transport, such as the setting of fare to balance the tradeoff between affordability and profitability, the subsidy mechanism, as well as the finance structure for the public transport sector. These problems indicate the insufficiency of pricing theory in policy making, and highlight the necessity of learning from the existing pricing practices, namely, the ex-post evaluation.

The objective of the research is to construct an ex-post evaluation framework and to identify the pricing problems through the review of the existing pricing policy. Cases of Singapore and Hong Kong are selected for ex-post evaluation. They are top-ranked in terms of both GDP per-capita and population density, comparable in city size and geography, as well as with a good reputation in public transport. There are multiple pricing schemes implemented in Singapore and Hong Kong, which can be briefly classified into Fare Scheme, Subsidy Scheme, and Finance Scheme. Data on these pricing schemes are collected from diverse sources, including research papers, reports, legislation documents, and Statistics websites, to conduct the ex-post evaluation.

The ex-post comprehensive evaluation framework is constructed. Well-established methods and theories in policy evaluation domain, including the Multi-Criteria Evaluation method, performance indicator-based evaluation method, Theory of Change, and Realist Evaluation, are comprehensively integrated into the framework. Ex-post evaluation emphasizes on the concept of learning from the past and address the questions of “What” is implemented and achieved, “How” and “Why” the pricing policy produced changes. The policy implementation evaluation based on Multi-Criteria Evaluation method, and policy performance evaluation based on performance indicator-based evaluation method, are carried out to address the “What” question. Results of implementation criteria scores and performance indicators are integrated and visualized by the integrated analytical framework. The causality analysis adopts a theory-based approach combined with the Theory of Change and Realist Evaluation method, to identify the causal links between policy implementation and policy performance, and to answer the question of “How” and “Why”. Findings from causality analysis are summarized in the form of CMO (context-mechanism-outcome) configurations, based on which causality maps are made, showing the

interactions between key factors and the policy interventions. The comparative study is carried out and implications are derived for future pricing policy making.

The findings indicate that the priority for Singapore is the improvement of transport system capacity, while for Hong Kong, the social need for affordable fare is emphasized. Under such context, Fare Scheme, Subsidy Scheme, and Finance Scheme that implemented in the 2 cases produced different impacts.

In the case of Singapore, with the Finance Scheme, the public fund is provided to support the capacity improvement. Through the shift of finance structure, the operator's profitability is guaranteed by the service fee paid by the government, which would make the operators concentrate on the provision of service. The Fare Scheme keeps fare at an affordable level, which is justified by the fare and affordability indicator. The Fare Scheme charges fare only with reference to the distance-traveled, benefiting the seamless service of public transport. The New Capacity Factor Scheme considers the cost of capacity expansion by introducing a new factor into the fare adjustment formula. With the factor, the negative effect on fare and affordability is created, though the government tried not to impose cost burden on the low-income group. The Concession Scheme address affordability issue through the direct discount of fare at the cost of public fund. As a result, Singapore faces the problem of economics of the transport system, especially the government finance burden.

The basic principle in Hong Kong is that public transport is operated by private operators on a commercial basis. There is no direct subsidy from the government to the operators. In Fare Scheme, the profitability of operators is concerned, which resulted in continuously increasing the revenue of the operators and the raising fare level. Affordability is addressed by 2 Subsidy Schemes. Work Incentive Transport Subsidy is a mean-tested subsidy to an eligible individual or household applicants, while Public Transport Subsidy Scheme is a non-mean-tested subsidy to the whole population. Both of them have a negative impact on the public fund and a positive impact on affordability. The Finance Scheme is aiming at the improvement of network capacity and the enhancement of service standards, supported by the public fund and operator revenue. As a result, Hong Kong also faces the problem of economics of the transport system, especially government finance burden.

Singapore and Hong Kong face the same problem, government finance burden, though they have different policy intentions and have applied different policy instruments. Based on the comparison of practices in 2 cities, it is implied to apply the stronger instruments of one city to another in order to solve the problem. Incorporation of the Profit-Sharing mechanism and Price Cap in fare adjustment scheme in Singapore could be a solution of affordability to impose restriction on fare increasing and share a certain amount of operator revenue with the general public in Hong Kong. And Hong Kong's subsidy should be provided in a direct way, and the non-mean tested subsidy can be revised from flat subsidy structure into differentiated subsidy structure, to save subsidy fund and make it better distributed among population groups, which is similar to the cases in Singapore. On the other hand, Hong Kong's innovative financing model is implicative to Singapore, which may help release the finance burden of public fund, which is extensively used to address the network capacity and affordability problems.

This research addresses the urban public transport pricing problems through the ex-post comprehensive evaluation of existing pricing cases. It sheds light on how to set public transport fare and adjust fare to balance the tradeoff between operator profitability and affordability, how to maintain the fare at an affordable level with subsidy mechanism, as well as the finance structure that can support a sustainable public transport system.

The academic contribution lies in the ex-post comprehensive evaluation framework. The methodology framework is the systematic integration of research methods and designed specifically for the purpose of the ex-post evaluation on urban pricing policy. The presenting forms of radar chart and causality maps are utilized in order to communicate and share knowledge with policy makers, interested public, and relevant researchers.

As the case study based ex-post evaluation, more cases would result in more powerful CMOs, which would increasingly test and refine the CMOs obtained based on cases of Singapore and Hong Kong. Pricing policy evaluation for cities with different populations, geographies, economic development levels, and with different priorities, may reveal different attributes and novel CMOs. The understanding of urban context is important for the application of findings from this research.

Future research could include comparisons with more international cases, which enable us to produce more general knowledge and implications. And it will be expected to simulate the performance of policy in order to design an appropriate policy after fully understanding the complex relations among the context, mechanism, and outcome.

To my family

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Currently, the Wuhan new coronavirus is spreading in China, as well as other countries. I hope my family and friends, and everyone stay healthy. Taking this opportunity, I would like to express my full respect to frontline medical staff. We shall overcome soon. 加油!

徐凯 (Kai Xu)

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1 Introduction

1.1 Research background

1.1.1 Urban transport

Cities are the agglomeration of humans and goods. Urban transport supports the mobility of humans and goods and plays an important role in long-term sustainable development. Generally speaking, the urban transport system has the following features:

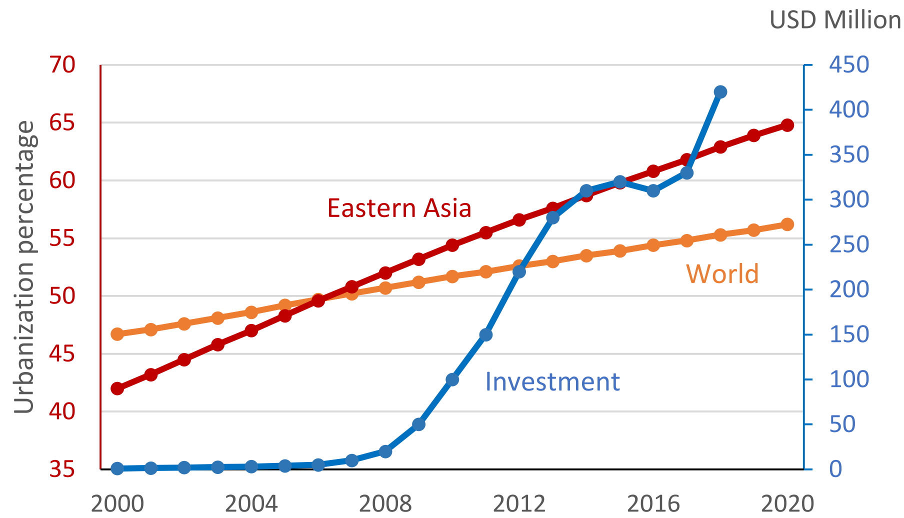
Firstly, urban transport serves a high-dense population and economy. For the urban transport system, population and economy are the basic social parameters. The urban transport system, including both the hard infrastructure and the soft policies, should align with the current population and economic situation and meet the future demand. With the growing population and economy for most cities, the urban transport system is facing more challenges.

Secondly, there is limited land space for urban transport. Compare to the non-urban area, there are tighter land constraints and more trade-offs in land-use patterns. The balanced geographic distribution of different land use, such as commerce, industry, residence, greenery and recreational space, is the key to sustainable urban development. Normally, public transport is promoted to meet the competing needs of transport growth and land use.

Thirdly, the externality of the transport system is more concerned in the urban context. The transport system has direct and indirect impacts. Externality stands for the impacts indirectly generated by the transport system, such as safety and environmental impact. To improve the quality of life, citizens expect a higher level of connectivity, safety, and comfort through the urban transport system, against a low level one with problems such as noise pollution and carbon emissions.

Urban transport is composed of private transport and public transport. Private transport is the personal or individual use of transportation vehicles that are not available for use by the general public, where essentially the user can decide freely on the time and route of transit. The cost of private transport is born directly or indirectly by the individual user. Private transport is the dominant form of urban transport in some places, but may not be suitable for big cities due to features of the urban context, as mentioned above.

Compare to private transport, public transport is playing an essential role in urban context. In some megacities, such as Hong Kong and Tokyo, the share of public transport can be as high as over 90%. It has become more important under the trend of urbanization, as shown in Figure 1.1. Statistics from the United Nations Population Division show that in the past 20 years the percentage of the urbanized population of the world as a whole increased from 47% to 55%. It is more increase to Eastern Asia, from about 40% to 60%. The investment in public transport projects from the Asian Development Bank (ADB), as indicated by the blue line in the diagram, has seen a surge in the past few years. In “ADB Strategy 2030”, which is the course for ADB’s long-term investment in the Asia and Pacific region, more resource is going to be allocated to the development of public transport.



Source: United Nations Population Division

Figure 1.1 Urbanization and public transport investment

Public transport is one of the fundamental compositions of a modern urban infrastructure system. A highly-efficient public transport network with comprehensive coverage would not only facilitate the daily commute of the public and address passenger demand, but also promote the further development of the community, optimize land use as well as facilitate mobility of people and goods. This would bring economic benefits and promote the quality of life.

1.1.2 Urban public transport pricing policy

The development of urban transport system is, to a large extent, shaped by the interactions between transport policy and evolving social needs. A sustainable public transport system involves the complex balance between, such as efficiency and equity. Regulators will often have to make trade-offs between such considerations in the policy-making.

Transport pricing is a critical factor in transport management that requires careful examination. Price, in the public transport field, is the fare that paid by commuters to enjoy the public transport service. Gathering the individual fare, the fare box revenue is the main revenue of public transport operators, who provide service to users. Depending on the urban context, part of the fare box revenue may go to the public fund to support the construction of transport infrastructure. Fares can go up and down, which affects the public affordability and operators' profitability. Sometimes, subsidy is provided from government to operators to keep the financial sustainability, or to commuters to maintain the fare affordable.

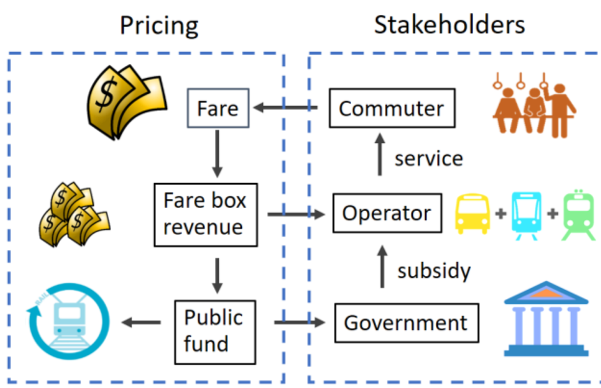
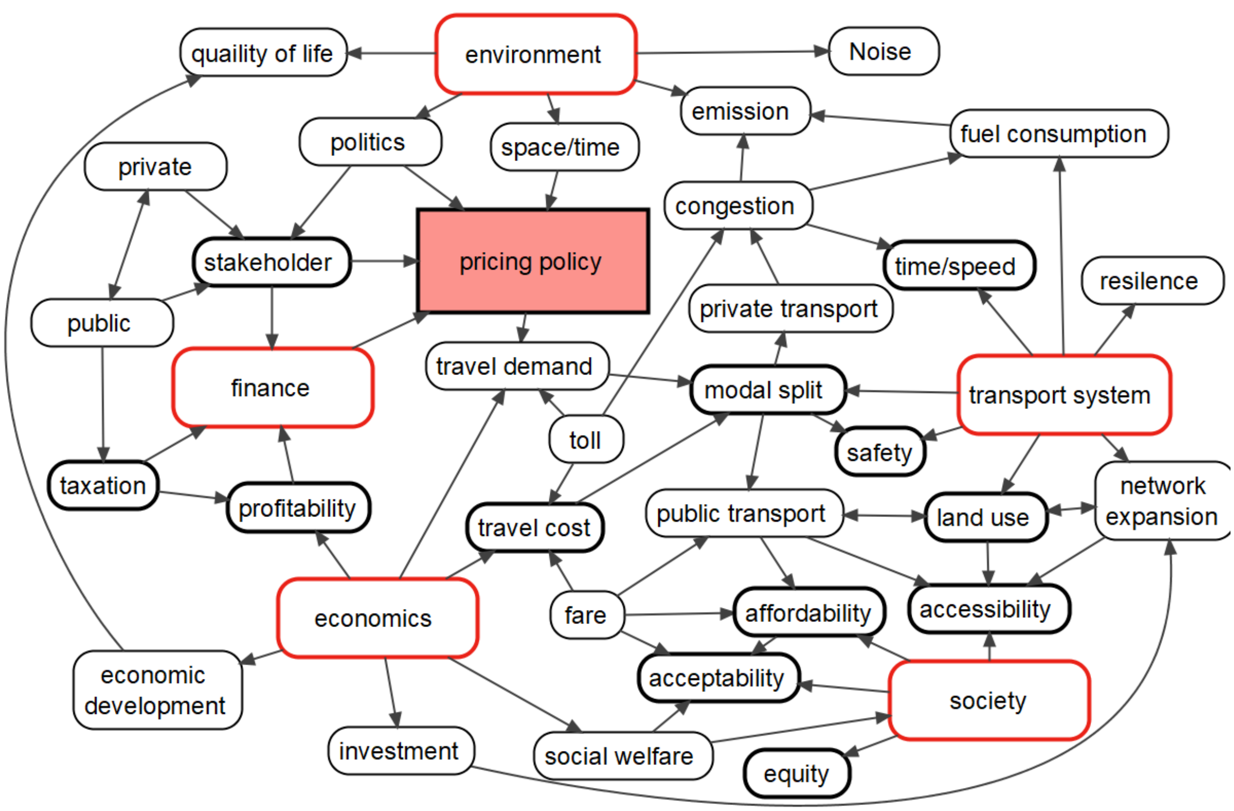


Figure 1.2 Public transport pricing and stakeholders involoved

The simple framework (Figure 1.2) illustrates the flow of public transport pricing and the stakeholders involved in the public transport pricing system. Fares are a direct and flexible instrument to influence passenger behavior, as well as the main revenue source to recover the cost of public transport system.

The urban transport system is very complicated, as indicated in Figure 1.3. Pricing policy does not only affect the narrow-sense public transport system itself, but it also has broader impact on aspects of finance, economics, society, and externalities.



Source: compiled from the literature

Figure 1.3 Pricing policy in urban transport system

Past researchers have summarized the multiplicity of impacts of pricing policies, which broadly falling into the following categories (Ricci, 2003):

- Transport system impacts, covering the performance on speed, capacity, fare level, modal split, and service reliability;
- Economics and finance impacts, including social welfare, efficiency, public expenditure, taxation, and profitability;
- Social impacts, including equity, affordability, and social acceptability; and
- Externalities, such as the associated environmental impacts caused by public transport.

Making an appropriate pricing policy for sustainable urban transport is not easy. In most cases, policy makers are challenged to choose the appropriate option in relative, rather than absolute terms, and the actual policy could be an imperfect option. Urban public transport management needs balance across multiple dimensions with a varied array of measures and actions, among which pricing policy plays an increasingly important role, especially for urban transport solutions that challenged to serve large, dense, and active populations.

1.1.3 Review of pricing practice

Various pricing practices are carried out for cities with different populations, geographies, economic development levels, and other backgrounds. In reality, the design and implementation of pricing schemes are geared to a set of priorities, which may change according to the policy context.

Pricing practices in public transport have evolved greatly during the last years. A variety of case studies are examined from multiple continents including Europe, Asia, and America, covering both developing and developed regions, to showcase the existing approaches. It is hoped that the review of the case study could provide a systematic and comprehensive understanding of current pricing policies, and to highlight pricing problems in practices.

Free public transport in Luxembourg

In 2019, Luxembourg announced that from March 2020, it would introduce free nationwide public transport, making it the first country in the world with totally free public transport.

Luxembourg faces the challenges of increasing travel demand, against the high car ownership, which brings the problems of road congestion. According to the Statistics Department, Luxembourg's working population has increased from 161,000 in 1998 to 427,000 in 2018, with a 168% rise in cross-border workers. The huge commuting demand creates pressures on the urban transport system. In terms of private car ownership, the country has the highest number of cars per capita in the EU, with 662 cars per 1 000 population as of 2018[1]. More than 60% of commuters use cars as the main mode, compared to just 19% of public transport. Under this background, congestion occurs during rush hours, making the commuting situation even worse.

[1] https://ec.europa.eu/eurostat/web/lucas/data/primary-data/2018

The purpose of free public transport pricing policy is to reduce congestion by shifting commuters from private cars to public transport. The free ticker of public transport would definitely help the affordability of low-income groups, whose transport cost is relatively a heavier burden. Though Luxembourg is regarded as a wealthy country, according to Luxembourg's statistics office, its bottom 10% earns only an average of 1,011 euros (€) per month, putting this group at risk of poverty. In addition, the emissions of greenhouse gases produced by cars would be reduced.

The impact of the free public transport policy would be multi-dimensional: cultural, sociological, economic, environmental, and it is still in the puzzle by the simple fact that the policy is in the future (this reflects the advantages of ex-post evaluation). In terms of finance structure, the policy will cause a finance burden to the government. The fare is already heavily subsidized that a single ticket costs only € 2. Though the fare revenue (41 million euros) is just a small part of the operation cost (491 million euros), this "small" revenue source is going to disappear.

Another concern is whether the expected mode shift would actually happen. The combination of low fuel price and high income of citizens would make it difficult for people to abandon their cars for a free commute, which makes the policy ineffective. It seems more education on congestion and environment is needed to facilitate the policy implementation. It is worth mentioning the side policy that the government plans to put more investment in public transport infrastructure, to increase 20% of the network capacity by 2025.

As the first country to implement the free public transport policy, Luxembourg stands out as a pioneer. The case of Luxembourg remains to be assessed and it can serve as an example to other countries.

MRT Line3 in Manila

Manila is the typical developing megacity. There are different stages of transportation infrastructure development. Generally, developing regions are more challenged by the shortage of transport infrastructure and management experience and the focus is on infrastructure construction, while developed cities tend to focus on the management of already established public transport system.

The MRT Line3 is owned and operated by the government. Fare setting is mainly based on social acceptability. In order to boost ridership, the government has kept fares low to make it affordable to the public. Though a distance-based fare structure is in place, fares for road-based modes rise more steeply with respect to distance compared to fares for rail-based modes, including MRT Line3 (Mijares & Regmi, 2014).

Under the low fare, the fare revenue is not able to cover the operation and maintenance cost. What is more, the ridership went beyond capacity in 2005 and has been increasing ever since, deteriorating the service quality and increasing the cost even more. Huge government subsidies were spent on MRT Line3. According to previous estimation (Mijares & Regmi, 2014), 77% of passenger cost is subsidized. The high subsidy cost for balancing the gap between passenger fare revenues and actual costs created a huge financial burden to the government. Against this, the deteriorating service quality such as over-crowded and uncertain waiting time, and inequality between commuter groups of various lines and transport modes have raised social dissatisfactions, which is the unintended impact of the low fare policy.

There is a call for reform of pricing policy in Manila. A reasonable fare should balance the tradeoff between affordability, government finance burden, and service quality. A proper increase in fare would generate revenues that can be used to improve service quality. The public transport system should be considered as a whole, and fare-setting for a particular line such as MRT Line3 should also consider the balance between all modes of transport system.

Public transport compensation in Tokyo

Tokyo has a very extensive public transport network that composed of railways run by a variety of operators, with buses, trams, monorails, and other modes supporting the railways. In terms of public transport pricing, the Japanese case is quite unique. Commuters' public transport expense is normally compensated by the commutation allowance (or "Tsukin Teate" in Japanese) provided by the employer firms. This convention has a long history that can date back to the period when large scale factories took over small scale home workshops. The commutation allowance was started to support workers who were not able to commute between their homes and workplaces. For the time being, according to the Japan Ministry of Health, Labor and Welfare, about 90% of Japanese companies pay their employees' commuting allowance. The allowance is sometimes regarded as a legal mandate, though it isn't.

The tax law also promotes the implementation of a commutation allowance through the regulation that the commutation allowance is tax-exempt. From the long-term perspective, this simply offset the employees' wages that without the allowance, they would have higher wages and bear the public transport cost by themselves. Deeper social impacts are also there, such as cross-subsidy between short- and long-distance commuters, which may affect the social equity. Since the distance to the workplace becomes insensitive, more people would choose to live further from the city center, which may cause longer commuting time in general. The influence on land use patterns would help the expansion of city scope, as well as inhibition style and housing price. Interested reader could go to previous discussions (TANI, 2004) for more detailed information.

With the development of ICT, recently Japan introduced the nation-wide transport program: Mobility as a Services (MaaS)[2]. Utilizing the latest technology such as autonomous driving and artificial intelligence, MaaS aims to provide more comfortable and fulfilling lives and more efficient management through services that combine a variety of mobile efficiencies. Pricing of public transport in cities, such as Tokyo has been emphasized to optimize routes and timetables based on travel supply and demand reflected by big data. Application examples include time-based pricing to ease the congestion, integrated pricing schemes to enhance network integration, among others.

Public transport voucher in Brazil

The public transport voucher is the form of a demand side subsidy scheme, which is legally mandated by law in Brazil. As stated, the objective of the subsidy scheme is to make fare affordable and promote the functioning of the urban public transport system.

[2] https://www.meti.go.jp/press/2018/01/20190118006/20190118006-2.pdf

The subsidy scheme involves the participation of employer companies and adopts a self-decision mechanism on the determination of beneficiaries. It became compulsory for all companies since 1987. Urban the scheme, employers buy public transport voucher at the municipality office and distribute to their employees for daily commute between home and office on a monthly basis. With the voucher, employees are able to take means of public transport freely (or without direct out-of-pocket expense). All employees can be beneficiaries. The cost of this free commute is that 6% of the employees' monthly salary will be deducted. However, they still have the option of not receiving the public transport voucher while getting their full salary.

The rule places the decision criteria to the employees, as can be simply imagined, that if the employee has a high salary (one in which 6% would be higher than amount spent on daily commute), the employee would choose not to have the subsidy and the 6% deduction of salary. The determination of beneficiaries builds on a self-decision mechanism that mostly depending on the level of salary. It is worth mentioning that same as Tokyo's commutation allowance, the amount spent with transport voucher for employees are deducted from annual income tax.

The public transport voucher, as the subsidy scheme for urban public transport in Brazil, represents the transfer of capital and support from urban companies to public transport system. It guarantees the employees' expense of public transport to be not more than 6% of salary income. However, due to the scheme rule, it might exclude higher-income employees from benefiting from the scheme and cause the inequality problem. Further discussions are on the effectiveness of the subsidy mechanism, based on the fact that a substantial number of vouchers are sold at a discounted value in the secondary market instead of using them for travel. This is more likely to happen on low-income employees who would walk to work and save the discounted value for more necessary living expenses. In this sense, low-income employees would be better off by an equivalent direct monetary transfer rather than a subsidy mechanism using voucher for public transport.

As can be seen from the pricing practices, various pricing policies are utilized to manage the public transport under different contexts. For instance, low public transport fare is advocated to attract commuters in Manila, and even, the fare is going to be free in Luxembourg. However, if a low fare brings volume that overpasses the network capacity, congestion may occur and the crowds would worsen the service quality, as the case for Manila. Affordability is one of the important issues of public transport. To solve the problem, subsidy is provided, such as the commute allowance in Tokyo and the public transport voucher in Brazil, and the effectiveness of different subsidy mechanisms deserves a careful examination. Further on, the question may come to that who is going to provide the subsidy, finance the improvement of network capacity. A public sector operator is likely to operate the transport system with a fare structure that is closer to the welfare maximizing model, while a private sector operator would be interested in profits. Rationales would be different according to finance structures, as have briefly described in above cases.

Based on the simple investigation into pricing cases, public transport pricing-related tradeoffs of public affordability and operator profitability, operator service provision and associated costs, and choices on subsidy forms and finance structures, are highlighted. They are summarized and discussed in the following section.

1.2 Research problem

Public transport plays a main role in urban transport. Pricing of public transport is essential for sustainable development. The extent to which pricing policy instruments are used and directed at a specific issue is referred to as policy implementation. Past research and practices have pointed out problems impeding the sustainability of urban public transport pricing policies, as discussed below:

1.2.1 Fare affordability and operator profitability

The transport system is very complicated and a pricing policy will need to deal with trade-offs and have multiple consequences, both intended and unintended ones. For instance, low public transport fare is advocated to attract commuters. However, if a low fare brings traffic volume that overpasses the public transport capacity, congestion may occur and the crowds would worsen the ride experience. This may call for the expansion of public transport network or other measures to improve the capacity. At the same time, better service should be provided. Then, the question may come to that who is going to finance these capacity and service improvement schemes. Suppose the public transport operator assumes all the responsibility: the investment on infrastructure, the spending on better service, and the lower fare, together the intended policy goal will become a disaster to public transport operators. This simple imagined scenario shows that lower fare would be problematic under certain circumstances.

Public transport should meet the diverse needs of different levels of groups, including the rich group and the poor group. From the commuters' perspective, transport cost including the time cost and fare cost is the key parameter in considering public transport. Since the travel time is determined by the configuration of the transport network, which is not possible to improve in a short period of time, the setting and adjusting of public transport fare are therefore crucial for the promotion and sustainable development of public transport. Fares are out-of-pocket expenses and users are sensitive to fare changes, which can affect ridership. A lower level of fare will of course attract more users. However, too low a fare would cause excessive public transport use that overpasses the capacity of the network. What is more, from the perspective of finance, a low fare would create a financial burden to the government if the transport system is funded by the public sector, and insufficiency of fare box revenue if the public transport is operated by private sectors, who prioritizes the profitability. The trade-off between the operator's profitability and public's affordability has to be balanced in pricing policy making.

1.2.2 Subsidy scheme and effectiveness

Subsidy is the financial support from Government to producer and consumer, or both. In the context of public transport, subsidy is one solution to the issue of public transport affordability (Serebrisky, Gómez-Lobo, Estupiñán, & Muñoz-Raskin, 2009). It is the direct or indirect transfer of money to the target group. There are various subsidy mechanisms, which can be briefly divided into demand side subsidy and supply side subsidy, with the funding source differing from general tax/local tax, cross subsidy, and so on. Problems associated with subsidy policies include inefficiency and inequality, such as the unintended distribution among population, or sometimes even benefiting the non-poor group more.

Therefore, thorough considerations should be made in making the subsidy policy, based on the city context and the policy objective. For example, how much should the Government subsidize the needy group? How to define the criteria of eligibility? Should the subsidy be a direct monetary transfer to users, a reduction in public transport fare from operators or a combination of the two (concession or subsidy)? What are the public opinions towards these subsidies? How to monitor and review the performance of the policy, as well as the effectiveness of subsidy schemes? These questions are to be examined by the research.

1.2.3 Finance structure of public transport system

The financing of the public transport system generally comes from two main sources, the fare box revenue and the government fund. Fare box revenue is the main revenue source for operators. If the operation is managed by private companies on a commercial basis, the revenue from fare collection will need to cover the cost of operation and maintenance. Even if the government runs the public transport, without proper management, the problems of deficit, low efficiency, bad service may occur.

Finance structure defines who (public or private sector) receives revenue and pays the cost, and the percentage of doing so. There are different forms of partnership between public and private sectors, and this research is going to investigate how they aligned with different urban contexts and the impacts.

1.2.4 Lack of ex-post evaluation method on pricing policy

In terms of policy evaluation, there are mainly 3 types: ex-ante evaluation, benchmarking, and ex-post evaluation. The ex-ante evaluation makes predictions of how a scheme or policy might perform and provides the policy making tool for policy maker. It is for policy making and optimization. The benchmarking evaluation describes the status of policy implementation and gives score to the one-shot static situation of the public transport system. The ex-post evaluation is based on the facts, or the actual interventions and outcomes of existing policies. It addresses the question that "under what background, what has been done, and what has been achieved". Ex-post evaluation is carried out after the policy is implemented. Evidence from ex-post evaluation can be used to improve the future policy making. The differences are shown in Table 1.1.

Table 1.1 Types of policy evaluation

Type	Ex-ante evaluation	Benchmarking evaluation	Ex-post evaluation
Evaluation Focus	Policy making and optimization	Description on policy implementation status	Policy intervention and performance interaction
Associated policy stage	Policy idea and decision stage	Policy implementation stage	Operational stage
Evaluation challenge	Difficulty of incorporating practical constraints into simulation	Benchmarking score is for static ranking only	Capture of intervention and identification of performance

Example of evaluation	Pricing theory, such as Self-Finance Theorem (Mohring & Harwitz, 1962) for optimal fare; Policy making tools, such as STAR from ADB[3], and KonSULT from Leeds University[4]	Sustainability benchmarking report with ranking across 24 cities (Knupfer, Pokotilo, & Woetzel, 2018)	Ex-post evaluation method for pricing policy is not seen, necessity emphasized by OECD (*OECD Regulatory Policy Outlook 2015*, 2015)

It is believed that there is large potential for improving the existing regulatory framework through more systematic ex-post evaluations of regulations (*OECD Regulatory Policy Outlook 2015*, 2015). Literature review shows that there has not seen such ex-post evaluation method specifically for urban public transport pricing policy, due to challenges on analytical method (Worsley, 2017). Another challenge for the ex-post evaluation on existing pricing practices lies in the need to organize the data collected in an integrated way, in order to provide a comprehensive measurement of urban public transport.

1.3 Selection of case study

Pricing policy is the management of public transport. Pricing management is more needed when travel demand is high. Generally, high population (reflected by total population * density) creates more travel demand. However, due to the infrastructure development level (reflected by GDP), it is more likely that cities with low GDP focus on construction (e.g. Manila), while cities with high GDP focus on the management of already established public transport systems.

According to the ADB city database, among 478 cities with population above 500,000 in the Asian and Pacific Regions, Singapore and Hong Kong are top ranked in terms of GDP and Population density.

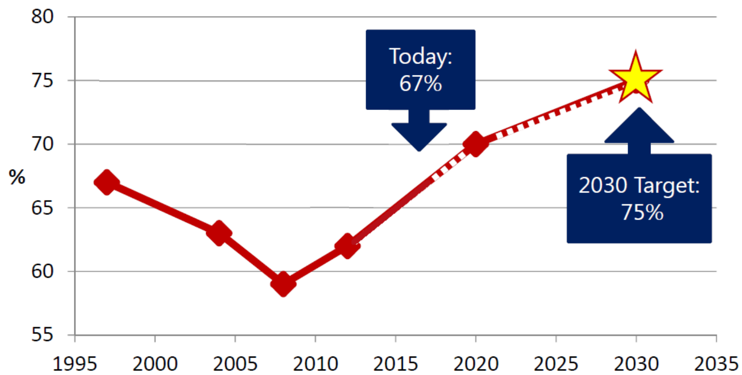
Singapore and Hong Kong's urban transport system, due to the consistent successful operation against the limited urban area and excessively high level of traffic volume, have been highly recognized globally. While their success and achievements of urban transport system are valuable examples for other cities, there are still challenges that may hinder sustainability in the long run, if proper addressing is missing. Therefore, while admitting the success and sharing the knowledge, it is also essential to identify the major critical and challenging issues, such as the affordability, subsidy, and finance structure issues that may stand against sustainability. In order to achieve this, a thorough investigation of the existing situation and a holistic evaluation of the performance of Singapore and Hong Kong's urban transport and the related pricing policies, are strongly needed.

In the case of Tokyo, its unique public transport compensation system makes the travel demand less elastic with price level, which may affect the fundamental mechanism of pricing policy as a travel demand management instrument, according to transport economics. Therefore, it is excluded. Detailed introduction on the case of Singapore and Hong Kong is provided in the following section.

[3] https://www.adb.org/publications/toward-sustainability-appraisal-framework-transport
[4] http://www.konsult.leeds.ac.uk/

1.3.1 Case of Singapore

Singapore is an island nation with little natural resources, yet facing the challenge of meeting increasing travel demand against growing population. Travel demand in Singapore has increased with the population increase, especially for the traffic demand in the morning peak period. Figure 1.4 has shown a declining public transport share (1995-2008) in recent years. While around 67% (as of 2016) of commuters travel on public transport in the morning peak period (Land Transport Authority, 2019a), recent increases in travel demand are putting on more challenges on public transport system.



Source: LMTP 2013

Figure 1.4 Public transport mode share in Singapore

According to the recent Public Transport Customer Satisfaction Survey 2012 (Land Transport Authority, 2012), public satisfaction with public transport was 90.3% in 2011, 88.8% in 2012, and 88.5% in 2013, reflecting a decreasing trend.

Under such context, policies and approaches for efficient use of its land and public transport system are launched to meet the needs in Singapore. It is commonly regarded that Singapore has demonstrated itself as a success for managing public transport system towards sustainable urban transport with pricing policy instruments under the pressure of economic development and resource constraints. The Government implemented a series of policy packages with a mix of policy instruments to influence the urban transport demand, supply, and service.

Chronologically, there are 3 main comprehensive transport policy packages.

White Paper 1996

White Paper 1996 was the comprehensive policy package on land and transport management in Singapore. It was the beginning of Integrated Land Use and Transport Planning. The policy focused on the expansion of road networks as part of the plan to meet rising travel demand. It was laid down the concept that advanced technologies are to utilized for traffic management. Significant measures to address the improvement of public transport were also addressed.

In White Paper 1996, Singapore aimed to establish and maintain a world-class transport system, including a high quality public transport network that occupies a small amount of land but carries a major portion of trips. The main components of Singapore's public transport infrastructure include the Mass Rapid Transit (MRT) as the backbone of the system, the Light Rapid Transit (LRT), and buses as feeder services to the MRT and LRT network (Land Transport Authority, 1996).

Land Transport Master Plan of 2008

The Land Transport Master Plan of 2008 was a major milestone. It aimed to adopt strategies to convert public transport as the main choice mode. Methods to manage road usage were also addressed. The document itself was people-centered and aimed to meet the diverse needs of the commuters through a holistic approach. It also includes a concerted effort to improve pedestrian access and cycling provisions for last-mile travels (Land Transport Authority, 2008).

Land Transport Master Plan of 2013

The Land Transport Master Plan of 2013 is the latest integrated transport policy in Singapore. As stated in the LTMP 2013 report, the policy goal is to create a more people-centered land transport system with more connections and better service. More consideration is given to the well-being of diverse communities and the enhancement of the livability. Public transport is made to be an attractive mode of travel to discourage the use of the private car (Land Transport Authority, 2013).

The policy goal of LTMP2013 are that by 2030, Singapore will have:

- 8 in 10 households living within a 10-minute walk from a train station;
- 85% of public transport journeys (less than 20km) completed within 60 minutes; and
- 75% of all journeys in peak hours undertaken on public transport.

To achieve the goal of LTMP 2013, public transport related pricing schemes are proposed and implemented. They are Distance-based Fare Scheme, New Capacity Factor Fare Adjustment Scheme, Transport Concession Scheme, Service Enhancement Program, and New Finance Scheme, as listed in Table 1.2. Detailed analysis of the pricing schemes is available in Chapter 4.

Table 1.2 Singapore public transport pricing policy in LTMP2013

Type	Pricing Scheme	Description
Fare policy	Distance-base Fare Scheme	Fare charged based on distance traveled regardless of modes, to improve the connectivity and integration of the public transport system
	New Capacity Factor Fare Adjustment Scheme	New Factor in fare adjustment formula to reflect capacity change and share the cost of capacity improvement
Subsidy policy	Workfare Transport Concession Scheme	Concession fare (15% discount) for eligible low-income workers to assure affordability

Finance policy	Service Enhancement Program	Capacity improvement through construction of rail lines and provision of bus fleets; Enhance service(frequency, punctuality)
	New Finance Scheme	Operating assets transfer from public transport operators to Government through PPP contracts. Operators bid to run services, government keeps fare revenue and pays operators

Public transport institution in Singapore

Land Transport Authority (LTA) and Public Transport Council (PTC) are the 2 main institutions in Singapore.

The LTA is a statutory board under the Ministry of Transport. It is responsible for primary decision-making in the transportation sector, including planning, designing, building and maintaining Singapore's land transport infrastructure and systems. PTC is the authority to regulate public transport fares and ticket payment services. It works closely with the public transport operators and LTA.

Public transport operator in Singapore

There are 2 main operators in Singapore: SMRT Corporation and SBS Transit.

SMRT Corporation is a multi-modal transport operator in Singapore. It operates bus, rail, taxi, and other public and private transport services. Its business covers leasing advertising and commercial spaces within the transport network it operates, as well as in engaging operations and maintenance services, project management and engineering consultancy in Singapore and overseas.

SBS Transit is a leading bus and rail operator in Singapore. It is formed in 1973 through the merger of three private bus companies and by listed on the Stock Exchange of Singapore in 1978. The company operates more than 200 bus services with a fleet of some 3,000 buses, including the North East MRT Line, and Light Rail Lines[5].

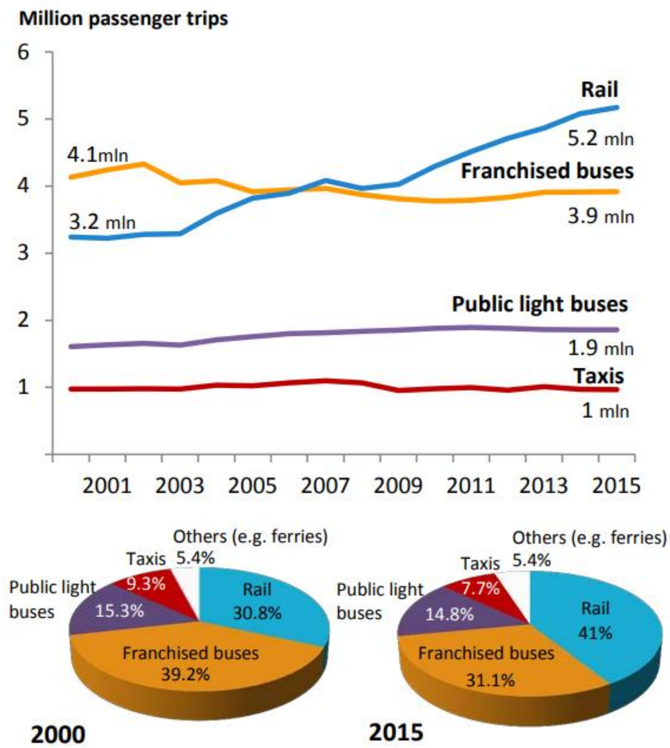
The two companies are assigned specific areas or territories of responsibility within which, each company is responsible to plan and deliver a comprehensive network to meet the service standards set by the regulator. They are expected to deliver satisfactory bus services to meet the mobility needs of commuters.

1.3.2 Case of Hong Kong

Hong Kong is also known for its efficient public transport system. In Hong Kong, public transport is the major mode of transport, and the demand for public transport is increasing all the time. According to the estimation of Transport Department in Hong Kong (HKSAR Transport and Housing Bereau, 2017), the number of passenger trips of public transport is expected to rise from 12.59 million per day in 2016 to

[5] https://www.sbstransit.com.sg/about-us

around 13.20 million per day. Heavy rail ridership will increase from around 37% of local public transport patronage in 2016 to around 39% in 2021. Franchised buses are the largest road-based carriers and it accounts for 31% of total daily public transport trips in Hong Kong (as of 2015).



Source: (HKSAR Transport and Housing Bereau, 2017)

Figure 1.5 Public transport mode share in Hong Kong

It is the Government's established policy that public transport services should be run by the private sector in accordance with commercial principles to enhance efficiency and cost effectiveness. Currently, there is no direct subsidy from the Government for public transport services.

Table 1.3 lists the public transport pricing schemes implemented in Hong Kong. They are: Fare Adjustment Scheme, Work Incentive Subsidy Scheme, Public Transport Fare Subsidy Scheme, Rail Development Strategy, and Bus Route Rationalization Scheme. Detailed analysis of the pricing schemes is available in Chapter 5.

Table 1.3 Hong Kong public transport pricing policy

Type	Pricing Scheme	Description
Fare policy	Fare Adjustment Scheme	Fare adjustment based on formula that takes into account Composite Consumer Price Index (CCPI), Wage Index (Transportation Section) and productivity factor

Subsidy policy	Work Incentive Subsidy Scheme	Help low-income workers to reduce financial burden on commute cost. Eligible (mean-tested) low-income worker receives subsidy (up to HK$600 per month) to reduce cost
	Public Transport Fare Subsidy Scheme	Relieve the fare burden of commuters who travel on local public transport. Commuters (non-mean tested) get subsidy for 25% of actual PT expenses in excess of $400
Finance policy	Rail Development Strategy	Capacity improvement through construction of rail lines and interchange centers; Enhance service(frequency, punctuality)
	Bus Route Rationalization Scheme	Adjust bus routes in accordance with demand changes for better use of resources

Public transport institution in Hong Kong

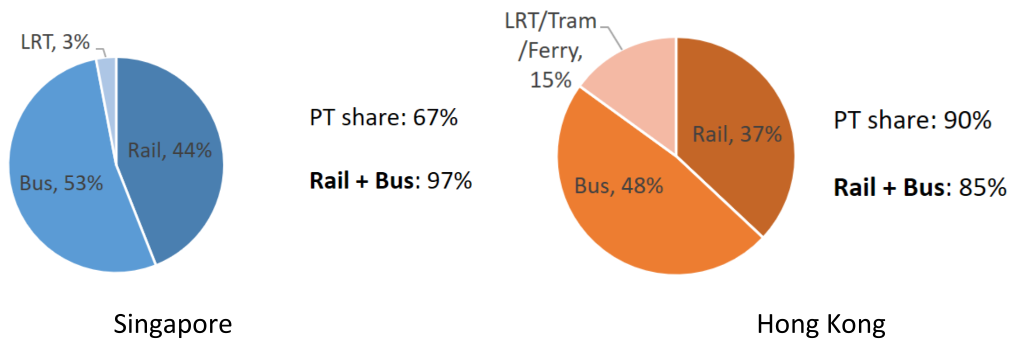
The Transport Department is the authority for administering the Traffic Ordinance and legislation for the management of road traffic, regulation of public transport services and operation of major transport infrastructures. It is responsible for managing and regulating public transport services, as well as planning for the future to cope with the growth in demand for transport facilities and services, to achieve a public transport system that is safe, reliable, efficient, environmentally friendly and satisfying to both users and operators.

Public transport operator in Hong Kong

MTRCL is the main rail operator in Hong Kong. It was established in 1975 with a view to constructing and operating, under prudent commercial principles, a safe, reliable and efficient urban underground metro system to help meet Hong Kong's public transport needs. The Corporation was listed on the Stock Exchange of Hong Kong through an Initial Public Offering by the Government in October 2000. The Government now owns around 76% of the shares of MTRCL (HKSAR Transport and Housing Bereau, 2016).

In terms of bus operators, there are five franchisees operating bus services in Hong Kong, namely the Kowloon Motor Bus Co. Limited (KMB), Citybus Limited (Citybus), New World First Bus Services Limited, Long Win Bus Company Limited, and New Lantao Bus Company Limited. KMB is the main operator of bus service in the region of Kowloon, the New Territories and most of the cross-harbor routes. It operates 309 bus routes in Kowloon and the New Territories and 61 cross-harbor routes. Besides, Citybus is the main operator for the Hong Kong Island and cross-harbor routes, as well as the Airport and North Lantau bus network. It operates 103 bus routes, including 52 Hong Kong Island routes, 29 cross-harbor routes, 1 New Territories route and 21 routes to Tung Chung and the Airport (Transport Department 2017).

In terms of governance, there are different levels of authorities, such as the city government, regional government, as well as the national government. Normally, city level authority deals with detailed and direct issues, while national government makes decisions on large-scale long-term policies. Singapore is a city-state and Hong Kong is the special authority region of China. Due to their small-size yet efficient governance systems that different levels of authorities (city and national) are synthesized, they are comparable in policy making. A variety of public transport pricing policies are integrated into the policy making process and guaranteed by the strong governance of the city governments.



Source: website of Transport Department of Singapore and Hong Kong

Figure 1.6 Rail and bus mode share

Figure 1.6 highlights that rail and bus are the main public transport modes in Singapore and Hong Kong. They have the important function of carrying people and goods around the city, with rail works as the artery carrying the mainstream and buses are like blood vessels circulating nutrients to feed the city. Therefore, rail and bus are the main scopes in the following evaluation of public transport.

1.4 Research objective

1.4.1 Construct an ex-post evaluation method for existing pricing policy

First, this research will construct an ex-post evaluation method for existing pricing policy. Transport policies are complicated, and there is a serious lack of detailed understanding of policy implementation and the impacts, and of their transferability to different contexts. The ex-post-policy evaluation focuses on the real effects, and justifies the impact of an intervention and its achievements. It helps to formulate a diagnosis of effects, both intended and unintended, to identify strong and weak points of an intervention and to indicate directions of development and modification of future interventions.

1.4.2 Identify problems of existing pricing policy

Through the review of current situation and existing pricing policies in Singapore and Hong Kong, the research will identify the problems including:

- How to set fare, adjust fare to keep fare affordable to public and profitable to operators?

- How to subsidize fare, in which form and at what level, when the affordability or profitability issues occur?
- How to finance the public transport, to maintain the system efficiency and good service?

The review will identify the problems that actually occurred in the two cities, and how are they different due to urban contexts.

1.4.3 Identify and present how the problems are addressed

With the reveal of the problems on public transport pricing, the research will focus on how the problems are addressed through the investigation on pricing schemes implemented and the associated performance, based on the ex-post evaluation method. The result of the evaluation is presented to inform policy makers. The review also provides foundation for further causality analysis and the derivation of implications.

1.4.4 Compare and derive implications

Implications from the past practices are important for future policy making. Based on the evaluation result, the causality analysis and comparison between Singapore and Hong Kong are carried out to derive implications for future urban public transport pricing policy. The research provides comprehensive, consistent and up to date assessments of evidence on the impacts of a wide range of urban transport policy instruments for use by decision-makers in the development and implementation of integrated transport strategies.

1.5 Research methodology

The research utilizes an integrated methodology framework to achieve the objective of ex-post evaluation on pricing policy. A neutral evaluation perspective is taken rather than, for example, the operators' or the government's perspective. The methodology framework highlights the policy intervention into the public transport system, with special attention to pricing related impacts. Though proposed for and applied to the two specific cases analyzed in this research, the framework is generally applicable to a broader background with the purpose of ex-post evaluation on pricing policies.

The proposed methodology framework adopts the existing methods of Multi-Criteria Decision Making method, performance indicator method, Theory of Change, as well as Realist Evaluation. They are integrated into a systematic and functional way to serve the research objective. The detailed information on the construction of the method can be found in Chapter 3.

Generally, for any policy, the process can be divided into 4 stages: policy problem and objective identification, policy design and preparation, implementation, and policy performance monitoring and review, as illustrated in Figure 1.7. The policy process initiates with the investigation on the existing problems, and the policy objective is formulated accordingly into the policy statement. The policy is then designed and prepared by policy makers. Its effectiveness is influenced by the degree of understanding and the appropriateness of the policy design. Once implemented, the policy starts to generate outcomes and impacts. The policy's performance is then monitored and reviewed, to further improve the policy.

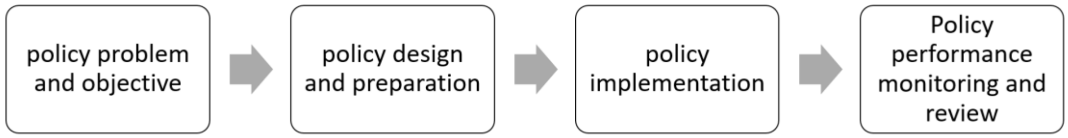


Figure 1.7 Policy process

Figure 1.8 shows how the above-mentioned existing methods are associated with the policy process, and how they are integrated into the methodology framework. In the figure, the first 3 steps of policy process (policy problem and objective identification, policy design and preparation, and policy implementation) are generalized into the broader "policy implementation" concept. Policy implementation and policy performance are located in the middle of the framework. In the upper half, the evaluation of policy implementation (based on the Multi-Criteria Evaluation method) and evaluation of policy performance (based on performance indicators method) is carried out separately. The result of the two is integrated together by the proposed integrated analytical framework. The integration incorporates the process of aggregation, normalization, and integration, and visualization, which can explicitly display the gap of policy implementation and performance in an intuitive way. A total of 11 criteria in 4 categories (of transport system, economics and finance, society, and externality) and a set of indicators for pricing policy evaluation are selected and employed. Criteria are assigned scores based on the level of implementation. Performance indicators are calculated based on data before and after the policy intervention. Development of the criteria identification and scoring approach, and mechanism for indicator calculation are described in detail in Chapter 3.

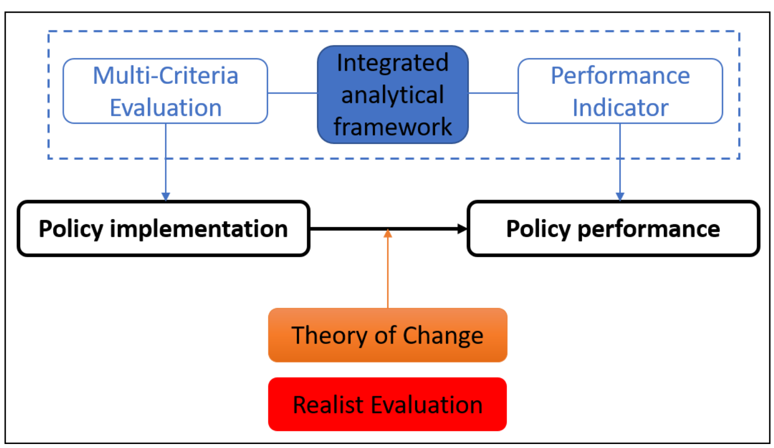


Figure 1.8 Integrated methodology framework

In the lower half of the framework, Theory of Change and Realist Evaluation methods are utilized to identify the causal links between policy implementation and policy performance. The information from the integrated analytical framework in the upper half is translated into the building blocks of the intervention logic model through Theory of Change analysis. Quantitative and qualitative links among the blocks are identified and displayed. Further on, Realist Evaluation highlights the role of contexts and extracts intervention mechanisms from the cases study. The CMO configuration (context-mechanism-outcome) is developed for causality analysis, which is useful in deriving implications for future policy making.

The methodology framework combines multiple methods. Each is with a specific evaluation purpose. However, the methods and evaluation packages are not segregated. Rather, they are integrated. There is the horizontal integration of policy implementation and performance evaluation through the integrated analytical framework, as well as the vertical integration of Theory of Change and Realist Evaluation on the analysis of causality. Therefore, the methodology framework is the systematic integration of research methods and designed specifically for the purpose of the ex-post evaluation on urban pricing policy. It can address the research problems and fulfill the research purposes.

As the post-policy evaluation method, the proposed framework facilitates the policy learning from the past examples. The policy learning process is analogous to the PDCA (Plan, Do, Check, Act) approach. The advantage of the PDCA approach is that it describes simple, consecutive stages to follow in order to gain more objective insight for continuous improvement. It is one of many ways for evidenced-based reviewing and improvement. Similarly, in the transport pricing policy making, through the ex-post evaluation by the proposed integrated analytical framework, a continuous evidence-based policy process can be built up, to derive improvements for future policy making.

1.6 Structure of the thesis

Chapter 1 introduces the research background and discussed the research problems and objectives. The cases selected for evaluation are justified with a brief introduction to methodology.

In Chapter 2, a systematic literature review on the transport pricing theory and policy evaluation methods are presented. Based on that, in Chapter 3, the integrated methodology framework is proposed and constructed. The introduction follows the analytical process, with detailed discussion on the selection of evaluation criteria and indicators, the integration, as well as the framework for causality analysis.

Chapter 4 and 5 are cases study on Singapore and Hong Kong respectively. They share the identical framework proposed in Chapter 3. With the input of data collected through diverse resources, the evaluation result of each case is generated and presented at the end of each chapter.

Chapter 6 further compares the two cases and tries to derive implication based on the causality analysis and comparative study of cases.

Chapter 7 concludes the study.

It is hoped that this study would contribute to the improved implementation of urban transport pricing policy by, specifying, analyzing, and disseminating information of ongoing practices, for the sustainable development of urban transport.

2 Literature Review

In the public transport field, price means the fare paid by commuter to enjoy the public transport service. Pricing is a critical factor in transit planning that requires careful consideration from the viewpoints of both transit service providers and users. The major source of revenue for transit agencies is the fare collected from users, which naturally makes agency financial health dependent on fare level and demand. Fares constitute the majority of the cost of an individual's travel expense. Setting fares is, therefore, a fundamental task for sustainable urban public transport. Pricing theories are proposed, mostly from the transport economics perspective, to instruct the setting and adjusting of fare.

2.1 Transport pricing theory

2.1.1 Literature Review on pricing theory

As an economical instrument for transport intervention, pricing has gained attention from transport economists for many years. Previous research has proposed theories to guide, and to provide justifications for transport policy decisions. There are series of pricing theories and plenty of review papers have been published. Rouwendal and Verhoef briefly reviewed the history of road pricing in the paper (Rouwendal & Verhoef, 2006).

"The economic theory of road pricing dates back to Pigou (1920) and Knight (1924), who wrote their seminal contributions about the misallocation of resources that would result from free access to public roads. The fundamental reason behind this phenomenon is a so-called external effect: if there is congestion, each trip on the road forces other users to slow down, and therefore to have longer trip times. In the absence of a toll, a driver does not have to pay for the additional costs he imposes on others. When this cost is ignored, the market fails. The situation can be improved by corrective policy measures, a toll being the main example."

The general economic principle for pricing can be illustrated in Figure 2.1.

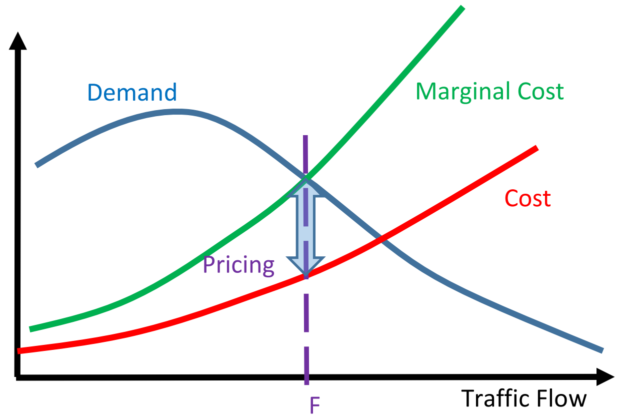


Figure 2.1 Economic principle for pricing

It utilizes the cost-benefit analysis approach. The optimal level of pricing should maximize the system efficiency, as illustrated. The horizontal axis stands for traffic flow (in the case of toll road) or passenger flow (in the case of public transport), and the vertical axis is cost (or benefit). The blue curve is the traffic demand, which generally goes down when the flow increases. The red curve is the direct cost of an individual driver/commuter (here we suppose the time cost is the only cost for the sake of simplicity). The green curve stands for the marginal cost, which is the cost one commuter imposed on other commuters. The pricing is the gap between the direct cost and marginal cost. It is the indirect or additional cost charged to commuters, to reveal the true cost under a certain traffic flow, and to maximize the social efficiency and welfare.

The Self-Finance Theorem (Mohring & Harwitz, 1962) is the cornerstone of the pricing theory. The theorem concludes that under certain conditions, an optimally designed and priced road can generate toll revenues just sufficient to cover its capital costs.

The theorem is derived as follows. Assume that user travel costs *C* are characterized as a simple function of the flow *F*, and capacity *K*. The model assumes that besides travel time, there is only one other component of cost, namely a toll τ. Marginal benefits *D(F)* are Defined as:

$$D(F) = C(F/K) + \tau \qquad \mathbf{2.1}$$

Social welfare is expressed by the difference between aggregate benefits and the general social cost. With *D(F)* representing marginal benefits, its integral between *0* and *F* represents total benefits. The social cost consists of two components, 1) total user cost, *F·C(F/K)*, and 2) capacity cost, dependent only on capacity *K,* written as $C_K(K)$. Maximization of social welfare *S* thus reads:

$$Max\ S = \int_0^F D(x)dx - F \cdot C(F/K) - C_K(K) \qquad \mathbf{2.2}$$

$$s.t.: D(F) - C(F/K) - \tau = 0$$

The first-order condition with respect to flow *F* shows that it is optimal to equate marginal benefit *D(F)* to the marginal social cost, which is the sum of the private cost *C(F/K)* incurred by the individual, and the marginal external cost $F \cdot \partial C/\partial F$ that a road user imposes on fellow road users due to congestion:

$$\partial S/\partial F = D(F) - C(F/K) - F \cdot \partial C/\partial F = 0 \rightarrow \tau = F \cdot \partial C/\partial F \quad \textbf{2.3}$$

Total toll revenue *R* is then:

$$R = F^2 \cdot \partial C/\partial F \quad \textbf{2.4}$$

The first-order condition of (2) with respect to *K* tells us to expand capacity up to the point where the marginal benefits of doing so are equal to the marginal cost of capacity:

$$\partial S/\partial K = -F \cdot \partial C/\partial F - dC_K/dK = 0 \quad \textbf{2.5}$$

By introducing scale economy indicator α, after equation transformation, we have:

$$R = \alpha \cdot C_K \quad \textbf{2.6}$$

Equation 2.4 and 2.6 tell us that, provided an optimal toll is charged and capacity is optimized, the revenue *R* is equal to the capacity cost C_K, multiplied by the elasticity α. Generated revenues are equal to capacity cost, meaning that the road is self-financed.

Implications of the theorem are of profound significance. It provides a practical check on how to set pricing under certain network capacity and tolls conditions. The theorem implies that revenue collected from pricing is just enough to sustain the transport system, which is desirable in terms of economy-wide efficiency. The charge determined by economics principle can be perceived as fair and transparent, which promotes public acceptability (Small & Verhoef, 2007).

With the input of cost and benefit functions, optimal capacity and tolls that maximize social welfare can now be calculated through cost-benefit models. As implied from the self-finance theorem, capacity and toll are two variables of the self-finance equilibrium, which means that for any given toll level, there is always a corresponding optimal capacity, and vice versa. Generally speaking, tolls are high for congested roads with less capacity and moderate for roads with sufficient capacity. However, the optimal capacity and toll under the self-finance theorem are static. Dynamic considerations, such as would the optimal capacity be stable at a certain value and how do optimal tolls fluctuate over time, are required to provide insight into the long-term sustainability of systems. The long-term sustainability is examined based on the modeling in next section.

2.1.2 Modeling of the theory

Carefully distinguishing between long-term and short-term approaches, and rigorously defining the associated demand and cost functions, helps to clarify what factors need to be considered in particular policy decisions.

Long-term optimal capacity. In order to operate the road network efficiently, it is more desirable to increase the road capacity if demand exceeds supply, and similarly, road capacity should be decreased if supply exceeds demand (Misui & Nemoto, 2010). When a road is congested, the road administrator can levy a congestion charge to bring in excess revenue and invest it in increasing road capacity. Thus, investments in expanding road capacity can be made whenever short-term optimal congestion pricing yields revenues that exceed the incremental capital cost of capacity. Capacity will incrementally increase and congestion prices incrementally decrease due to network improvements. In the long-term, by iteration of the self-finance theorem, capacity would stabilize at a certain level, reaching a stabilized level of sustainable optimal capacity.

Long-term optimal toll. When long-term stable capacity is reached, the toll level also stabilizes. The possible toll evolution scenario, according to the self-finance theorem, would be: road users faced with insufficient road capacity problems would be charged higher tolls in an early stage, and road users who are facing sufficient road capacity would enjoy lower charges. However, as users faced with insufficient road capacity are not responsible for the poor road capacity, the acceptability of early users would remain low and the generational equity gap would be considered unfair (Misui & Nemoto, 2010).

The optimal toll is a useful implementation scheme to achieve long-term optimal road capacity with small losses to the cost-benefit ratio. Efficiency trade-offs will affect feasibility and equity, and so the optimal toll should be a strategically tailored long-term scheme, which offsets revenue losses incurred from higher toll levels at the initial low-demand stages through compensation schemes such as government capital loans, private provisions, or other financial instruments.

In this section, we first build up a dynamic model based on a single link. By implementation of the Self-Finance Theorem, long-term optimal capacity and optimal tolls can be identified.

Model composition

The dynamic cost-benefit analysis model incorporates travel demand and cost analyses (Lakshmanan, Nijkamp, & Verhoef, 1997). Travel demand analysis is based on simplified portrayals of user behavior. The demand for travel takes place in a multi-dimensional setting that includes parameters such as residential and job locations, and vehicle ownership. In order to plan transportation facilities, it is necessary to forecast demand. In order to price them rationally and determine the best operating policies, it is also necessary to know how users respond to prices and service characteristics. In order to evaluate whether a project is feasible, it is necessary to have a measure of the benefits it produces. Travel demand analysis provides insights into understanding travel behavior and can measure the attractiveness, accessibility, and social welfare of transport infrastructures.

Similar to multi-dimensional demand analysis, cost analysis provides multiple outputs, such as average costs, marginal costs, and economies of scale and scope. Take congested expressway for instance, it is possible to use cost functions to understand the outcome of trip frequencies, routes, and possibly travel schedules that dominated by congestion, accidents, and parking cost.

Our model considers congestion for homogeneous travelers between a single origin-destination pair connected by a single link (60 km). Demand is isoelectric and the inverse demand function is shown in Table 2.1. The time cost function is now specified according to the widely used BPR (Bureau of Public Roads) function. We ignore road maintenance and depreciation. The capital cost is also isoelectric, as shown below:

Table 2.1 Model input

Input	Function	Parameter and value	
Demand	$D(F) = \delta \cdot F^{1/\varepsilon}$	δ – demand parameter	10^{12}
		ε – demand elasticity	-0.35
Cost (variable)	$C_{\boldsymbol{var.}}(F, K) = \alpha \cdot (1 + \beta \cdot (\frac{F}{K})^{\gamma})$	α – value of time	3.75
		β – BPR parameter	0.15
		γ – BPR parameter	4.0
Cost (fixed)	$C_{\boldsymbol{fix.}}(K) = \mu \cdot \frac{K_0}{{K_0}^{\lambda}} \cdot K^{\lambda}$	μ – unit price of capacity	7.0
		K_0 – initial capacity	4000
		λ – capital elasticity	1.0

The model has selected the following parameters: On the demand side, we use an elasticity ε of -0.35. To create a reasonable reference equilibrium, we calibrate δ as 10^{12}. On the cost side, we set the value of time α at 3.75 (the average monetary value for 1 hour perceived by society), and the BPR parameters β and γ are set equal to 0.15 and 4, respectively, as their conventional values (Verhoef & Mohring, 2009). A maximum flow is not defined for BPR functions. The average unit price of capacity μ at capacity level K_0 (4000, vehicles per hour) is set equal to 7.0. With a unit of time of 1 hour, this parameter can reflect the hourly capital costs. The capital elasticity equals to 1.0 since depreciation is ignored. Please note that the dynamic model is quite general. The numerical value itself doesn't have much significance and some parameters are set for simplicity. However, the findings from the model have a wide range of applications.

Model output – long-term optimal capacity and optimal toll

With the basic input, we derive the optimal toll for the base capacity by maximizing social welfare. The base equilibrium for optimal toll is 10.55.

Our dynamic model is more focused on the long-term effect, namely the long-term optimal capacity and the fluctuation of the optimal toll. Carefully distinguishing between long-term and short-term approaches, and rigorously defining the associated demand and cost functions, help to clarify what factors need to be considered in particular policy decisions.

Long-term optimal capacity. In order to operate the road network efficiently, it is more desirable to increase the road capacity if demand exceeds supply, and to decrease road capacity if supply exceeds demand (Misui & Nemoto, 2010). When a road is congested, the road administrator can levy a congestion charge to bring in excess revenue and invest it in increasing road capacity. Thus, investments in expanding road capacity can be made whenever short-term optimal congestion pricing yields revenues that exceed the incremental capital cost of capacity. Capacity will increase incrementally and congestion prices will decrease incrementally due to network improvements seen as a result of investment. In the long-term, by iteration of the Self-Finance Theorem, capacity would stabilize at a certain level, which would represent the sustainable state of optimal capacity. When long-term stable capacity is reached, the toll level also stabilizes.

The following diagram shows the algorithm to derive the long-term optimal capacity.

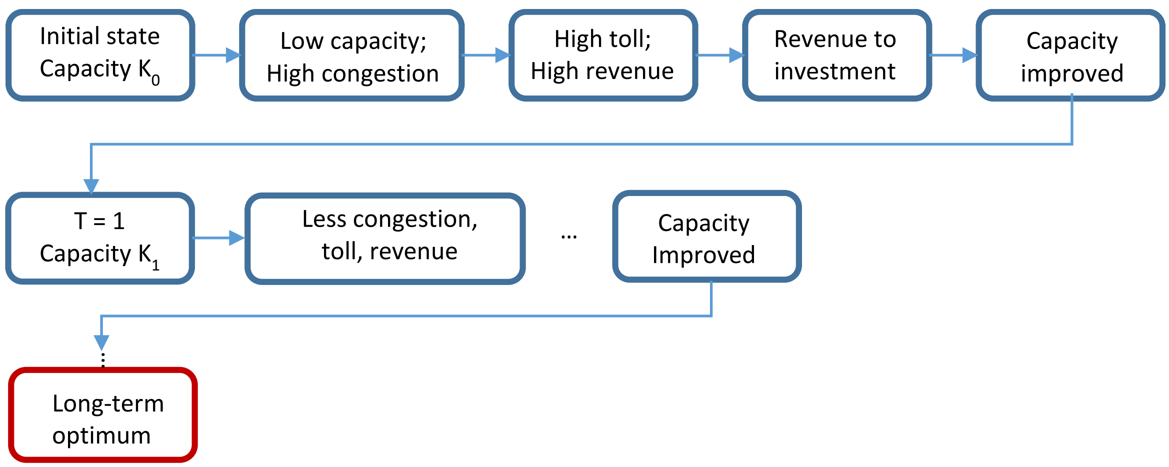


Figure 2.2 Algorithm for generating long-term optimum capacity

Suppose that 10% of the revenue is invested in the expansion of the capacity, which is reasonable if we consider operation and maintenance costs. Finally, the iteration will be stopped when observed improvements to capacity become less than 0.1% of the previous capacity. The calculation process of the long-term optimum is illustrated below.

Table 2.2 Calculation of long-term optimum

Time	Capacity K	Flow F	Toll τ	Revenue	Investment	Capacity increase
Initial	4000	5886	10.55	29265	2926	418
1	4418	6197	8.7	19343	1934	276
…						…
10	5399	6844	5.81	1584	158	23
…						…
30	**5505**	6908	**5.58**	52	5	1

Translating the calculation table into graph, the trajectory of the evolution of optimal capacity and toll is shown in Figure 2.3.

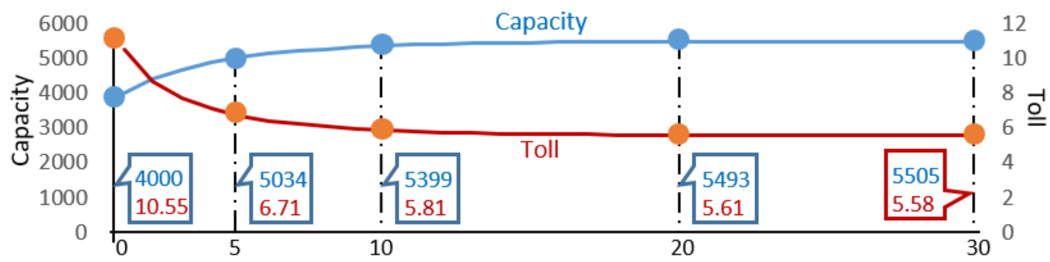


Figure 2.3 Evolution of optimal capacity and toll

Both of the optimal capacity and toll change rapidly at the beginning, then gradually become stable. The long-term optimum is reached at the 30th iteration. The long-term optimal capacity for the link is 5505, and the corresponding optimal toll is 5.58.

This simulation shows how optimal pricing varies with the change of time and capacity, and provides insight into the long-term consideration in pricing policy making, from the pricing theory perspective.

Though the simulation is carried out based on private toll road, the concept of transport economics applies to public transport pricing. Proost (Proost, 2018) compares the pricing theory for private transport and public transport and claims that "similar pricing principles (of private transport) exist for metro and urban rail." Pricing of public transport are affected by a wide range of cost and benefit factors, as well as time spans of short and long terms. Building new public transport infrastructure, changing the level of service, or modifying fares would affect the costs and benefits associated, which can be analyzed in the same approach of cost-benefit analysis. The difference between short-term and long-term scenarios, which is shown based on the simulation on private transport, exists for public transport. In the short-run fare changes would push commuters either switch modes or not travel, while in the long-run, commuters are open to more options including changing destinations of jobs and homes, purchasing a car etc.

The pricing theory is the theoretical and ideal approach to the "right" solution of urban transport problems. However, there are gaps between theoretical analysis and practical implementation. In practice, due to physical constraints, the reliance on pure theoretical analysis is inappropriate. Constraints include but are not limited to the inability to: meet theoretical capacity requirement since transport networks are lumpy, distinguish between classes of users, differentiate pricing level continuously over time, incorporate imperfect information, external factors such as economic environment, and distortions outside the transportation market.

As the case can be seen in many cities, transport policies often do not follow any optimization rules, rather responding overwhelmingly for practical constraints, such as political considerations. For example, the primary design motive of pricing policy can be different, which would have impact on pricing objectives and problems. A public sector is likely to operate a fare structure with the priority of social welfare while a private operator would be interested in investment profits. Transport policies will have to balance the power struggles between interest groups, meaning the priorities and preferences differ and outcomes of the policies are uncertain. Therefore, transport policy making requires pricing theories to be adapted for implementation, and theoretical insights need to be translated into practical applications.

2.2 Transport policy evaluation methods

The evaluation of transport policies can help policy makers understand relations among components, causes, and effects, as well as improve the policy accordingly. A variety of evaluation methods have been proposed to evaluate transport policy. Sayyadi and Awasthi (Sayyadi & Awasthi, 2017) summarized the commonly used approaches reported in the literature and categorized them into five main categories, namely Multi-Criteria Evaluation, indicator-based evaluation method, optimization, simulation, and others such as life-cycle analysis, cost-benefit analysis, and scenario building. Interested reader could go to the original paper for detailed classification. As discussed in 1.2.4, there are different evaluation types of ex-ante, benchmarking, and ex-post, in terms of relationship between the evaluation and policy stages. The following table (Table 2.3) matches the main evaluation methods with different evaluation types.

Table 2.3 Main policy evaluation method

Category of evaluation method	Evaluation type		
	Ex-ante evaluation	Benchmarking evaluation	Ex-post evaluation
Multi-Criteria Evaluation	Yes	Yes	Yes
Performance indicator-based evaluation	No	Yes	Yes
Optimization	Yes	No	No
Simulation	Yes	No	No
Others	NA	NA	NA

Source: (Sayyadi & Awasthi, 2017)

Note: "Yes" means the method is generally suitable for that type of evaluation; "No" means the method is generally not suitable for that type of evaluation; "NA" means not applicable.

Among these methods, as pointed out by Sayyadi and Awasthi, Multi-Criteria Evaluation and indicator-based evaluation methods are well established and widely used. Optimization aims at the "best" design of a policy under the pre-determined goals. The optimal pricing theory of Self-Finance Theorem (Mohring & Harwitz, 1962), as illustrated in 2.1.2, would be a perfect example. Simulations require rigorous mathematical expressions, such as those used in system dynamics that based on the definition of precise relationships between variables which is difficult and/or costly to obtain and often distorted from practical implementation. The methods in the "Other" category have particular evaluation interests, for instance, Cost-Benefit Analysis (CBA) is focused on the economic performance of the policy, Theory of Change and Realist Evaluation are focused on impact evaluation and the associated causalities.

Multi-Criteria Evaluation, performance indicator-based evaluation method, Theory of Change and Realist Evaluation method are the foundation of the methodological framework later proposed in Chapter 3. The following section will discuss more them and investigate how they can be adapted to serve for the ex-post evaluation purpose.

2.2.1 Multi-Criteria Evaluation method

Multi-Criteria Evaluation (MCE) is an approach that suitable for addressing complex problems featuring high uncertainty, conflicting objectives, different forms of data and information, multi-interests and perspectives, and accounting for complex and evolving socio-economic systems (Wang, Jing, Zhang, & Zhao, 2009). The multi-disciplinary and multi-participatory nature of transport policy will require the implementation of such a method with multiple criteria.

Multi-Criteria Evaluation usually includes four main stages: criteria selection, criteria weighting, evaluation, and final aggregation. Criteria selection is the preliminary step in MCE. The identification of criteria is a prerequisite for understanding the policy making and implementation, and informing policy makers of the integrated impacts on urban public transport system. The transport system is complicated and it is not easy to identify the criteria adopted in actual policies. Researchers have developed principles (Wang et al., 2009) to guide the selection of criteria, in order to translate the trade-offs of transport policy into the MCE analysis. The principles for pricing policy criteria selection are:

- Systemic principle: reflecting system characteristic and comprehensiveness;
- Consistency principle: consistent with the research objective and scope;
- Independency principle: avoiding inclusion relationship between criteria; and
- Measurability principle: indicative for policy making.

While selected criteria should be able to incorporate and assess multiple, often conflicting objectives, they should also incorporate attributes like environmental or social issues that are intrinsically difficult to quantify (Annema, Mouter, & Razaei, 2015). The suitable criteria for ex-post evaluation on pricing policies that categorized as transport system, economics and finance, society, and externality are recognized through the investigation of pricing policies (which is done in 3.1.1).

Criteria selection is followed by criteria weighting. Literature on transport-related criteria weighting is reviewed, as provided below.

Liu (Liu, 2015) proposed a framework for prioritizing urban transport projects, incorporating scenario planning and MCE with a balanced view of both the analytical and intuitive components of the decision-making process and comparisons between various stakeholders.

Based on the investigation, the paper summarizes the weights for urban transport criteria. For reference, selected results are listed in Table 2.4.

Table 2.4 Selected criteria weighting from literature (1)

Criteria	Decision Maker	Project Designer	System User
traveling time	4.03	4.46	4.42
average traffic	3.92	3.76	3.29
road network	3.79	3.92	3.43
traffic accident	4.20	3.88	3.75

Source: (Liu, 2015)

As can be seen from the table, take the stakeholder of decision maker as an example, the weights for criteria of travel time (4.03), average traffic (3.92), road network (3.79), and traffic accident are very close. Same finding applies to different stakeholders as well. The ranges of transport-related criteria weighting are not varying much.

Rahman & Hoong (Rahman & Hoong, 2011) utilize Balanced Scorecard to evaluate Singapore's land transport system with a holistic framework of sustainability. The scope of the paper is broad and criteria considered include institution capacity, innovation and so on. The criteria weight related to public transport system are listed in and the same result comes out: weights for different criteria are not varying much.

Table 2.5 Selected criteria weighting from literature (2)

Criteria	Review of Literature	Field Interview	Expert Judgment
Accessibility, connectivity, and travel time	4.0	3.8	4.1
Affordability	4.5	3.7	4.5
Level of service and comfort	3.8	3.3	3.9
Safety enhancement	4.4	4.1	4.4
Social equity and coherence	4.3	4.2	4.3
Security enhancement	4.8	4.7	4.8
Employment growth	3.5	3.4	3.6
Revenue enhancement	4.6	NA	4.8
Management of travel demand	4.3	NA	4.3
Efficient cost distribution and cost control	4.1	NA	4.3
External cost savings	3.7	NA	3.8

Source: (Rahman & Hoong, 2011)

In the field of sustainable energy decision making, Wang (Wang et al., 2009) reviewed weighting methods used in the research and concluded that:

"equal weights method was popularized and applied in many decision-making problems that this method often produced the results nearly as good as those optimal weighting methods. Equal weights method is the most popular in sustainable energy decision making"

Therefore, based on the literature review, it is clear that equal weighting is used widely. For papers with differentiated weighting method in the public transport field, weights for different criteria don't vary so much.

At the same time, differentiated weighting method is considered to be funds/efforts consuming, and sometimes is criticized as it provides room for result manipulations and lack of robustness (Schlickmann, 2018). In addition, this research compares the case of Singapore and Hong Kong, which calls for a common set of weights (instead of a weight set that calibrated specifically for each city). Therefore, in this study, the equal weighting method is adopted for the ex-post evaluation.

As the application of MCE method on the ex-post evaluation of existing transport pricing policies, the evaluation process and final aggregation need to be customized to combine the results from case studies, which is discussed in detail in Chapter 3.

2.2.2 Performance indicator evaluation method

Performance indicator-based evaluation utilizes the indicators to assess the performance of the policy after implementation. Performance indicators are broadly defined as variables representing an operational attribute of a system or policy measuring progress toward an objective. It is commonly used for ex-post evaluation, considering its ability to compare developments over time and space (Chakhtoura & Pojani, 2016).

There are 2 challenges associated with indicator-based evaluation method: firstly, how to select appropriate indicators; secondly, how to organize the selected indicators for evaluation.

Challenge 1: Selection of indicators

There is a wide range of indicators to choose from. Even within the scope of this research, indicators for transport policy evaluation range from the straightforward to the complex, from the purely quantitative to the highly qualitative type. In reality, the 'perfect' indicator or a set of indicators that could meet all evaluation demands is often not an option and the selection principles are needed in order to determine which indicators to choose or to set aside (Bjerre, 2016). Indicators should be carefully selected to provide useful and robust information for the evaluation. The appreciate indicators should be specific, measurable, and accountable. Litman (Litman & Burwell, 2006) has proposed principles on how indicators can be selected to realize an effective evaluation of the policies' performance, as listed below:

- Comprehensive – Indicators should reflect various impacts and transport aspects, and consistent with policy objective.
- Accountable – Indicator information is accurate and understandable to the general public.
- Comparable – Indicators should be standardized so the results are suitable for comparison between various jurisdictions, times and groups.
- Accessible and available – Indicator details should be available to all stakeholders and be cost effective in data collection.

These principles are good reference in selecting the indicators. At the same time, understanding the characteristics of indicators will help in indicator selection. Generally, indicators can be classified into 3 types: the immediate output indicator, the short-term outcome indicator, and the long-term impact indicator.

Output indicator

Output indicator captures the immediate change of policy intervention. It is a direct and reliable measurement of policy performance. For example, the indicator of "public transport fare" is an output indicator for Fare Adjustment Schemes. How much fare would be adjusted is decided by the fare adjustment formula that written in the policy document with a specific time point to take effect. The change in fare happened immediately after the policy starts.

Outcome indicator

Policy outcome is the conditions that altered by policy, and outcome indicator is deployed to reflect the changed conditions. Different from output, it usually takes more time for the outcomes become evident. Usually, there is certainty about what outputs produced by a specific policy, but no perfect certainty of what outcomes are caused by which policy. This uncertainty between policy and its impact challenges the selection and calculation of appropriate outcome indicators in policy evaluation.

Impact indicator

Impact indicators provide an important signal for illustrating the connection between policy instruments. Policy impacts that including transport safety, transport-oriented environment influence and so on, takes longer time than policy output and outcome. It is typically not possible for an individual policy to achieve impacts without the contribution of others.

Based on the discussion of types of indicators, it is clear that the selection of indicators is closely related to policy attributes, objective, and policy evaluation purposes. There are direct and indirect policy impacts. The impact that aligns with the policy objective is the direct impact. In most cases, the direct impact is the main impact of the policy. However, not all the policy is effective in achieving its pre-determined objectives, and sometimes the policy impacts are counter to their objectives, creating the indirect impacts. The more explicit policy objectives are in this respect, the easier it is to develop appropriate indicators.

There is often a trade-off in deciding upon the number of indicators (Bjerre, 2016). On one hand, settling for a smaller number of indicators is seen as cost-effective in terms of subsequent data collection, and focusing on fewer indicators makes it easier to communicate. However, choosing too few indicators can reduce the possibility to identify comprehensive policy performance. The more information condensed into a single index the less meaning it has for specific policy targets and the greater the likelihood of double counting. Therefore, the policy performance indicator needs to be investigated on a case-by-case basis.

Examples of indicator-based evaluation

Literature review on performance indicators for transport evaluation would provide examples of indicator sets adopted in real evaluation. However, before going into the examples, it is necessary to introduce the concept of sustainability and sustainability indicators. Recent indicator-based evaluation of transport policy has seen an increasing trend of sustainability indicators application.

In April 2001, the EU Ministry of Transport and Communication at their meeting in Luxemburg adopted the following statement as the European Union’s definition of Sustainable transport:

“*A sustainable transport is one that:*

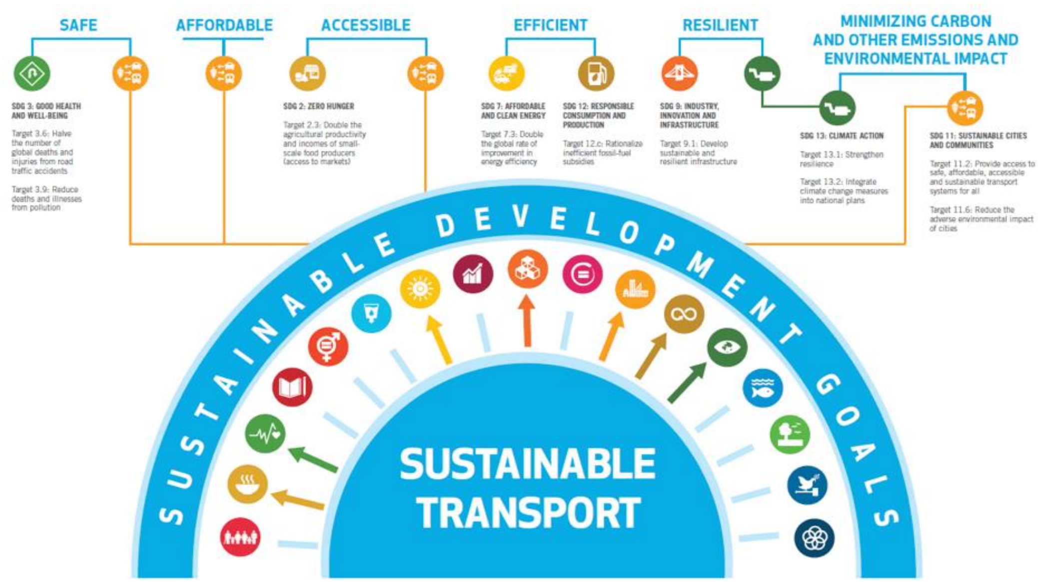
• Allows the basic access and development needs of individuals, companies and societies to meet safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;

• Is affordable, operates fairly and efficiently, offers choice of transport modes, and supports a competitive economy, as well as balanced regional development;

• Limits emissions and waste within the planet's ability to absorb them, use renewable resources at below their rate of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes while minimizing the impact on the use of land and generation of noise."

From the above definition, sustainable transport should be accessible, inclusive and equal to all social groups, affordable and efficient, and environmental. Sustainable transport can be framed into environmental, social and economic aspects. The environmental aspect covers fuel consumption, the rate of pollution emission; the Social part refers to accessibility and equity; the Economic aspect emphasized financial limitations, affordability, efficiency, and cost of land, among others.

Sustainable transport is also discussed in Sustainable Development Goals (SDGs). SDGs are a collection of 17 global goals set by the United Nations General Assembly in 2015. Among all broad and interdependent goals aimed at the balance of social and economic activities and the environment, some are directly and indirectly connected to sustainable transport. A sustainable urban transport should be safe, affordable, accessible, efficient, resilient, as well as minimizing the environmental impact (UN, 2016), as indicated by Figure 2.4.



Source: (UN, 2016)

Figure 2.4 Sustainable transport

Other international development institutions such as the Asian Development Bank and the World Bank proposed the definition of "Sustainable transport" as well. Jeon (Jeon, Amekudzi, & Guensler, 2013) and

Litman (Litman, 2017) summarized the major sustainability indicators sets from various institutions, agencies, universities, and suggested the indicators for transport policy evaluation (see example 1). Chronically, the definition of "transport sustainability" is developing all the time. Banister (Banister, 2008) describes the change of the concept of sustainability and emphasizes that urban transport policy needs to reflect the concept of sustainability and the trend of norms.

Example 1: Suggested indicators based on literature review

Based on a vast literature review on indicator-based evaluation methods, Litman collects indicators for transport policy evaluation. Examples of indicators are provided and recommendations of indicator sets are suggested, for selecting sustainable transport indicators for use in a particular situation (Litman, 2017).

Table 2.6 Indicator set suggested by literature

Economic	Social	Environmental
Per capita mobility (daily or annual person-miles or trips). Mode split (personal travel, public transport; freight: truck, rail, ship and air). Average commute travel time and reliability. Average freight transport speed and reliability. Per capita congestion costs. Total per capita transport expenditures (vehicles, parking, roads and transit services).	Per capita traffic crashes and fatalities. Quality of transport for disadvantaged people (disabled, low incomes, children, etc.). Affordability (portion of household budgets devoted to transport). Overall satisfaction rating of transport system (based on objective user surveys). Universal design (consideration of disabled people's needs in transport planning)	Per capita energy consumption, disaggregated by mode. Energy consumption per freight ton-mile. Per capita air pollution emissions. Per capita land devoted to transport facilities. Air and noise pollution exposure and health damages. Impervious surface coverage and stormwater management practices.

From the suggested list of indicators, we can see that the indicators are generally divided into 3 categories: economic, social, and environmental. The evaluation objects are general transport system.

Example 2: Indicator set for Atlanta transport plan evaluation

In the case of Atlanta metropolitan region, the long-term regional transport plan has the following goals:

(1) Improving accessibility and mobility;

(2) Maintaining and improving system performance and preservation;

(3) Protecting and improving environment and quality of life; and

(4) Increasing safety and security.

Three transport plan alternatives to achieve the goals are proposed. Jeon uses the indicator-based evaluation to evaluate the performance of different plans (Jeon et al., 2013). Based on local sustainability issues and the goals of the transport plan, the following indicators sets are utilized in the evaluation of the alternatives.

Table 2.7 Indicator set for Atlanta transport plan evaluation

Sustainability dimension	Indicator
Transportation system effectiveness	Freeway/arterial congestion
	Total vehicle-miles traveled
	Freight ton-miles
	Transit passenger miles traveled
	Public transit share
Environmental sustainability	CO_2 emissions
	Ozone emissions
	VOC emissions
	CO emissions
	NO_x emissions
	Traffic noise level
	Fuel consumption
	Land consumption
Economic sustainability	User welfare changes
	Total time spent in traffic
	Point-to-point travel cost
	Improved accessibility
	Increased employment
	Land consumed by retail/service
Social sustainability	Equity of welfare changes
	Equity of exposure to emissions
	Equity of exposure to noise
	Exposure to emissions
	Exposure to noise
	Accidents per VMT
	Crash disabilities
	Crash fatalities
	Access to activity centers
	Access to major services
	Access to open space

Both qualitative data on regional goals and quantitative data on performance measures are utilized to support the analysis of three transportation plans. The indicators fall into 4 sustainability dimensions: transport system, environment, society, and economics.

Based on the two simple examples, we could see that sustainability indicator method that takes into account a wide range of impacts can measure the policy performance and reflect the policy objectives.

The indicators are generally categorized into sustainability dimensions, and under each dimension, a certain number of detailed indicators are deployed. Considering the fact that sustainability concept is widely advocated by different level of authorities in transport policy making, it is appropriate to use sustainability indicators to evaluate the performance of transport policies. Given the ambiguity associated with sustainability concept, the indicator sets vary depending on the approach that policy makers adopt to make it operational and measurable.

Challenge 2: Organization of indicators

As mentioned earlier, another challenge of indicator-based evaluation method is how to organize the selected indicators for the purpose of evaluation.

In practice, policies interact with each other. Policies may have impacts on attributes that out of the objective scope. Similarly, for a particular objective, its targeted outcome may be affected by multiple policies. For instance, the land use policy, which is not directly linked with transport, may affect the configuration of transport network, and the corresponding transport capacity and pricing policy.

In terms of ex-post evaluation on urban public transport pricing policy, pricing instruments are concurrently existing. In some cases, they are integrated into policy packages or strategies (such as Singapore's LTMP2013). The impacts of policy instruments are co-existing, creating the challenge for identifying indicators to evaluate the performances of transport policy.

An ideal indicator captures the essence of the policy objective while minimizing the influence of confounding factors. The right indicators should be as little as possible influenced by factors that lie outside of the policy objective, and be comprehensive to cover most aspects of the objective. Literature review shows that transport policy is commonly assessed by indicator sets that organized around specific sustainability themes or dimensions, with relevant indicators and performance measures identified based on each policy objective. The indicator evaluation framework needs to be aligned with detailed pricing policy objectives, which is discussed in Chapter 3.

2.2.3 Theory of Change and Realist Evaluation

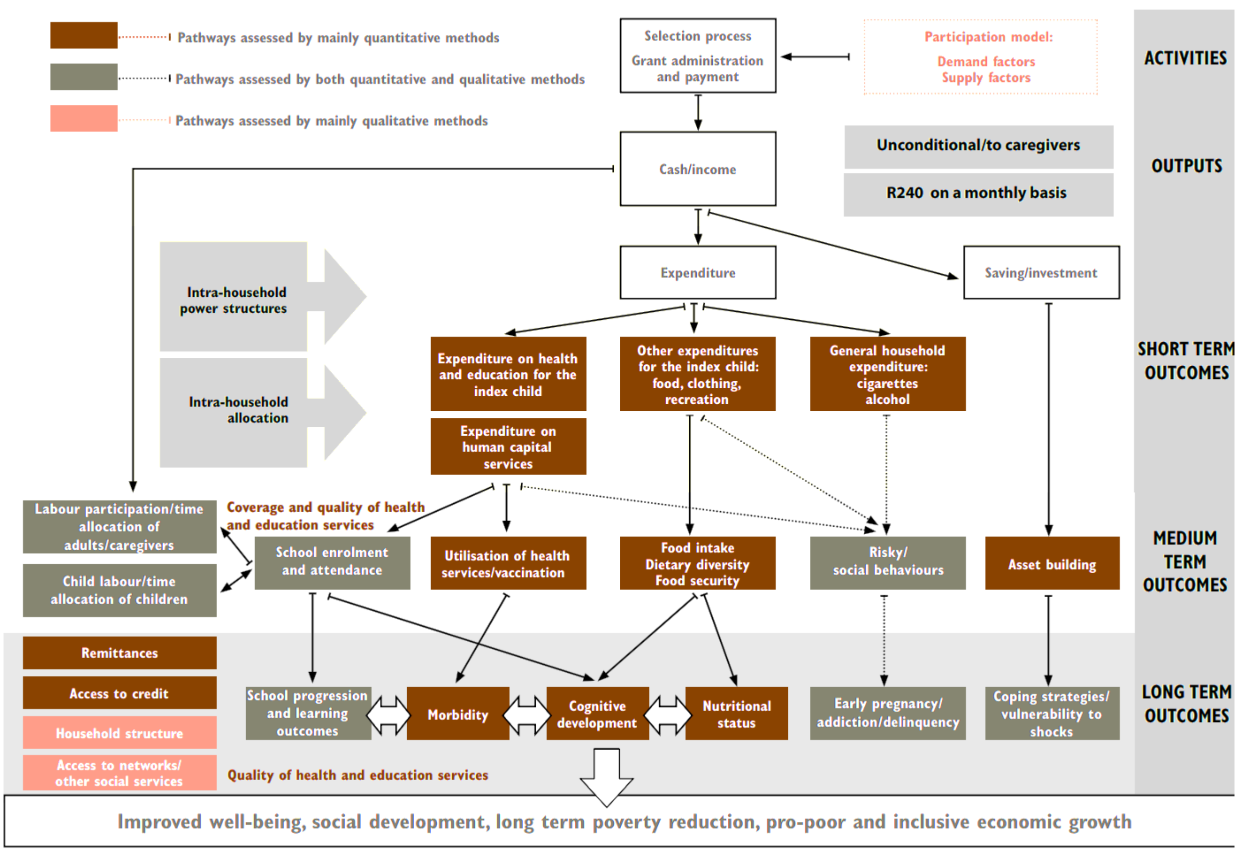
Theory of Change and Realist Evaluation method are classic evaluation methods in medical research (Eastwood et al., 2019), and recently has seen an increasing application in transport policy evaluation (Hills & Junge, 2010). They are categorized as the theory-based approach for policy impact evaluation.

Theory-based approaches to impact evaluation allow for a systematic examination between policy interventions and the associated impacts. Based on the understanding of "what" interventions are in place and "what" outcomes have been achieved, the theory-based evaluations proceed further on "why" and "how" the changes happened, with a special focus on the contexts and conditions. Utilizing potential qualitative and quantitative data obtained from different sources, theory-based approaches provide evidence on the outcomes and impacts achieved by the intervention (including unintended ones), the combination of factors that contributed to achieving them as well as how outcomes and impacts were achieved (Hills & Junge, 2010). Therefore, theory-based approaches are particularly suitable for ex-post evaluations that have a problem focus and seek to generate learning for future policy interventions.

Theory of Change

Theory of Change is a systematic and cumulative study of the links between activities, outcomes, and context of an intervention. In terms of ex-post evaluation, Theory of Change is used to investigate the implementation theory of policy interventions. The evaluation often adopts the form of intervention logic model, which is a structured map to include all the components and to show links of which factors at which levels are combined to produce the observed outcomes. A simple example of the application of Theory of Change is given below.

In the analysis of how the program of Child Support Grant affected the well-being and development of children, the Theory of Change evaluation is carried out based on the intervention logic model (Unicef, 2014).



Source: (Unicef, 2014)

Figure 2.5 Theory of Change evaluation by intervention logic model

As can be seen from the example, the paradigm of intervention logic model is followed. The left side of the diagram sets out the map into stages: activity, output, and outcomes of short-, medium-, and long-term. Multiple boxes are shown for each stage and the relevant boxes are linked to show how particular activities lead to particular outputs, and how particular outputs lead to particular outcomes. An outcomes hierarchy shows many levels of intermediate results that lead to the final impacts. The evaluation not only shows how the program might contribute to a range of positive impacts, but also identifies other contributing factors (such as the quality of health and education services) needed in order to achieve these. Multiple causal paths towards changes and impacts can be identified through the Theory of Change evaluation on an intervention, which would allow a more complete explanation of how the intervention delivered the intended and unintended impacts.

Realist Evaluation

Realist Evaluation is a species of theory-driven evaluation (Pawson, 1997). Realist evaluation is pragmatic and inclusive to combine quantitative and qualitative methods. Qualitative methods are often crucial to the elicitation of promising theory amongst program architects and workers (Pawson, 1997).

Realist Evaluation focuses on the question of "what works, under what context, and how it works". Context and mechanism are the key component of Realist Evaluation. Context describes those features of the conditions in which programs are introduced. The context of the intervention is a key factor determining outcomes and impacts. By taking into consideration the importance of context, the evaluation is able to uncovering the circumstances in which, and the reasons why, a particular intervention works.

Mechanisms describe what it is about programs and interventions that bring about any effects (Pawson, 1997). Mechanism explains why an intervention has had a particular result, which can be defined as capturing the reaction of people and reasoning of choices when faced with an intervention under a specific context.

Following the notion of generative causation, Realist Evaluation is geared around investigating which combination of mechanism and context factors is responsible for producing the observed outcome of an intervention. It seeks to identify underlying causal mechanisms and relevant contexts and aims to develop and refine "context-mechanism-outcome" (CMO) configurations (Table 2.8). The results of the evaluation would therefore be universal and generalizable.

Table 2.8 CMO configuration as result of Realist Evaluation

Some potential contexts	Some plausible mechanisms	Some possible outcomes
C_1	M_1	O_1
C_2	M_2	O_2
C_3	M_3	O_3
C_4	M_4	O_4
C_5	M_5	O_5
C_6	M_7	O_6

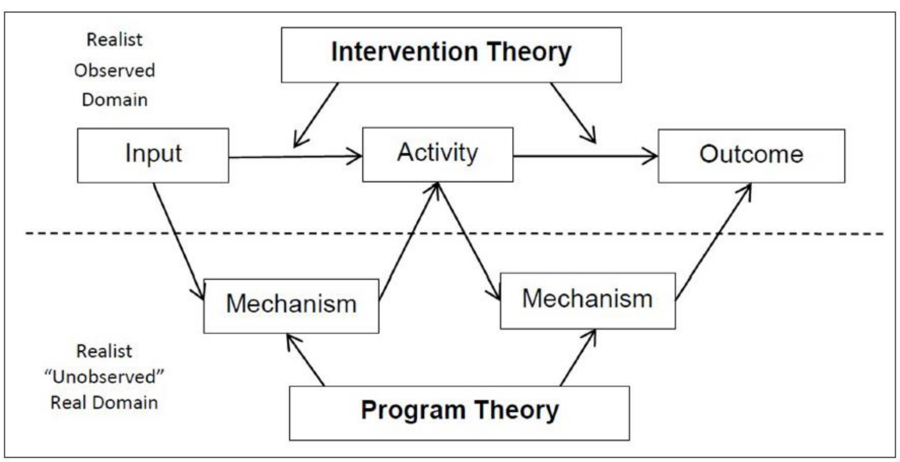
Source: (Pawson, 1997)

Due to the similarity of the 2 theory-based approaches that emphasize the importance of context in understanding how interventions lead to changes and outcomes, the paper of "Theories of Change and Realist Evaluation" (Blamey & Mackenzie, 2007) further explores the differences between the two approaches and considers how knowledge is generated and cumulated in subtly different ways depending on the approach that is taken. The main messages are summarized in Table 2.9.

Table 2.9 Comparison of Theory of Change and Realist Evaluation

Method	Theory of Change	Realist Evaluation
Definition	Theory of Change is a systematic and cumulative study of the links between activities, outcomes, and context of an intervention	Realist Evaluation explains why an intervention has had a particular result (called a mechanism), and what effect the context of an intervention has on these mechanisms
Commons	Both are concerned with understanding the theory of an initiative/intervention, and emphasize the importance of context in understanding how interventions lead to changes and outcomes	
Features	• Focus on implementation theory • concerned more with overall outcomes and the synergies between interventions	• Focus on program theory • concerned less with the overall program and more with the promising CMO configurations

Blamey and Mackenzie identified 2 discrete conceptualizations of theory that are relevant to ex-post evaluation. One relates to the links between intervention activities and the associated outcomes, which is called "implementation theory". The second type of theory refers to the causal links between mechanisms released by an intervention and outcomes, as the "program theory". Similar finding has been confirmed in the earlier mentioned medical research paper (Eastwood et al., 2019) and summarized into the following evaluation framework (Figure 2.6, in which "implementation theory" is called "intervention theory").



Source: (Eastwood et al., 2019)

Figure 2.6 Implementation theory and program theory

In summary, Theory of Change basically focuses on "implementation theory" concerned more with overall program interventions and outcomes at the implementation level, while Realist Evaluation examines “program theory” and pays more attention to promising CMO configurations and precise and substantive learnings. Different approaches are best suited to different evaluation challenges, and in some circumstances, a combined theory-based approach can be used to serve the evaluation purposes. “There is no obvious reason for believing that Theories of Change and Realist Evaluation could not coexist within the one evaluation, with the former providing broad strategic learning about implementation theory and the latter bearing down on smaller and more promising elements of embedded program theory”, as stated by Blamey (Blamey & Mackenzie, 2007). Understanding the difference and advantage of each method would help in designing the appropriate approach for ex-post evaluation on urban public transport pricing policy, and an explicit attempt to bring the two approaches together is made in the following methodological discussion.

2.3 Chapter summary

This chapter reviews transport pricing-related theory and policy evaluation methods.

As an economical instrument for transport intervention, pricing has gained attention from transport economists for many years. Pricing theory normally utilizes the cost-benefit analysis approach to derive optimal level of pricing that maximizes the system efficiency. Based on the modelling of “Self-Finance Theorem”, the dynamic evolution of optimal pricing is illustrated and the difference between long-term and short-term pricing is highlighted.

The pricing theory is the theoretical and ideal approach to the “right” solution of urban transport problems. However, there are gaps between theoretical analysis and practical implementation, and the reliance on pure theoretical analysis in policy making is inappropriate. This is why ex-post evaluation of pricing policy is needed.

The evaluation of transport policies can help policy makers understand relations among components, causes, and effects, as well as improve the policy accordingly. A variety of evaluation methods are reviewed. As the ex-post evaluation method for existing pricing policy, the review focus is put on Multi-Criteria Evaluation method and performance indicator-based evaluation method, as well as the theory-based approaches of Theory of Change and Realist Evaluation, which are the foundation of the integrated analytical framework and causality analysis later elaborated in Chapter 3.

Urban public transport pricing policies are complicated. The robustness of ex-post evaluation is depending on the appropriateness of criteria and indicator set, the availability and quality of information, such as data completeness and accuracy, as well as a suitable analytical framework to integrate them, as shall discussed in next chapter. Combining different elements of the broad evaluation approaches is not only possible but even necessary that the approaches are not mutually exclusive and ex-post evaluation can benefit from incorporating elements of approaches to generate expected results. What methodological combination is most useful depends on the evaluation questions, intervention applied, and the evaluation objectives, as shall be discussed in the following Chapter.

3 Methodology Framework

The research problem and objective are reviewed before building the methodology framework. The research identified 3 specific pricing problems related to urban public transport: the public transport fare and the tradeoff between fare affordability and operator profitability, the subsidy mechanism and its effectiveness, as well as the finance structure of public transport. As the ex-post evaluation, the research objectives are firstly to identify these problems through the cases study (Chapter 4 and 5). Secondly, the research will focus on how the pricing problems are addressed through the investigation on pricing schemes implemented and the associated performance, namely answering the question of "what has been done" and "what has been achieved". Then, based on the understanding of "what", the question of "how" and "why" are addressed through causality analysis and comparison between cases. As the final step, implications are derived for future pricing policy making.

In order to support the research objective, the methodology framework is proposed.

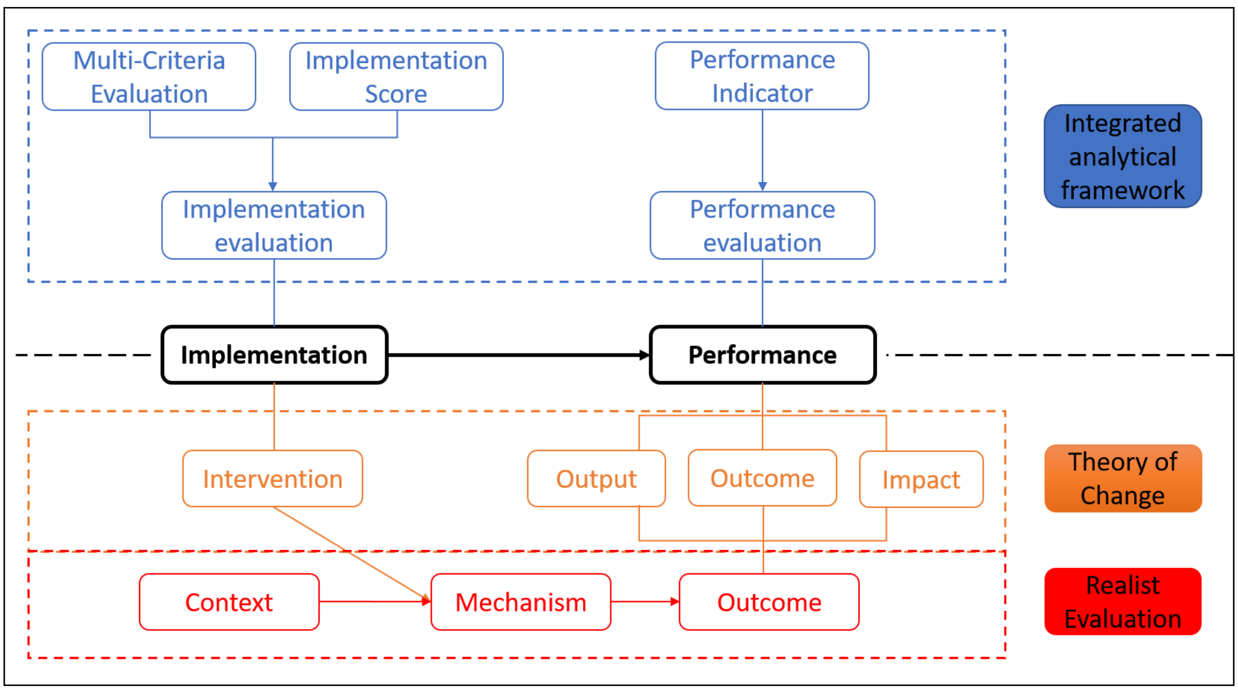


Figure 3.1 Methodology framework

The framework is arranged following the policy process of implementation and performance that located in the middle. In the upper half of implementation theory, the policy implementation evaluation (based on Multi-Criteria Evaluation method) and policy performance evaluation (based on performance indicator method) are carried out to address the "what" question. They are integrated by the integrated analytical framework to explicitly display the gap of policy implementation and performance. The lower half of the framework is to explore program theory by the Theory of Change and Realist Evaluation method. The purpose is to identify the causal links between policy implementation and policy performance, and to answer the question of "how" and "why". Theory of Change analysis bridges the integrated analytical framework and the intervention logic model that highlights the quantitative and qualitative links between interventions and outcomes. Further on, Realist Evaluation imports the links with special attention paid on underlying contexts and mechanisms. The causality analysis findings are summarized in the form of CMO (context-mechanism-outcome) configurations, based on which the implications for future policy making are derived.

The methodology framework combines multiple methods. Each is with a specific evaluation purpose. However, the methods and evaluation packages are not segregated. Rather, they are integrated. There is the horizontal integration of policy implementation and performance evaluation through the integrated analytical framework, as well as the vertical integration of Theory of Change and Realist Evaluation on the analysis of causality. Therefore, the methodology framework is the systematic integration of research methods and designed specifically for the purpose of the ex-post evaluation on urban pricing policy. It can address the research problems and fulfill the research purposes.

In this chapter, the integrated analytical framework is introduced at first, followed by the framework for causality analysis.

3.1 Integrated analytical framework

The research utilizes an integrated analytical framework to achieve the objective of ex-post evaluation on urban public transport pricing policy. The proposed analytical framework adopts the existing evaluation methods (as reviewed previously) and integrated them in a functional way to serve for the evaluation objective.

This map illustrates the main process of the construction of the integrated analytical framework.

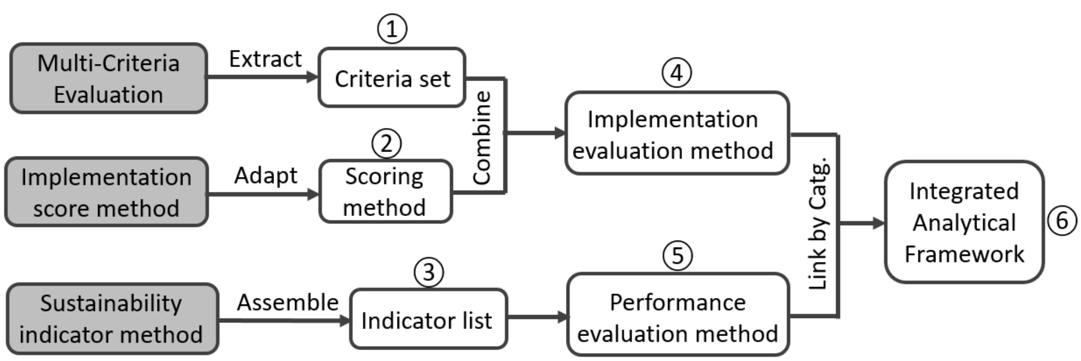


Figure 3.2 Constructuion of integrated analytical framework

From left to right, the map shows how evaluation methods and evaluation processes are organized. The basic methods (in grey color) for the integrated analytical framework are well-established methods imported from existing literature. Both Multi-Criteria Evaluation method and performance indicator method are widely used in the evaluation of transport policy, not only in academia but also in practice, as discussed in previous review section.

Implementation score method proposed by Pinter (Pintér & Swanson, 2004) locates in the middle of them. The method is to assessing policy implementation and discussed it in detail in the following part of this chapter.

There are 6 steps of analytical process (in white color): criteria set, scoring method, indicator list, implementation evaluation method, performance evaluation method, and integration, as marked in the map. The analytical processes are connected with evaluation methods through “actions” of extract, adapt, and assemble, and organized together as an integrated framework.

The existing evaluation methods are customized to fit the research background and improved to serve the research objective. The concept of MCE method that deconstructing complicated policies from multiple criteria perspective is borrowed. Criteria for pricing policy evaluation are extracted and selected from previous research. The criteria are scored by the adapted scoring method based on level of implementation. The implementation score can reflect the importance of criteria considered in actual policy. Combining criteria set and corresponding scores, the evaluation of policy implementation is carried out. As for the policy performance evaluation, sustainability indicator method is used. Indicators suitable for pricing policies are assembled from literature. The result of policy implementation and performance are linked through the categorization of criteria and indicators, then visualized to reveal the gap between them and complete the ex-post evaluation. All these processed together constitute the integrated analytical framework. In the following, the objective, input, process, and output of each analytical process are discussed in detail.

3.1.1 Criteria set

The objective of step 1 is to create the criteria set for the evaluation of pricing policy implementation. Figure 3.3 indicates the brief data input, the corresponding process, and output of the step.

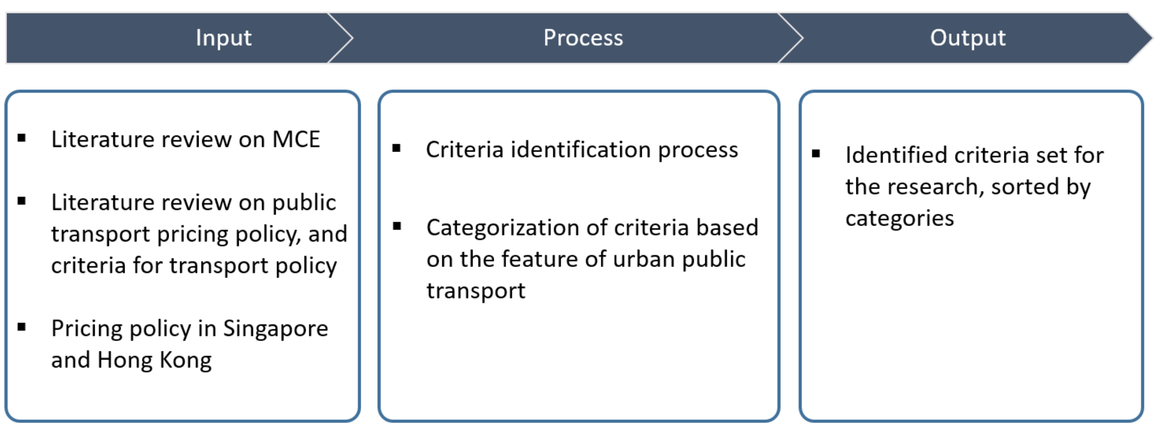


Figure 3.3 Step 1: Criteria set

In Chapter 2, literature on MCE method is reviewed, with detailed examples of criteria adopted in the evaluation of transport policy. Meanwhile, general criteria selection principles are discussed, which are the Systemic principle, Consistency principle, Independence principle, and Measurability principle.

The criteria set is identified based on the logic flow (Figure 3.4). First, a long list of criteria is assembled from literature on transport policy evaluation. This research has a narrow scope on public transport pricing policy, and the objective is to identify pricing problems from ex-post evaluation on existing policies. Pricing policy in Singapore and Hong Kong is briefly reviewed in 1.3, and the problems are related to fare affordability, subsidy, finance, and so on. With the gravity on these key words, the list is shortened. For instance, institutional capacity criteria that adopted by Liu (Liu, 2015) and Rahman & Hoong (Rahman & Hoong, 2011) in transport policy evaluation, is excluded from this research, due to the research scope and objective.

The abovementioned criteria selection principles are employed to further condense the criteria set. Technology and innovation has always been an important criterion in pricing policy making. However, due to the Measurability principle, the criteria is removed from the set. Dynamic modification refers to the adjustment of criteria set during the research period. Some criteria that considered to fulfill the principles, may found to be unavailable later; new suitable criteria may also be added when necessary. This dynamic update guarantees the appropriateness of the criteria set. After the criteria set is determined, scores are assigned based on the policy implementation information, which is the task of step 2.

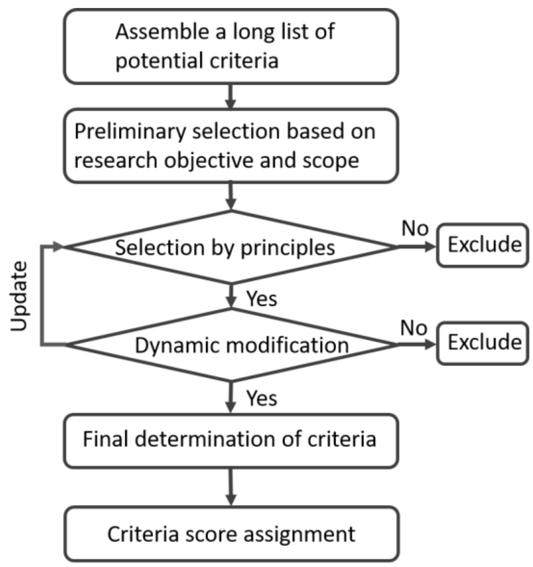


Figure 3.4 Logic flow for criteria identification

The identified criteria set is shown in Figure 3.5. There are totally 11 criteria, categorized into four conventional categories. For simplicity, labels are attached to categories and criteria under each category. The color used for different categories is consistent through the thesis.

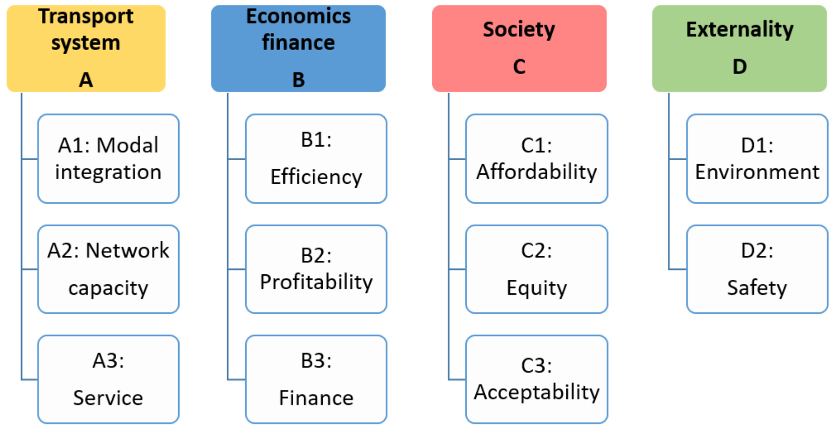


Figure 3.5 Identified criteria set

Transport system category

A1 Modal integration

Modal integration is the integration of some or all of the different public transport modes into the public transport system in such a way that these modes support and complement each other and that they operate as a coordinated public transport system, while providing an effective, efficient and affordable service to the user[6].

A2 Network capacity

Public transport network capacity is defined as the maximum number of passengers the network, including various modes, could carry. It reflects the network's ability to meet the ridership demand.

A3 Service

Public transport service is a broad concept that refers to the entire range of transport services provided by public transport operators that are available to the public. A high-quality service should be responsive to transport demand, available and accessible, as well as reliable.

Economics and finance category

B1 Efficiency

Efficiency means the benefits of public transport system, after taking account of the costs of provision and operation of the system. Efficiency can be evaluated by cost-benefit analysis that incorporates travel demand and cost analyses (Lakshmanan, Nijkamp, Rietveld, & Verhoef, 2005). Travel demand is

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[6] https://repository.up.ac.za/bitstream/handle/2263/8297/64%20van%20Zyl.pdf?sequence=1

based on multi-dimensional settings such as residential and job locations, vehicle ownership, and users' response to prices and service characteristics.

B2 Profitability

Profitability is the profits gained by operators, or the rate of return of public transport investments.

B3 Finance

Finance is the funding of the public transport industry. It concerns the fund sources to support the development of public transport system, as well as the revenue generated from the system.

Society category

C1 Affordability

Affordability is defined as the monthly household expenditure of the household on public transport divided by monthly household income of that household group. It is measured as a ratio of expenditure.

C2 Equity

Equity in public transport refers to the distribution of benefits and burdens from public transport system equally across all income levels and communities. It implies that socially equitable public transport is concerned with fairness in the distribution of transport investments, internal and external costs, and benefits.

Theoretically, three types of equity are identified: horizontal equity, which focuses on fairness between those of comparable wealth and ability, vertical equity with regard to income and social class, which looks at distributions between social and economic groups, and vertical equity with regard to mobility need and ability, which assesses "how well an individual's transportation needs are met compared with other in their community" (Farber, Bartholomew, Li, Páez, & Nurul Habib, 2014).

Equity can be examined from a variety of perspectives. Studies have also shown that implementation schemes for road policy should incorporate regional and generational equity considerations (National Surface Transportation Infrastructure Financing Commission, 2009). "Generational Accounting" suggests that it is essential to consider the relationship between benefits and burdens among generations and proposed methods on generational equity assessment (Auerbach, Gokhale, & Kotlikoff, 1992). Spatial price equilibriums (Paul A. Samuelson, 1952) also provide a method for detailed, quantitative assessments of regional equity effects on road tolls.

C3 Acceptability

Public acceptance is important in pricing policy making. Policy instruments would be more feasible if social acceptability is investigated (Giuliano, 1992). It refers to the broad agreement among stakeholders, and the percentage of respondents who are satisfied with specific aspects of public transport service.

Externality category

D1 Environment

The environmental factors of concern to transport include emission of pollution, vibration, visual intrusion, and consumption of land and fuel. The environmental consideration involves reducing the impact of transport facilities on the environment of both users and non-users of public transport.

D2 Safety

It stands for the number of all types of public traffic accidents, usually expressed through total traffic fatality and injury.

The criteria set creates a multi-dimensional examination space for pricing policies. As the output of step 1, the criteria are assigned scores based on the scoring method introduced in next section, for the purpose of policy implementation evaluation.

3.1.2 Scoring method

The objective of step 2 is to create the scoring method for the evaluation of pricing policy implementation. Figure 3.6 indicates the brief data input, the corresponding process, and output of the step.

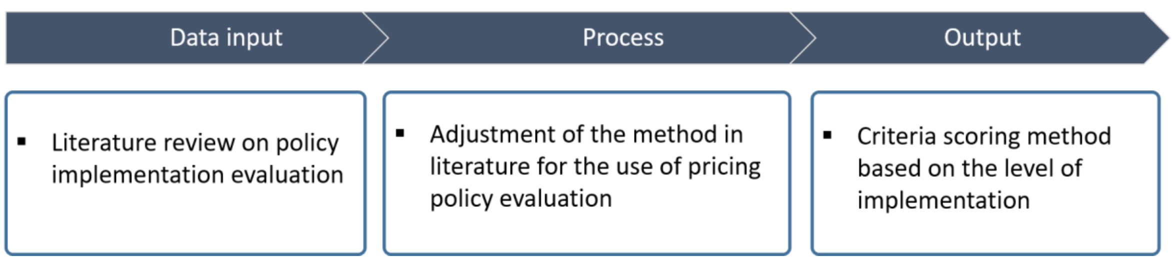


Figure 3.6 Step 2: Scoring method

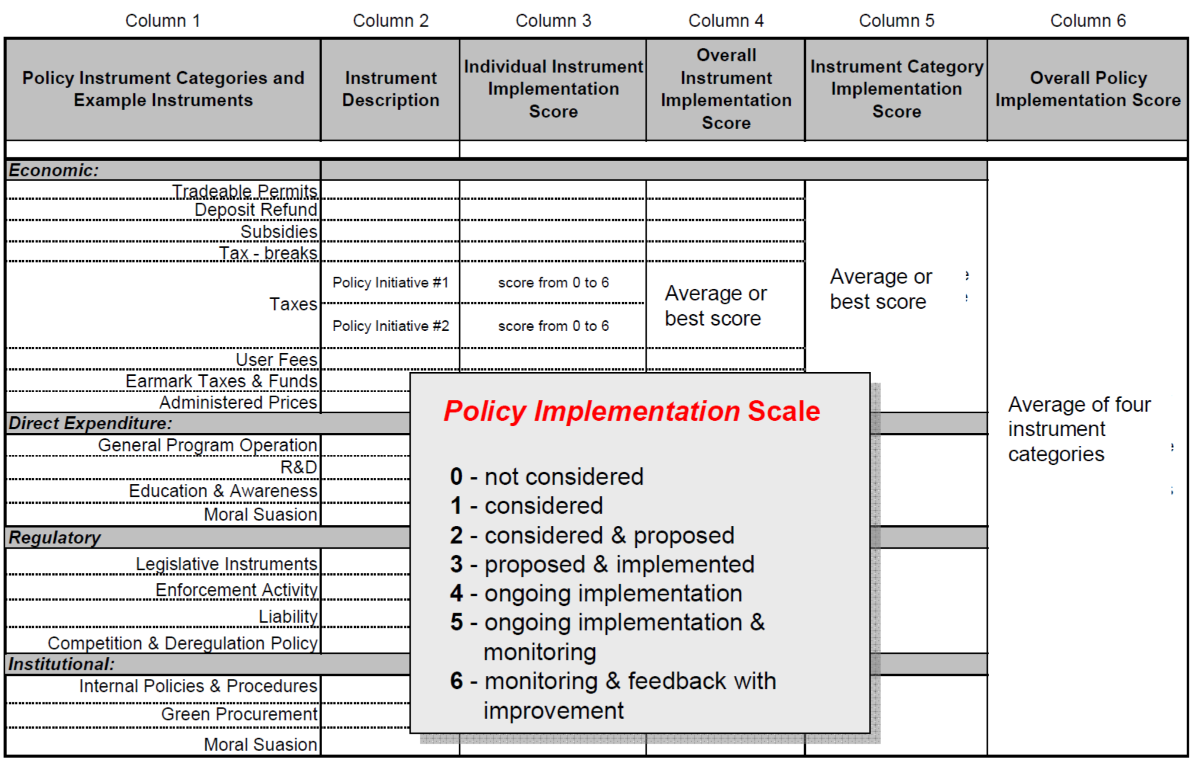
As the ex-post evaluation on urban public transport pricing policy, the actual policy objective and associated outcomes of existing policies are important. The question that “under what background, what has been done, and what has been achieved”, needs to be addressed by the evaluation.

However, transport policies are complicated. Sometimes the policy objective is very vague, as discussed in 2.2.2. Even for policy with a clear objective, due to the constraints of practical factors, the actual implementation of the policy may not completely follow the policy objective. Purely rely on the pre-claimed goals is not sufficient enough for supporting the ex-post evaluation, which focuses on the real actions and effects. There is a serious lack and challenge of identifying the real policy implementation, namely “what has been done”.

MCE method is employed for policy implementation evaluation. MCE method usually includes four main stages: criteria selection, criteria weighting, evaluation, and final aggregation (Wang et al., 2009). In step 1, the criteria set for pricing policy evaluation has been selected. Equal weighting is adopted, based on the finding from literature review. In the following stage of evaluation, criteria should be scored, to reflect the actual “level of implementation”.

In a training module prepared for the World Bank Institute, Pinter (Pintér & Swanson, 2004) proposed a method for assessment of policy implementation. The background and objective of the assessment is like this. A program named Energy Sustainability Gauge Program[7] is launched, under the support of Canadian International Development Agency, to promote efficiency and environment protection. A mix of policy instruments is contained in the program. The assessment method is proposed to identify the extent to which a mix of policy instruments is being implemented by governments to address sustainability issues.

The assessing table is shown below (Figure 3.7).



Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Policy Instrument Categories and Example Instruments	**Instrument Description**	**Individual Instrument Implementation Score**	**Overall Instrument Implementation Score**	**Instrument Category Implementation Score**	**Overall Policy Implementation Score**
Economic:					
Tradeable Permits					
Deposit Refund					
Subsidies					
Tax - breaks					
Taxes	Policy Initiative #1	score from 0 to 6	Average or best score	Average or best score	
	Policy Initiative #2	score from 0 to 6			
User Fees					
Earmark Taxes & Funds					
Administered Prices					Average of four instrument categories
Direct Expenditure:					
General Program Operation					
R&D					
Education & Awareness					
Moral Suasion					
Regulatory					
Legislative Instruments					
Enforcement Activity					
Liability					
Competition & Deregulation Policy					
Institutional:					
Internal Policies & Procedures					
Green Procurement					
Moral Suasion					

Policy Implementation Scale

- **0** - not considered
- **1** - considered
- **2** - considered & proposed
- **3** - proposed & implemented
- **4** - ongoing implementation
- **5** - ongoing implementation & monitoring
- **6** - monitoring & feedback with improvement

Source: (Pintér & Swanson, 2004)

Figure 3.7 Method for assessing policy implementation

The table simply provides an overall scoring to reflect the level of implementation of a mix of policies directed at an issue. It does not assess the effectiveness of policies but the extent to which a mix of policy instruments is being implemented.

The policy instruments are falling in four broad categories: economic, regulatory, expenditure, and institutional instruments. A range of specific policy instrument is listed under each category. Implementation score of each individual instrument is main body of the assessment. The implementation scale is shown in superimposed box, which ranges from 0 to 6, with 0 indicating that this instrument was not considered and 6 indicating that the instrument has been not only implemented

[7] http://www.iisd.org

but also monitored and improved based on this monitoring. The scoring is followed by aggregation operation.

Having described the assessment method from literature in a detailed way, it is time to adapt the method for pricing policy implementation evaluation. Two major difference are there between the assessment example and this research:

Evaluation type

The assessment type in the literature is the implementation monitoring. The program is still in progress and more careful distinguish of implementation level (6 scale) is needed. This research is the ex-post evaluation of existing schemes. Therefore, it is sure that the scheme is already implemented.

Evaluation object and unit

For the example from literature, the assessment object is a program with mix instruments and the assessment unit is each individual instrument. By one-time assessment through one single table (Figure 3.7), which covers all the instruments in the program, the whole assessment is done. Comparing to this, the evaluation object in this research is pricing scheme. The evaluation is repeated for each individual and within an evaluation, it unfolds following the criteria set. Score is given to each criteria – the smallest unit of the evolution, rather than each policy instrument (of a program).

Based on this understanding, the implementation scale for each criteria is adapted, which ranges from 0 to 4 (Figure 3.8), with 0 indicating that this criteria was not considered and 4 indicating that the criteria are not only implemented but also monitored and reviewed. A higher score means a deeper level of implementation.

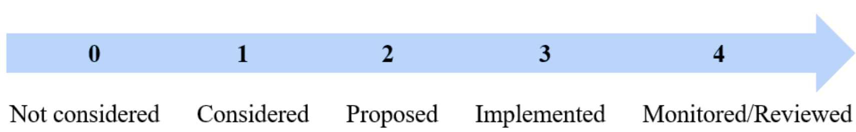


Figure 3.8 Scoring method based on level of implementation

The scoring is based on publicly and readily accessible information sources such as policy documents, press releases, and internet information. This makes analysis cost effective and transparent. Step 1 and 2 together create the general basis for MCE evaluation on policy implementation. Detailed evaluation needs to be associated with each pricing scheme, which is available in the following case study section.

Turning from policy implementation evaluation, the general basis for policy performance evaluation – the performance indicators, are discussed in next process.

3.1.3 Indicator list

The objective of step 3 is to select a list of indicators for the evaluation of pricing policy performance. Figure 3.9 indicates the brief data input, the corresponding process, and output of the step.

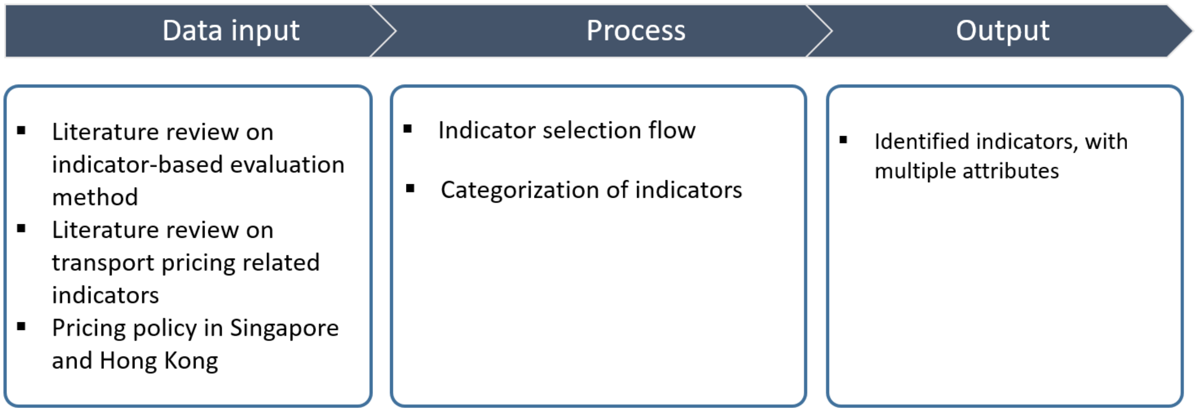


Figure 3.9 Step 3: Indicator list

Similar with step 1 of criteria identification, the indicators are identified based on the logic flow (Figure 3.10). First, a long list of indicator is assembled from literature on transport policy evaluation. Concentrated on public transport pricing policy, pricing related indicators are high valued, such as the indicator of average public transport fare, and its affordability to public.

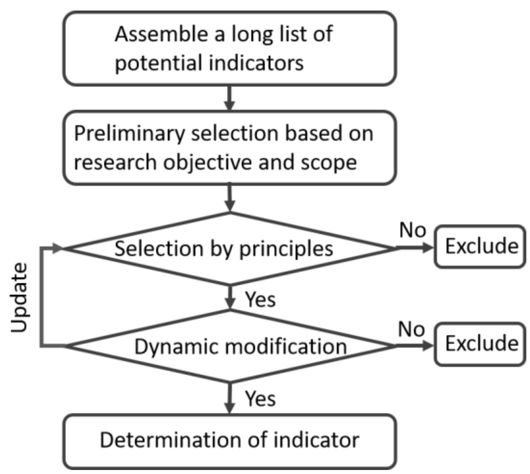


Figure 3.10 Logic flow for indicator selection

As mentioned earlier in 2.2.2, recent indicator-based evaluation on transport policy has seen an increasing trend of sustainability indicators application. However, the ambiguous definition of sustainability creates a problem in assembling the indicator list. For example, some scholars proposed sustainability indicators following the SDGs framework, with indicators divided into 6 aspects of safe, affordable, accessible, efficient, resilient, as well as environmental (Figure 2.4). As the solution, indicators that belong to different sustainability aspects are channeled into the 4 conventional categories, as shown in Figure 3.11.

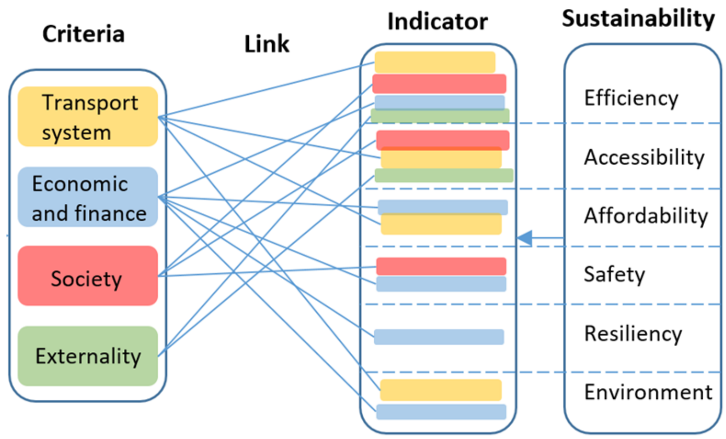


Figure 3.11 Link between sustainability indicators and criteria category

Sustainability indicators adopted in previous research may follow a different categorization system. In a "local" sustainability aspect, there are a group of indicators that if examined from the 4 conventional categories' perspective, maybe grouped differently. This is illustrated by the colors. However, based on the nature of indicators and the evaluation objective, it is possible to tell them apart and categorize into the conventional categories. The rationale for the transformation is based on the belief that a pricing scheme requires that policy makers take account of the full range of considerations towards sustainable development. In this way, the link between sustainability aspects and categories are created, which enlarges the scope of indicator assembling as well.

The general indicator selection principles that indicators need to be Comprehensive, Accountable, Comparable, Accessible, and Available (Litman & Burwell, 2006) are employed to further condense the indicator list. Indicators with a limited coverage in terms of data availability (breaking of Availability principle) have been excluded from the list. Indicators that lack empirical correlation with implementation criteria have been treated as explanatory evaluation (Accountability principle).

The indicator list is adjusted dynamically during the research period. Some indicator that considered to fulfill the principles, may found to be unavailable later; new suitable indicator may also be added when necessary. The heterogeneity of urban characteristics and priorities will certainly imply differences in indicator selection that would enrich a city-specific analysis, but invalidate a cross-city comparison. The consistency between the indicators is important for this type of analysis and makes it possible to compare policy performances. This dynamic update guarantees the appropriateness of the indicators in tracking pricing policy performance.

As a result of the selection flow, indicator list is determined as follows (Table 3.1).

Table 3.1 List of indicators

Label	Indicator	Category	Type	Sign
ID1	public transport fare	Transport system	output	-
ID2	public transport ridership	Transport system	outcome	+
ID3	network capacity	Transport system	output	+
ID4	service reliability	Transport system	outcome	+
ID5	operator profitability	Economics	outcome	+

ID6	government expenditure	Economics	output	-
ID7	operator expenditure	Economics	output	-
ID8	affordability	Society	outcome	+
ID9	revenue distribution	Society	outcome	+
ID10	subsidy distribution	Society	outcome	+
ID11	public satisfactory	Society	outcome	+
ID12	emission	Externality	impact	-
ID13	number of fatalities	Externality	impact	-
ID14	number of injuries	Externality	impact	-

For each indicator, the related category are shown in the right column of Table 3.1. Comparing the indicator list with criteria set, it can be seen a roughly corresponding relationship (see Figure 3.5). this relationship is important in creating the basis of linkage between criteria-based policy implementation evaluation and indicator-based policy performance evaluation.

As mentioned earlier in 2.2.2, the indicator-based evaluation is challenged by the co-existence of pricing schemes and their impacts. An indicator should measure an outcome that can be reasonably expected to be affected by that policy. As most policy objectives are complex and often only partially quantifiable, it is normal that there are discrepancies between the outcomes of policy objectives and the outcomes measured by indicators. However, if the differences become too large, there is a risk that an indicator measures an outcome that is not responsive to the policy in question. Such an indicator would be ineffectual for monitoring and should therefore be discarded (Schumann, 2016).

The importance of policy objectives is different. Among pricing policies, there are parallel relations that one is as important as another, and vertical relations that one contributes to another at a higher level. For example, subsidy policy reduces the fare expense directly. It is at the same level with fare adjustment policy, in terms of realizing affordable fare. An affordable fare and higher service standards that addressed by service enhancement policy may promote the public transport system. Therefore, subsidy policy at a lower level (with parallel relation with fare policy) contributes to affordable fare, which together with service policy, contribute to public transport system at a higher level.

It is important to understand the hierarchy of pricing policy objective, as shown below (Table 3.2). Indicators need to be well-aligned with policy objectives. Being aware of the hierarchical order of policies can facilitate the development of appropriate indicators.

Table 3.2 Hierarchy of pricing policy objective

Type of indicator	Low hierarchy	Mid-hierarchy	High hierarchy
Output	Transport system indicators		
Outcome		Economics and Society indicators	

Impact	Externality indicators

Generally speaking, indicators for transport system category are the direct output indicator at a lower level; indicators for economics and society are the outcomes that sit in the middle of the hierarchy; indicators for the externalities are the impact indicator, with a higher level. The hierarchy of different case (the case of Singapore and Hong Kong in this research) are identical, making the comparison between cases justifiable. Indicator type is shown in Table 3.1.

The last column of “Sign” in the indicator list table denotes the positive and negative attribute of an indicator. Indicators can be split into “+” and “-” accordingly. A positive direction means the higher the score of an indicator is, the more the benefits to public transport system.

3.1.4 Implementation evaluation method

The implementation evaluation method is built based on step 1 and 2. The objective of the step is to produce the scheme sheet and criteria aggregation sheet for individual pricing scheme respectively, for the use of the last step – integration of the analytical framework. The brief input, the corresponding process, and output of the step is described in Figure 3.12.

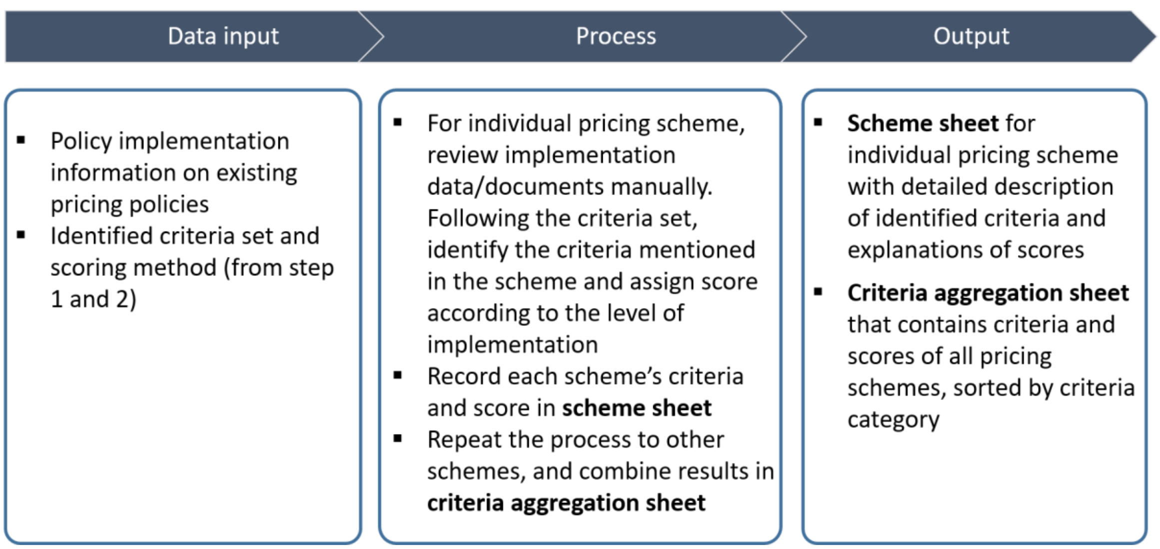


Figure 3.12 Step 4: Implementation evaluation method

Scheme implementation information will be collected from diverse sources, including papers, reports, recorded documents, Statistics Department website, Transport Department website, and so on. The investigation is on the case basis. The details will be presented in the case study chapter.

The scheme sheet of implementation is organized with 4 columns, namely criteria, score, description of how the criteria and score are identified, as well as the relevant data source. Below is the sample.

Table 3.3 Sample of scheme sheet - implementation

Scheme sheet - Implementation

Criteria	Score	Description	Source
(e.g. affordability, from step 1, criteria set)	(0~4, based on step 2)	(detailed explanation of criteria identification and scoring)	(Data and information source)

The description column is important. Evaluation that based solely on indicator scores can be misleading and it is important to ensure that valuable information is not lost in the process. Qualitative description is often combined with quantitative score to provide a detailed information that are not easily quantifiable, and to provide contextual detail to numerical findings.

The criteria aggregation sheet aggregates all the implementation information of each scheme sheet. The sample is presented in Table 3.4.

Table 3.4 Sample of criteria aggregation sheet

Criteria aggregation sheet

Category	Criteria	Score	Scheme
transport system	modal integration network capacity service	(import criteria and score from individual scheme sheet of implementation. One criteria may be identified in multiple schemes, taking more than 1 row of criteria aggregation sheet)	(specify the scheme that contributes the score)
economics	efficiency profitability finance		
society	affordability equity acceptability		
externality	environment safety		

In making up the criteria aggregation sheet from scheme sheets, the criteria with the score of “0” in the scheme sheets are not imported to the criteria aggregation sheet. This is because of the normalization method adopted in the final step. Clarification is made in 3.1.6.

3.1.5 Performance evaluation method

In step 3, we have selected a list of indicators. Based on the indicators, this part will discuss how to conduct pricing policy performance evaluation. The brief input, the corresponding process, and output of the step is described in Figure 3.13.

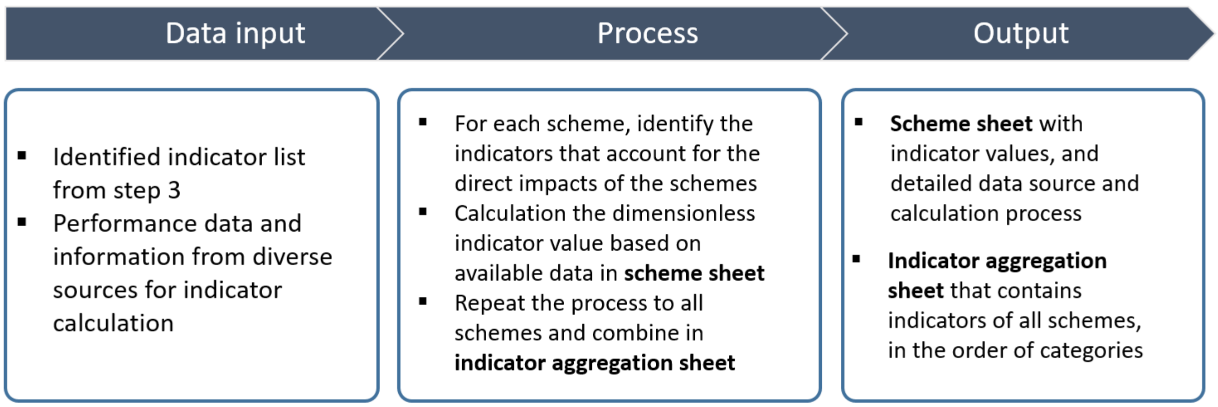


Figure 3.13 Step 5: Performance evaluation method

The scheme sheet of performance is organized with 4 columns, namely the indicator, normalization score, description of the indicator, as well as the relevant data source. Below is the sample.

Table 3.5 Sample of scheme sheet - performance

Scheme sheet - performance

Indicator	Normalization score	Description	Source
(as listed in Table 3.1)	(detailed normalization score is explained below)	(detailed explanation of indicator and score)	(Data and information source)

The calculation of indicator normalization score utilizes a mixed empirical and normalization approach. The normalization procedure for transforming the raw data into indicator value is indicator-specific, which takes into consideration of the availability of data, indicator attributes, as well as the hierarchy of policy objective.

Basically, for output indicator, the before-after comparison method is taken. For the outcome indicators, the indicator value is calculated based on the accumulated improvement since the commence of the policy. In any case, for the same indicator, the normalization method is consistent for different cases study, for the sake of further comparison.

A single pricing scheme produces one scheme sheet on performance. Duplicate this indicator-based performance evaluation on various pricing schemes, we have multiple performance sheets. Further on, the indicator aggregation sheet aggregates all the performance information of each scheme sheet (thus with the information of which scheme contributes the indicator). It reports the values used for each indicator of various categories and attributes. The sample is presented in Table 3.6.

Table 3.6 Sample of indicator aggregation sheet

Indicator	Normalization score	Scheme	Category
public transport fare			Transport system
public transport ridership			Transport system
network capacity			Transport system
service reliability			Transport system
operator profitability			Economics
government expenditure			Economics
operator expenditure	(see case study)	(see case study)	Economics
affordability			Society
revenue distribution			Society
subsidy distribution			Society
public satisfactory			Society
emission			Externality
number of fatalities			Externality
number of injuries			Externality

It is worth noting that the indicator list may be expanded when various pricing schemes are investigated. One indicator may be repeatedly employed by multiple schemes. For example, affordability may be used in both evaluations on fare adjustment scheme and the subsidy scheme. Meanwhile, there may be sub-indicator in the detailed evaluation. For instance, network capacity may be sub-divided into bus network capacity and rail network capacity. Therefore, in the case study, the total number of indicators will be more. Detailed indicator aggregation is available from cases study.

After step 5, indicators and their scores for individual scheme are ready, which will be integrated in step 6 for the evaluation of the policy package.

3.1.6 Aggregation and integration

It is very useful for summarizing complex and multidimensional data into integrated value, in order to provide a comprehensive evaluation, and to communicate with policymakers and the general public.

The criteria aggregation sheet (of step 4) and indicator aggregation sheet (of step 5) have been loaded with policy implementation and performance information respectively. In step 6, the multi-level aggregation approach is taken, to go beyond single scheme to the whole policy package. Criteria-based policy implementation evaluation and indicator-based performance evaluation, as well as associated criteria and indicator scores are integrated into dimensionless synthetic value, and then visualized as the final output of the analytical framework. The integration process is shown in Figure 3.14.

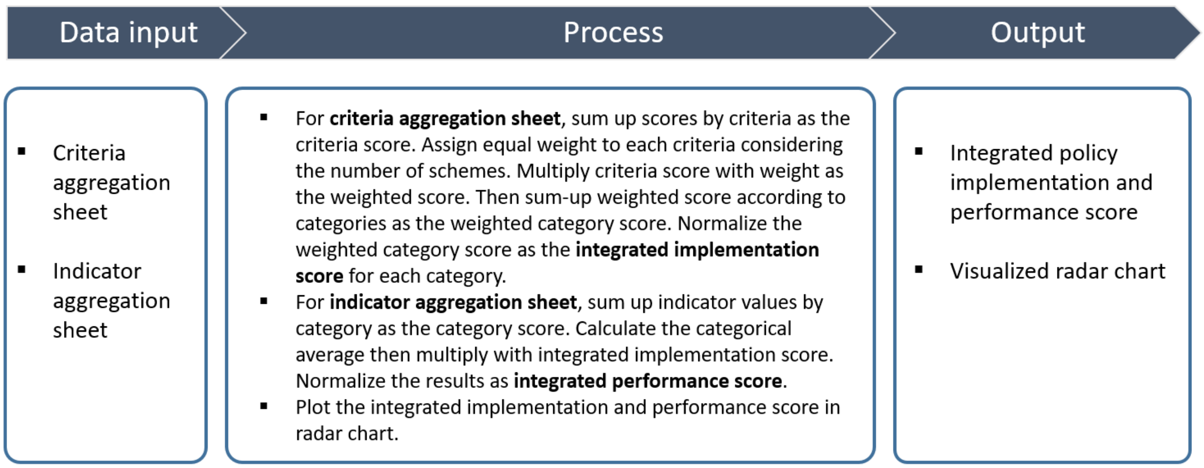


Figure 3.14 Step 6: Aggregation and integration

To make the process clearer, a sample of sheet for integrated implementation score is provided (Table 3.7). Column titles from left to right indicate the integration process. From criteria aggregation sheet, category, criteria, and score can be imported. Sum up scores by criteria, the criteria score is calculated. Carry that forward (to next right column) and assign equal weight to each criteria considering the number of schemes, and multiply criteria score with weight as the weighted score. Then sum-up weighted score according to categories as the weighted category score. Finally, normalizing the weighted category score to make the total sum of them at 4, the result is the integrated implementation score.

Table 3.7 Sample of sheet for integrated implementation score

Category	Criteria	Score	criteria score	weight	weighted score	weighted category score	integrated implementation score

As for the integration of policy performance score, as illustrated in Table 3.8, the first 3 columns are imported from indicator aggregation sheet. In the fourth column, indicator values are sum up by category as the category score. Divide the category score by the number of indicators in that category, the categorical average is put in the fifth column. Integrated implementation score in the sixth column is imported from previous sheet. Multiply that with categorical average, then normalize the results under the principle of "total sum equals 4", the integrated performance score is derived in the last column.

Table 3.8 Sample of sheet for integrated performance score

Category	Indicator	Indicator value	Category score	Categorical average	Integrated implementation score	Integrated performance score

Overall, the integration process is based on the criteria and indicator aggregation sheet, which are the output of step 4 and 5 respectively. The integrated score of implementation and performance is the final output of the framework. In the cases study, this analytical process is strictly followed.

One thing deserves an explanation before closing the analytical process. In this research, if a pricing scheme has a score of "0" for one (or some) specific criteria, the "0" score is not recorded in the criteria aggregation sheet. This is different from the general Multi-Criteria Evaluation method. The objective of general MCE Method is to compare and choose from the alternatives, while the objective of the implementation score that sorted in terms of criteria in this research is to reflect the intension of the pricing package as a whole, rather than an individual scheme in the package. It is common that within a package, different schemes have different "tasks", and sometimes a scheme is designed to address a specific issue in the public transport domain. For example, concession and subsidy schemes are specifically designed for the affordability problem. If such a scheme is contained in a package, the rest schemes may no longer need to work on this issue, and they may have "0" score for the criteria of affordability. Considering equal weights are assigned on the criteria basis, the more schemes registered under a certain criterion, the smaller the distributed weights for each scheme would become. Namely, the criteria weighted score and the final integrated implementation score is affected by the number of schemes registered under that criteria. Therefore, the registration of "0" scores would dilute the intense of implementation level, which is not the fact, since that problem has already been specifically treated.

After integration, visualization is carried out in the form of radar chart. A diamond-shaped radar chart is capable in reflecting the 4 categories, as well as the corresponding integrated scores. The difference of diamond shapes conveys the relative attribute of dimensions. Using the visual tool, the gap between policy implementation and performance can be revealed vividly, making the analytical results easier interpreted by policy makers and public.

3.2 Causality analysis framework

Through the integrated analytical framework, the policy implementation and performance are evaluated based on criteria scores and performance indicators. In nature, criteria score and performance indicators are the quantitative evidences of "what" interventions are implemented and "what" performances have been achieved. Utilizing these quantitative evidences as well as potential qualitative evidences, the causality analysis is to address "how" and "why" the interventions achieved changes under specific contexts and conditions, and further on to seek to generate implications for future policy making. The integrated analytical framework and causality analysis together composed the ex-post comprehensive evaluation of urban public transport pricing policy.

A key consideration in choosing the appropriate causality analysis method, is the number of cases analyzed. There are 2 types of causality analysis in terms of this, namely the Large-Number case study and the Small-Number case study, as shown in Table 3.9. In conducting the causality analysis, Large-N case study utilizes the statistical analysis, such as the regression analysis. It needs large amount of cases and data to feed in the analysis. The experimental and quasi-experimental causality analysis requires the clearly defined control and treatment groups, with controllable intervention applied to check the corresponding impacts. Ideally, Large-N, as indicated by the name, will be numerically large so that statistically robust and significant evaluation methods can be used. The experimental and quasi-experimental analysis also requires the ideal environment to carry out. However, these methods are not applicable to ex-post urban public transport policy evaluation, due to practical constraints.

Table 3.9 Literature review on causality analysis

Research type	Method for causality analysis	Note	
Large-N (many cases)	Statistical analysis e.g. Regression analysis	Need large amount of cases and data; Focus on variables, often ignore contexts (Stake, 2006)	
	Experimental/ quasi-experimental e.g. Control/treatment group	Not feasible for urban pricing policy	
Small-N (one/few cases)	Theory-based approach: Theory of Change Realist Evaluation	Requirement: In-depth study into cases Resource-intensive Systematic approach (Goodrick, 2014)	Process: Pattern matching Process tracing Causal narrative (Mahoney, 2000)

The limited number of cases create the challenges for causality analysis. As a consequence, statistically resilient and rigorous methods are difficult to progress. In order to address causality analysis for Small-N case study, theory-based approaches are utilized with greater emphasis on qualitative considerations.

Large-N case study based on statistical analysis is focused on particular variable and often ignore the specific contexts of each case (Stake, 2006). However, homogeneity is intrinsically difficult for pricing policies to achieve, essentially because they implemented across different territories, each of which has their own different rules, regulations, cultures. The theory-based qualitative comparative analysis identifies different combinations of factors that are critical to a given result, in a given context.

As for the Small-N case study, in-depth study into cases is necessary. To support the in-depth analysis, intensive resources are needed and they need to be structured systematically by the systematic approach to reflect the underlying causality (Goodrick, 2014). When examined by the proposed analytical framework, the policy intention is numerically reflected by the scores of level of implementation in the multi-criteria space. The policy impact on the system is also multi-dimensionally checked by indicators. In other words, there are hundreds of credible links and connections, both causes and effects, available for the construction of the causality analysis.

Based on the result of integrated analytical framework, and with the help of qualitative data and evidence on potentially relevant causal factors, the following process needs to be followed to derive the causal links. They are pattern matching, process tracing, and causal narrative (Mahoney, 2000). Following the process, this research adopts a systematic theory-based approach to identify the causal links between policy implementation and policy performance. As reviewed in2.2.3, the Theory of Change provides the broad strategic understanding about implementation theory, while Realist Evaluation focuses on smaller but promising CMO configurations embedded in program theory. In this section, the causality analysis framework incorporating Theory of Change and Realistic Evaluation is briefly outlined, with the steps taken to conduct the analysis.

3.2.1 Theory of Change

The Theory of Change analysis adopts the form of intervention logic model. The intervention logic model is a structured way to arrange components of interventions and outcomes, and to show links of which factors at which levels are combined to produce the observed outcomes. A format is given below (Figure 3.15).

The intervention logic model requires the input of context, intervention, short-term output, medium-term outcome, and long-term impact, as indicated at top row. Context is defined as features of the conditions in which the intervention is introduced, implemented, and functioned. Intervention here is defined as a regulation or enforcement action consistent with transport schemes or policy packages. Output is the immediate effects of policy intervention, while outcome and impact are for medium- and long-term effects of policy intervention respectively. They can be directly or indirectly, intended or unintended, positive and negative. With the explicit definition of each component, the analysis would start by reviewing the policy implementation and performance information to recognize the input components that to be filled into the intervention logic model as building blocks, which affects the building form and the final analysis result.

The building blocks are linked. The links are from an intervention to its outputs and, subsequently, to its impacts on public transport system. The impacts are categorized into Transport system, Economics, Society, and Externality, which is consistent throughout the research. The 4 categories are noted on the right side of the diagram, with swim lanes drawn in the middle. There are quantitative and qualitative links as indicated by the solid and dotted arrows, depending on the qualitative and quantitative evidence. For quantitative links, a value label is attached. The values are the normalized indicator values calculated by the integrated analytical framework. The arrow with a red cross means the intervention caused an unintended outcome.

A link is to show how particular intervention leads to a particular output, and how a particular output leads to particular outcome. One intervention may have multiple impacts, and one impact may be contributed by multiple interventions. This is reflected by the number of links connected. The outcome hierarchy shows levels of intermediate results that lead to the final impacts. Therefore, the evaluation not only shows how the intervention might contribute to a range of positive impacts, but also identifies other contributing factors needed in order to achieve these. Multiple causal paths towards changes and impacts can be identified, which would allow a more complete explanation of how the intervention delivered the intended and unintended impacts.

The 3 pricing problems: the public transport fare and the tradeoff between fare affordability and operator profitability, the subsidy mechanism and its effectiveness, as well as the finance structure of public transport, are being paid attention. During the evaluation, components that highly related to the pre-defined pricing problems are highlighted with orange frames. These orange framed components are “key factors” for pricing policy evaluation, which is the building blocks for later Realist Evaluation.

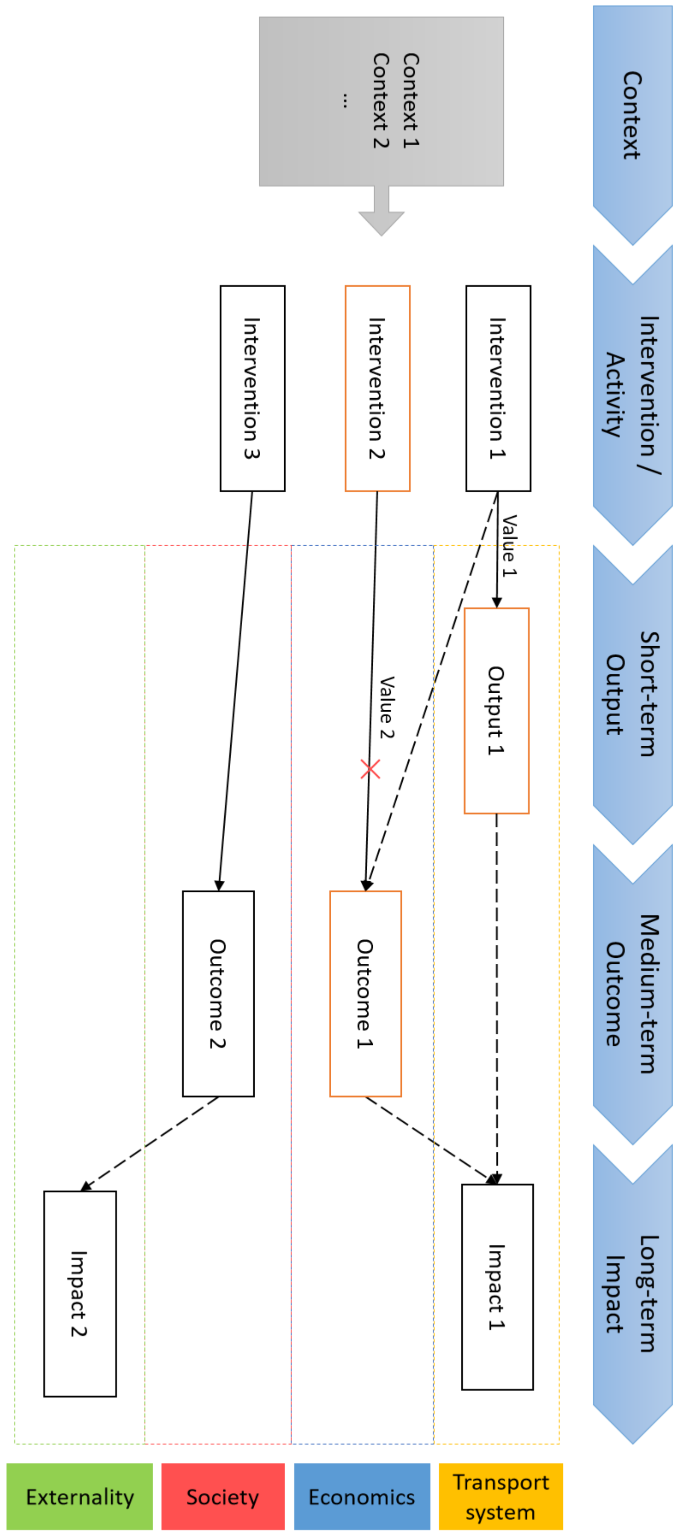


Figure 3.15 Theory of Change intervention logic model

Starting with the contexts, the intervention logic chains connect components involved. The logic chains are distinct in content, and clear in their sequential flow, thus accessible and understandable to evaluators and policy makers. Theory of Change analysis is important for ex-post evaluations. It moves the ex-post evaluation on particular cases from being a descriptive tool to an explanatory statement of how, and why the component performed, delivered, and interfaced in achieving the policy objectives.

3.2.2 Realist Evaluation

Theory of Change analysis channels the quantitative evidence of integrated analytical framework into the intervention logic model that highlights the quantitative and qualitative links between interventions and outcomes. Further on, Realist Evaluation imports the links with special attention paid on underlying contexts and mechanisms, and tries to extract the CMO (context-mechanism-outcome) configurations as the completion of causality analysis.

Realist Evaluation is to understand why an intervention in a particular context makes changes. Compare to the intervention logic of Theory of Change analysis, Realist Evaluation, in essence, focuses on investigating the spaces between the interventions and outcomes, which is filled with mechanisms, as illustrated in Realist Evaluation format (Figure 3.16).

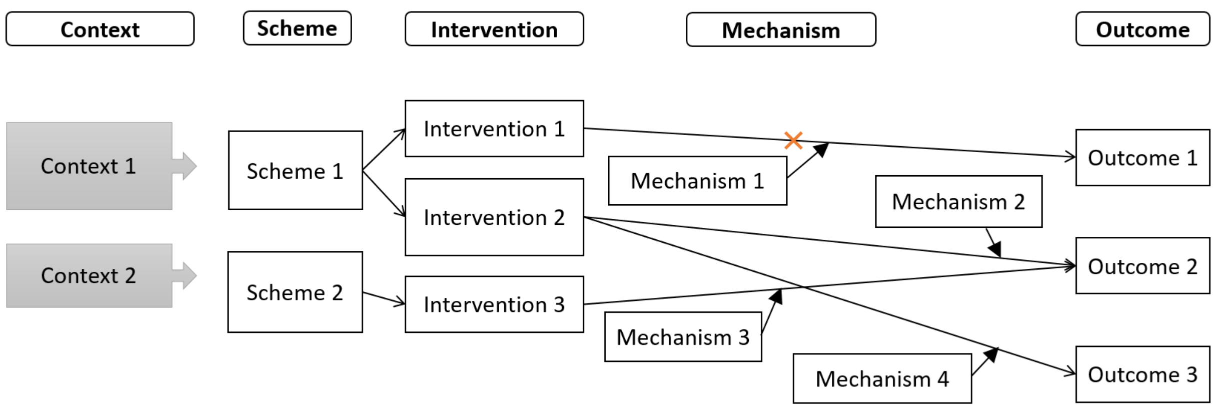


Figure 3.16 Realist Evaluation format

In the diagram, the blocks of context, scheme, intervention, and outcome are imported from the Theory of Change analysis on individual pricing schemes. Only "key factors" in orange frames that highly relevant with the pricing problems are imported. Links between key factors are imported at the same time, including the red cross indicating the unintended outcomes. It is worth noting that the Realist Evaluation is carried out at the policy package level. The Theory of Change analysis on individual pricing schemes are combined and compressed (according to key factors) in Realist Evaluation.

In between the interventions and outcomes are mechanisms. Mechanism is a logical description of how an intervention creates certain outcome under specific context. They are simple in logic, and evident in reasoning. For each link, there is a corresponding mechanism denoted.

Realist Evaluation considers context as part of the mechanism. The context of the intervention is a key factor determining outcomes and impacts. By taking into consideration the importance of context, the evaluation is able to uncovering the circumstances in which, and the reasons why, a particular intervention works. Following the generative causation process, the revealed sets of context-mechanism-outcome is tested and refined and eventually becomes independent of specific cases, and would therefore be universal and generalizable. This is the rationale and foundation for deriving implications based on Realist Evaluation results.

Table 3.10 CMO configuration of Realist Evaluation

Context	Mechanism	Outcome	Key factor

CMO configurations are the final output of Realist Evaluation. A sample is shown in Table 3.10. The last column records the key factor that related to that particular CMO.

As the summary of the causality analysis framework, the key steps are:

Table 3.11 Steps of causality analysis framework

Theory approach	Key step	Analysis level
Theory of Change	• Review ex-post evaluation on each scheme; • Identify input components and fill-in intervention logic model; • Link factors based on quantitative and qualitative evidence; • Highlight key factors and add quantitative labels (if applicable)	Individual scheme level
Realist Evaluation	• Import and compress key interventions, outcomes, and links from Theory of Change analysis; • Identify mechanism for each link (and mark on links); • Summarize CMOs as completion of causality analysis and support for implications	Policy package level

The input of causality analysis framework are the quantitative evidences from previous integrated analytical framework, as well as other qualitative evidences obtained from case study. Through the theory-based approach of Theory of Change and Realist Evaluation, the causality analysis is done with CMO configurations as the output. Based on the output, implications are derived. The added learning generated from the evaluation would be useful to imply policy intervention elsewhere.

3.3 Robustness of methodology framework

The methodology framework proposed has the following features to guarantee its robustness:

Saliency. Based on the literature review, the methodology framework has identified the important criteria and indicators for ex-post evaluation of existing pricing policy, considering the characteristics of urban public transport system, as well as the evaluation objective. Following the 6-step process of integrated analytical framework and the framework of causality analysis, the framework is able to translate the actual policy implementation and performance information into criteria and indicator score-based analytical results, to the causality, and finally into the knowledge for future policy making.

Credibility. The methodology framework is composed of MCE method and performance indicator-based evaluation method, Theory of Change, and Realist Evaluation. These are well-established methods in policy evaluation domain. Logic flow and principles are developed for the identification of criteria and indicators. Rigid analytical process is followed for Theory of Change and Realist Evaluation. All these methods and actions guarantee the robustness of the analysis.

Understandability. In order to communicate with government decision-makers and interested public, the research methodology should be easy to interpret and the output should be simple and intuitive to understand. The presenting form of the research findings, such as the radar chart in showing the gap between policy implementation and performance, and the causality map in expressing the interaction between interventions and outcomes, and simple, intuitive, yet direct in highlighting issues and spreading knowledge.

Functionality. The ex-post comprehensive evaluation methodology framework integrates multiple functional packages. Each is with a specific evaluation purpose to serve for the research objectives. There is the horizontal integration of policy implementation and performance evaluation through the integrated analytical framework, as well as the vertical integration of Theory of Change and Realist Evaluation on the analysis of causality. Therefore, the methodology framework is the systematic integration of research methods and designed specifically for the purpose of the ex-post evaluation on urban pricing policy. The input ports are clearly defined, and the whole or part of the framework is ready to be adjusted, customized, and applied in a broader context.

3.4 Chapter summary

This chapter built up an integrated methodology framework for ex-post comprehensive evaluation on urban pricing policy.

The policy implementation evaluation (based on Multi-Criteria Evaluation method) and policy performance evaluation (based on performance indicator method) are carried out to address the “what” question. They are integrated by the integrated analytical framework to explicitly display the gap of policy implementation and performance. Theory of Change and Realist Evaluation method are utilized for causality analysis. The purpose is to identify the causal links between policy implementation and policy performance, and to answer the question of “how” and “why”. The Theory of Change analysis is fed with quantitative information generated from the integrated analytical framework and highlights the quantitative and qualitative links between interventions and outcomes. Further on, Realist Evaluation imports the links from Theory of Change analysis with special attention paid on underlying contexts and mechanisms. The causality analysis findings are summarized in the form of CMO (context-mechanism-outcome) configurations, based on which the implications for future policy making are derived.

4 Public Transport Pricing Policy in Singapore

In this chapter, the existing public transport pricing schemes in Singapore are reviewed and analyzed by the proposed analytical framework. As listed in Table 1.2, the pricing schemes are: Distance-base Fare Scheme, New Capacity Factor Fare Adjustment Scheme, Workfare Transport Concession Scheme, Service Enhancement Program, and New Finance Scheme. The evaluation is following this order.

4.1 Distance-based Fare Scheme

Distance-based fare scheme is one type of the fare structures, which directly determines the differentiation of price by the distance travel with public transport. Fare is a powerful tool on transport demand management through its influence on price elasticities. Fare constitutes the majority of the cost of an individual's travel cost, especially for public transport users. It is out-of-pocket expenses and users are sensitive to fare changes, namely elastic to fare change.

Fare elasticity is an important consideration in the design of fare structures because it determines the change in demand that will occur as a result of a change in the fare level. If demand is price elastic, then it will change significantly as a result of a given change in fare, and vice versa. Factors that affect price elasticity include income levels, service quality, competition from other modes, age and sex, and journey purpose, among others (Farber et al., 2014).

In Singapore, the distance-based fare scheme was introduced in 2010, replacing the old flat-rate fare scheme. Compare to the flat-rate fare, the distance-based fare structure is regarded as efficient. The former does not reflect the actual costs of providing service, which constantly fluctuate throughout the day. Longer trip routes requires more capital investments. Additionally, there is the issue of "cross-subsidization", since flat fares do not distinguish distance of travel, the shorter distance commuters are cross-subsidized by the commuters of longer distance.

The following sections will discuss the implementation and performance of the scheme, and by applying the proposed integrated analytical framework, the evaluation of implementation and performance are carried out.

4.1.1 Policy implementation

Problem identification and scheme objective

The transport system in Singapore is a hub-and-spoke design, which is an efficient model to bring commuters to a transport hub and then onwards to their destination. Transfers are an integral part of this system. Before the distance-based fare scheme, commuters making transfers (between bus and MRT, and between buses) had to pay a boarding charge each time they board. Hence, commuters paid more to make a transfer journey compared to a direct journey, even if he travelled on a comparable route over the same distance. This additional cost of making a transfer discouraged people from making transfers, and further public transport, even when it made more sense to do so.

The objective of introducing the distance-based fare scheme is to improve the connectivity and integration of the public transport system. Under the new scheme, commuters only need to pay a fare based on the total distance traveled from origin to destination, regardless of the number of transfers they make. At the same time, distance-based fare scheme removed the previous fare penalty associated with bus-MRT or bus-bus transfers and made transfers more seamless and convenient. With the integrated fares, commuters have more flexibility and choice over the routes for their journeys with a better travel experience, compared to having to wait for a direct service in order to avoid higher cost. Commuters can choose to take direct trips or transfers, which can be faster or cheaper journeys (Ministry of Transport of Singapore, 2018).

Policy design and preparation

Institutions of LTA and PTC prepared regulations for the distance-based fare scheme. Accordingly, a clear Transfer Rules for the distance-based fare scheme is developed. Under Distance-Based Fares, for a single journey, commuters:

- Can make up to 5 transfers within a single journey (45-minute time allowance between each transfer)
- Can take up to 2 hours to complete a journey
- Should not take the same bus service number consecutively
- Should not exit and enter at the same rail station
- Can transfer between different rail stations (15-minute time allowance between each transfer)

If the following guidelines are breached, a transfer would be considered as a New Ride with no transfer discount. Tapping in and out of buses are also required to apply Distance-Based Fares.

Under current scheme, the fare curve with respect to distance is:

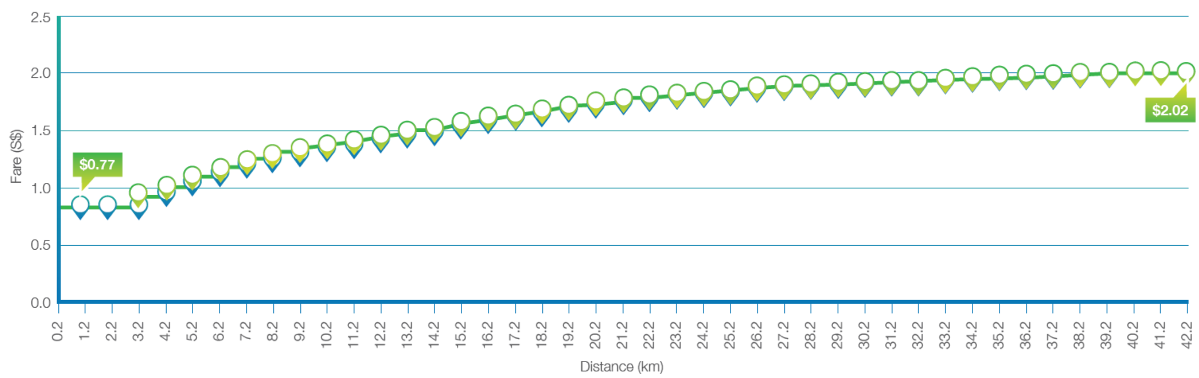


Figure 4.1 Singapore fare curve (as of 2016)

The advance of technology has promoted the application of distance-based fare scheme. Although a distance-based fare scheme is regarded to achieve flexible transfers and equity in fare charging, it has not been widely adopted in the early days. Shifting from a flat-rate fare to a distance-based fare often end up being more complicated to develop and enforce.

Recent technological developments in Automatic Fare Collection (AFC) and GPS devices create a favorable condition for implementing a distance-based fare scheme. In Singapore, to qualify for Distance-Based Fares, commuters must have a stored value smartcard (e.g. EZ-Link), a concession card or an approved bank card for Account-Based Ticketing. The AFC systems' compatibility with multiple operators makes a distance-based fare structure implementable by consolidating transit systems and collecting differentiated fares based on the actual distance traveled by passengers. Customers have to tap their EZ-Link card on the reading device every time they enter and leave a train station or a bus. Thus, besides of the information on boarding time and location, the data collected from EZ-Link cards contains detailed records of alighting times and destination location for both buses stops as well as Mass Rapid Transit (MRT) and Light Rail Transit (LRT) stations.

Policy implementation

The implementation of AFC system allowed the introduction of a distance-based fare scheme for all modes of public transport in Singapore. The fare charge for each customer is based exactly on the traveled distance, transport mode and demographic attributes as there are prioritized rates for children, students and senior citizens. Payments with EZ-Link card account for 96% of all trips.

The payment system is evolving as well. Since April 2019, the new SimplyGo Scheme came into effect. Commuters are able to use their Mastercard or debit cards with contactless function for fare payments. There will be no need for upfront top-ups and the train and bus fares will be consolidated, processed and charged to the credit or debit card bill. Interested readers could go to LTA website for more information.

During implementation, transfer rules are updated to cope with the changing situation, to achieve the objective of the distance-based fare scheme. There will be another update of transfer rules in the near future. Distance Fares Transfer Rules is under review to facilitate more efficient and seamless travel (Public Transport Council, 2018c). In particular, a truly distance-based rail fare structure came into effect. Commuters would be charged based on the route with the shortest distance route between starting entry and exit station sending points, rather than the distance of the fastest route, as had been the case. The higher fares charged for trips made on train lines below ground – which incurred higher operating costs – were also lowered to be the same as that for above-ground lines. With this, the fare structure between bus and rail for all rail lines became fully integrated uniform as commuters would pay the lowest fare regardless of the route taken or modes of travel within the rail network. Commuters will be able to make walking transfers or utilize multiple rail trips to reach their destination, without incurring additional boarding charge. Before, only one single entry and exit is allowed for rail for each journey. In the future, multiple rail transfers allowed with no additional boarding charges (Chia, 2017).

4.1.2 Criteria, scoring, and implementation evaluation

In this section, the above mentioned implementation information of the Distance-Based Fare Scheme is examined following the criteria set proposed in 3.1.1, and the identified criteria will be scored according to the scoring method (see 3.1.2). Namely, the Step 1 and 2 of the analytical framework will be applied. Then, the identified criteria and score will be presented in the scheme sheet (see Table 3.3), as the output of implementation evaluation of this scheme, which is the Step 4 of the analytical framework. Additional information and data source will be noted when referred.

At the stage of policy problem identification, it is admitted that transfer between lines and different modes has "discouraged people from" using the public transport. In the policy document published on the Government website (Ministry of Transport of Singapore, 2018), the objective of promoting model integration was highlighted. In the following stage of implementation, detailed rules are designed and the scheme was implemented, taking advantage of AFC system. Recently, as stated in PTC annual report of 2018 (Public Transport Council, 2018c), the scheme is under further revise to achieve the "fully integrated uniform" of the public transport network, showing the criteria of model integration is reviewed as well. According to the method of scoring, the criteria of model integration is scored as 4.

An easier accessibility of public transport would serve users better. This is correct not only to people who rely on public transport, but also to people who have access to a private vehicle and choose public transport as an alternative. It is critical for the implementation of Distance-Based Fare Scheme to determine fares to ensure the public transport accessibility that encourage people to use public transport. The score is 3, which means the criteria of accessibility is implemented.

The distance-based fare scheme is regarded as more efficient for its ability of representing the actual cost of a travel, compare to the flat-rate fare scheme. There is one consideration of Singapore when replacing the old flat-rate fare scheme with distance-based fare scheme in 2010. The criteria of efficiency was proposed in the design of fare differentiating strategy. However, to what extent the criteria is adopted is not cleat, and considering the fact that no actual check has been made on the efficiency performance of this scheme, a score of 2 is appropriate for efficiency criteria of the distance-based fare scheme.

Affordability has been paid special attention in the implementation of the scheme since commuters are sensitive to fare level. A fare raise may motivate consumers to use a public transport less or shift to another mode of transport, say cars. This is opposed to the policy objective of promoting public transport. In revising the fare level, the fare level and its increment is strictly control. Therefore, the score of affordability is 3.

On the contrary, the profitability of public transport operators, which is mostly relying on the fare revenue, though considered to have positive impact due to the potential higher charge on longer trips under the new scheme, is not adequately proposed in the design process, nor implemented. Actually, as discussed later, the profitability performance after the implementation of the scheme is negative. Therefore, the score for profitability criteria is 1.

Equity is scored as 1. It is only considered for travelers of different travel distance. There are a number of different demographic groups who are significantly or disproportionately impacted by the current public transport fare structure, such as elder people, low-incomes. Equity is not explicitly proposed during the implementation of the scheme.

Acceptability has a score of 3. Before the commence of the scheme, consultations with the communities were held to collect their feedback from different perspectives, which was a good opportunity to secure better understanding. Generally, the public it acceptable to see a fare structure with a lower fare.

Based on the discussion, criteria identified and the corresponding score can be summarized in the scheme sheet of Table 4.1.

Table 4.1 Scheme sheet – implementation of Distance-Base Fare Scheme

Criteria	Score	Description	Source
Modal integration	4	Main purpose of the scheme, reviewed and updated for implementation	Government website (Ministry of Transport of Singapore, 2018); PTC annual report of 2018
Network capacity	3	Fares ensure public transport accessibility and promote public transport	Policy document published on the Government website and LTA website
Efficiency	2	Proposed in the design stage for fare strategy	Research paper (Chia, 2017)
Profitability	1	profitability of public transport operators is only considered	The Fare Review Mechanism Committee Report (Yong PHANG, 2013)
Affordability	3	Fares became more affordable	PTC city comparison report (CH Chua, 2016)
Equity	1	only considered for travelers of different travel distance	Research paper (Chia, 2017)
Acceptability	3	Public consulting meetings and publicity events held	LTA and PTC website

4.1.3 Policy performance

As discussed in 3.1.5, policies interact with each other, and the impacts of one policy lie in multiple aspects, which create the challenge of identifying the accountable performance from a particular policy. Policies may have impacts on attributes that out of the objective scope. Similarly, performances may be affected by multiple policies. In this section, the description of the performance of distance-base fare scheme is organized according to the concept proposed in 3.1.5, namely investigating the policy performance in terms of the impact hierarchy. Based on that, the indicators for performance evaluation are identified later in 4.1.4, falling into 3 types of the immediate output indicator, the short-term outcome indicator, and the long-term impact indicator.

Public transport fare

In terms of fare level, basically, commuters had a lower fare, which can be reflected by the average fare before and after the distance-based fare scheme.

A change of average public transport fare from 0.98 (S$, as of 2010 before implementation) to 0.92 (S$, as of 2011 after implementation) is observed, according to the Singapore Land Transport Statistics in Brief of the year 2010 (Land Transport Authority, 2011).

Impart on travel behavior

Under the distance-based fare scheme, the average distance for single trip becomes shorter, and the number of transfers taken increases as well.

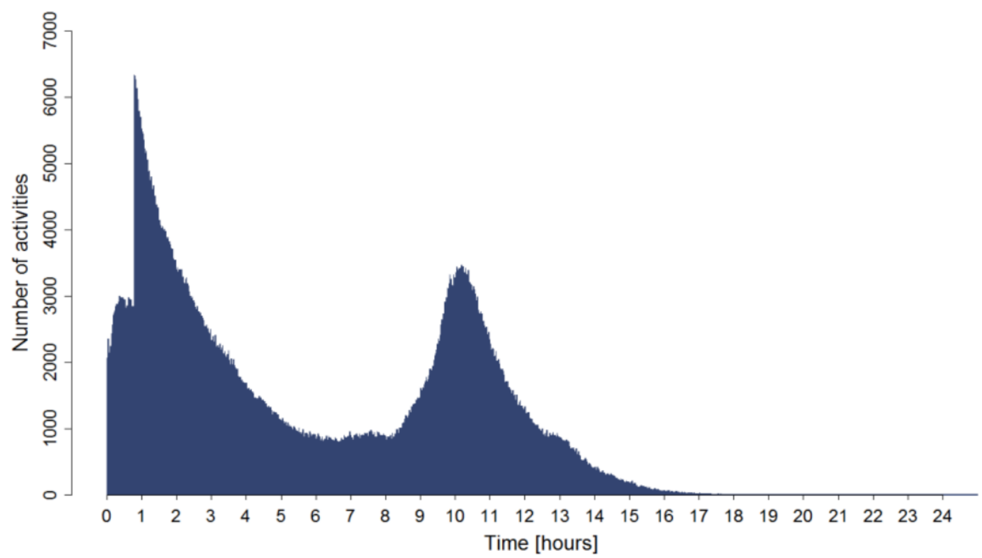
According to the Singapore transport statistics website[8], the average trip distance for 3 consecutive years of 2010 to 2012 are as follows (Table 4.2,note that the implementation starting year is 2010):

Table 4.2 Public transport average trip distance (km)

PT mode/ Year	2010	2011	2012
MRT	10.3	10.0	9.6
Bus	4.8	4.5	4.4
LRT	2.1	2.0	1.0

Travel time pattern is affected by the introduction of the scheme as well. Using the aggregated EZ-Link data, (Richner, 2011) analyzed the time span between two journeys of a consistent journey chain after the implementation of the scheme. The distribution of activity durations between journeys is shown in Figure 4.2.

[8] Source: DATA.GOV.SG, Public Transport Utilization - Average Trip Distance



Source: (Richner, 2011)

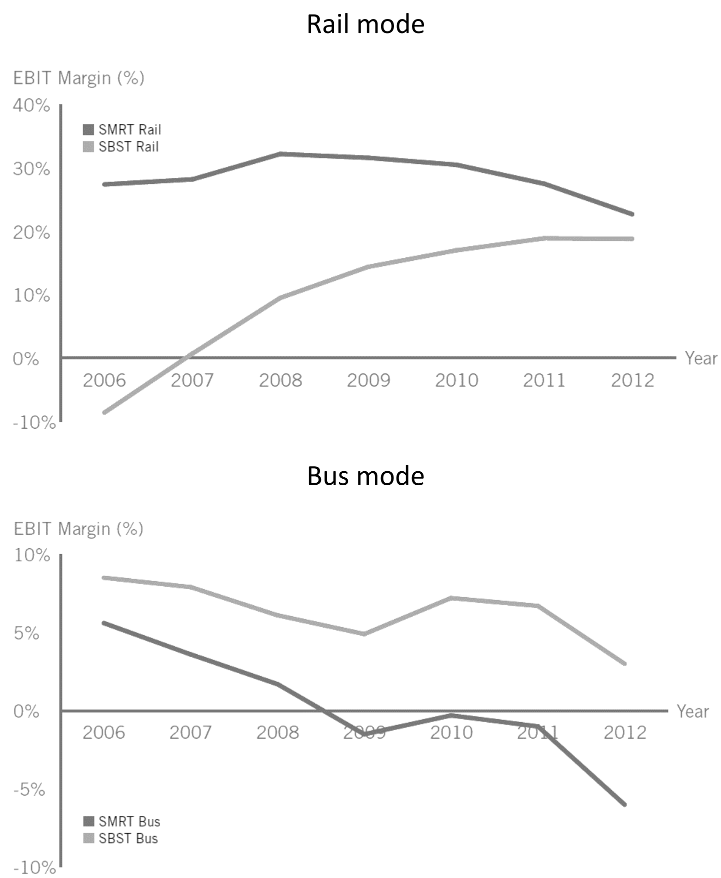
Figure 4.2 Distribution of time span between two journeys

The sharp peak at 45-minute is a result of “45-minute time allowance between each transfer” of the distance-based fare scheme (see 4.1.1). According to these rules, 45 min is a time limit, under which two consecutive trips are considered as a part of one journey. The observed second peak of 8 to 12 hours indicates the typical working time span in Singapore.

Impact on public transport operators

Charging only based on distance may lead to uneven impact on operators of different modes. Generally, as bus services do not have a dedicated right-of-way and are generally regarded as less reliable than train services, it is justifiable to differentiate bus and train fare levels to help bus operations cope with market situation. With the seamless transfers of the distance-base fare scheme, distance is the only determinant of fares. Fares became indifferent to modes, and bus fares are set at the same level as the train fares. The overall fare revenue collected under the scheme would shift from bus to trains and the bus operator may be worse-off.

The data from the fare review report (Yong PHANG, 2013) has shown some evidence about the adverse impact on the operators of bus and rail modes. The bus financials, in terms of Earnings Before Interest and Tax (EBIT) margins, have been trending downwards, and there is the deteriorating viability of buses as compared to trains.



Source: (Yong PHANG, 2013)

Figure 4.3 Scheme impact on operators of different modes

Note: SMRT and SBST are the 2 major public transport operators in Singapore.

Under the distance-base fare scheme, bus mode seems to be restructured to perform more of a "feeder" role to connect to rail mode, due to trains are a more viable public transport option. At the same time, the higher cost of premium service provided by bus operator (which rail mode doesn't have) is not able to be reflected in the scheme. Overall, it may create a situation where the contributing mode (bus mode) being made worse-off with the unsustainable revenue allocation between bus and rail modes. This unintended impact of the scheme is challenging the objective of generating higher levels of ridership and greater levels of fare-box revenue.

4.1.4 Indicator and performance evaluation

In this section, indicators are selected from the pre-identified indicator list (refer to 3.1.3) and the right indicator values are captured, for the purpose of pricing policy performance evaluation.

ID1 of Public transport fare, as the immediate output indicator of distance-based fare scheme, is appropriate and accountable to represent the scheme performance. Following the value-capture methods discussed in 3.1.5, the before-after comparison method is taken for output indicator.

Based on the Land Transport Statistics in Singapore (Land Transport Authority, 2011), the average public transport fare decreased from 0.98 (S$, as of 2010 before implementation) to 0.92 (S$, as of 2011 after implementation). Applying the before-after comparison, the normalized indicator value for average public transport fare is 0.98/ 0.92 =1.065.

Fare changes also affect operators' revenue directly. We select ID5 of operator profitability and ID9 of revenue distribution to evaluate the scheme performance. Data utilized is collected from the fare review report (Yong PHANG, 2013). Compiling and averaging operators' EBIT data in terms of bus and rail modes, the operator profitability data are listed in Table 4.3.

Table 4.3 Operator profitability (EBIT)

PT mode/ Year	2010-2011	2011-2012
Rail (average)	23.1%	22.4%
Bus (average)	1.8%	1.2%
Overall	24.9%	23.6%

Source: (Yong PHANG, 2013)

Applying the before-after comparison, the normalized indicator value for operator profitability is 0.236/ 0.249 =0.948.

To calculate ID9 of revenue distribution, data from the fare review report can also be utilized. However, the problem of uneven distribution of revenue between operators that caused by the distance-based fare scheme had been noticed by the Government (PTC, specifically), and an additional intervention mechanism had been considered to adjust the revenue allocation between bus and train modes. It was analyzed and suggested that the weight for revenue allocation for bus mode should be raised to 1.05 while maintaining the weight of 1.00 for train mode. This is illustrated in Figure 4.4.

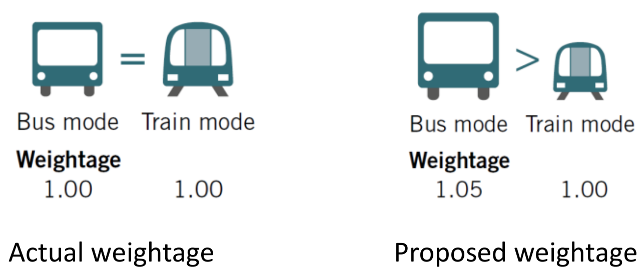


Figure 4.4 Proposed weightage for revenue allocation

Under the proposed allocation mechanism, slightly more fare revenue would shift to the bus mode as compared to the train mode. Since it is the back-end allocation of fare revenue, there would be no explicit impact on commuters.

Though the proposed revenue allocation mechanism was not implemented at last (due to the introduction of the new finance scheme), it provided the implication of a 1.05 to 1.00 revenue distribution between operators under the distance-based fare scheme. Therefore, for ID9 of revenue distribution, 0.95 is taken as the normalized value.

The indicators analyzed can be summarized in the scheme sheet of performance of the Distance-Base Fare Scheme.

Table 4.4 Scheme sheet – performance of Distance-Base Fare Scheme

Indicator	Normalization score	Description	Source
average public transport fare	1.065	General decrease of public transport fare	Land Transport Statistics in Singapore
operator profitability	0.948	Down-trend performance under the scheme	PTC fare review report
revenue distribution	0.950	Bus mode operators are worse-off	Proposed revenue allocation mechanism by PTC

4.1.5 Scheme summary

The distance-based fare structure is efficient because the variable costs of transit service is properly reflected. The distance-based fare scheme has been considered to have positive impact on social equity as well as the operators' financial health, especially by switching from a flat fare model to a distance-based model (Yook & Heaslip, 2015).

Automatic fare collection (AFC) systems for public transport offers many advantages and benefits for operators of public transport as well as their customers. Convenient, easy and almost instantaneous payment process saves customers time and makes use of public transport more attractive. Furthermore, lower operation costs, high efficiency and reliability as well as new opportunities for implementation of flexible fare schemes are additional benefits for operators. Data on boarding and alighting can be captured for rigorous impact analysis of possible fare adjustment options.

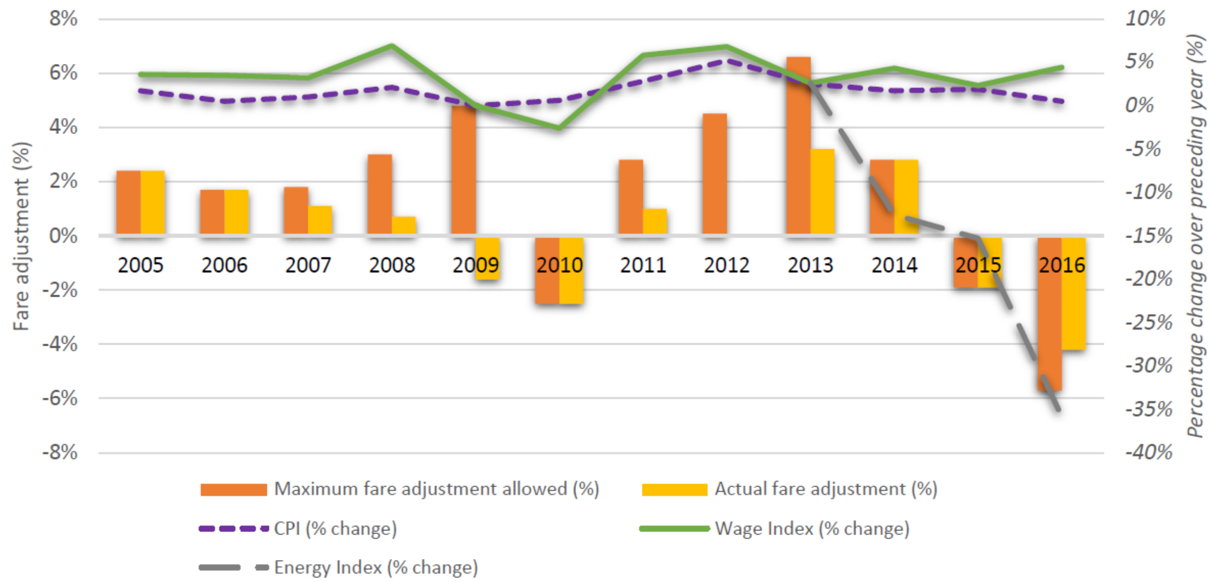
4.2 New Capacity Factor Fare Adjustment Scheme

The adjustment of public transport fares is a sensitive issue. Generally, different perspectives need to be considered for the pricing scheme on fare adjustment. For the public transport operators, the operating revenue should cover operating costs, namely the profitability. From the commuters' perspective, fares have to be affordable. From the government's perspective, fare should be revised periodically to adjust for justifiable cost increases, considering the profitability and affordability. Regulating the fare adjustment is to archive the balanced the need between commuters' interests and operators' financially viability.

4.2.1 Policy implementation

Problem identification and scheme objective

Public transport fare adjustments in Singapore is carried out annually. Historical fare adjustment compiled is shown below.



Source: (Chia, 2017)

Figure 4.5 History of fare adjustment in Singapore

As implied by the historical adjustment, in recent fare review exercises, the actual fare increase granted by the PTC has been less than that determined by the fare adjustment formula. This creates problem on the public transport operators that the fare revenue was not able to fully compensate for cost increases in operations, affecting the financial performance of the PTOs adversely.

According to PTC website[9], between 2012 and 2016, annual operating costs for PTOs increased by over $900 million. Annual fare revenue increased by around $230 million over the same period, mostly due to ridership growth. However, this only covered about 25% of the increase in annual operating costs. A widening gap between cost and fares is not sustainable for the development of public transport network.

The government had been subsidizing more and more of operating costs over the years, which is a departure from the principle that commuters should cover operating costs through fares. To address this issue, PTC has introduced a New Capacity Factor (NCF) in the fare formula to better reflect cost movements due to public transport capacity changes and commuter usage. The NCF allows the fare formula to better track the increase in costs incurred by the operators to provide better services to meet demand.

Policy design and preparation

The NCF is designed to reflect the cost fluctuation under the background of capacity improvement and commuter demand changes on public transport. It measures the change in place kilometers (total distance covered by the operated bus and train trips) per passenger kilometer (total distance travelled

[9] https://www.ptc.gov.sg/regulation/bus-rail/fare-regulation-framework

by each commuter within the public transport network) over the preceding year, with equal weightage to both bus and rail modes. Its definition formula is as follows (Public Transport Council, 2018c):

$$NCF = 0.5 \times \Delta \frac{\text{Operated train place km}}{\text{Passenger km for train}} + 0.5 \times \Delta \frac{\text{Operated bus place km}}{\text{Passenger km for bus}}$$

Figure 4.6 Definition formula for NCF

Based on the supply and demand of public transport marker, the NCF may be positive or negative. It will be positive where demand grows slower than capacity. Conversely, if capacity remains stagnant in a given year and demand grows faster than capacity, resulting in more crowded trains, the NCF will be negative.

A higher NCF value (above 0, see Figure 4.7) implies the increase of investment in public transport (the supply side) and will result in the increase of price index, based on the which, the public transport fare will be revised accordingly to reflect the cost increase (thus affects the demand side).

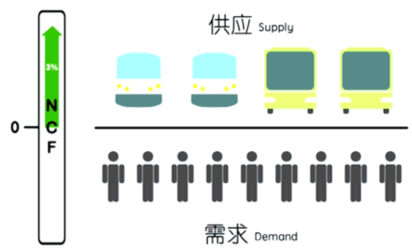


Figure 4.7 Public transport market and NCF

Under the NCF fare adjustment scheme, the revised fare formula (from 2018 to 2022), is as follows:

$$Maximum\ Fare\ Adjustment = 0.5cCPI + 0.4\,WI + 0.1EI - 0.1\% + NCF \qquad \textbf{4.1}$$

Please note that 0.1% is the updated weights for the Productivity Extraction Factor to reflect the latest public transport industry cost efficiency. Extracting from the PTC annual report of year 2018, the comparison of the new NCF fare adjustment with the previous one is listed in Table 4.5.

Table 4.5 Comparison of NCF fare adjustment scheme with previous scheme

COMPONENT	2013–2017 FARE FORMULA	2018–2022 FARE FORMULA	KEY CHANGES
CORE CONSUMER PRICE INDEX (cCPI)[1]	0.4 cCPI	0.5 CCPI	Increase in weightage of 0.1 cCPI
WAGE INDEX (WI)[2]	0.4 WI	0.4 WI	No change
ENERGY INDEX (EI)[3]	0.2 EI	0.1 EI	Decrease in weightage of 0.1 EI
PRODUCTIVITY EXTRACTION (PE)[4]	Half of operators' productivity gains (estimated to be 0.5%)	Half of operators' productivity gains (estimated to be 0.1%)	No change in formula. Despite the rapid workforce expansion to support the capacity enhancements between 2012 and 2016, the industry managed to achieve average productivity gains of 0.2%. Half of this, or 0.1%, will be shared with commuters through the PEF from 2018 to 2022.
NETWORK CAPACITY FACTOR[5]	NIL	New component. See more details on page 30.	

Source: (Public Transport Council, 2018c)

In terms of institutional preparation, it was considered better to have an independent body with representatives from the various sectors, to make the decision of approving fare changes.

In 2012, a Committee termed the Fare Review Mechanism Committee (FRMC) – comprising representatives from academia, the Consumers Association of Singapore (CASE), grassroots, labor movement, as well as the people and private sectors – was formed to review as well as propose improvements to the current fare review framework and fare adjustment formula for the Government's consideration (Chia, 2017). In Singapore, public transport fares were regulated by the Public Transport Council (PTC).

Policy implementation

The implementation of NCF Fare Adjustment Scheme is depending on the five components of the formula 4.1. According to the commence report of the scheme (Public Transport Council, 2018b), the components are assigned with the following:

- Core Consumer Price Index (cCPI): the change in core Consumer Price Index over preceding year; 1.5% in 2017.
- Wage Index (WI): the change in Average Monthly Earnings (Annual National Average) over the preceding year, adjusted to account for any change in the employer's CPF contribution rate; 3.0% in 2017.
- Energy Index (EI): the change in Energy Index which is a composite of cost changes in electricity and diesel; 26.2% in 2017.
- Productivity Extraction factor, 0.1% for 2018 to 2022.
- Network Capacity Factor (NCF): the change in NCF over preceding year, which means capacity provision relative to passenger demand for the entire public transport system; 3.0% in 2017.

> This round, the NCF - which took into account the additional buses pumped into the network last year and the first two stages of the Downtown MRT line - contributed 3 percentage points.

The output of the formula indicated an overall 4.3% increase in bus and train fares, which has been in effect since 29th December 2018.

As a result, there was a 6-cent increase for ordinary commuter (adult commuter with card payment). The detailed fare increase for different groups is as follows (Public Transport Council, 2018a).

Table 4.6 Fare increase for different groups under NCF fare adjustment scheme

Commuter group	Fare increase
Adults	6-cent (card fare) 10-cent (cash fare)
Children below 7-year	No change (free)
Students	1-cent (card fare)
Senior Citizens	1-cent
Persons with Disabilities	1-cent
Lower-Wage Workers	1-cent
Monthly Concession Pass	No change

As can be seen from the table, generally speaking, fare increased by 6-cent for card fare, and 10-cent for cash fare. Full-time students who are eligible for student concession fares saw 1-cent increase. The same increase applied for Senior Citizens as well. The concern on affordability is highlighted that Singapore Government decided to cap the fare increase at 1 cent for the Lower-Wage Workers.

Public participation is regarded to be crucial to the fare adjustment and review. Hence, blog site, website, email account, as well as postal box were created so that the public can be reached out and feedback in the implementation of the scheme.

4.2.2 Criteria, scoring, and implementation evaluation

In recent years, the Singapore government had been subsidizing more and more of public transport operators. This is not sustainable for the long-term development of the public transport system that in principle, commuters should cover operating costs through fares. The NCF fare adjustment scheme, that with the introduction of a New Capacity Factor in the fare adjustment, is to balance the tradeoff between public transport operators' finance and the commuters' affordability, to better reflect cost-efficiency against the changes of public transport capacity.

Based on the discussion, it is clear that among the criteria set in 3.1.1, B3 of finance, C1 of affordability, B1 of efficiency, and A2 of capacity can be identified. With the implementation of the scheme from December 2018, all of these 4 criteria are actually implemented. The fare review is held annually by PTC, and it is safe to assume the finance criteria will be reviewed. Therefore, according to the scoring method (see 3.1.2), finance criteria is assigned a score of 4, while the other criteria of affordability, efficiency, and capacity are 3.

From Table 4.6, we can see that different group of people are treated differently. Particularly, for the low-income group, the fare increase is only 1-cent. This represents the criteria of vertical equity (3.1.1). for C2 of equity, the score is 3.

C3 of acceptability is also implemented that blog site, website, email account, as well as postal box were created so that the public can be reached out and feedback on the scheme. The component of Energy Index is proposed in the new fare adjustment formula. The emphasize on energy cost and consumption would definitely help the protection of environment. Therefore, for the criteria of D1 of environment, the score of 2 is given.

For the NCF fare adjustment scheme, criteria identified and criteria score can be summarized in the scheme sheet of Table 4.7.

Table 4.7 Scheme sheet – implementation of NCF Fare Adjustment Scheme

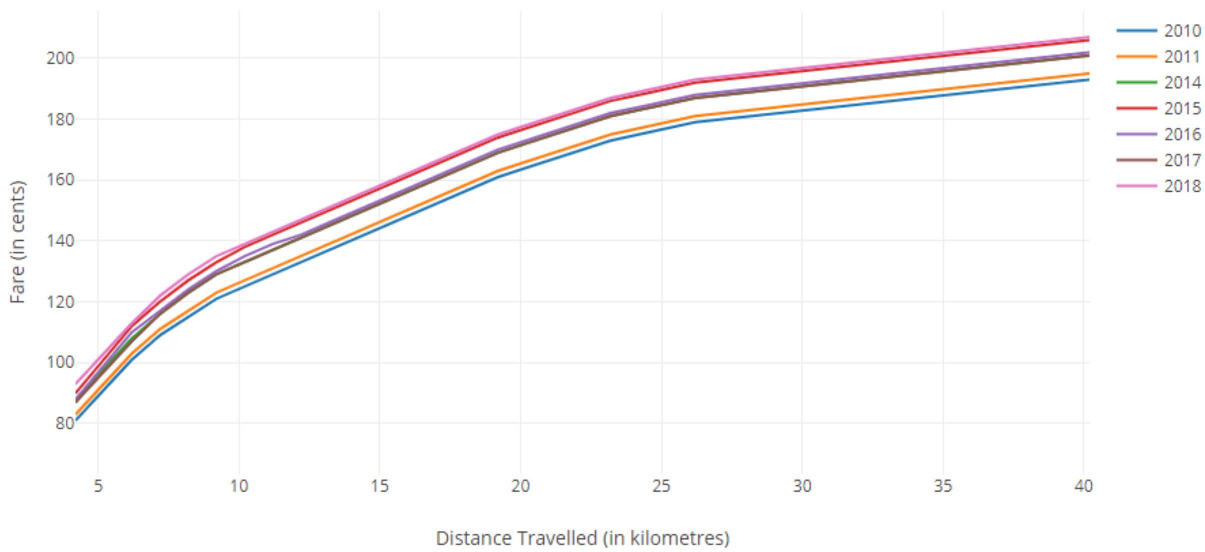
Criteria	Score	Description	Source
Network capacity	3	New factor to reflect the cost of capacity	Report on commence of new fare adjustment scheme (Public Transport Council, 2018b)
Efficiency	3	Economic condition incorporated in fares adjustment to promote public transport	PTC annual report of 2018
Finance	4	Main purpose of the scheme, fare is annually reviewed	Fare review exercise of 2018 (Public Transport Council, 2018a)
Affordability	3	Main purpose of the scheme, only 1-cent increase for low-income	Report on commence of new fare adjustment scheme (Public Transport Council, 2018b)
Equity	3	Fares increase for different group are regulated differently	Report on commence of new fare adjustment scheme (Public Transport Council, 2018b)
Acceptability	3	Means for public reach-out and feedback were created	LTA and PTC website
Environment	2	Energy cost and consumption proposed in the adjustment	The Fare Review Mechanism Committee Report (Yong PHANG, 2013)

4.2.3 Policy performance

According to PTC Fare Review annual report (Public Transport Council, 2018a), the fare increase produced by NCF fare adjustment scheme is the highest increase in percentage terms in the history of public transport in Singapore[10], and the implementation of the scheme involved a delicate balance between fare affordability and finance of public transport operators. In this section, the impacts of this scheme are investigated.

Fare changes

Under the new fare adjustment scheme, the average fare increase is 4.3% since December 2018. In absolute terms, the increases were small, ranging from one to six cents for users of contactless cards, and ten cents for cash fares (Table 4.6). The prices of monthly concession passes remained unchanged. Detailed fare changes over time in Singapore is attached in Appendix, based on which, the figure of fare changes in Singapore can be drawn.



Source: (Public Transport Council, 2018a)

Figure 4.8 Fare changes in Singapore

Judging from the fare curves, we can see the curve of 2018, as the impact of the NCF fare adjustment scheme, is on top of the curve group, meaning it is the highest increase in the history of public transport in Singapore. The curve closest to 2018 curve is the 2015 curve, indicating that for the past consecutive 3-year, there was a decrease in public transport fare.

Using the historical data, we understand the fare adjustment was indeed responsive to changes in economic conditions over time. Under the objective of developing the capacity of public transport network, the NCF fare adjustment scheme is necessary.

Impact on public transport operators

[10] The timeline of fare adjustment is available from the PTC website: https://www.ptc.gov.sg/regulation/bus-rail/fare-milestones

Before the NCF fare adjustment scheme, the public transport operators reported revenue losses. According to the PTC fare review report, SBS Transit cited that their rail operations have been facing finance pressures since 2013 as a result of the expansion of the railway network. Manpower cost has been rising due to the increase in headcount and salary adjustment to attract and retain staff. Repair and maintenance costs, in particular, have increased by more than 87% from 2015 to 2018; mainly attributed to maintaining and improving the performance of an aging network. Other operators had seen similar situation in terms of finance pressures.

With the implementation of the scheme, the overall fare adjustment of 4.3% translates to an increase in fare revenue of about $78.2 million a year in fare revenues for public transport in 2019, where rail revenue will rise by $35 million ($10.9 million for SBS, $24.1 million for SMRT). Bus fare revenues will increase by $43.2 million, which reduces the bus operating subsidies from Government. The increase of fare revenue under the NCF fare adjustment would make-up the gap of finance shortage of the operators.

Affordability

Under the new fare adjustment scheme, there is only 1-cent increase for the low-income group. The impact is rather limited. As for the general public, according to the 2018 fare review report, PTC conducted surveys of more than 10,400 commuters, and the result showed that more than 7 in 10 found public transport fares in Singapore affordable. 6 out of 10 commuters, when asked, said they were willing to pay higher fares if there was a fare increase, so that others like low-incomes, seniors, and students, would be less affected by the scheme. Therefore, there seems no server deterioration in the affordability of the public transport fares.

Moreover, as part of the fare adjustment scheme (Public Transport Council, 2018a), public transport operators are required to contribute 5% of their expected increase in fare revenue to the Public Transport Fund. The Public Transport Fund is used to make available 300,000 Public Transport Vouchers (PTVs), worth $30 each, to help lower income families cope with the fare adjustment. Through this transport fund, that contributed by the PTOs with a portion of their revenue, the affordability of the low-income group had been specifically addressed.

Affordability will be further discussed in the following section on the low-income subsidy scheme.

Public acceptability

The original intent of the fare adjustment was to make fare responsive to the investment of network capacity, encourage efficiency for the benefit of commuters. However, it would be difficult for the ordinary commuters to understand the economic reasoning, and there was a need of tangible benefits to promote public acceptability.

Public acceptability is firstly addressed by paying attention to public messaging. The consultation with the public transport operators, experts and a general public was held to collect feedback from different perspectives. These sessions proved to be useful as it gave a more balanced view on the issues and concerns, and an opportunity for the authority to explain the various complex issues and considerations to secure better understanding.

Till now, public protest over the fare increases was not seen. This was likely the result of greater clarity and responsiveness of the new scheme to the current changes. For any fare increase, commuters would link fare adjustment with service quality to ensure the value-for-money of the additional cost. In terms of the NCF fare adjustment, the public might have found it acceptable for fare increases when the network capacity improved.

4.2.4 Indicator and performance evaluation

ID1 of Public transport fare is the immediate output of fare adjustment scheme. According to PTC fare review report (Public Transport Council, 2018a), the average fare increase is 4.3%. Applying the before-after comparison, the normalized indicator value for average public transport fare is 0.957.

Fare changes also affect operators' revenue directly. ID5 of operator profitability is adopted to evaluate the scheme performance. Since the rail operation is owned by Temasek Company, which is a state-owned company without financial disclosure to public, the bus fare revenue is investigated. Under the bus contract scheme (will elaborate more in the section of the new rail finance scheme), the bus fare revenue goes to the Land Transport Authority (LTA), who administers bus contracts. Data utilized is collected from the LTA Financial Statement of Year 2018 (Land Transport Authority, 2018a). Compiling the bus operators' fare revenue data, the bus fare revenue increases by $43.2 million, from $831.9 million, to $875.1 million. Applying the before-after comparison, the normalized indicator value for operator profitability is 875.1/ 831.9 =1.052.

The fare increase affects affordability. Affordability indicator measures the percentage of household income spent on public transport. The Public Transport Affordability Indicator (PTAI) in Singapore regards the second quintile households as the average commuter. To calculate the indicator under the new fare adjustment scheme would require large amount information on Households income changes, with detailed transport expense in terms of various income groups, which is not possible for the time-being. It is noticed that, after the new adjustment, the fare level is almost same as the fare level in 2015. Therefore, the rough estimation of affordability changes is made based on the PTAI in 2015, and the household change from 2015 to 2018.

Data on PTAI is collected from PTC fare review report. For 2015, it was 2.08%; for 2017, it was 1.90%. Data on average household income is collected from Statistics Department of Singapore (Statistics Department of Singapore, 2019). For 2015, it was $8666; for 2018, it was $9293. Therefore, the PTAI under the NCF fare adjustment scheme is: 2.08%*8666/9293=1.94%. Applying the before-after comparison, the normalized indicator value for affordability is 1.90/ 1.94 =0.979. This is a small change.

The indicators analyzed can be summarized in the scheme sheet of performance of NCF Fare Adjustment Scheme.

Table 4.8 Scheme sheet – performance of NCF Fare Adjustment Scheme

Indicator	Normalization score	Description	Source

average public transport fare	0.957	average fare increased under new scheme	PTC fare review report (Public Transport Council, 2018a)
operator profitability	1.052	public transport operators' revenue increased	LTA Financial Statement of Year 2018 (Land Transport Authority, 2018a)
affordability	0.979	Only 1-cent increase for low-income group	Statistics Department of Singapore (Statistics Department of Singapore, 2019)

4.2.5 Scheme summary

The NCF fare adjustment scheme was designed for a sustainable and publicly acceptable fare that would balance the commuters' interests and the operators' financial viability over the long term. The new NCF factor incorporated in the fare adjustment formula has managed to combine the economic way of thinking and the socio-political considerations.

Under the new fare adjustment scheme, there is only 1-cent increase for the low-income group, so that they would be less affected by the scheme. A review on profitability is necessary, and the affordability of fares should be closely monitored.

4.3 Workfare Transport Concession Scheme

Concession schemes offer the opportunity to specific population group to travel on public transport at a reduced fare, sometimes can be free travel. Many concession schemes are adopted globally, and the targeted group that eligible for concession fare, and the levels of discount differ from local authority areas and time.

Generally speaking, the basic objective of a concession scheme is to improve social exclusion. The elderly, the disabled, the students, the unemployed are the typical groups. By providing discounted fares for these targeted groups it is hoped that they will be able to afford public transport.

In Singapore, the Public Transport Concession Scheme covers a wide range of groups, including children under the age of 7, students from primary to tertiary, full time National Servicemen, senior citizens, Persons with Disabilities (PWD), and the adult monthly travel concession[11]. On average, almost half a million commuters are able to benefit from the concession schemes. This section is focused on the Workfare Transport Concession Scheme (WTCS), which is the latest concession scheme packaged with LTMP2013, and also a scheme that deliberately designed for low-income group.

[11] https://www.mof.gov.sg/docs/default-source/policies/support_for_lower_middle_income_infographics_v4.pdf

4.3.1 Policy implementation

Problem identification and scheme objective

Transport expense imposes a burden on commuters, especially for low-income households. With the already existing income gap, this problem would become worse, if nothing is done to ensure the affordability of public transport.

In order to identify the problem of low-income group affordability on public transport, surveys are conducted by the Singapore Government. In March 2013, the meeting was held with commuters, including representatives from the student groups, the grassroots, and voluntary welfare organizations for more feedback on concession schemes and fare affordability. Later in 2013, a quantitative household survey was conducted to validate the feedback and suggestions gathered. This survey was to provide a reality check on some of the key considerations by testing them out with a representative group of the Singapore population. About 4,600 individuals from various types of housing profiles, statistically representative of Singapore's population distribution, were surveyed. As a result of the survey, the key feedback and suggestions received is the need of Government-funded concessions for low income workers that following more than 75% of respondents' selection. This clearly shows a strong preference of the scheme.

In Singapore, prior to WTCS, there was no public transport concession schemes targeted at the low income worker group. At that time, low income workers only receive public transport vouchers. With the WTCS, Singaporeans who are low income workers depending on public transport to travel between their homes and workplaces, would benefit from reduced expenditure on fares through concessions. To help such low income workers find jobs and stay employed by making their means of travel more affordable, the Government introduced concessionary fares for this group.

Policy design and preparation

The WTCS is designed to serve the targeted group, namely the low income workers. Commuters eligible for the WTCS enjoy 15% discount off adult fares.

To identify the target group is always an effort-taking task. We have seen various methods are adopted for screening the group, such as location-based screening method, the category-based screening method, and so on. Besides these mean-test methods, recently in Hong Kong, the non-mean tested subsidy has been put in effect (see Hong Kong pricing policy). As for WTCS in Singapore, it borrowed the selection principle from the existing concession scheme. The Government provides multiple concessions for low-income group of different domains, such as Workfare Income Supplement (WIS), Workfare Training Support (WTS), and Public Rental Housing. WTCS utilizes the eligibility set up by the WIS. To qualify for WIS, a worker must meet the following criteria[12]:

- Be a Singapore citizen;
- Be aged 35 years and above on 31 December of the work year;

[12] For more detailed information, please refer to: https://www.transitlink.com.sg/PSdetail.aspx?ty=art&Id=95#3

- Earn a gross monthly income of not more than $2,000 in the month worked;
- Earn an average gross monthly income of not more than $2,000 in the past 12 months;
- Work at least one month;
- Be staying in a property with an annual value not exceeding $13,000 assessed as at 31 December of the preceding year;
- Not owning two or more properties;
- If married, with spouse together do not own two or more properties.

The eligible applicant can enjoy 15% discount of the regular adult fares. It is implemented through the form of personalized card, the Workfare Transport Concession Card.

In terms of financial arrangement, different from other existing concession schemes for specific groups of commuters, such as student concession scheme, that the concessionary fares are cross-subsidized by commuters paying full fares, the WTCS is funded by the Government, as part of the Government's overarching social policies.

In terms of institutional arrangement, the Transit Link Company (short for TransitLink, a semi-public company) is appointed as the administrator for the concession schemes. TransitLink provides services such as the issuance, replacement and refund of concession cards, and manages public feedback on all concession issues.

Policy implementation

The scheme took place on 6 July, 2014 (Ministry of Transport of Singapore, 2015).

As the new concession scheme to promote the usage of public transport, it needed to get public awareness at first. Many measures were taken for this purpose. The information had been publicized in newspapers, television advertisements, displayed at MRT stations and bus stops, and so on. Certain amount of buses were also wrapped with special advertisements to create awareness and remind commuters about the concession scheme (Figure 4.9).

Source: (Ministry of Transport of Singapore, 2015)

Figure 4.9 Bus wrapped with special advertisements for WTCS

The scheme is implemented through the Workfare Transport Concession Card. Concession Cards are personalized smartcards that allow card holders to pay for public transport at a subsidized rate. Besides paying for bus and rail fares, concession cards can also be used in retail and payment of healthcare services and so on.

4.3.2 Criteria, scoring, and implementation evaluation

The concession scheme is implemented to solve the problem of low-income group affordability, and make the public transport accessible and inclusive for all groups of the society. This objective is pursued through the design, preparation, and review phases. Therefore, in terms of the level of implementation, C1 of affordability and C2 of equity should be scored as 4.

Another criteria with the score of 4 is C3 of acceptability. As descripted previously, meetings with public representatives covering the student groups, the grassroots, and voluntary welfare organizations were held. Quantitative household survey was also conducted to gather the feedback and suggestions on concession schemes and fare affordability.

Low-income group is the group with large number of people who rely on public transport very much. The concession scheme reduced expenditure on fares, which allows people to access a wider range of goods, services and employment opportunities than before. Efficiency is improved by the implementation of WTCS (NAIDU, 2014). However, how much exactly percentage is affected is not monitored nor reviewed. It is appropriate to score 3 for B1 of efficiency. This improved accessibly of public transport is also considered to be helpful to modal integration, though no special action was taken, therefore a score of 1 for A1 of modal integration is reasonable.

The WTCS is funded by the Government, as part of the Government's overarching social policies. To be specific, it is co-funded by multiple departments, including Ministry of Transport, Ministry of Manpower, Ministry of Social and Family Development (One Singapore Organization, 2016). As for B3 of finance, the score is 3.

Public transport operator was not involved in the financing part, but it was considered to be benefited by the increased number of users that contributed by low-income group who would not be able to travel without the scheme. B2 of profitability is considered and scored as 1. But in the design and preparation stage of the scheme, we couldn't see any evidence of emphasize on operator profitability.

For the WTCS scheme, criteria identified and criteria score can be summarized in the scheme sheet of Table 4.9.

Table 4.9 Scheme sheet – implementation of Workfare Transport Concession Scheme

Criteria	Score	Description	Source
Modal integration	1	Improved accessibility promotes modal integration	PTC annual report of 2018 (Public Transport Council, 2018a)
Efficiency	3	accessibility to more goods, services, and employment opportunities	Research report on Welfare Programs in Singapore (NAIDU, 2014)
Profitability	1	Users generated from low-income group by WTCS	TransitLink's website (www.transitlink.com.sg)
Finance	3	Co-funded by multiple departments	Report on finance of welfare schemes in Singapore (One Singapore Organization, 2016)
Affordability	4	Main purpose of the scheme	Report on scheme commence (Ministry of Transport of Singapore, 2015)
Equity	4	Main purpose of the scheme, concession for low-income	Report on scheme commence (Ministry of Transport of Singapore, 2015)
Acceptability	4	Meetings and surveys for public opinion and feedback conducted	LTA and PTC website

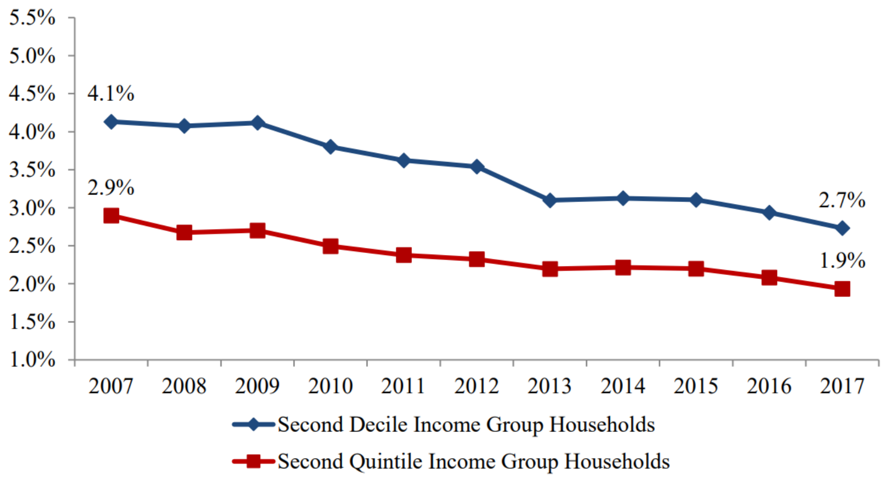
4.3.3 Policy performance

Affordability

Fare affordability is one of the key goals of the concession scheme. Keeping a price at a very low level does not necessarily mean that it is affordable to a person. This is because a person's ability to spend is also relative to how much income the person has. The ratio will get smaller when the increase in expenditure is outstripped by income growth. Conversely, affordability will deteriorate if expenditure increases faster than income growth.

In Singapore, the fare affordability had been monitored through the 5-yearly Household Expenditure Survey (HES). In the public transport field, PTC tracked the affordability trends more closely on an annual basis rather than relying on the 5-yearly HES findings. In calculating the public transport fare affordability, the representative household was constructed using information on the household income, expenditure, and travel data collected by the HES and Household Interview Survey (HIS). The characteristic household is the 20th to 40th income percentile group, with two working adults and two school-going children. The characteristic family was assumed to have a certain weekday travel pattern on bus and rail. This indicator was used to track, annually, the changes in public transport expenditure and income, and it would be validated every five years based on the latest HES and HIS results (Looi & Tan, 2007).

Extracted from the government fare review report of 2018 (Public Transport Council, 2018a), Figure 4.10 shows the evolution of fare affordability in Singapore. Based on the established Affordability Indicator, it can be seen that public transport fares have become more affordable over the last decade. Since 2007, the average commuter (second quintile income households) and lower income commuters (second decile income households) have seen an improve from 2.9% to 1.9% and 4.1% to 2.7% respectively.



Source: (Public Transport Council, 2018a)

Figure 4.10 Fare affordability evolution in Singapore

Though the public transport fares are also becoming more affordable for the 2nd decile income group households, data shows that this group spends a higher proportion of household income on public transport as compared to the 2nd quintile income group households. This is the reason why the WCTS concession is targeted at low-income group. Since the commence of the scheme in late 2014, it can be seen that the fare affordability for the 2nd decile income group households gradually improved, as a result of the scheme implementation.

It is also worth note that the distance-based fare scheme that implemented in 2010 also helped the performance on affordability, which is indicated by the change of the curve.

Finance impact of concession scheme

While fares had become more affordable to the public, another crucial impact of the public transport concession scheme was the affordability to the government in terms of financial sustainability.

The Government spending is around $50 million a year, as the cost of implementing concession scheme. A total of about 400,000 low-income workers are benefit from the concession scheme[13].

The concession scheme creates demand on public transport. The operators may have to increase the bus and rail supply to meet any additional demand, which adds to their costs. At the same time, the operators are asked to provide public transport voucher, which is targeted for low-income household in the year of fare hike, to further protect the affordability of low-income group.

Through the concession scheme and low-income voucher, the fares remain affordable for lower-income families. However, the implementation of the affordability scheme creates financial pressure on the funding bodies, the government and the public transport operators. There is the need to balance the government and the public transport industry's long-term financial viability and keeping fares affordable for the public, especially for the low-income group.

4.3.4 Indicator and performance evaluation

The WTCS scheme offers 15% discount of public transport fare for beneficiaries. As the direct impact, the ID1 of public transport fare for low-income is normalized as 1.150.

For public transport users as a whole, ID8 of affordability is an appropriate indicator. Indicated by Figure 4.10, before the concession scheme start, the affordability index was 3.15%; after the implementation, the index went down to 2.7%, showing the public transport is becoming more affordable. The normalized value is 3.15/2.7=1.167.

As discussed above, the scheme caused finance pressure to the government, as well as the public transport operators. The annual concession cost is around $50 million, assumed by the Government. The financial statement report of LTA (Land Transport Authority, 2018a) shows that, this cost stands for a 17% increase of total government grant. ID6 of government expenditure is normalized as 0.830 for WTCS scheme.

Moreover, as part of the fare concession scheme (Public Transport Council, 2018a), public transport operators are required to contribute 5% of their fare revenue to fund the Public Transport Vouchers for low-income families to cope with the public transport fare cost. Therefore, ID7 of operator expenditure is 0.950.

The indicators can be summarized in the scheme sheet of performance of WTCS Scheme.

Table 4.10 Scheme sheet – performance of WTCS Scheme

Indicator	Normalization score	Description	Source

[13] https://landtransportguru.net/public-transport-fare-adjustment-2014/

public transport fare (low-income)	1.150	Concessionary fare for scheme beneficiaries	Scheme commence report (Ministry of Transport of Singapore, 2015)
affordability	1.167	The main purpose of the scheme	PTC fare review report (Public Transport Council, 2018a)
government expenditure	0.830	concession cost is assumed by the Government	LTA Financial Statement Report (Land Transport Authority, 2018a)
operator expenditure	0.950	operators contribute to fund Vouchers	PTC fare review report (Public Transport Council, 2018a)

4.3.5 Scheme summary

The WTCS scheme helps those who rely mainly on public transport to travel between home and their workplaces, including pursuing better job opportunities further away from their homes, by reducing their transport expenditure. It is targeted at lower income workers who have a greater need to travel on a regular basis to remain economically active. For those who have no income (retirees, unemployed, or those who choose not to work for various reasons), there are various other social assistance schemes available to help other lower income persons and dependents.

In the long-term, the scheme could reduce car use, and hence reduce congestion, accidents, and environmental impact. The social exclusion is improved by offering a more equal chance of access through public transport. This will aid the low-income in pursuing what they want, get a job in a previously inaccessible area, or go shopping in different locations.

4.4 Service Enhancement Program

Pricing, network capacity, and service are the main factors to drive the transport demand. The direct pricing schemes under implementation in Singapore, the pre-discussed scheme of distance-based fare scheme, the NCF fare adjustment scheme, as well as the WTCS that focused on affordability, have been discussed in previous sections. In this part, the scheme of Service Enhancement Program and its impact on public transport system will be examined.

4.4.1 Policy implementation

Problem identification and scheme objective

In the Land Transport Master Plan 2013 (Land Transport Authority, 2013), it is made clear that a more comprehensive public transport network will be built for sustainable development. It is also decided to reach a share of 75% of the morning and evening peak hours trips by public transport by 2030. To make public transport more attractive, improving the capacity and reliability of train and bus services is essential.

It is admitted that there is a shortage of public transport capacity in Singapore. The Singapore government released the LTMP 2040 (Land Transport Authority, 2019a), in June 2019. The report provides the official review of the past progress, and addressed the necessity of improving public transport capacity.

Another evidence on network capacity shortage is the adoption of parallel bus routes to secure the operation of rail network. Normally, the rail mode is prioritized due to it is regarded as more efficient and reliable, and the buses are considered as feeders to the train. When the rail network is built up, bus services were rationalized to reduce duplication with the rail network within the public transport system, to ensure optimal use of resources. This was also the case for Singapore that when the first train came into operation in 1987, and some bus services that covered the same routes as the rail network were withdrawn or re-routed to become feeder services (Menon & Kuang, 2006). However, with the rapid increase of travel demand, as well as the slow development of rail network, the rail capacity has seen an insufficiency. Buses are returned to some corridors because they offer more choice, and people still want them, though the bus routes are duplicating the rail lines. Therefore, the parallel bus routes along the high volume rail lines were adopted recently, as the short-term remedy.

On the other hand, some service related issues happened in the past few years, showing the necessity of service improvement. For example, the North-South MRT line suffered two unprecedented major breakdowns on December 15 and 17 in 2011[14]. The service disruptions lasted several hours, making passengers trapped in stalled trains and left tens of thousands of commuters delayed. The MRT network would continue to be affected by numerous service delays and disruptions. The incidents prompted the government to tighten the services standard.

Demands for public transport services have also increased significantly over the last few years, creating a large increase in ridership. Average daily ridership on MRT and bus was 1.33 million and 2.78 million respectively in 2005. By 2015, MRT passenger-rides had more than doubled to 2.89 million a day, while daily bus passenger-rides had risen by a third to 3.89 million (Chia, 2017). This has led to greater crowding on the public transport system, especially during peak periods, and calls from the public for higher public transport service standards to reduce crowding and increase reliability and frequency of bus and rail services.

It is under this situation that the Service Enhancement Scheme was lunched. The objective of the scheme is very clear: improve the public transport network capacity and enhance service levels, to encourage people to take public transport as their primary commuting option.

Policy design and preparation

The Service Enhancement Scheme is composed of public transport capacity improvement program and service enhancement program, as well as the regulation framework to ensure these measures.

[14] https://www.mot.gov.sg/news-centre/news/Detail/Release of December 2011 MRT Disruptions

The improvement of rail network capacity is achieved by the construction of new lines. The Government is committed to expand the rail network. As planned (Land Transport Authority, 2013), the total length of the rail network will be doubled from the current 178 km to about 360 km by 2030. The lines that are under construction include the extension section of Downtown Line, North East Line, Circle Line, Tuas West Extension, Thomson Line, and Eastern Region Line, as well as the new lines of Cross Island Line, and Jurong Region Line. With completion of these new lines and extensions, about 8 in 10 households will be within a 10-minute walk of a train station.

Improvement of transport network capacity, such as the construction of new rail lines, takes time. While waiting for new lines to be built, public transport services need to be taken care of first. That is why the Rail Operating Performance Standards (ROPS) on service enhancement is proposed. The ROPS aims to enhance the rail service and reliability by shorter wait times, fewer delays, and better reliability. Instead of building new lines to expand the network, ROPS is focused on the service enhancement of existing lines. The immediate measures are to add more train trips to rail network, to reduce crowding and shorten waiting times. The replacement of sleeper and the update of signaling system for the existing lines will also increase the frequencies and reliability.

Compare to rail network, the bus network capacity can be improved in relatively short-term, considering the cost and efforts needed. The Bus Service Enhancement Program (BSEP) is designed to address the bus capacity problem. Under the BSEP, around 1000 new bus fleets were planned to add to the current bus network, for both the existing and new bus routes, roughly a 20% increase in the public bus fleet. Bus frequencies were to be improved. Previously, all services had to operate within 30-minute scheduled intervals, of which 80% must be within 10-minute scheduled intervals. As the BSEP requirements, all services have to operate within 20-minute scheduled intervals, of which 80% must be within 10-minute intervals and another 10% within 12-minute intervals. During the morning and evening peak periods, the bus services are to operate at scheduled intervals of 10 minutes or less.

Regulation frameworks are necessary to ensure the performance of these service enhancement programs. This is due to the inherent tension between service quality and costs. It is not possible for the public transport operators to pay serious attention to service quality. With the fare adjustment scheme, particularly the component of productivity extraction and the fare adjustment cap in the fare adjustment formula, the operators could not easily pass on higher costs from high service standards to commuters. Therefore, operators have little incentive to provide comprehensive and reliable services, and to sufficiently provide socially important but relatively unprofitable services.

As a carrot-and-stick approach, the regulation frameworks are advocated. Service quality, including frequency and reliability, is addressed by setting standards for incentive and penalties. Service quality would be better addressed under a separate regulation framework for bus and rail services.

The ROPS is intended to improve rail service reliability by setting standards on the operation of scheduled mileage and accident rates. Indicators on train disruptions and severe service degradation incidents, such as the Mean Kilometers Between Failure (MKBF), is tracked. The associated financial penalties ranges from $20,000 per month for each non-compliant route to $100,000 per month for each violation. The maximum penalty was also raised to up to $1 million or 10 per cent of the rail operator’s annual fare revenue from the respective rail line, whichever is higher.

As for bus service, the Bus Service Reliability Framework (BSRF) is proposed. Under the BSRF, bus operators are provided with monetary incentives to minimize instances of irregular and prolonged waiting times by management of bus operations. If the operator meets the standards, it will receive a performance payment of up to 10% of its annual service fee. On the other hand, if the Operator does not meet the standards, up to 10% of its annual service fee will be deducted. Operators are encouraged to over-perform to gain additional payment for services, utilizing the market mechanism to incentivize the public transport operators to do better.

To summarize, the programs of ROPS, BSEP, and BSRF under the Service Enhancement Scheme not only means more capacity but also more commuters being able to take advantage of the comfort and reliable public transport.

Policy implementation

As the long-term goal, the construction of new rail lines started since 2008. By the time the LTMP 2013 launched, the length of rail network had increased from 138km to 178km in about 5 years (Land Transport Authority, 2013). By 2019, the length has reached to 229km (Land Transport Authority, 2019a).

The ROPS came into effect from 1 January 2014, to provide better service while the large scale infrastructure construction is in progress. With the deployment of new trains from 2015 and the completion of signal system update on the North-South Line (NSL) and the East-West Line (EWL) in 2016 and 2018 respectively, commuters can expect even shorter wait times, especially during the peak periods.

Train service incidents happened since the implementation of the ROPS had been dealt with according to the regulation. For example, the reported incident[15] on 23 September 2014, which is the disruption of train services between Marina Bay and Newton stations for about two hours, after a train stalled near the northbound platform of Somerset station, was subjected to a penalty of $210,000, due to the operator of SMRT had breached the ROPS rule as the disruption affected about 33,000 passengers.

Regarding the bus network capacity and service, the BSEP was introduced in September 2012, and completed in December 2017. Since 2012, 1,000 Government-funded buses had been added to the bus network. To enhance bus connectivity island-wide and integration with other public transport modes, 80 new services have also been rolled out as part of BSEP. Many of the new services introduced are feeders or short trunks intended to improve local connectivity to major transport nodes and key community and commercial facilities[16].

The BSRF was announced by LTA in January 2014. It was a 2-year trial involves monitoring an initial 22 bus services, which later expanded to an additional of 23 more bus services and extended till Aug 2016. The extension was to create the seamless implementation of the program, since the government brought all bus services under the BSRF from the second half of 2016 with the transition to Bus Contract

[15] https://www.lta.gov.sg/content/dam/ltaweb/corp/PublicationsResearch/files/FactsandFigures/Investigation-Findings-on-Rail-Incidents.pdf
[16] https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=fa0bb307-b327-4132-b4c9-65dee82ea989

Scheme (a financing scheme that will be introduced later). The bus services covered by BSRF included a mix of long and short trunk routes, as well as feeder services, spread across the island. Under BSRF, bus operators were rewarded or penalized based on how regular the bus arrival intervals are at bus stops and incentive amounts are calibrated in accordance with the effort[17].

4.4.2 Criteria, scoring, and implementation evaluation

Public transport network capacity improvement and service enhancement are the main objectives of the Service Enhancement Scheme. As the components of this scheme, the programs of ROPS, BSEP, and BSRF have been implemented. The progress of these programs, such as the length of rail network, the number of bus fleets, and the indicator on service performance, are reviewed monitored carefully. A2 of network capacity and A3 of service are assigned the score of 4.

The cost of capacity improvement and service enhancement is mainly assumed by the government, with a small fraction provided by the operators. In implementing the scheme, B3 of finance is only considered as an instrument to make the programs feasible. This is the same to B2 of operator profitability. Though incentive is provided to operators, the penalty is there as well. The plus or minus of profitability is depending on if the pre-determined service requirements are met. There is no mechanism proposed to secure the government financing and the profitability of operators.

Measures that promote public transport efficiency, such as shorter waiting times and higher service level, are implemented. However, efficiency indicates not only the benefits gained, but also the cost paid in exchange of the benefit. The investment of rail infrastructure is huge. The conclusion of better efficiency will need the review of the overall cost and benefit, for which, it is not seen yet. Therefore, for the criteria of efficiency (B1), a score of 3 is assigned.

Safety of D2 is scored as 3. Safety is essential for service, and to make the public transport competitive. It is enhanced while the capacity is developed. In ROPS and BSRF, there are specific service requirements on safety, such as the accident rate standards. The operators are required to meet a set of mandatory standards that establishes the performance required relating to service quality, safety and reliability. With more bus fleets and higher frequencies, there still needs proper review on safety criteria that a generally busier network taken shape by the high service standards may sometimes hinder the public transport safety.

Public opinions are valued in the implementation of the programs. According to LTA (Land Transport Authority, 2013), online consultations with public by form of surveys and discussion forums were taken place, which enabled policy makers to appreciate the perspectives of different users. It is shown that expanding the public transport network and improving service quality are the focus of public. In terms of C3 of acceptability, the score is 3.

As mentioned earlier, the Capacity Factor Fare Adjustment Scheme and Workfare Transport Concession Scheme are the designated schemes on affordability, to deal with the affordability issue under the

[17] https://landtransportguru.net/bus-service-reliability-framework/

background of capacity expansion. For the Service Enhancement Scheme that started earlier, the criteria of C1 of affordability was only proposed. The score is 2.

C2 of equity and D1 of environment is scored as 1, since they are just considered as the side benefit of the development of public transport capacity and service level.

For the Service Enhancement Scheme, criteria identified and criteria score can be summarized in the scheme sheet of Table 4.11.

Table 4.11 Scheme sheet – implementation of Service Enhancement Scheme

Criteria	Score	Description	Source
Network capacity	4	Rail lines under construction, bus fleets added	Long-term planning (Land Transport Authority, 2013)
Service	4	The objective of programs of ROPS and BSRF	Policy page on government website
Efficiency	3	shorter waiting times, higher service level promote efficiency	Urban transport economics research (Small & Verhoef, 2007)
Profitability	1	Operators are incentivized to have better service performance	Program introduction of ROPS and BSRF
Finance	1	The programs are mainly financed by the government	Program introduction of ROPS and BSRF
Affordability	2	Proposed only (implemented under NCF and WTCS scheme)	Affordability (Land Transport Authority, 2013)
Equity	1	Side-effect of public transport development	Policy instrument introduction (KonSULT, 2016)
Acceptability	3	Public surveys and discussion forums conducted	Report on policy progress on government website
Environment	1	Side-effect of public transport development	Research paper (Van Eggermond & Erath, 2016)
Safety	3	Requirement on safety standards	Policy page on LTA and PTC website

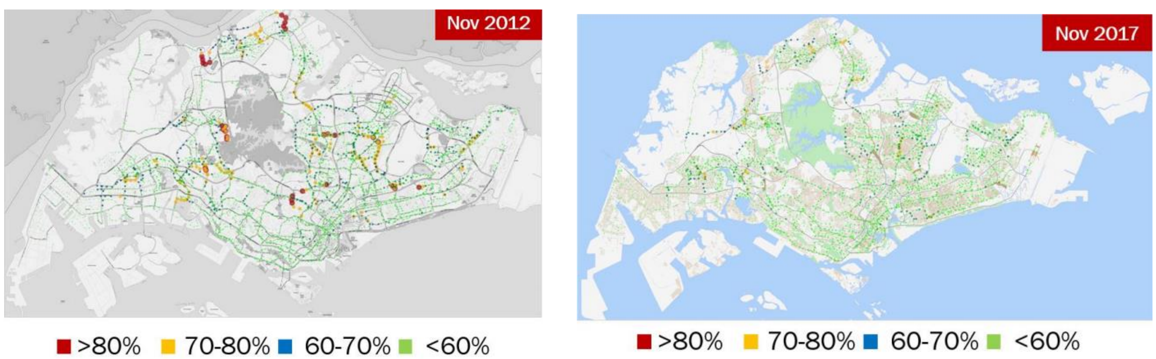
4.4.3 Policy performance

Capacity improvement

The expansion of public transport network, such as with the opening of new train lines and the introduction of new bus fleets, has allowed commuters to take more efficient travel routes, saving time and money(Leong, Goh, Hess, & Murphy, 2016). With the improved connectivity of the network, commuters have more flexibility to optimize their trips. (Public Transport Council, 2018a).

By the end of 2017, 1,000 new buses fleets and 80 new bus services were added to provide greater connectivity, ease commuter crowds and shorten waiting time. The waiting times during peak periods as maximum scheduled headways were reduced from 30 minutes to 20 minutes as part of BSEP, and had further improved to 15 minutes with the transition to the bus contracting model. The scheduled peak headways for feeder services are even shorter at six to eight minutes.

By the deployment of higher capacity buses and the operation of more frequent bus trips, the crowding has been reduced substantially, especially during peak periods. Figure 4.11 shows the comparison of loading during morning peak period in 2012 and 2017. The red color indicates a higher crowding degree, while the green color means less crowding. In 2012, the red color was seen at a couple of links. But in 2017, the green was prevailing in the city, with barely no red sign. According to the BSEP completion report, there was a 95% reduction in bus services which experienced overcrowding during the peak periods.



Source: LTA website https://www.lta.gov.sg/data/apps/news/press/2017/20171209_BSEPLoadingAMPP.pdf

Figure 4.11 Comparison of loading during morning peak period

In terms of the rail network, the new signaling system helped reduce the headway between trains during peak periods from 120 to 100 seconds. Together with more trains injected to the network, the capacity improved by as much as 20%. In summary, in terms of the network capacity, the scheme has resulted in tangible improvements through shorter waiting times, less crowding, and better connectivity for commuters.

Service enhancement

The Public Transport Customer Satisfaction Survey (PTCSS) is conducted by LTA and PTC annually to understand commuters' satisfaction with the public transport, as well as to identify areas for improvement (Public Transport Council, 2018d). The survey covered various aspects of public transport, such as safety and security, waiting times, reliability, comfort, service information and customer service. This survey can investigate the performance of the SES.

According to survey introduction, respondents are asked to provide a rating of '1' to '10' based on their level of satisfaction with and the importance of eight bus and MRT service attributes based on their latest journey on public transport, with '1' representing 'very dissatisfied/unimportant' and '10' representing 'very satisfied/important'. The service attributes are as follows:

- Safety and security
- Waiting time
- Reliability
- Service information
- Bus interchange/ bus stop/ MRT station accessibility
- Comfort
- Travel time
- Customer service

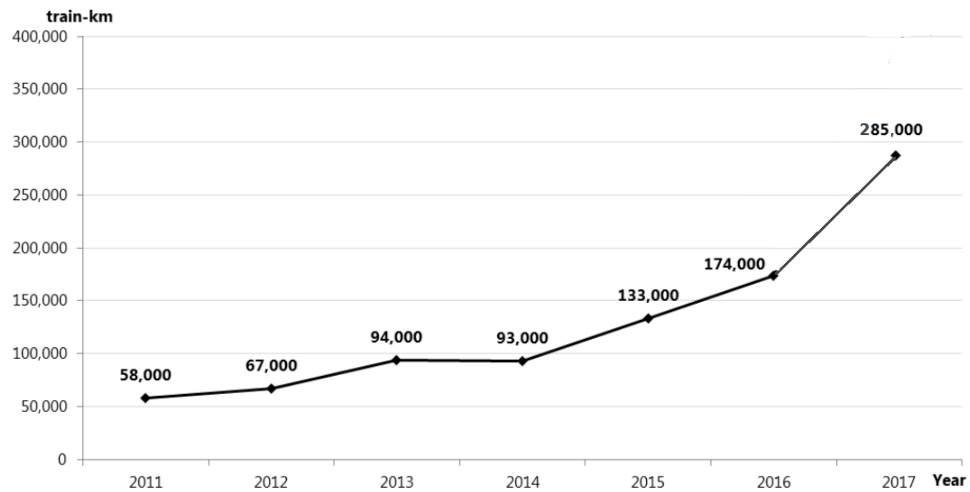
Table 4.12 shows the percentage of respondents' satisfaction with public transport from 2014 to 2018. This is the latest result that incorporates the 2018 survey.

Table 4.12 Satisfaction with public transport, bus, and MRT services

Year	2014	2015	2016	2017	2018
Public transport	91.3	91.8	96.4	94.5	97.9
Bus	90.2	90.7	96.7	96.7	98.0
MRT	92.8	93.2	96.0	91.8	97.8

The overall satisfaction on public transport increased from 91.3 in 2014 to 97.9 in 2018. For bus mode, the improvement is from 90.2 to 98.0; for MRT, it is from 92.8 to 97.8. basically, bus mode had a bigger progress, and a higher satisfaction rate.

The improvement of satisfaction is a reflection of the ROPS program. This is also identifiable from the indicator of Mean Kilometers Between Failure (MKBF) on MRT network. According to the report released by LTA (Land Transport Authority, 2019b), the mean distance travelled between delays that over 5-minute for the overall MRT network has raised from 133,000 train-km in 2015 to 285,000 train-km in 2017 (Figure 4.12). This can be attributed to the implementation of ROPS program, the huge government investments, and the public transport operators' effort to improve rail reliability over the past years.



Source: LTA website

Figure 4.12 MRT mean distance travelled between delays

For the bus mode, the indicator of Excess Wait Time (EWT) can be utilized to reflect the performance of BSRF program, which aims to improve bus reliability by reducing the instances of delay. EWT is the average additional wait time experienced by commuters at bus stops, compared to the scheduled wait time if the buses had arrived at regular intervals. A lower EWT score indicates that the service has had fewer instances of prolonged wait times on average in the assessment period (6-month). Detailed information of EWT for each bus route is available at the government website[18]. Based on the empirical analysis, paper (Leong et al., 2016) estimated the EWT improvements, and concluded that the BSRF trial in Singapore has yielded promising results to date with a majority of bus services under the trial notching improvements in their EWT scores.

Finance impact

The SES calls for huge investments. For the BSEP only, between 2012 and 2017, $1.1 billion was cost for the provision of new buses and services. According to the report from SMRT Company (SMRT Company of Singapore, 2016), the investments in service quality enhancements caused a financial burden to the company. There is also the need for workforce that SMRT Trains would employ or allocate at least 700 additional maintenance headcount or equivalent to approximately 20% increase, to meet the strict service standards. This is in addition to the 30% increase in technical workforce that SMRT Trains had made before 2016. Figure 4.12 has shown the basic data.

The finance gap created by SES is clear and would hamper the achievement of the scheme if it is not properly solved. The shift to the new finance scheme is necessary, which will be highlighted in next section.

[18] Results of Third BSRF Assessment Period, https://www.lta.gov.sg/data/apps/news/press/2016/20160509_Results_of_third_BSRF_assessment_period_(Jun%E2%80%93Nov15)_AnnexC.pdf

4.4.4 Indicator and performance evaluation

First of all is the capacity improvement progress. It is stated that by opening new rail lines, buying new trains, injecting new buses into the system through the BSEP and mandating higher service standards of ROPS and BSRF, bus and train capacities have increased by about 20% and 50% respectively between 2013 and 2018. This has reduced crowding, shortened waiting times and created more connections for you. ID3 of network capacity, which can be divided into bus capacity and rail capacity, are normalized as 1.200 and 1.5000, respectively.

The Statistics Department of Singapore records the Average Daily Public Transport Ridership for public transport utilization, and this information can be used to calculate ID2 of public transport ridership. The value of daily public transport ridership for the SES starting year of 2013 is 36010000 (person-trip). The available latest data is 3939000 (person-trip, as of 2016, date updated in March, 2018). The value for ID2 of public transport ridership is 1.094.

ID4 of service reliability is a good indicator to evaluate the performance of Service Enhancement Scheme. The government has officially checked the indicator of Excess Wait Time (EWT) on bus, and the indicator of Mean Kilometers Between Failure (MKBF) on MRT network. Considering the BSRF was a 2-year trial and the bus services joined the program in different time, it is not possible to generate the comprehensive service reliability indicator based on records of EWT of individual bus services. The MKBF is used as the indicator for service reliability. A comparison before and after the implementation of ROPS (the program came into effect from 1 January 2014) is carried out, to identify the “pure impact”.

Table 4.13 Service reliability comparison

Before ROPS	Year	2011	2012	2013	2014	annual rate
	MKBF	58000	67000	94000	93000	1.183
After ROPS	Year	2014	2015	2016	2017	annual rate
	MKBF	93000	133000	174000	285000	1.458
Comparison (difference of annual rate)						0.275

The annual increase rate of mean distances travel was 1.183, while after the implementation of ROPS program, the annual increase rate reached 1.458, a raise of 0.275. The normalized value for ID4 of service reliability is 1.275.

ID5 of operator profitability represents the financial status of public transport operators under the scheme. A good indicator for this purpose is the Earnings Before Interest and Tax (EBIT). To address the profitability issue, data on EBIT are collected based on operators’ financial statements (SMRT Company of Singapore, 2016) submitted to the PTC, and the data from 2014 (the scheme starting year) are listed in Table 4.14. The average annual decrease rate is adopted as the normalized value.

Table 4.14 Earnings Before Interest and Tax (EBIT) of operator

Year	2014	2015	2016	Normalized value
EBIT (million S$)	112	89	78	
Annual rate	NA	0.795	0.876	0.836

ID11 of public acceptability can be measured based on the result of public survey. In terms of Service Enhancement Scheme, the survey of Public Transport Customer Satisfaction Survey (PTCSS) that covers various aspects of public transport, such as safety and security, waiting times, reliability, comfort, service information and customer service, can provide reliable information on public satisfactory. As shown in Table 4.12 Satisfaction with public transport, bus, and MRT services, the satisfaction with overall public transport increased from 91.3 in 2014 to 97.9 in 2018. Normalizing the progress, we have the value of 1.072 for ID11 of public acceptability.

Safety of public transport, which is represented by the indicator of number of fatalities and number of injuries, is one important dimension to evaluate the sustainability performance of Service Enhancement Scheme. The indicator of number of fatalities and number of injuries are checked and released annually in the series of Statistics In Brief, which is available on the website of LTA[19]. The most up to date data are for 2014. Relevant data are compile in Table 4.15.

Table 4.15 Fatality and injury of transport accident

Accident	2010	2011	2012	2013	2014	2012/2014
Fatalities	193	197	168	160	154	1.091
Injuries	11065	9752	9106	8902	9834	0.926

The scheme started in 2013. The data for 2012 and 2014 are selected for the before and after comparison, and the result is listed in the right column of the table. ID13 of number of fatalities and ID14 of number of injuries are normalized as 1.091 and 0.926, respectively.

The promotion of public transport, due to the network capacity improvement and service enhancement, would benefit the environment sustainability, though it is not the main objective of the Service Enhancement Scheme. It hasn't been mentioned that a certain amount of green bus fleets were introduced to the bus network under the scheme. Therefore, it is reasonable to take account of ID12 of emission as the indicator on environment performance, to make the evaluation complete.

From the Statistics Department of Singapore[20], the data of major emissions produced by urban transport system are collected. The before (2013) and after (2014) data are listed in Table 4.16.

Table 4.16 Major emissions produced by urban transport system

Emissions	O^3	NO_2	SO_2	
2013	25	139	14	Mean
2014	24	135	12	
Change ratio	1.042	1.030	1.167	1.079

[19] https://www.lta.gov.sg/content/ltaweb/en/publications-and-research.html

[20] O^3 data: https://data.gov.sg/dataset/air-pollutant-ozone;
NO_2 data: https://data.gov.sg/dataset/air-pollutant-nitrogen-dioxide;
SO_2 data: https://data.gov.sg/dataset/air-pollutant-sulphur-dioxide

Calculating the arithmetic mean of the changes of these emissions, the normalized value is noted as 1.079.

The indicators can be summarized in the scheme sheet of performance of Service Enhancement Scheme.

Table 4.17 Scheme sheet – performance of Service Enhancement Scheme

Indicator	Normalization score	Description	Source
network capacity (bus)	1.200	Injection of buses through the BSEP	LTMP 2040 (Land Transport Authority, 2019a)
network capacity (rail)	1.500	Construction of new rail lines	LTMP 2040 (Land Transport Authority, 2019a)
public transport ridership	1.094	Result of capacity and service improvement	Statistics Department of Singapore
service reliability	1.275	Government records MKBF for MRT network	LTA report (Land Transport Authority, 2019b)
operator profitability	0.836	Higher service standards cost higher to operators	Operators' financial statements (SMRT Company of Singapore, 2016)
public acceptability	1.072	Survey of Public Transport Customer Satisfaction	PTC report (Public Transport Council, 2018d)
number of fatalities	1.091	Fatalities caused by transport accident	Statistics In Brief on LTA website
number of injuries	0.926	Injuries caused by transport accident	Statistics In Brief on LTA website
emission	1.079	Impact of public transport promotion and green bus	Statistics Department of Singapore

4.4.5 Scheme summary

Unlike the Distance-based Fare Scheme, the NCF Fare Adjustment Scheme, and the Concession scheme, which have the direct and immediate effect on the transport system, the Service Enhancement Scheme has wider impacts that take time to be effective. In evaluating the performance, the outcome indicators (see Table 3.2 for the hierarchy of policy objective) is utilized to capture the changes accumulated in a short-term.

For bus, with the Bus Service Enhancement Program (BSEP), more buses are on the road. With Bus Service Reliability Framework, bus regularity and reliability are improved. With fewer crowded services during peak hours and shortened waiting times, as well as the improved connectivity, the trips are made easier.

For trains, stronger maintenance programs are showing good results. Taking into account the additional train trips that the system is running, train reliability has improved and is still being improved. New trains ease crowdedness. At the same time, the Government is investing in rail infrastructure, and new lines or extensions are to open every year in the next few years.

Service regulation should be strengthened to ensure that operators would not compromise on their basic obligations while being motivated to be cost efficient.

4.5 New Finance Scheme

The service enhancement, including providing good service of public transport system, improving network capacity for seamless connectivity, and ensuring the safety for the commuters, is the shared responsibilities of the government and public transport operators, and the finance of that tends to come from two main sources, the fare box and financial support from local/transit authorities.

An appropriate financing framework for public transport balances the Government's financial sustainability, the operators' profitability, the commuters' affordability, while keeping high service standards. In Singapore, with the launch of the Service Enhancement Scheme, the New Finance Scheme that covers the infrastructure planning and the business structure of public transport is called for.

4.5.1 Policy implementation

Problem identification and scheme objective

Under the previous framework, the Government plans and provides the transport infrastructure. The operators provide public transport services to commuters under the regulatory oversight of the Land Transport Authority (LTA) and the Public Transport Council (PTC). Commuters pay public transport fares, which help cover the operating costs of the operators. For the long-term sustainability of the framework, public transport fares have to be revised regularly to adjust to justifiable cost increases, in order to ensure the operators to generate sufficient revenue to cover their operating costs and implement sustainable asset replacement and growth plans.

On the social ground, fare also needs to be regulated to keep it affordable to the public. The old finance framework did well to benefit commuters by keeping public transport fares at very affordable levels (see Figure 4.10).

All infrastructure costs for the construction of new rail lines and other public transport infrastructure is backed up by the Government. To meet the investment gap, the NCF Fare Adjustment Scheme was applied to reflect the capacity cost by slightly increasing the fares. However, the scheme does not recover the past operating costs nor infrastructure construction costs. The operation and service quality enhancements caused a financial burden to the operators, which is reflected in the operators' profitability, as discussed previously. The public transport industry faced a deteriorating financial situation.

In summary, under the previous finance framework that based on the partnership between the Government and the operators, due to the pressure of fare affordability, and the network expansion, as well as the service enhancement to meet the increased demand, the financing of public transport system is not sustainable. This situation created the necessity of finance scheme changes for public transport. With the introduction of Service Enhancement scheme to decisively and expeditiously improve network capacity and service levels, a new finance scheme is needed to better sustain the development of public transport in the changing social and operating environment.

Policy design and preparation

The New Finance Scheme is composed of the Bus Contracting Model (BCM) and the New Rail Financing Framework (NRFF), for bus and rail mode respectively.

Bus Contracting Model (BCM)

The objective of the BCM program is to make public bus services more responsive to changes in ridership and commuter needs, as well as inject more competition into the industry. The essence is the restructuring of the contracting model. The previous model of Bus Service Operating Licenses that held by the two main bus operators is expired and substituted by competitive tendering mechanism, which welcomes more operators to join. The role of the Government is strengthened. It determines the bus routes and the service standards, as well as the service fee to the operators who successfully awarded through the bidding. All bus infrastructure and operating assets, as well as the fare revenue are retained by the Government[21].

This shift of ownership synergies with the competitive tendering mechanism. It lowers the barriers of entry to the market, attracts more bus operators, and promotes greater competition and efficiency among operators. In the long-term, this would lead to the provision of better bus services in a cost-competitive manner, thus benefitting commuters.

The comparison of the Bus Contracting Model (BCM) and the old finance framework would provide a better understanding[22], as shown in Table 4.18.

Table 4.18 Comparison of previous model with BCM

Model type	Previous Model	Bus Contracting Model (BCM)
Asset ownership	All operating assets owned by both Government and Operators	Government owns all bus assets
Service	Operators make decisions on service, unprofitable services often do not receive improvements	LTA is the central bus planner, decides on bus services to be provided, and the service standards which operators have to meet
Fare revenue	Bus operators keep the fare revenue	Bus operators are paid service fee, with incentives and penalty

[21] LTA website: Commuters Will Experience More Responsive Bus Services and Higher Service Levels, https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=28fca09a-bed6-48f4-99d4-18eeb8c496bd

[22] Bus Contracting Model, https://landtransportguru.net/bus/bus-contracting-model/

Expenditure	Service and operating expenses	All fare revenue will be retained by the Government and to ensure the affordability of public transport fares
Operators	Only 2 major operators (SBS Transit and SMRT)	Bus operators bid for bus service packages through a competitive tendering process

The BCM has the advantage of amplifying the ability of the central Government on quick response to changes in travel demand and service level expectations. It can secure the affordability without hurting the profitability of the operators. With the revenue guarantee from the Government, bus operators are able to focus more on operating the bus services and meeting service standards. In addition, with the introduction of market competition, the public transport market is supposed to be more efficient and beneficial to commuters.

Regarding the design of the tending mechanism, all tender submissions are evaluated by LTA. When the bid is awarded, the winner operator is required to set up a local company for operation, under the supervision of LTA. Generally, the contract lasts for 5 years, and can be extended by another 2 years with good performance. During the contract period, the service fee is paid on a monthly basis, which will be adjusted to better reflect the operating cost, considering factors such as inflation, wage levels, and fuel costs.

New Rail Financing Framework (NRFF)

The objective of the NRFF is to transfer the operating assets and responsibility of investing from the operators to the Government.

As discussed previously, when the rail operators own the operating assets and bear the financial risk, they may be reluctant to undertake capacity expansion and service enhancement, as well as response to growing demand actively, due to the profit-seeking essence. This was the case before.

Under the NRFF, while the daily operation is still managed by operators, rail infrastructure and operating assets are placed in the hands of the Government. This change of assets' ownership would free operators from financial concerns and enable them to focus on rail service that the operators are obligated to maintain the service standards according to requirements made by the Government. It is also good for the Government to undertake integrated and long-term planning for the whole rail network.

The NRFF builds a partnership between the Government and the operators of sharing profit and risks. This profit and risk sharing mechanism is expressed by the comparison between the previous framework and the new NRFF[23].

Table 4.19 Comparison between previous financing framework and NRFF

Framework type	Previous financing framework	NRFF
License period	30 to 40 years	15 years

[23] https://www.lta.gov.sg/data/apps/news/press/2016/20160715_NRFF.pdf

Rail infrastructure	Government funds the capital cost of public transport infrastructure	
Operating assets	Rail operators own, maintain and make decisions on operating assets	LTA owns and make decisions on the assets, while rail operator remains responsible for maintenance
Regulatory regime	Outcome-based regulation	Outcome-based regulation coupled with process-based regulation for maintenance
Revenue risk	All fare and non-fare revenue risk borne by rail operators	LTA shares in revenue risk with rail operator
Regulatory risk	All regulatory risk borne by rail operators	Costs incurred by regulatory changes are compensated by government grants to rail operator, vice-versa
License charge	No license charge	Rail operator pays an annual license charge into the railway sinking fund for operating assets
Operators' profit margin	No cap on EBIT margin	"cap and collar" mechanism applies. The license charge increases with higher profits, vice-versa
Fares	Regulated by Public Transport Council	

With the profit and risk sharing mechanism, if profits outperform, operators will pay an increased License Charge to the Government fund; If there are changes to the operator's operating cost or revenue incurred by regulatory changes initiated by the Government, the Government may reimburse the operator, or vice-versa. The "cap and collar" mechanism keeps an operator EBIT margins within a range (not to exceed 5% and fall below 3.5%).

Regarding the contract management, the operating licenses would be valid for 15 years. The shorter licensing periods would boost competition in the rail industry, compel incumbents to improve the efficiency and service, and provide the flexibility for the Government to adjust the licenses' conditions, based on the developments of public transport sector. The new framework attracted new players into the industry, such as Australia's Tower Transit and UK's Go-Ahead.

In summary, the NRFF is an integral part of the Government's effort to enhance the quality, reliability and sustainability of the rail system. With the NRFF, the Government is able to plan network capacity holistically and improve rail capacity in a timely manner. Operators are focused on providing the service without financial concerns. Commuters are also benefited from a rail network with a higher service level and advanced capacity, which is more responsive to their needs.

Policy implementation

The BCM was first announced in 2014. Since then, the bus services were gradually taken under the new scheme. The entire bus industry completed its transition to the new contracting model in September 2016.

The bus services were shifted to competitive tendering through a gradual transition. The whole bus services were bundled into fourteen bus packages with about 300-500 buses each under BCM scheme. To deal with the existing contacts, negotiations with the incumbent operators (SBS Transit and SMRT) were held. In 2016, there were still 11 packages within the contract period signed years ago with SBS Transit and SMRT. For the purpose of full completion of bus industry into BCM, the two dominant bus operators in Singapore agreed to continue operating their existing bus routes for the remaining contract years (after which the route packages will be up for open tender) under a negotiated contract which basically applied the BCM framework. The bus services packages were gradually tendered out, after such negotiated contracts expire. Detailed information on bus packages and the contacting is available from the Government website[24]. This gradual, phased transition allowed the Government to refine and improve the management of contracts, as well as the tendering and handover process, and minimize the risk of service disruption. This is also good to the employees of SBS Transit and SMRT for not being affected by the full implementation of the BCM, since there was no change of operators for existing bus services.

The transaction of assets is based on the net book value, which is considered to be fair and objective (this was also the approach used for the transfer of assets from the Government to operators in 1998, will elaborate later). Rather than the mass purchasing of existing buses, the government decided to lease all operator-owned buses from SBST/SMRT at the expense equal to buy-over the buses at net book value as of 1st September 2016 (the transaction day). At the same time, new Government-owned buses were reallocated to their new operators as more route packages are handed over. Altogether, close to S$7.2 billion were given to SBS Transit and SMRT Buses on this phase of the BCM transition, and in return, LTA would collect all fare revenue gathered by these bus operators. Similarly, the operators have to deliver service standards set by the LTA.

The transition to NRFF went through a similar way. The first implementation of the NRFF scheme was for the Downtown Line operated by the operator of SBS Transit, the longest underground Line in Singapore with a length of 42km Line with 34 stations with full service commence on 21 October 2017. NRFF then subsequently extended to other lines operated by SMRT, such as the North-South and East-West Lines. The transaction was made after more than four years of intense negotiations between operators and the Government[25].

For SBS Transit, the full transition to the NRFF was made on 1 April 2018. The license for SBS Transit to operate the lines was awarded, and the expire date is set at 31 March 2033. The Government took over all operating assets from SBS Transit for $30.8 million, representing the net book value of the assets. SBS Transit continues operating its lines on a daily basis and retains a share of the earnings. It pays a license charge to LTA annually, which varies according to SBS Transit's profitability. Also, higher service standards are mandated with SBS Transit.

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[24] https://landtransportguru.net/bus-industry-completes-transition-to-bus-contracting-model/
[25] https://landtransportguru.net/new-rail-financing-framework/

SMRT Trains made a full transition to the NRFF on 1 October 2016 with a license to operate the lines until 30 September 2031. The net book value for taking over the operating assets is $1.06 billion. Other arrangements are similar with SBS Transit.

With the implementation of the NFS, the Government becomes the owner of all operating assets and takes the responsibility to build up, replace and upgrade the operating assets in a timely manner. Rail operators, relieved of heavy capital expenditure, can focus on providing reliable and well maintained rail services for commuters.

4.5.2 Criteria, scoring, and implementation evaluation

As the associated scheme for the SES scheme, the objective of NFS is, through the new financial instruments, to realize the improvement of network capacity and the enhancement of service. With the implementation of NFS, the financial situation, the capacity and service progress are monitored all the time. Therefore, the criteria of A2 capacity, A3 service, and B3 finance are assigned with the score of 4, based on the level of implementation.

Competition mechanism, as well as the incentive and penalty framework have been introduced to the public transport industry by the NFS, to promote the efficiency. However, further examination is needed to review the intended output. 3 would be the appropriate score of B1 of efficiency.

The acceptability of operators is addressed by the negotiations held with the operators. At the same time, the commuters are all made clear about the benefits the scheme would bring about. Right now, it is not seen any particular action taken to monitor the afterthoughts of operators after the buy-out (and the commuters are supposed to be happy with the result since there is no direct cost to them at all). The score for C3 acceptability is 3.

In the scheme document that posted on the Government website, affordability of public transport fares for commuters are proposed to be ensured under the new finance model. Score of C1 affordability is 2. Finally, the NFS is considered to facilitate the long-term sustainability of public transport system and environment. For A1 modal-integration and D1 environment, the score is 1.

For the New Finance Scheme, criteria identified and criteria score can be summarized in the scheme sheet of Table 4.20.

Table 4.20 Scheme sheet – implementation of New Finance Scheme

Criteria	Score	Description	Source
Modal integration	1	Connections between rail and bus network are promoted	LTMP 2013 Report (Land Transport Authority, 2013)
Network capacity	4	NFS provides funds for investment in transport infrastructure	Policy webpage on government website
Service	4	NFS is the associated scheme of SES scheme to back-up service	Program introduction of ROPS and BSRF

Efficiency	3	Introduction of competition mechanism into public transport industry promote efficiency	Urban transport economics research (Small & Verhoef, 2007)
Finance	4	New financial framework for bus and rail are implemented	Program introduction of BCM and NRFF
Affordability	2	Ensured through the fare adjustment regulated by PTC	Affordability (Land Transport Authority, 2013)
Acceptability	3	Negotiations with operators were held in making the contracts	Report on policy progress on government website
Environment	1	Long-term effect of public transport development	Long-term planning (Land Transport Authority, 2013)

4.5.3 Policy performance

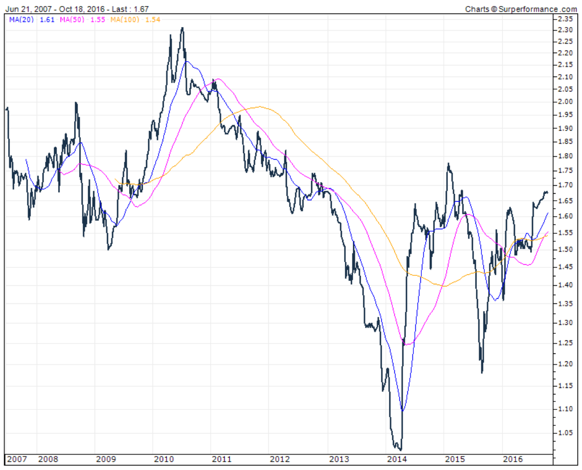
With the NFS, operating assets are transferred to the Government, making the public transport keep pace with growing ridership demand, more capable to support the investment and construction of transport infrastructure, as well as the greater internal competition, thereby raising service levels for commuters over time.

Chronologically, the NFS started later than the SEP. It is actually the supporting scheme for SEP. The need of network expansion and service enhancement is admitted, and the SEP was lunched to meet the need. However, after the short-term implementation of SEP, the financial situation was unsustainable, which creates the necessity of transforming into the NFS. Therefore, for the discussion of policy performance in this section, the focus is on the financial impact of NFS on the public transport operators and the Government. As for other aspects, such as the impact on capacity development and service enhancement, due to the associated relationship with SEP, they have been discussed in SEP section.

Financial impact on public transport operators

The two dominant operators in Singapore, the SBS Transit Ltd and SMRT Corporation, were both public listed companies on the Singapore Stock Exchange, previously. They were both commercially viable and had operated successfully on a commercial basis, with no direct operating subsidies from the Government. Fare revenue are the major source of revenue to the operators, which is regulated by the PTC. As the independent company, the fares, advertisement and rental revenues need to cover operating and maintenance expenditure and depreciation. The public transport infrastructure, as the sunk cost, is funded by the Government, to ensure the commercial viability of the operators.

However, with the announcement of the NFS, this commercial basis was fundamental changed. The change of stock price may imply the impact of the new finance scheme on the companies (Figure 4.13).



SMRT Corporation

SBS Transit Ltd

Source: https://www.marketscreener.com/

Figure 4.13 NFS impact on stock price of operators

It is clear that at the time of the scheme came into effect (the year of 2014), the stock price of both companies hit the bottom. It is worth noting that in September 2016, Temasek Holdings, a subsidiary of the Government established in 1987, completed a successful takeover of SMRT, which resulted in SMRT being delisted from the Singapore Exchange and returning to government control. All its train operating assets were sold to the government under the NRFF. This is the reason why the stock line for SMRT stopped at the year of 2016.

Financial impact on Government

It is reported by the Ministry of Transport[26] that the Government subsidies for BCM would amount to $3.5 to $4 billion over the next five years, while the cost of rail operating assets for the next five years was expected to exceed $4 billion, under NRFF. Considering the annual budget of Singapore Government of around $80 billion[27], it is a huge finance burden.

The Land Transport Authority Annual Report 2017/18 (Land Transport Authority, 2018b) provided detailed information on the operating income and expenditure (Figure 4.14).

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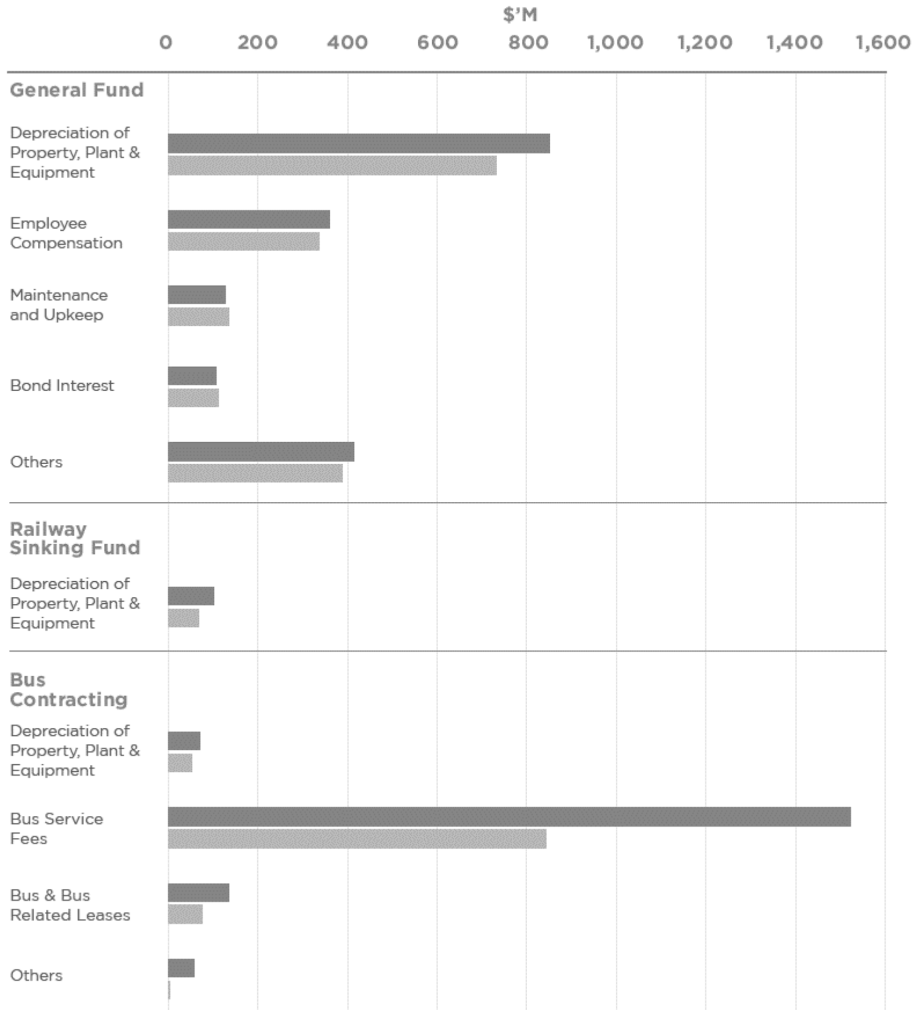
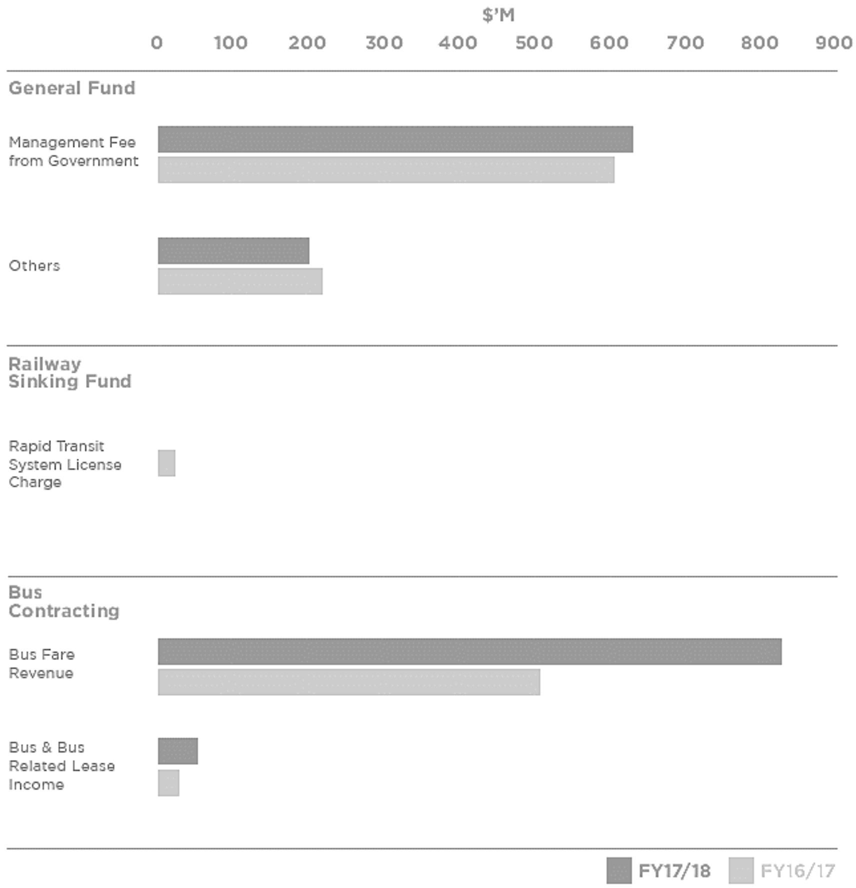
[26] Ministry of Transport. “Written Reply by Minister for Transport Khaw Boon Wan to Parliamentary Question on the Possibility of a Fare Reduction with the New Operating Models for Public Transport”, September 13, 2016. Retrieved from https://www.mot.gov.sg/News-Centre/News/2016/Written-Reply-by-Minister

[27] Government website of Singapore, https://www.singaporebudget.gov.sg/budget_2019/revenue-expenditure



Operating expenditure



Operating income

Source: Land Transport Authority Annual Report 2017/18

Figure 4.14 NFS impact on operating expenditure and income of LTA

As can be seen, the total operating income of $1,728m in FY17/18 is an increase of $318m (23%) over FY16/17 ($1,410m), and the operating expenditure saw an increase of $1,034m (38%), from $2,718m to $3,752m. Compare to the previous fiscal year, the major change lies in the expenditure of bus service fee and the revenue of bus fare revenue, due to the rapid progress of NFS, especially the full completion of BCM in 2016 (full completion of NRFF is in 2018).

4.5.4 Indicator and performance evaluation

The financial burden of the Government can be reflected by the ID6 of government expenditure. The annual government grants to LTA, the designated fund to balance the government expenditure on transport, is recorded and published by the Land Transport Authority Annual Report. The latest report available is for the fiscal year of 2017-2018. Data compiled from the report, stating from the launch of NFS, is plotted in Figure 4.15 and listed in the Table 4.21.

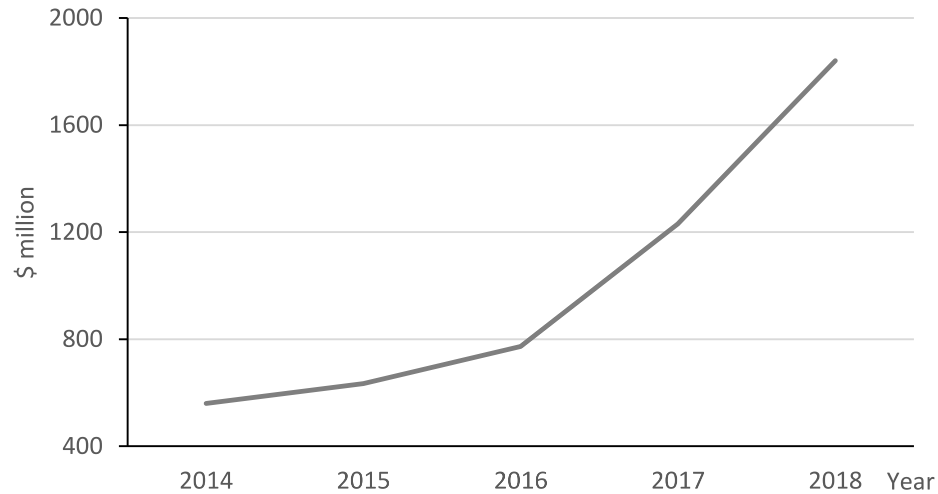


Figure 4.15 Government transport grant

The annual rate of Government grant is accelerating along with the progress of the NFS, told by the curve. The calculation of annual rate is done in the table. The average annual increase rate of Government grant is 1.360. Considering the negative attribute of the expenditure indicator, the normalized value is taken as 0.740.

Table 4.21 Annual increase of Government transport grant to LTA

Government transport grant	Year	2014	2015	2016	2017	2018
	$ million	560	634	773	1231	1840
	Annual rate	NA	1.132	1.219	1.592	1.495
Average annual rate						1.360

Put it in the scheme sheet of performance of NFS Scheme, we have:

Table 4.22 Scheme sheet – performance of New Finance Scheme

Indicator	Normalization score	Description	Source
government expenditure	0.740	Huge Government finance is needed	Land Transport Authority Annual Report 2017/18 (Land Transport Authority, 2018b)

4.5.5 Scheme summary

Under the NFS for bus and rail, the operators were turned to be asset-light and more cost efficient in providing public transport services. Operating assets are owned by the Government.

Rail operators would continue to collect fare revenues, and pay an annual license charge – channeled to LTA's Railway Sinking Fund – for the right to operate, and responsibility to maintain the MRT lines. The license charge was structured with a cap and collar to keep the Earnings before Interest and Taxes (EBIT) margin for rail operators at about 5 percent. Similarly, the PTC would determine adjustments to rail fares. Under the NRFF, LTA would share operating revenue fluctuations with rail operators via a flexible license fee paid by the latter, while rail operators would continue to apply for fare changes.

4.6 Aggregation of policy schemes

Pricing schemes under the LTMP 2013 package have been reviewed following the policy cycles of problem identification, design and preparation, and implementation. At the same time, the proposed the analytical framework has been applied on each schemes, producing the scheme sheets with policy implementation and performance information. In this section, the criteria and scores, and the performance indicators for individual scheme are aggregated, for the purpose of evaluation of the pricing package.

4.6.1 Policy implementation aggregation

The criteria aggregation sheet aggregates all the implementation information of each scheme sheet.

Table 4.23 Criteria aggregation sheet for Singapore

Category	Criteria	Score	Scheme
transport system	modal integration	4	Distance-based Fare Scheme
		1	Workfare Transport Concession Scheme
		1	New Finance Scheme
	network capacity	3	Distance-based Fare Scheme
		3	NCF Fare Adjustment Scheme
		4	Service Enhancement Scheme
		4	New Finance Scheme
	service	4	Service Enhancement Scheme
		4	New Finance Scheme
economics	efficiency	2	Distance-based Fare Scheme
		3	NCF Fare Adjustment Scheme
		3	Workfare Transport Concession Scheme
		3	Service Enhancement Scheme
		3	New Finance Scheme
	profitability	1	Distance-based Fare Scheme
		1	Workfare Transport Concession Scheme
		1	Service Enhancement Scheme
	finance	4	NCF Fare Adjustment Scheme

		3	Workfare Transport Concession Scheme
		1	Service Enhancement Scheme
		4	New Finance Scheme
society	affordability	3	Distance-based Fare Scheme
		3	NCF Fare Adjustment Scheme
		4	Workfare Transport Concession Scheme
		2	Service Enhancement Scheme
		2	New Finance Scheme
	equity	1	Distance-based Fare Scheme
		3	NCF Fare Adjustment Scheme
		4	Workfare Transport Concession Scheme
		1	Service Enhancement Scheme
	acceptability	3	Distance-based Fare Scheme
		3	NCF Fare Adjustment Scheme
		4	Workfare Transport Concession Scheme
		3	Service Enhancement Scheme
		3	New Finance Scheme
externality	environment	2	NCF Fare Adjustment Scheme
		1	Service Enhancement Scheme
		1	New Finance Scheme
	safety	3	Service Enhancement Scheme

Criteria and scores identified from policy implementation of each pricing scheme in Singapore are collected and arranged in terms of categories. The last column of the table also notes the specific contributing scheme.

4.6.2 Policy performance aggregation

The indicator aggregation sheet aggregates the performance information of each scheme sheet. It reports the indicator values, the corresponding scheme, as well as the category.

Table 4.24 Indicator aggregation sheet for Singapore

Indicator	Value	Scheme	Category
average public transport fare	1.065	Distance-based Fare Scheme	transport system
operator profitability	0.948	Distance-based Fare Scheme	economics
revenue distribution	0.950	Distance-based Fare Scheme	society
average public transport fare	0.957	NCF Fare Adjustment Scheme	transport system
operator profitability	1.052	NCF Fare Adjustment Scheme	economics
affordability	0.979	NCF Fare Adjustment Scheme	society

public transport fare (low-income)	1.150	Workfare Transport Concession Scheme	society
affordability	1.167	Workfare Transport Concession Scheme	society
government expenditure	0.830	Workfare Transport Concession Scheme	economics
operator expenditure	0.950	Workfare Transport Concession Scheme	economics
network capacity (bus)	1.200	Service Enhancement Scheme	transport system
network capacity (rail)	1.500	Service Enhancement Scheme	transport system
public transport ridership	1.094	Service Enhancement Scheme	transport system
service reliability	1.275	Service Enhancement Scheme	society
operator profitability	0.836	Service Enhancement Scheme	economics
public acceptability	1.072	Service Enhancement Scheme	society
emission	1.079	Service Enhancement Scheme	externality
number of fatalities	1.091	Service Enhancement Scheme	externality
number of injuries	0.926	Service Enhancement Scheme	externality
government expenditure	0.740	New Finance Scheme	economics

There are 20 indicators collected from 5 pricing schemes in Singapore, listed following the order of schemes being evaluated. The last column of the table notes the specific category.

4.6.3 Integration and visualization of the result

The criteria aggregation sheet (Table 4.23) and indicator aggregation sheet (Table 4.24) have been loaded with policy implementation and performance information respectively. As the last step of the analytical framework (3.1.6), the multi-level aggregation approach is taken, to integrate all the derived criteria and indicator scores for the evaluation of the pricing policy package.

Detailed description of the process is shown in Figure 3.14. Following the process, the integration of implementation score in done in Table 4.25.

Table 4.25 Integrated implementation score

Category	Criteria	Score	criteria score	weight	weighted score	weighted category score	integrated implementation score
transport system	modal integration	4 1 1	6	0.030	0.182	0.864	1.316
	network capacity	3 3 4 4	14	0.023	0.318		
	service	4 4	8	0.045	0.364		
economics	efficiency	2 3 3 3 3	14	0.018	0.255	0.618	0.942
	profitability	1 1 1	3	0.030	0.091		
	finance	4 3 1 4	12	0.023	0.273		
society	affordability	3 3 4 2 2	14	0.018	0.255	0.750	1.143
	equity	1 3 4 1	9	0.023	0.205		
	acceptability	3 3 4 3 3	16	0.018	0.291		
externality	environment	2 1 1	4	0.030	0.121	0.394	0.600
	safety	3	3	0.091	0.273		

Equal weighting method is adopted, as discussed in 3.1.6. There are 11 criteria, therefore the weight for each criteria is 1/9=0.091. The weight listed in the Table 4.25 has considered the number of schemes registered under each criteria, which can multiply with criteria score directly, for the weighted score.

The multiplier is applied in the normalization of the weighted category score, to make the total sum of the integrated implementation score as 4. This is in accordance with the 4 categories of urban transport system. The same principle is also applied in the later normalization of integrated performance score, making the comparison of policy implementation and performance on the same scale.

In order to produce the integrated performance score, the indicator aggregation sheet (Table 4.24) needs firstly rearranged in terms of categories. The transformation is done in Table 4.26.

Table 4.26 Integrated performance score

Category	Indicator	Indicator value	Category score	Categorical average	Integrated implementation score	Integrated performance score
transport system	average public transport fare	1.065	5.816	1.163	1.316	1.442
	average public transport fare	0.957				
	network capacity (bus)	1.200				
	network capacity (rail)	1.500				
	public transport ridership	1.094				
economics	operator profitability	0.948	5.356	0.893	0.942	0.792
	operator profitability	1.052				
	government expenditure	0.830				
	operator expenditure	0.950				
	operator profitability	0.836				
	government expenditure	0.740				

society	revenue distribution	0.950	6.593	1.099	1.143	1.183
	affordability	0.979				
	public transport fare (low-income)	1.150				
	affordability	1.167				
	service reliability	1.275				
	public acceptability	1.072				
externality	emission	1.079	3.096	1.032	0.600	0.583
	number of fatalities	1.091				
	number of injuries	0.926				

The category score is the sum-up of indicator values under the same category, which aggregates the impacts created by different schemes. The categorical average indicates the degree of changes for that particular category. A value above 1 means a progress while below 1 means regress. Multiply categorical average with the integrated implementation score and then normalize the result under the principle of total sum as 4, we have the final integrated performance score.

Visualization by radar chart is shown in Figure 4.16. The 4 dimensions of the radar chart are the 4 categories of transport system, economics, society, and externalities, respectively. The orange curve stands for the policy implementation, while the blue curve is the policy performance.

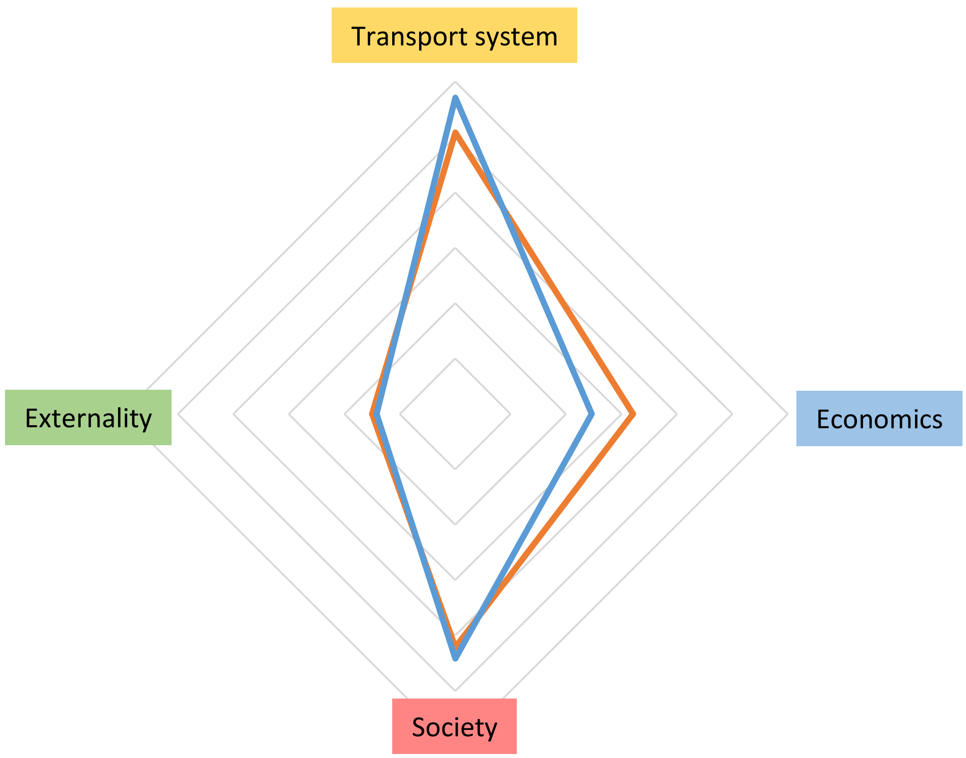


Figure 4.16 Singapore pricing policy implementation and performance

Based on the visualization, it is clear that transport system and society are emphasized in the pricing policy in Singapore. There are gaps between policy implementation and performance in terms of transport system and economics, and the major trade-off is the sacrifice of economics, for the improvement of transport system.

4.7 Chapter summary

In this chapter, pricing schemes in Singapore are evaluated through the integrated analytical framework propose in Chapter 3. Within the evaluation of each scheme, the introduction follows the policy cycle: from problem identification, to policy design and implementation. MCE method is used in policy implementation evaluation, while indicator-based evaluation is carried out in policy performance evaluation. After all schemes are investigated, the results are aggregated. Integrated implementation and performance scores are calculated and visualized at the end.

Singapore's pricing policies as a whole, transport system and society are emphasized in terms of policy intention. Based on the radar chart, the major trade-off is the sacrifice of economics, for the improvement of transport system.

5 Public Transport Pricing Policy in HK

Similarly, Hong Kong is a high-dense island city with large population, yet with a reputation of an advanced public transport system. According to the report of Public Transport Strategy Study (HKSAR Transport and Housing Bereau, 2017) conducted by the Hong Kong Government, there are over 12 million passenger trips are made through different public transport services in Hong Kong, which accounts for over 90% of the total passenger trips each day, the highest in the world.

Pricing policies are essential to sustain such a system, considering the background that public transport are operated by private operators without direct government subsidy. The pricing needs to be fair to both commuters and operators, namely balancing between affordability and profitability. On top of this, there is the necessity of a suitable financing mechanism for the government, as well as the service regulations to guarantee the efficiency and resiliency of the public transport system.

In this chapter, 4 pricing schemes that currently under implementation are reviewed. They are the Fare Adjustment Scheme, the Work Incentive Transport Subsidy Scheme, the Public Transport Subsidy Scheme, as well as the Service Programs. Generally, they are in a good correspondence with the identified schemes with Singapore. Unlike Singapore's case with the LTMP 2013 package, these schemes in Hong Kong are not launched at one time. However, except the Public Transport Subsidy Scheme that started from the beginning of 2019, the other schemes were in effect around 2012 -2014, making the comparison between the 2 cases possible.

In the following part of this chapter, the pricing schemes are reviewed and analyzed through the analytical framework. Based on that, policy evaluation and comparison will be carried out.

5.1 Fare Adjustment Scheme

5.1.1 Policy implementation

Problem identification and scheme objective

Regulating and adjusting fare is the fundamental pricing scheme. The key principles for fare adjustment are the maximization of profit and social welfare. As for the private public transport operators, the priority will be the maximization of profits, while the government will tend to focus on the society welfare. A public sector operator will nonetheless need to consider the financial implications of every decision that it makes, and conversely the private sector operator may not have complete freedom to pursue the maximization of profits with no regard for overall welfare (KonSULT, 2016).

In Hong Kong, the public transport service operators are private companies without direct government subsidy. There is only limited support from the government, which means they have to sustain the businesses with the revenue they earn from providing the services and investment in other aspects. Therefore, the government and the service operators, such as the MTR Corporation Limited (MTRCL), the Kowloon Motor Bus Co. (1933) Limited and the New World First Bus Services Limited, conduct fare adjustment reviews regularly and jointly strive to control fares to ensure its affordability while maintaining the financial provision of the operators at the same time (Chu, 2017).

Policy design and preparation

In designing the fare adjustment, the costs of operators, the changes of macro-economic situation, as well as the possible impact on public transport industry should be properly reflected. The fare adjustment mechanisms for rail and bus modes, which are the 2 main modes in Hong Kong, are introduced separately, considering their different development paths.

Before 2007, the rail operators (MTRCL) was authorized to set and adjust fare according to the factors, such as the operating company's financial situation and commerce strategies. The setting and adjustment was totally based on the company' decision, other than principles or mechanisms. The process was not disclosed and the public just passively accepted the changes.

In 2007, the Fare Adjustment Mechanism, which is an objective and transparent formulaic approach took effect in determining fare adjustments, replacing the fare autonomy of MTRCL. The scheme was first discussed in the Legislative Council and then approved through voting at the MTRCL's shareholders meeting, and finally included as a condition for the merger. Therefore, the scheme is legally binded into the Operating Agreement.

According to the scheme, the fare is reviewed every 5-year upon request by either the government or MTRCL. The fare adjustment formula takes into account of Composite Consumer Price Index (CCPI), Nominal Wage Index (Transportation Section) and a pre-determined productivity factor (share benefit of productivity improvement). Specifically, the formula is: Fare Adjustment Rate = (0.5 x Change in CCPI) + (0.5 x Change in Nominal Wage Index) – Productivity Factor.

The adjustment considers the economic conditions and wage levels by the adoption of CCPI and NWI(TS). The CCPI reflects the macroeconomic environment and public affordability to a certain extent, whereas the NWI(TS) reflects MTRCL's labor cost. These two indices are published data of the Census and Statistics Department and are objective and verifiable. Based on the data of these objective indices under the Fare Adjustment Scheme, fares will be maintained, or adjusted upwards or downwards. If, in a given year, the outcome of the calculations on the overall fare adjustment rate is within the range of ±1.5%, there shall be no fare adjustment and the unadjusted percentage shall be rolled over to the next annual fare review for calculation (HKSAR Transport and Housing Bereau, 2016).

There are multiple bus operators, the fare adjustment for bus fare is not depending on the outcome of fare adjustment formula (explained later) only, but also on other factors that contained in the so-called "Basket of Factors"(Hong Kong Transport Department, 2009). The factors include:

- Changes in operating costs and revenue;
- Forecasts of future costs, revenue and return;
- The need to provide the operator with a reasonable rate of return;
- Public acceptability and affordability;
- Quality and quantity of service provided; and

- Outcome of the fare adjustment formula

The fare adjustment formula is: 0.5 x Change in Wage Index + 0.5 x Change in CCPI - 0.5 x Productivity Gain. It has almost the same form as the one for rail, with the only difference of the coefficient for Productivity to be 0.5. Since the fare level is not adjusted automatically according to it, there is no minimum level or ceiling of rate of adjustment of the fare adjustment outcome. It is the reference indicator when making adjustment.

The objective of taking into account of the abovementioned basket factors is to adjust the fare level based on the financial performance of the bus operators that the operators can maintain efficient and safe public bus service, as well as the public acceptability and affordability. These factors could enhance the objectivity of the fare adjustment and enable minor tunes in accordance with economic conditions. The cost of capital of the bus industry is referred in considering the reasonable rate of return. For public acceptability and affordability, the median household income is considered, in addition to the change of CCPI.

The bus fare adjustment is reviewed every 3-year.

Policy implementation

The Fare Adjustment Scheme for rail first implemented in 2007, then reviewed in 2013. The second review was originally due for 2018 but conducted in 2017, 1-year forward upon the request of the Government. The review of the scheme has two major objectives: reviewing the fare adjustment formula and incorporating the changing situation of profitability, service performance, as well as public affordability, especially for remote commuters, whose fare burden is high.

In the first review in 2013, the annual overall fare adjustment rate from 2013 to 2017 was calculated according to the formula. The third component of the formula, the Productivity Factor was set to be 0.6%, which could moderate the fare increase by 0.5% each year, benefitting all passengers. In the review, new measures were proposed. For example, the “Affordability-Cap” was introduced, which set the ceiling for fare increase with no more than the year-on-year change in the Monthly Medium Household Income (MMHI) for the previous year.

The early implementation of the second review in 2017 considered the possible room for an improvement to better respond to the public concern about the fare adjustment and MTRCL’s profitability, as well as the passengers’ affordability. The outcome of the second review in 2017 is applicable to the fare adjustment in the six-year period between 2017 and 2022.

The latest fare adjustment exercise for 2019 follows the FAM as reviewed in 2017. The report from Legislative Council Panel on Transport (Hong Kong Transport Department, 2019) provided the detailed information. According to the figures released by the Census and Statistics Department on 22 January 2019, the year-on-year increase in the CCPI for December 2018 over December 2017 is 2.5%. On 28 March 2019, the Census and Statistics Department published the year-on-year increase in the Nominal Wage Index (Transportation Section) for December 2018 over December 2017, which is 5.9%. Applying the fare adjustment formula with the above two published figures, and subtracting the special annual adjustment of 0.6% (Productivity Gain) offered by MTRCL, the adjustment rate for MTR fares in 2019/20 should be +3.6%.

In each review, perspectives from multiple stakeholders were considered to reach a balanced result, including Legislative Council of the government, MTRCL of the private operator, passengers, shareholders, academics, etc.

In 2008, the first implementation of the Fare Adjustment Scheme for bus was carried out. The fare adjustment formula was first calculated to provide an objective indicator for the adjustment. Based on the nominal wage index for the transport sector for the period from the first quarter of 2006 to the fourth quarter of 2007 and the CCPI for the period from January 2006 to March 2008, the outcome of the fare adjustment formula was +4.67% (Hong Kong Transport Department, 2009).

The outcome of the formula is the reference for the final adjustment rate, and the other factors in the factors' basket were investigated to balance the relationship between bus operators and commuters in the implementation process.

Regarding the normal fare adjustment, the process is initiated by the bus operators if there is the need for fare increase. Upon the fare increase application, the relevant data is collected and calculated. the bus fare adjustment is only triggered if the fare increase amounts to a certain amount (10 cents), to avoid frequent fluctuation in bus fares which causes inconvenience to the public. The Transport Department then consults with the Legislative Panel on Transport before making a recommendation to the Council, who retains the ultimate determination.

Since there are multiple operators, considering the limit of space, only the simple introduction of Kowloon Motor Bus Co. Limited (KMB), which is the largest bus operator in Hong Kong, is given. From 2007 to 2017, KMB has conducted 4 times of fare increase, and the rate of adjustment ranges from 3.6% to 4.9%.

5.1.2 Criteria, scoring, and implementation evaluation

Based on the policy implementation information of the Fare Adjustment Scheme, the criteria will be identified and scored following the criteria set proposed in 3.1.1, and the scoring method in 3.1.2. This is the first and second step of the analytical framework. The output of this section, the identified criteria and score will be registered in the scheme sheet.

As stated in the policy document (Legislative Council Panel on Transport, 2019), the objective of the scheme is to take into account of the profitability of the public transport operators for an efficient and safe public bus service, as well as the public acceptability and affordability. These factors could enhance the objectivity of the fare adjustment and enable minor tunes in accordance with economic conditions. Therefore, the criteria of B2 Profitability, C1 Affordability, C3 Acceptability, B1 Efficiency, A3 Service, and D2 Safety are all covered under the scheme.

As the basic principle in Hong Kong, the public transport is operated by private companies on the commercial basis to enhance the economic efficiency and competition. This assures the efficiency of the public transport system, which makes the score of B1 Efficiency as 4.

For both the fare adjustment of rail and bus, the operating costs and revenue, the cost of labor that reflected by the wage index, as well as the future costs, revenue, and return are all considered. There is the written rule that a reasonable rate of return should be guaranteed for the operators. The profitability is score as 4.

At the same time, the change of fare level is a sensitive topic to public, considering the attribute of out-pocket money. Therefore, the public acceptability and affordability is specifically emphasized from the beginning. Public hearing and consulting was held (HKSAR Transport and Housing Bereau, 2016), and its result had been properly incorporated into the update of the scheme. The acceptability is assigned a score of 4. There is a lack of review on affordability (which causes the introduction of subsidies), and the score for this criteria is 3.

According to the government report (HKSAR Transport and Housing Bereau, 2016), Fare Adjustment Scheme introduced the "Service Performance Arrangement", to improve the public transport service level by upgrading and enhancement of operation systems and equipment, and by penalties for serious service disruptions caused by operators. This agreement is under implementation and its effect is going to be reviewed. The implementation score for service criteria is 3.

The MTR network capacity in Hong Kong has reached the mature stage, which can be seen from the network development diagram (To be added). There is only the proposal of capacity improvement on Light Rail, initiated by the Government in the report of "Public Transport Strategy Study" (HKSAR Transport and Housing Bereau, 2017). The preliminary feasibility study on capacity improvement of Light Rail in under discussion, and the implementation level of capacity is defined as proposed (score is 2).

Equity is scored as 2. There are a number of different demographic groups who are significantly or disproportionately impacted by the fare adjustment. It is proposed not to put heavy burden on the remote commuters. Such proposal on equity is not explicitly implemented during the implementation of the scheme. Safety is considered in designing the scheme, but not actually being brought forward later on. Therefore, the score for safety criteria is 1.

Based on the discussion, criteria identified and the corresponding score can be summarized in the scheme sheet of Table 5.1.

Table 5.1 Scheme sheet – implementation of Fare Adjustment Scheme

Criteria	Score	Description	Source
Network capacity	2	Feasibility study of Light Rail capacity improvement proposed	Report on "Public Transport Strategy Study" (HKSAR Transport and Housing Bereau, 2017)
Service	3	Service Performance Arrangement put in place in the review of scheme	Public consulting report (HKSAR Transport and Housing Bereau, 2016)
Efficiency	4	Public transport operators are private companies based on the commercial principles	Transport Department website

Profitability	4	Cost and revenue of public transport operators is important factors in setting the fare	Policy document (Legislative Council Panel on Transport, 2019)
Affordability	3	Fares adjustment considers public affordability	Policy document (Legislative Council Panel on Transport, 2019)
Equity	2	Remote commuters are examined not to incur fare burden	Policy document (Hong Kong Transport Department, 2019)
Acceptability	4	Public consulting meetings held and feedback incorporated into scheme	Public consulting report (HKSAR Transport and Housing Bereau, 2016)
Safety	1	Mentioned in the scheme objective	Scheme introduction on Transport Department website

5.1.3 Policy performance

The performance of Fare Adjustment Scheme can be checked following the objectives: the profitability of public transport operators, including changes in operation costs and revenues, and the affordability of commuters. The examination will start from the direct impact of the scheme: the changes of fare level.

Fare change and affordability

Following the scheme, the MTR has increased its fares every year from 2010 and the range of adjustment is between +2.05% and +5.4%, with a cumulative increase of 25.2% until 2016. Details of the overall fare adjustment rate of each year is shown in Table 5.2.

Table 5.2 MTR Fare Adjustment Rate from 2010 to 2016

Year	Fare Increase Rate (%)	Notes
2010	2.05	Direct outcome of fare adjustment formula is +1.35%, plus the roll-over +0.7% from 2009
2011	2.2	Direct outcome of fare adjustment formula is +2.3%. MTRCL revised to +2.2%.
2012	5.4	NA
2013	2.7	First review on the fare adjustment formula.
2014	3.6	NA
2015	4.3	NA
2016	2.65	Direct outcome of fare adjustment formula is +2.7%. MTRCL revised to +2.65%.

Source: Report on Review of the MTR Fare Adjustment Mechanism (HKSAR Transport and Housing Bereau, 2016)

As for bus fare adjustment, taking the same example of Kowloon Motor Bus Co. Limited (KMB), its fare increase from 2010 is within the range of +3.6% and +4.9%. Details of the overall fare adjustment rate of each year is shown in Table 5.3.

Table 5.3 KMB Fare Adjustment Rate from 2010 to 2016

Year	Fare Increase Rate (%)
2010	4.5
2011	3.6
2012	NA
2013	4.9
2014	3.9
2015	NA
2016	NA

Note: fare increase rate is the overall weighted average rate for all routes operated by the bus operator

Source: An evaluation of public transport pricing and fare affordability in Hong Kong (Chu, 2017)

It is clear that both the rail and bus mode have seen a fare increase, which means the commuters have to pay more of their income on public transport than before. Based on the statistics of the Hong Kong Government (Hong Kong Transport Department, 2019), the average annual fare increase is 2.6%. As introduced previously, the fare adjustment formula considers the income changes by taking in the Wage Index component. The comparison of changes in income against the fare increase of bus and rail would show whether the rate of fare increase is justifiable or if it is increasing at a faster pace than the increase in wages in general. Collecting data from the website of Census and Statistics Department, the annual growth rate of wages is shown in Table 5.4.

Table 5.4 Wage Growth Rate from 2010 to 2016

Year	Index	Annual Growth Rate (%)
2010	121.7	+1.3
2011	127.1	+4.4
2012	127.7	+0.4
2013	127.5	-0.2
2014	117.9	-7.5
2015	120.7	+2.3
2016	121.1	+0.3

Note: Index is set at 100 for the year of 1992

There are years of wage increase, as well as years with a decrease of wages, such as the year of 2013 and 2014. Recalling the monotonic increase of public transport fare (Table 5.3, Table 5.4), it is safe to conclude the affordability is deteriorated under the current Fare Adjustment Scheme. This also explains that, according to the feedback of public consulting, a significant number of the submissions suggest that the scheme should better reflect public affordability, and more fare concessions are requested. Affordability issue will be further discussed in the section of subsidy schemes.

Operator profitability

With the increase of fare level, the revenue of operators also increased. Operating profit of major public transport operators are available from the statistics released by the Transport Department[28]. Considering the diversity of bus operators, here only lists the data of rail operator.

Table 5.5 Operating profit of rail operator in Hong Kong

Year	2011	2012	2013	2014	2015	2016	2017	2018
Profit (HK$ billion)	6.2	6.5	6.7	7.0	7.2	7.6	7.5	8.2

Note: data after 2015 is collected from MTR company finance disclosure report (http://www.mtr.com.hk/archive/corporate/en/investor/profit_en.pdf)

We can see the trend of increased profit of the operator. Same trends also apply to bus operators.

5.1.4 Indicator and performance evaluation

In Chapter 3, based on sustainability indicators from literature review, we obtained the indicator list (refer to 3.1.3) for the evaluation of urban transport pricing policy. In the following section, indicators are selected from the list for the evaluation of the Fare Adjustment Scheme in Hong Kong. The normalized indicator values are calculated (the 5th step of the integrated framework), for the purpose of policy performance evaluation.

ID1 of Public transport fare, as the immediate output indicator of Fare Adjustment Scheme, is appropriate and accountable to represent the scheme performance. Following the value-capture methods discussed in 3.1.5, the before-after comparison method is taken for output indicator.

Based on the report from Hong Kong Legislative Council Panel on Transport (Legislative Council Panel on Transport, 2019), the average annual public transport fare increase rate is 2.6%. Applying the before-after comparison, the normalized indicator value for average public transport fare is 0.974.

As for the normalized value of ID5 of operator profitability, the average annual increase rate is adopted, based on the operator profitability data shown in Table 5.5. Following the calculation table (Table 5.6), the value for operator profitability is 1.041.

Table 5.6 Annual growth rate of operator profitability

Year	2011	2012	2013	2014	2015	2016	2017	2018	Average
Annual growth rate	NA	1.048	1.031	1.045	1.028	1.056	0.987	1.093	1.041

As discussed previously, under the Fare Adjustment Scheme, the profitability of operators kept increasing while the speed of fare increase surpasses the speed of income increase, creating the affordability problem to public. To balance the benefit distribution between the operators and the

[28] Statistical Highlight on Public Transport, https://www.legco.gov.hk/research-publications/english/1617issh06-public-transport-20161028-e.pdf

public transport users, the Profit Sharing Mechanism is introduced since 2013, during the first review of the scheme. The core idea of the mechanism is to set aside an amount of fare revenue to provide fare concessions and share the operating profit with passengers to relieve their burden from fare increase, based on operators' profits each year (HKSAR Transport and Housing Bereau, 2016). The calculation method is firstly proposed in 2013, and updated recently with an increased proportion being set aside.

Table 5.7 Profit sharing calculation method (HK$ billion)

2013 method		Updated method	
Profit in previous year (HK$ billion)	Amount to set aside (HK$ million)	Profit in previous year (HK$ billion)	Amount to set aside (HK$ million)
Under 5	0	Under 5	0
5-6	50	5-6	75
6-7	75	6-7	100
7-8	100	7-8	125
8-9	125	8-9	150
9-10	150	9-10	175
10-11	175	10-11	200
11-12	200	11-12	225
12-13	225	12-13	250
Above 13	250	13-14	275
		14-15	300
		Above 15	325

From 2013 to 2016, the data of operator expenditure (Table 5.8) caused by the scheme is available from the public consulting report (HKSAR Transport and Housing Bereau, 2016).

Table 5.8 Operator profit sharing

Year	Profit in previous year (HK$ million)	Amount to set aside (HK$ million)	Percentage (%)
2013	9775	150	1.53
2014	8600	125	1.45
2015	11571	200	1.73
2016	10894	175	1.61
		Average percentage	1.58

Therefore, for ID7 of operator expenditure under the Fare Adjustment Scheme, the normalized indicator value is 0.984.

The indicators analyzed can be summarized in the scheme sheet of performance of Fare Adjustment Scheme.

Table 5.9 Scheme sheet – performance of Fare Adjustment Scheme

Indicator	Normalization score	Description	Source

average public transport fare	0.974	Fare kept increasing under the scheme	Report from Hong Kong Legislative Council Panel on Transport (Legislative Council Panel on Transport, 2019)
operator profitability	1.041	Fare increase improves operator profitability	Statistics released by Transport Department
operator expenditure	0.984	Profit sharing to balance the benefit distribution	Public consulting report (HKSAR Transport and Housing Bereau, 2016)

5.1.5 Scheme summary

Fare adjustment considers wage levels, change in consumer price index, productivity, service performance and fare affordability, as can be seen from the policy document.

Under the scheme, profitability of public transport operators is improved that with the increase of fare level, the revenue of operators also increased. However, there is a cumulative 25.2% (from 2010 to 2016) in fare increase, which makes public transport less affordable.

5.2 Work Incentive Transport Subsidy Scheme

From the discussion on Fare Adjustment Scheme, we can see that public transport services in Hong Kong are provided by private operators on the basis of commercial principles without government subsidies. Under the fare policy, public transport fare is increasing all the time. This situation is worse for low-income households who spend a larger portion of income on travelling and face the heavy financial burden. The willingness to go to work, healthcare, social and leisure activities for low-income groups may be reduced and it will eventually lead to social isolation. Solutions are needed to improve the situation.

The Government has encouraged operators to offer more fare concessions, which would incur extra expense to them. It is against the commercial principles. Therefore, the government proactively introduces subsidy scheme to support low-income families, without hurting operators' profitability. The Work Incentive Transport Subsidy (WITS) Scheme and the Public Transport Subsidy Scheme are the 2 major subsidy schemes in Hong Kong, which will be discussed in 5.2 and 5.3 respectively.

5.2.1 Policy implementation

Problem identification and scheme objective

Hong Kong is a city with high Gini Coefficient (0.539 as of 2017). The travelling expenses is a financial burden for the low-income group, taking a high proportion of monthly income. According to Hong Kong Census and Statistics Department, public transport expenses to monthly income ratio for the whole population is about 5.4%, while for households with monthly income less than HK$10,000, the ratio can be much higher.

There is the need for supportable policy to encourage the low-income worker to seek and join jobs and ultimately promote sustained employment. It is believed that the direct monetary subsidy can help them relieve burden on travelling expenses commuting to and from work (Yeung, 2012).

The objective of WITS Scheme is to help low-income workers reduce the cost of public transport, which is their main mode of travelling to and from work, so that to secure them stay in employment.

Policy design and preparation

Same as no direct subsidy to public transport operators, there is normally no subsidy from the government to users. The predecessor of WITS Scheme, the Transport Support Scheme that started in 2007 was the first transport-related subsidy scheme in Hong Kong. The WITS Scheme replaced that with the new design of covering the whole territory of Hong Kong and regardless of social groups and employment status, including self-employed persons. Applicants were required to be means-tested with reference to the household size and the income statistics, the eligibility criteria are listed below (Labour Department, 2017):

- Being employed or self-employed, and be lawfully employable in Hong Kong;
- Incurring travelling expenses in commuting to and from work;
- Meeting the monthly income and asset limits; and
- Working hours should be no less than 72 hours per month (if applying for full-rate subsidy of $600 per month), or less than 72 hours but at least 36 hours per month (if applying for half-rate subsidy of $300 per month).

The mean-test is household based. A member of a household would receive a $600 monthly transport subsidy if his/her household passed the means test. In the latest review of the scheme, the mean-test basis has been shifted to individual (Labour Department, 2018).

Similar to the policies on housing, education, and healthcare, the WITS Scheme is the additional welfare measures to help needy groups especially the working poverty to improve their living standards. In terms of institutional arrangement, the Labour and Welfare Bureau was responsible for overseeing the details, implementation, administration and as well as promotion of the transport subsidy schemes. A new division with 300 staffs was set up to receive and process applications, handle reviews and appeals, effect subsidy payment, and etc.

Policy implementation

In 2012, the Hong Kong Labour Department introduced the WITS Scheme to help low-income group to reduce financial burden on the cost of travelling to and from work and encourage them to stay in work.

During the implementation, the detailed requirement, such as the monthly household income and asset limit are reviewed and updated annually. The existing annual adjustment mechanism on the income and asset limits for WITS applicants has been put in place following the recommendations of a mid-term review of the WITS Scheme conducted by the Labour Department and approval by the Finance Committee of the Legislative Council in 2012 (Labour Department, 2017). Specifically, both the income and asset limits are to be adjusted concurrently and updated on the basis of the median monthly domestic household income in the third quarter of the previous year.

The latest income and asset limit are released in 2018, as shown in Table 5.10.

Table 5.10 WITS Scheme income and asset limit

Household Size [3]	Application for Subsidy from February 2018 onwards [2] [3]		
	Monthly Income Limit	Monthly Asset Limit[4]	Effective Income Level[5] (for reference only)
1 person or individual-based application	$10,000	$91,500	$10,526
2 persons	$17,000	$123,000	$17,894
3 persons	$19,500	$184,500	$20,526
4 persons	$22,800	$246,000	$24,000
5 persons	$23,900	$246,000	$25,157
6 persons or above	$25,200	$246,000	$26,526

Source: Labour Department

5.2.2 Criteria, scoring, and implementation evaluation

As the subsidy scheme targeted at the low-income group, the objective is to reduce the cost of public transport and financial burden. Therefore, C1 of affordability criteria should have a score of 4. The detailed requirement of the scheme, such as the monthly household income and asset limit are reviewed, updated, and implemented after engaging the views and suggestions from the public. The public acceptability is always emphasized that public consulting is held, the application procedures are simplified, and the enquiry spots through phone and internet are set up to receive feedback (Labour Department, 2018). The criteria of public acceptability is scored as 4.

The WITS Scheme covers the whole territory of Hong Kong, regardless of locations; applies to whole population, regardless of social groups; and sustains to all employment status, including self-employed persons (Legislative Council, 2017). In terms of equity, the scheme is implemented thoroughly. The score of C2 equity is 3. (not 4 due to no review carried out)

In financing the scheme, the independence and profitability of operators are admitted that it is not appropriate to rely on the private companies to provide the subsidies. Considering the nature of social welfare policy, it is the public fund that supports the policy, executed by the government entity of

Labour and Welfare Bureau. However, the review of this way of financing and its impact is missing. Therefore, B3 finance is 3.

From the Legislative Council report (Legislative Council, 2017), the “Administration advised that as WITS was provided on are current basis, it had to ensure the prudent use of public money”, and proposed that the subsidy should be adjusted according to the macroeconomics condition. Measures are proposed for the efficient use of public fund through the WITS Scheme, and the efficiency criteria is score as 2.

With the subsidy, the cost of public transport is reduced. It is considered that a lower cost would attract more users, especially the direct beneficiary of low-income workers who rely on public transport more. As the side-effect of the change, the modal integration of public transport would be improved. Due to the low level of implementation, A1 of modal integration is scored as 1.

Based on the discussion, criteria identified and the corresponding score can be summarized in the scheme sheet of Table 5.11Table 5.1.

Table 5.11 Scheme sheet – implementation of WITS Scheme

Criteria	Score	Description	Source
Modal integration	1	Reduced travel cost promotes the public transport system	Public Transport Strategy Study (HKSAR Transport and Housing Bereau, 2017)
Efficiency	2	Measures are proposed for the efficient use of public fund	Legislative Council report (Legislative Council, 2017)
Finance	3	Financed by public fund and executed by Labour and Welfare Bureau	Labour Department report (Labour Department, 2017)
Affordability	4	Main objective of the policy	Research paper on Hong Kong subsidy (Yeung, 2012)
Equity	3	Coverage of whole territory, population, and employment status	Legislative Council report (Legislative Council, 2017)
Acceptability	4	Public consulting meetings held and feedback incorporated into scheme	Policy document (Labour Department, 2018)

5.2.3 Policy performance

According to the Labour Department report in 2017, as of May 2016, there are a total of 101,746 applicants who are receiving the subsidy under the scheme from the government. It amounts to $1,298 million of subsidy paid to the applicants. Most of the applicants are aged between 40 and 60 and they consist of 54% of the total applicants. The number of applicants who are aged between 20-30, 30-40 and

60 or above are also significant, consisting of 15%, 17% and 13% out of the total (Labour Department, 2017).

In terms of administration, according to the information provided by the Working Family Allowance Office, the WITS Division in 2018-19 comprised 136 civil service posts and 50 non-civil service contract positions responsible for processing WITS applications (Working Family Allowance Office, 2019).

5.2.4 Indicator and performance evaluation

As for subsidy policy, basically 2 indicators need to be examined: affordability and government expenditure. However, the individual-based mean-tested subsidy scheme requires applicants' self-application. When eligible applicants receive the subsidy, it is highly likely that the money is spent for other daily expense. Thus, the subsidy distribution and affordability performance of the WITS Scheme is not clear. Affordability will be discussed under Public Transport Subsidy Scheme.

According to data released by Working Family Allowance Office, the estimated expense of WITS Scheme is about $700 million for the year of 2019-2020 (Working Family Allowance Office, 2019). Based on the Government Budget Report (Goverment Budget, 2019), the government expenditure on WITS Scheme for 2018-2019 is about $593.9 million. Therefore, there is a 17.9% increase of government expenditure. For ID6 of government expenditure under the WITS Scheme, the normalized indicator value is 0.848.

The indicators analyzed can be summarized in the scheme sheet of performance of WITS Scheme.

Table 5.12 Scheme sheet – performance of WITS Scheme

Indicator	Normalization score	Description	Source
government expenditure	0.848	WITS Scheme increases government expenditure	Working Family Allowance Office (Working Family Allowance Office, 2019); Government Budget Report (Goverment Budget, 2019)

5.2.5 Scheme summary

The scheme is to help low-income earners to reduce their financial burden on the cost of travelling to and from work and encourage them to stay in work. Applicants are required to be being employed or self-employed and are lawfully employable in Hong Kong, and work no less than 72 hours per month to be liable to the full-rate subsidy of $600 per month. Alternatively, if they work less than 36 hours per month, they are only eligible to apply for the half-rate subsidy of $300 per month.

According to data released by Working Family Allowance Office, the estimated expense of WITS Scheme is about $700 million for the year of 2019-2020, about a 17.9% increase of government expenditure.

5.3 Public Transport Subsidy Scheme

Public Transport Subsidy Scheme, as the name suggests, is the designated subsidy scheme for public transport. Different from the WITS Scheme, this scheme is a non-mean-test scheme. This is by far, the first non-mean-test subsidy scheme for public transport all over the world.

5.3.1 Policy implementation

Problem identification and scheme objective

In Hong Kong, the public transport fares keep increasing for past years. A survey conducted by Hong Kong University (Chu, 2017), suggests that majority of the public, regardless of age and income groups, find the current fare levels of public transport too high. It is necessary to take actions to ensure the fare affordability, otherwise the problem would become worse if the fares keep increasing.

Unlike the WITS Scheme that targeting at the low-income working group, the new Public Transport Subsidy Scheme covers the whole population.

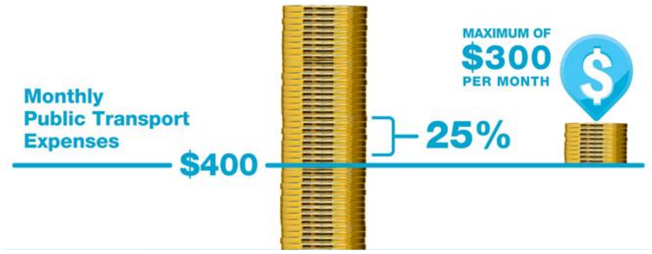
The objective of introducing the Scheme is to relieve the fare burden of commuters who travel on local public transport services for daily commuting and whose public transport expenses are relatively high.

Policy design and preparation

The scheme was first proposed in the 2017 Policy Address. In October 2017 and January 2018, the Government briefed the Legislative Council Panel on Transport on the preliminary proposal and enhancements to the scheme, and listened to Members' views. Funding application for the Scheme was approved by the Finance Committee of the Legislative Council in February 2018 (Legislative Council Panel on Transport, 2018). Overall speaking, the public welcome the introduction of the Scheme and consider that the Scheme could relieve their fare burden (Transport and Housing Bureau, 2018a).

The scheme is designed to be simple, easy to understand and operate, and open to all. All commuters, regardless of age and income levels, are able to enjoy the scheme. Neither application nor pre-registration is required. The scheme covers all modes of public transport, including the rail, bus, ferries, trams, as well as designated routes of minibuses that approved by the Transport Department.

The monthly public transport expense is the only principle. Commuters with monthly public transport expenses exceeding $400 are eligible for the public transport fare subsidy. The Government provides a subsidy for 25% of the actual public transport expenses in excess of $400, subject to a maximum of $300 per month (Transport and Housing Bureau, 2018b), as illustrated in Figure 5.1.



Source: (Transport and Housing Bureau, 2018b)

Figure 5.1 Subsidy arrangement of Public Transport Subsidy Scheme

The subsidy arrangement and level is proposed, as stated in the policy discussion paper, taking into account the policy objective to relieve the fare burden of commuters who relatively spend more on public transport for daily commuting, while not imposing severe impact on the travelling patterns which may affect the resource allocation of public transport services and create unintended consequences on public transport system.

The scheme has no conflict with the existing subsidy and concession schemes provided by the government and public transport operators so that the commuters can continue to benefit from various schemes currently. In the calculation of the monthly public transport expenses for Public Transport Subsidy Scheme, the actual public transport expense is taken into account, which is the amount deducting the benefits received from other schemes.

The public transport card, Octopus, is utilized for recording and collecting the subsidy. Monthly subsidy is calculated on the basis of the actual monthly transport expenses, based on the everyday use of Octopus for payment of the fares of public transport services, which is recorded automatically. Collection of subsidy is through the tap of Octopus at the designated subsidy collection channels and the subsidy is credited to the Octopus automatically. The channels include the Subsidy Collection Points installed at MTR stations, customer service centers, and convenient stores like 7-Eleven, Circle-K. Preparatory work for implementation include developing a new system to calculate, distribute and settle subsidy amount, modifying relevant software and hardware, installing dedicated Octopus readers, etc. Phone app is launched as well for checking and collecting subsidy.

In terms of financing source, the public fund that generated from annual dividends from the MTR Corporation Limited is utilized.

Policy implementation

The scheme is implemented on 1 January 2019, and commuters were able to receive the first subsidy starting from February 2019. They are also able to check the accumulated public transport expenses of the current month, as well as the total public transport expenses and the subsidy amount, along with the commencement.

To promote publicity, publicity campaign and media briefing, including the promotional videos, soft and hard copies of leaflet are conducted to explain to the public for further understanding on the features and operational details. The website of the scheme (www.ptfss.gov.hk), the Octopus App and the hotline of the scheme was also launched.

5.3.2 Criteria, scoring, and implementation evaluation

As the subsidy policy targeting at the whole population, the objective is to promote the affordability of public transport against the background of continuously raising fares. Since the scheme is just put into effect, there is no review of the scheme performance yet. However, the Legislative Council Panel has stated that "Upon the implementation of the Scheme, we will review the Scheme to examine its effectiveness and impact on the travelling pattern of commuters, the overall strategic arrangement of public transport services, as well as its financial implications. Since the review requires analysis of actual data after the implementation of the Scheme, we will commence the review around a year upon the Scheme's implementation" (Legislative Council Panel on Transport, 2018). Thus, it is appropriate to sore the criteria of affordability as 4.

This scheme is the first non-mean-test subsidy scheme for public transport. The scheme is designed to be open to all commuters, regardless of age and income levels. At the same time, in terms of the mode coverage, all modes of public transport, including the rail, bus, ferries, trams, as well as designated routes of minibuses are included. In the policy document (Transport and Housing Bureau, 2018b), it is made clear that "should not exclude any particular groups of commuters from the scheme based on their purposes of using public transport services or their travelling pattern." Therefore, the highest implementation level of 4 is assigned to the criteria of equity.

Various publicity promotion measures were taken for the implementation of the scheme, such as promotional videos, soft and hard copies of leaflet, setting up scheme website, designated App and the scheme hotline. Public acceptability is emphasized from preparation to implementation of the scheme. The criteria is scored to be 3.

Finance is scored 3 as well. The financing of the scheme considers the available sources and decided to use the public fund that generated from annual dividends from the MTR Corporation Limited (Transport and Housing Bureau, 2018a). At the same time, public fund is ensured to be used properly according to the principles of fiscal prudence, though the effect of such arrangement is not yet reviewed.

In the preparation of the scheme, it was proposed to control "the impact on the travelling pattern and the overall public transport services", which may affect the modal integration of the system and resource allocation of public transport services. Therefore, both modal integration and service are scored as 2.

The scheme is designed to be simple and not to impose unnecessary administrative cost, for the consideration of efficiency. However, efficiency is only considered (and the efficiency of the scheme is actually not high in terms of policy performance, as discussed later), thus the score is 1 for efficiency criteria.

Based on the discussion, criteria identified and the corresponding score can be summarized in the scheme sheet of Table 5.13 Scheme sheet – implementation of Public Transport Subsidy SchemeTable 5.1.

Table 5.13 Scheme sheet – implementation of Public Transport Subsidy Scheme

Criteria	Score	Description	Source
Modal integration	2	Scheme is proposed not to effect the public transport pattern	Policy document (Legislative Council Panel on Transport, 2018)
Service	2	Resource allocation of public transport services is maintained	Policy document (Legislative Council Panel on Transport, 2018)
Efficiency	1	Scheme is designed to be simple and to save administrative cost	Policy document (Transport and Housing Bureau, 2018b)
Finance	3	Financed by public fund from dividends from MTR	Discussion paper on Government Finance (Transport and Housing Bureau, 2018a)
Affordability	4	Main objective of the policy	Policy document (Legislative Council Panel on Transport, 2018)
Equity	4	Coverage of whole population, and all public transport modes	Policy document (Transport and Housing Bureau, 2018b)
Acceptability	3	Publicity promotion activities conducted; scheme designed to be simple in operation	Website of the scheme (www.ptfss.gov.hk)

5.3.3 Policy performance

Shortly before the commence of the scheme, in December 2018, it was estimated that the "annual subsidy amount would be around $2.3 billion and over 2.2 million commuters would benefit from the Scheme." (Legislative Council Panel on Transport, 2018).

The latest data released by the Transport and Housing Bureau covers the first 3 months after the implementation[29]. Detailed information is shown in Table 5.14.

Table 5.14 Statistics on Public Transport Subsidy Scheme

Month	January	February	March
Subsidy Amount (HK$ million)	185.7	120.9	181.8
Number of Beneficiaries (million)	2.35	1.94	2.36
Average amounts of subsidy (HK$)	79	62	77

[29] Public Transport Fare Subsidy Scheme https://www.thb.gov.hk/eng/legislative/transport/replies/land/2019/20190515b.htm

The amounts of subsidy for January, February and March 2019 are about $185.7 million, $120.9 million and $181.8 million respectively. The number of beneficiaries in the first three months is around 2.35 million, 1.94 million and 2.36 million respectively, and the average amounts of subsidy for each beneficiary in the first three months are around $79, $62 and $77 respectively. It is believed that the smaller amount of subsidy in February as compared to that in January is attributable to the Lunar New Year holidays as well as fewer calendar days and working days in February.

In terms of the government budget for the scheme, the allocated amount is $2,368.8 million for the year 2019-2020, which takes about 35.2% of all the allocated budget for Transport Department (Government Budget, 2019).

5.3.4 Indicator and performance evaluation

In evaluating the performance of Public Transport Subsidy Scheme, ID1 public transport fare, ID6 government expenditure, ID8 affordability, and ID10 subsidy distribution, are calculated. Since the scheme is newly launched at the beginning of this year, there is no quantitative assessment of impacts of the impacts on public transport yet. Therefore, necessary estimation based on the available data for the impact of the scheme is needed. The original estimation becomes more valuable, considering this is the first non-mean tested public transport fare subsidy scheme.

The objective of the estimation of is to check the policy impact on affordability, as well as the distribution of subsidy among population groups. The following data is collected for the estimation:

- 2014/15 Household Expenditure Survey, Hong Kong Census and Statistics Department, 2016

The Census and Statistics Department conducts the Household Expenditure Survey (HES) at five yearly intervals to collect information on the expenditure patterns of households in Hong Kong for updating the expenditure weights used for compiling the Consumer Price Indices. The latest round was conducted in 2014/15. Current affordability extracted from the survey is shown in Table 5.15.

Table 5.15 Public transport expenditure of household groups in Hong Kong

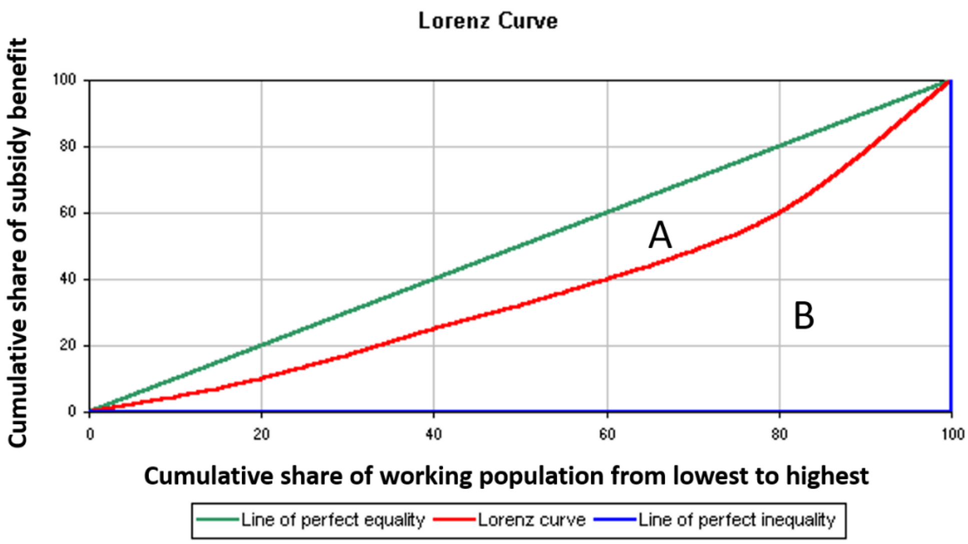
Household group	Expenditure	Percentage
1st quartile	480	5.3%
2nd quartile	816	4.6%
3rd quartile	971	3.6%
4th quartile	1026	1.8%
average	824	3.0%

- 2016 Population By-census, Hong Kong Census and Statistics Department, 2017

Conducted by the Census and Statistics Department of the Hong Kong Government. The census has been held every ten years since 1961 and the by-census is held between two censuses. The last census and by-census were in June 2011 and June 2016, respectively.

- Household Income Distribution in Hong Kong, Census and Statistics Department, 2017
- Travel Characteristics Survey 2011, Transport department, 2014
- MTR fare adjustment report, MTR corporation, 2016

In terms of estimation method, the concept of GINI Coefficient is utilized. In this research, Distribution Coefficient is defined as A/(A+B), as shown in Figure 5.2.



Source: Wikipedia (https://en.wikipedia.org/wiki/Lorenz_curve)

Figure 5.2 Defination of Distribution Coefficient

Following the estimation method, the estimation result for public transport subsidy scheme is shown in Table 5.16.

Table 5.16 Monthly public transport expenditure by income groups and subsidy effect (HK$)

Income group	<4000	4000-5999	6000-7999	8000-9999	10000-14999	15000-19999	20000-24999	25000-39999	>40000
Monthly cost	498.16	521.84	571.36	619.70	685.56	746.51	808.12	866.55	929.95
Subsidy	24.54	30.46	42.84	54.92	71.39	86.63	102.03	116.64	132.49
After subsidy	473.62	491.38	528.52	564.77	614.17	659.88	706.09	749.92	797.47

Subsidy ratio	4.93%	5.84%	7.50%	8.86%	10.41%	11.60%	12.63%	13.46%	14.25%

Total commute population is 2.2 million, annual expense for public transport subsidy is 2,310.6 million HK$. The weighted average subsidy is 87.16 HK$. Considering the average fare of 824 HK$, the normalized value for ID1 public transport fare is 824/ (824-87.16) = 1.118.

The above estimation results match with the official estimation of “annual subsidy amount would be around $2.3 billion and over 2.2 million commuters would benefit from the Scheme.” (Legislative Council Panel on Transport, 2018). The average subsidy is 87.16 HK$, which is also close to the actual data related of the first 3-month implementation of the scheme. The justifies the credibility of the estimation.

Table 5.17 Subsidy benefit by income groups

Income group	<4000	4000-5999	6000-7999	8000-9999	10000-14999	15000-19999	20000-24999	25000-39999	>40000	Total
Benefit	0.82%	0.85%	1.68%	4.91%	22.28%	17.83%	13.42%	19.11%	19.11%	100%
Population	3.6%	2.9%	3.8%	8.3%	26.1%	16.8%	10.9%	13.7%	14.0%	100%

Subsidy distribution among population groups are estimated in Table 5.17. Based on the result, the cumulative share of subsidy benefits plotted with respect to cumulative share of working population is illustrated below. Following the definition of Distribution Coefficient, the value is 0.185. The normalized value for ID10 subsidy distribution is 0.815.

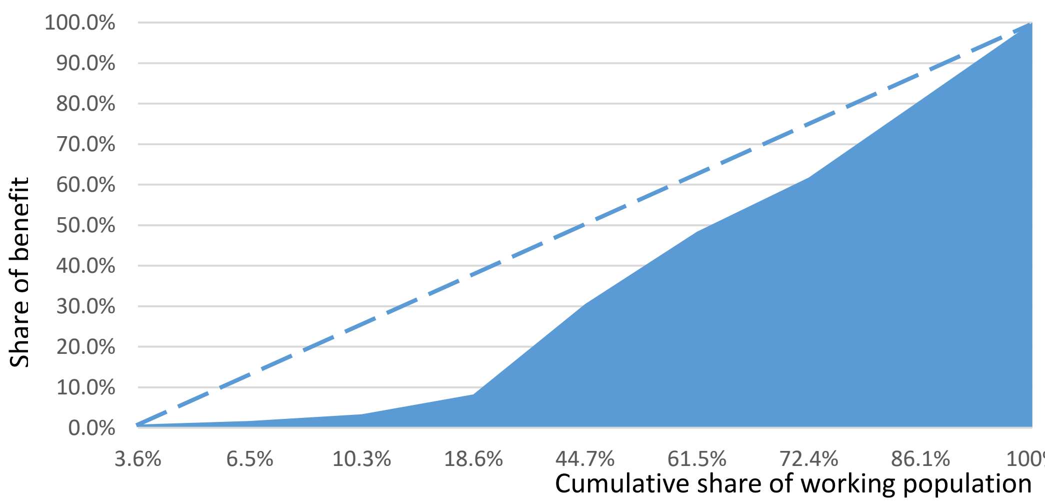


Figure 5.3 Cumulative share of subsidy benefits

In Hong Kong, the affordability is calculated based on the status of the second quintile population group. Since there is no direct information for the second quintile population group, the linear interpolation method is applied. Based on Table 5.15, the public transport expenditure and percentage for the second quintile group is 715.2 HK$ and 4.81%, respectively. When the Public Transport Subsidy Scheme applies, the expenditure and percentage for the same group becomes 651.8 HK$ and 4.31%. Therefore, the normalized value for affordability is 4.81/4.31 = 1.115.

As for ID6 government expenditure, the allocated budget for the first implementation year (2019-2020) is $2,368.8 million, which takes about 35.2% of all the allocated budget for Transport Department (Government Budget, 2019). Therefore, the normalized value is 0.648.

The indicators can be summarized in the scheme sheet of performance of Public Transport Subsidy Scheme.

Table 5.18 Scheme sheet – performance of Public Transport Subsidy Scheme

Indicator	Normalization score	Description	Source
average public transport fare	1.118	Fare is reduced by subsidy scheme	Author estimation
government expenditure	0.648	Finance source comes from public fund	Budget for Transport Department (Government Budget, 2019)
affordability	1.115	Based on result of second quintile population group	Author estimation
subsidy distribution	0.815	Subsidy benefits share for low-income is low	Author estimation

5.3.5 Scheme summary

Public Transport Subsidy Scheme is the first non-mean-test subsidy scheme for public transport all over the world. The scheme is to relieve the fare burden of commuters who travel on local public transport.

Since 1 January 2019, commuters with monthly public transport expenses exceeding $400 are eligible for the public transport fare subsidy. The Government will provide a subsidy for 25% of the actual public transport expenses in excess of $400, subject to a maximum of $300 per month.

The estimation of the scheme impact shows that, at the high cost of public fund, the subsidy distribution among population groups is not equal.

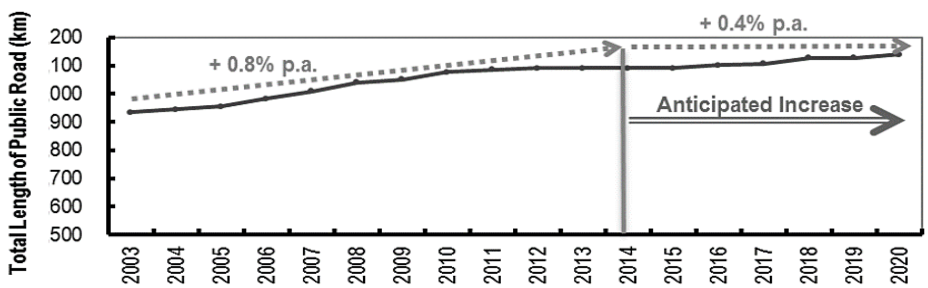
5.4 Service Programs

Quality and diversified public transport services play an important role in meeting changes in demand. Especially for rail and bus modes, the mass carriers serving as the vein of the public transport network, accounting for about 87% of the total patronage of all public transport services[30]. This part will discuss the existing service enhancement programs for rail and bus transport in Hong Kong.

5.4.1 Policy implementation

Problem identification and scheme objective

The population and travel demand is always increasing in Hong Kong. This requires the expansion of the public transport capacity. However, there are challenges on network capacity expansion, and the first one comes from the physical and spatial constraints by limited urban area in Hong Kong. It is difficult to build new roads, which can be seen from the growth rate of total length of public roads, as shown in Figure 5.4.



Source: Report on Study of Road Traffic Congestion in Hong Kong

Figure 5.4 Total length of public roads in Hong Kong

According to the Report on Study of Road Traffic Congestion in Hong Kong (HK Transport Advisory Commitee, 2014), the growth in the total length of public road slowed down with an average growth rate of 0.8% between 2003 and 2013. With the limited number of new road projects being implemented or planned in the coming few years, it is expected that the growth rate would drop to around 0.4% p.a. up to 2020. In terms of buses fleets, there was only 3.6% from 2003 (19 738) to in 2013 (20 456), which is insignificant compared to the population growth rate of 6.8% during the same period. The growth rate of road capacity cannot keep up with the growing speed of public transport demand.

Capacity improvement needs to be associated with service enhancement, especially when the former is constrained. The Government has been adopting multiple service programs to improve operational efficiency, service regularity and quality of public transport service through programs of such as Railway Development Strategy and the Bus Route Rationalization, to enhance the service standards and maintain the long-term and sustainable development.

[30] Statistical Highlight on Public Transport, https://www.legco.gov.hk/research-publications/english/1617issh06-public-transport-20161028-e.pdf

Policy design and preparation

The 2 service programs, the Railway Development Strategy and the Bus Route Rationalization, are inter-connected. Rail service is the backbone of public transport system. Under the Railway Development Strategy, new rail lines are going to be constructed, increasing overall capacity of the railway network considerably. At the same time, there is a need of optimizing the existing railway network, such as relief bottlenecks with small-scale rearrangement, and make connections for a more integrated network.

However, with the introduction of new rail infrastructure, the prevailing travelling pattern and modal integration may be affected. Bus Route Rationalization considers the intel-modal impacts, and adjust bus routes according to the changes of passenger demand and travelling pattern after the opening of the new railway and the impact on other road-based public transport services. This is actually taking advantages of bus services, as they are flexible and can be adjusted in short-term with relatively low cost.

Capacity expansion is not the only objective of the 2 programs. Attention has been paid to service enhancement as well.

The Discussion Paper on Railway Development Strategy 2014 (Transport and Housing Bureau, 2014) says that with the expansion of railway network, connectivity and accessibility, as well as operational robustness and reliability of the railway network will be improved. Railways can save land, reduce the use of energy and roadside pollutant emissions, such as nitrogen oxide and greenhouse gases, thus generating environmental benefits.

The objective of Bus Route Rationalization is to be responsive to the changing environment, and to utilize resources, enhance network efficiency, improve service quality, alleviate traffic congestion and reduce roadside air pollution (Transport and Housing Bureau, 2015). Resources would be used to strengthen existing services and introduce new services, and to enhance feeder services or provide more interchange concessions.

Service Improvement contains multiple measures. Based on the occupancy rate of any bus route, more vehicles will be installed on busy routes to enhance service frequency. Similarly, bus routes with low utilization would be rationalized through measures such as adjustment to service frequency and timetable, and even route cancellation. Regarding the fare changes under Bus Route Rationalization, the principle is that the total journey fare is not higher than that of the service being rationalized.

Policy implementation

The service programs of Rail Development Strategy and Bus Route Rationalization were launched in 2013 and 2014 respectively.

The proposed railway projects under the Rail Development Strategy (Transport and Housing Bureau, 2014) is as follows:

Table 5.19 Railway project implementation planning of Rail Development Strategy

Railway project	Implementation planning
Northern Link and Kwu Tung Station	2018 – 2023

Tuen Mun South Extension	2019 – 2022
East Kowloon Line	2019 – 2025
Tung Chung West Extension	2020 – 2024
Hung Shui Kiu Station	2021 – 2024
South Island Line (West)	2021 – 2026
North Island Line	2021 – 2026

The construction work of proposed lines is in progress. For the design and construction of individual projects, Executive Council is the authority while the Legislative Council issues approval for the funding concerned.

Public engagement is highlighted in the implementation. Public forums and meetings were held with various committees and organizations, including the Legislative Council Panel on Transport, Transport Advisory Committee, professionals, academics and the business sector. Feedback were received through various channels, including the website, post, email and calls.

As for Bus Route Rationalization, the first application was in 2013, with a total of 22 routes being rationalized (new routes introduced, frequency increased or reduced, and route cancelled). Resources saved from cancellation were put to the introduction of new routes and enhancement of service.

In terms of institutional arrangement, Transport Department and bus companies are the initiators of rationalization proposals. The proposals are submitted to the government annually, comprising service adjustment based on the forecast demands. Transport Department consults the relevant District Councils on their concerned proposal before implementing the service adjustments (HK Transport Advisory Commitee, 2014). The government makes the final decision with reference to the Guidelines on Service Improvement and Reduction in Bus Route Programs.

The implementation of bus route rationalization proposals requires the support of the community. Various publicity actions were taken to explain the concept of route rationalization and solicit understanding and support, including consult the district councils, conduct promotional campaigns, and arrange small group briefings. The implementation is monitored through reviewing the operational records of bus companies, conducting regular surveys, and acting on passengers’ complaints and suggestions (Transport and Housing Bureau, 2015).

5.4.2 Criteria, scoring, and implementation evaluation

The Service Programs, including the Rail Development Strategy and Bus Route Rationalization, aim at firstly the improvement of capacity of both rail and bus by the construction of new lines and introduction of new bus routes, as well as the integration of different modes through the building of transfer centers, and secondly the enhancement of severe level through measures on operational robustness and reliability. The rail construction is still in progress, and the bus rationalization proposals are submitted and reviewed annually. Therefore, for the 3 criteria under the transport system category, A1 modal-integration, A2 capacity, A3 service, the scores are 4.

Another criterion with a 4 score is C3 acceptability. Before and during the policy implementation period, we can see that public acceptability is valued all the time. Public forums and meetings were held with various committees and organizations. Regular surveys were carried out, and passengers' complaints and suggestions were received through channels of website, post, email and calls. The feedbacks were reviewed and incorporated into the new service programs. (Transport and Housing Bureau, 2015).

With the provision of new rail and bus infrastructure through the programs, new travel opportunities are created, which would help shorten journey time and make travel easier and contribute to accessibility and economic growth. Through the optimization of rail network and bus routes, resources can be saved to introduce new services and strengthen existing services in a timely manner, utilizing the limited resources efficiently. The efficiency criteria is assigned with 3.

Equity criteria is 3 as well. During the implementation of the programs, attention has been paid to groups who are not the majority of the society. For example, in the rationalization of bus service, if the low-utilization rate routes are socially essential for remote commuters or elderlies and without reasonable alternatives, the route would not be cancelled but considered other means to improve the service, such as through the use of vehicles with smaller carrying capacities (Transport and Housing Bureau, 2015).

In building an environmentally-friendly public transport system, the government has made legislative amendments to tighten the statutory emissions standards of newly registered public transport vehicles. At the same time, electric public transport vehicles had been put into trail, though thorough considerations are needed on electric vehicles adoption, such as their technical feasibility, operational feasibility and financial impacts.

Public transport can save land, reduce the use of energy and roadside pollutant emissions, such as nitrogen oxide and greenhouse gases, thus generating environmental benefits. Environmental benefits arising from the bus service rationalization can be reflected by the reduction in emission and busy corridors. Therefore, 3 is given for environment criteria. Another externality criterion, the safety, is scored as 1. In comparison with the private car, the improvement of public transport is considered to reduce congestion and enhance road safety and personal security (HK Transport Advisory Commitee, 2014).

Affordability criteria is score with 2. Under the changes of network capacity and service standards, the principle is that the total journey fare is not higher than that of the service being improved. However, this is remained at the proposal level and the fare kept increasing, as that discussed in the previous schemes.

In terms of funding source, basically the cost of construction of new public transport infrastructure is bear by the government. While for other expense related to service enhancement, the cost is proposed to be shared by the government and the private operators. The finance is scored as 3. The profitability of public transport operators is proposed not to be harmed, but the specific investment plan would need further discussion on a project-basis. Therefore, the profitability criteria's score is 2.

Based on the discussion, criteria identified and the corresponding score can be summarized in the scheme sheet of Table 5.20.

Table 5.20 Scheme sheet – implementation of Service Programs

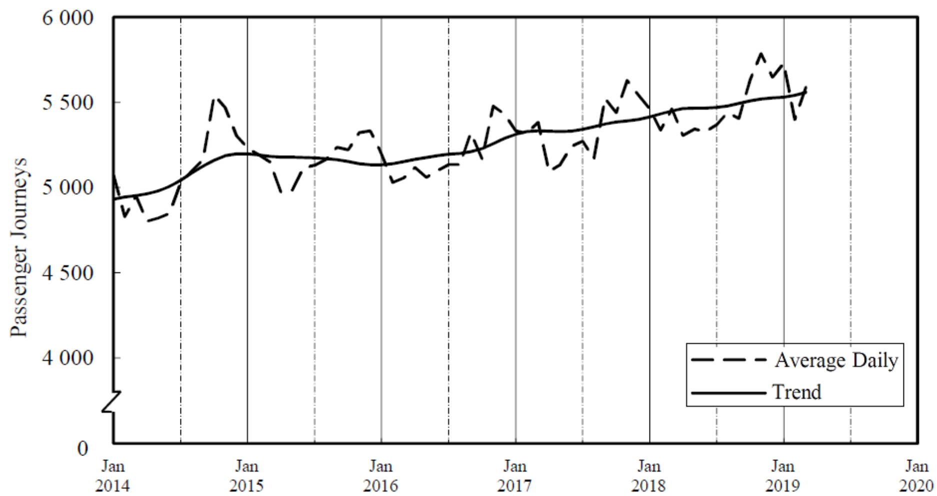
Criteria	Score	Description	Source
Modal integration	4	Transfer center are added to the network	Policy Discussion Paper (Transport and Housing Bureau, 2015)
Network capacity	4	Rail lines under construction, bus routes rationalized	Railway Development Strategy (Transport and Housing Bureau, 2014)
Service	4	The main objective of service programs	Policy Discussion Paper (Transport and Housing Bureau, 2015)
Efficiency	3	Shorter waiting times, higher service level, resource allocation	Policy instrument introduction (KonSULT, 2016)
Profitability	2	Profitability of operators is proposed not to be harmed	Public Transport Plan (HKSAR Transport and Housing Bereau, 2017)
Finance	3	Cost of construction is bear by the government, service enhancement cost is shared	Policy Document (Transport and Housing Bureau, 2014)
Affordability	2	New public transport service proposed not to incur higher expense	Policy Discussion Paper (Transport and Housing Bureau, 2015)
Equity	3	Social groups of remote commuters and elderly are paid attention	Policy Discussion Paper (Transport and Housing Bureau, 2015)
Acceptability	4	Public surveys and discussion forums conducted	Report on policy progress on government website
Environment	3	Reduced use energy and roadside pollutant emissions	Congestion Report (HK Transport Advisory Commitee, 2014)
Safety	1	Side-effect of public transport development	Policy introduction on Transport Department website

5.4.3 Policy performance

The performance of the service programs is examined from the following perspectives.

Rail capacity

The increase of rail network capacity has resulted in the steady increase of number of average daily passenger of MTR. According to the latest statistics released by Statistics Section of Transport Department on March 2019 (Statistics Section of Transport Department, 2019), the trend of changes of average daily passenger of MTR is shown in Figure 5.5.



Source: (Statistics Section of Transport Department, 2019)

Figure 5.5 Trend of average daily passenger of MTR from 2014 to 2019

Rail service

Apart from expanding the existing network, the service is monitored. With the objective of better service, many improvement measures have been taken place, including increasing train frequencies, upgrading of signaling system, deploying platform assistants to better manage the boarding and alighting process, and so on.

The service performance has been monitored by the indicator of annual disruptions, which can reflect the frequency of service breakdowns. Based on the data[31] from Statistics Department, number of disruptions occurred in MTR is listed in Table 5.21.

[31] MTR train service performance (ISSH07/17-18), https://www.legco.gov.hk/research-publications/english/statistical-highlights_1620.htm

Table 5.21 Number of disruptions occurred in MTR

Delays	2008	2009	2010	2011	2012	2013	2014	2015	2016
8-30 min*	222 (93%)	227 (92%)	263 (95%)	286 (95%)	240 (94%)	238 (94%)	253 (93%)	215 (93%)	204 (92%)
>30 min*	18 (8%)	19 (8%)	15 (5%)	14 (5%)	14 (6%)	16 (6%)	20 (7%)	17 (7%)	18 (8%)
Total (≥8 min)	***240***	***246***	***278***	***300***	***254***	***254***	***273***	***232***	***222***

Source: Statistics Department

The total number of disruption is decreasing from 2008 to 2016, indicating an improved the service performance.

Bus capacity

Under the Bus Route Rationalization Program, according to Statistics Department[32], from 2013 to 2017, 40 new routes were introduced with 278 routes increased the frequency. 36 routes of low patronage had been cancelled or amalgamated, and the frequency of 279 routes were reduced.

Bus service

In terms of bus service, the overall lost trip rate, the important indicator on service reliability that being recorded by the government, is collected. According to the Report of Topical Study Franchised Bus Service (Transport and Housing Bureau, 2015), the lost trip rate in 2012 was 4.2%, and 2.6% for 2013, 2.4% for 2014. For the year of 2015, the overall rate was 1.8%. The detailed breakdown was shown below.

[32] Franchised buses in Hong Kong (ISSH12/18-19), https://www.legco.gov.hk/research-publications/english/statistical-highlights_1620.htm

Table 5.22 Lost trip rates of bus operators in 2015

	Morning peak period	Evening peak period	Inter-peak period	After evening peak period	Overall rate in Hong Kong
KMB	1.4%	2.6%	1.5%	1.5%	**1.7%**
Citybus (Franchise for Hong Kong Island and Cross-Harbour Bus Network)	1.3%	1.5%	1.1%	1.5%	**1.3%**
Citybus (Franchise for Airport and North Lantau Bus Network)	0.5%	1.3%	1.1%	0.7%	**0.9%**
NWFB	3.6%	3.7%	2.6%	1.5%	**2.9%**
LW	1.5%	1.4%	0.8%	0.6%	**1.1%**
NLB	0%	0%	0%	0%	**0%**
Overall rate in Hong Kong	**1.6%**	**2.5%**	**1.5%**	**1.5%**	**1.8%**

Source: Transport and Housing Bureau, 2015

To provide quality and reliable services and ensure the long-term sustainable development, various measures were taken in enhancing the quality of bus service. The bus priority is one of them. with the objective of maintaining a high service reliability in traffic congestion, since the road space is shared with bus and other modes, the bus service can be easily affected by traffic congestion. With the priority use of roads to public transport bus service, such as designation of bus-only lanes, designation of bus stops and traffic light signal control, the bus system can maintain a high service reliability in traffic congestion. As of 2015, the total length of bus-only lanes was over 23 km (Transport and Housing Bureau, 2015).

It is worth noting that the implementation of bus priority measures would reduce the number of lanes for use by other vehicles on the same road section. The travelling speed of other vehicles may decrease as a result, which could be the unintended result of the policy intervention.

5.4.4 Indicator and performance evaluation

The performance evaluation follows the indicator listed proposed in 3.1.3.

The Service Programs of Railway Development Strategy and Bus Route Rationalization, are firstly focused on the capacity expansion of rail and bus mode, which can be captured by ID2 of public transport ridership and ID3 of network capacity. Based on the data from Statistics Section of Transport Department on March 2019 (Statistics Section of Transport Department, 2019), the improvement of the 2 indicators since the commence of the Service Programs is shown Table 5.23.

Table 5.23 Capacity improvement under Service Programs

Indicator	Baseline (2014)	Endline (2018)	Normalized value
public transport ridership (Rail, Daily Passenger Journeys)	4562000	4921000	1.079
public transport ridership (Bus, Daily Passenger Journeys)	3914000	4054000	1.036
network capacity (Rail, Train km operated)	4084	4525	1.108
network capacity (Bus, Car km operated)	38398	38787	1.010

ID4 of service reliability is a good indicator to evaluate the performance of Service Programs. The government has officially checked the indicator of lost trip rate on bus, and the indicator of number of operation disruption on MRT network, and they are adopted as the indicators for service reliability. Based on the available data from the Report of Topical Study Franchised Bus Service (Transport and Housing Bureau, 2015) and Statistics Department that given in the previous section, the key information are summarized in Table 5.24

Table 5.24 Service reliability under Service Programs

Year	2013-2014	2014-2015	2015-2016	annual rate
Bus lost trip rate	2.6%	2.4%	1.8%	1.208
Rail operation disruption	273	232	222	1.107

The normalized value for ID4 of service reliability is 1.208 and 1.107, for bus and rail mode respectively.

ID11 of public satisfactory can be measured by the number of complaint cases on public transport services. Based on the public survey conducted by the Transport Complaints Unit[33], the number of complaint cases on public transport service, including bus and rail modes, was 12234 cases in 2013-2014, and 11615 cases for the year 2017-2018. Normalizing the progress, the value for ID11 of public satisfactory is 1.053.

The indicator of number of fatalities and number of injuries are utilized to reflect the safety performance of public transport. The indicators are monitored and published annually by the Statistics Department (Statistics Section of Transport Department, 2019), based on that, the following table is derived.

Table 5.25 Fatality and injury of transport accident

Accident	2014	2015	2016	2017	2018	Normalized value
Fatalities	99	117	129	104	107	0.925
Injuries (per 1 000 Population)	2.732	2.779	2.726	2.676	2.617	1.044

[33] Franchised buses in Hong Kong (ISSH12/18-19), https://www.legco.gov.hk/research-publications/english/statistical-highlights_1620.htm

The programs started in 2014. The result of the before and after comparison is listed in the right column of the table. Indicator of number of fatalities and number of injuries are normalized as 0.925 and 1.044, respectively.

The performance of environment sustainability can be checked by ID12 of emission. From the report from Environmental Protection Department of Hong Kong (Environmental Protection Department, 2017), the data of major emissions produced by urban transport system are collected. The before (2014) and after (2017) data are listed in Table 5.26.

Table 5.26 Major emissions produced by urban transport system (μg/m³)

Emissions	NO_x	NO_2	CO	SO_2	O_3	Normalized value
2014	251	102	840	8.3	40	
2017	212	86	750	7.1	50	
Change ratio	1.184	1.186	1.120	1.169	0.800	1.092

Calculating the arithmetic mean of the changes of these emissions, the normalized value is noted as 1.092.

The indicators can be summarized in the scheme sheet of performance of Service Programs.

Table 5.27 Scheme sheet – performance of Service Programs

Indicator	Normalization score	Description	Source
public transport ridership (Rail)	1.079	Improved network attracts commuters	Statistics Section of Transport Department on March 2019 (Statistics Section of Transport Department, 2019)
public transport ridership (Bus)	1.036	Rationalized bus network and better service	
network capacity (Rail)	1.108	Construction of new rail lines	Statistics Section of Transport Department on March 2019 (Statistics Section of Transport Department, 2019)
network capacity (Bus)	1.010	Introduction of bus routes	
service reliability (Rail)	1.107	Rail operation disruption frequency	MTR train service performance report (ISSH07/17-18)
service reliability (Bus)	1.208	Bus lost trip rate	Report of Topical Study Franchised Bus Service (Transport and Housing Bureau, 2015)
number of fatalities	0.925	Fatalities caused by transport accident	

number of injuries	1.044	Injuries caused by transport accident	Statistics Department (Statistics Section of Transport Department, 2019)
emission	1.092	Impact of public transport promotion and green bus	Environmental Protection Department of Hong Kong (Environmental Protection Department, 2017)

5.4.5 Scheme summary

The service programs focused on the expansion of the rail and bus network, with the objective of maintaining the quality and diversified public transport services for sustainable development. Enhanced service would attract more people to commute by public transport.

5.5 Aggregation of policy schemes

5.5.1 Policy implementation aggregation

The criteria aggregation sheet aggregates all the implementation information of each scheme sheet.

Table 5.28 Criteria aggregation sheet for Hong Kong

Category	Criteria	Score	Scheme
transport system	modal integration	1	WITS Scheme
		2	Public Transport Subsidy Scheme
		4	Service Programs
	network capacity	2	Fare Adjustment Scheme
		4	Service Programs
	service	3	Fare Adjustment Scheme
		2	Public Transport Subsidy Scheme
		4	Service Programs
economics	efficiency	4	Fare Adjustment Scheme
		2	WITS Scheme
		1	Public Transport Subsidy Scheme
		3	Service Programs
	profitability	4	Fare Adjustment Scheme
		2	Service Programs
	finance	3	WITS Scheme
		3	Public Transport Subsidy Scheme

		3	Service Programs
society	affordability	3	Fare Adjustment Scheme
		4	WITS Scheme
		4	Public Transport Subsidy Scheme
		2	Service Programs
	equity	2	Fare Adjustment Scheme
		3	WITS Scheme
		4	Public Transport Subsidy Scheme
		3	Service Programs
	acceptability	4	Fare Adjustment Scheme
		4	WITS Scheme
		3	Public Transport Subsidy Scheme
		4	Service Programs
externality	environment	3	Service Programs
	safety	1	Fare Adjustment Scheme
		1	Service Programs

Criteria and scores identified from policy implementation of each pricing scheme in Hong Kong are collected and arranged in terms of categories. The last column of the table also notes the specific contributing scheme.

5.5.2 Policy performance aggregation

The indicator aggregation sheet aggregates the performance information of each scheme sheet. It reports the indicator values, the corresponding scheme, as well as the category.

Table 5.29 Indicator aggregation sheet for Hong Kong

Indicator	Value	Scheme	Category
average public transport fare	0.974	Fare Adjustment Scheme	transport system
operator profitability	1.041	Fare Adjustment Scheme	economics
operator expenditure	0.984	Fare Adjustment Scheme	economics
government expenditure	0.848	WITS Scheme	economics
average public transport fare	1.118	Public Transport Subsidy Scheme	society

government expenditure	0.648	Public Transport Subsidy Scheme	economics
affordability	1.115	Public Transport Subsidy Scheme	society
subsidy distribution	0.815	Public Transport Subsidy Scheme	society
public transport ridership (Rail)	1.079	Service Programs	transport system
public transport ridership (Bus)	1.036	Service Programs	transport system
network capacity (Rail)	1.108	Service Programs	transport system
network capacity (Bus)	1.01	Service Programs	transport system
service reliability (Rail)	1.107	Service Programs	society
service reliability (Bus)	1.208	Service Programs	society
number of fatalities	0.925	Service Programs	externality
number of injuries	1.044	Service Programs	externality
emission	1.092	Service Programs	externality

There are 17 indicators collected from 4 pricing schemes in Hong Kong, listed following the order of schemes being evaluated. The last column of the table notes the specific category.

5.5.3 Integration and visualization of the result

The criteria aggregation sheet (Table 5.28) and indicator aggregation sheet (Table 5.29) have been loaded with policy implementation and performance information respectively. As the last step of the analytical framework (3.1.6), the multi-level aggregation approach is taken, to integrate all the derived criteria and indicator scores for the evaluation of the pricing policy package.

Detailed description of the process is shown in Figure 3.14. Following that, the integration of implementation score in done in Table 5.30.

Table 5.30 Integrated implementation score

Category	Criteria	Score	criteria score	weight	weighted score	weighted category score	integrated implementation score
transport system	modal integration	1 2 4	7	0.030	0.212	0.758	1.081
	network capacity	2 4	6	0.045	0.273		
	service	3 2 4	9	0.030	0.273		
economics	efficiency	4 2 1 3	10	0.023	0.227	0.773	1.103
	profitability	4 2	6	0.045	0.273		
	finance	3 3 3	9	0.030	0.273		
society	affordability	3 4 4 2	13	0.023	0.295	0.909	1.297
	equity	2 3 4 3	12	0.023	0.273		
	acceptability	4 4 3 4	15	0.023	0.341		
externality	environment	3	3	0.091	0.273	0.364	0.519
	safety	1 1	2	0.045	0.091		

Equal weighting method is adopted, as discussed in 3.1.6. The multiplier is applied in the normalization of the weighted category score, to make the total sum of the integrated implementation score as 4.

The integrated performance score is calculated in Table 5.31.

Table 5.31 Integrated performance score

Category	Indicator	Indicator value	Category score	Categorical average	Integrated implementation score	Integrated performance score
transport system	average public transport fare	0.974	5.207	1.041	1.081	1.121
	public transport ridership (Rail)	1.079				
	public transport ridership (Bus)	1.036				
	network capacity (Rail)	1.108				
	network capacity (Bus)	1.010				
economics	operator profitability	1.041	3.521	0.880	1.103	0.967
	operator expenditure	0.984				
	government expenditure	0.848				
	government expenditure	0.648				
society	average public transport fare	1.118	5.363	1.073	1.297	1.385
	affordability	1.115				
	subsidy distribution	0.815				
	service reliability (Rail)	1.107				
	service reliability (Bus)	1.208				
externality	number of fatalities	0.925	3.061	1.020	0.519	0.527
	number of injuries	1.044				
	emission	1.092				

The category score is the sum-up of indicator values under the same category, and the categorical average indicates the degree of changes for that particular category. A value above 1 means a progress while below 1 means regress. The final integrated performance score is the normalized result under the principle of total sum as 4.

Visualization of the evaluation results as shown in Figure 5.6. The 4 dimensions of the radar chart are the 4 categories of transport system, economics, society, and externalities, respectively. The orange curve stands for the policy implementation, while the blue curve is the policy performance.

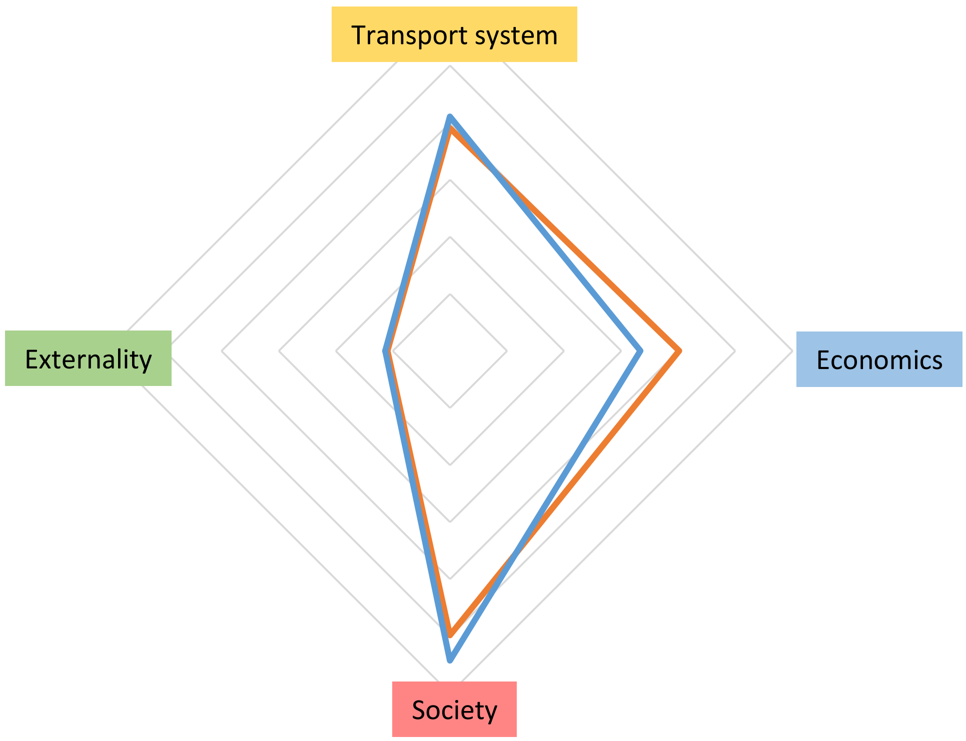


Figure 5.6 Hong Kong pricing policy implementation and performance

Based on the visualization, it is clear that society and economics are emphasized in the pricing policy in Hong Kong. There are gaps between policy implementation and performance in terms of society and economics, and the major trade-off is the sacrifice of economics, for the improvement of society.

5.6 Chapter summary

In this chapter, pricing schemes in Hong Kong are evaluated through the integrated analytical framework proposed in Chapter 3. Within the evaluation of each scheme, the introduction follows the policy cycle: from problem identification, to policy design and implementation. MCE method is used in policy implementation evaluation, while indicator-based evaluation is carried out in policy performance evaluation. After all schemes are investigated, the results are aggregated. Integrated implementation and performance scores are calculated and visualized at the end.

Hong Kong's pricing policies as a whole, society and economics are emphasized. Based on the radar chart, the major trade-off is the sacrifice of economics, for the improvement of society.

6 Causality Analysis and Implication

Applying the integrated analytical framework, case studies on Singapore and Hong Kong has been carried out in Chapter 4 and 5 respectively. Based on the output of the framework, the gap between policy implementation and performance in terms of different categories is shown through radar charts, and the preliminary results are discussed for each individual case.

This chapter combines the analysis of the 2 cases and further compares them in a systematic way. The observed gap between actual performance and policy intention is analyzed to identify opportunities for improvement. Causality analysis based on the combined theory-based approach is carried out. Causality maps are made based on interaction between the policy schemes and the key factors of the transport network, to highlight the policy interventions under different urban contexts. Implications for sustainable public transport pricing policies are developed to address the pre-defined research problems.

6.1 Comparative case study

Different public transport systems produce different types of cities, and vice versa. As the ex-post evaluation on pricing policy, comparison is necessary to highlight the difference in policy contexts and policy intervention impacts. Singapore and Hong Kong, as megacities both compacted by island topography and with highly integrated public transport system, are comparable. The comparison could start with the outputs of the integrated analytical framework, to provide a general understanding of the differences between the 2 cities.

From the implementation and performance perspectives, the aggregation sheets (Table 4.23 for Singapore and Table 5.30 for Hong Kong, to be specific) have summarized the implementation criteria score for both cities, as listed in following table.

Table 6.1 Summary of criteria score for Singapore and Hong Kong

Category	Criteria	Criteria score		Sum-up
		Singapore	Hong Kong	
transport system	modal integration	6	7	13
	network capacity	14	6	20
	service	8	9	17
economics	efficiency	14	10	24
	profitability	3	6	9
	finance	12	9	21
society	affordability	14	13	27
	equity	9	12	21
	acceptability	16	15	31
externality	environment	4	3	7
	safety	3	2	5

The criteria score shows the intentions of policy interventions. The sum-up of criteria scores in Singapore and Hong Kong is shown in the last column. Different criteria have different scores. Among them, criteria that with a high implementation score include: network capacity, service, efficiency, finance, affordability, equity, and acceptability. Other criteria have a relatively low score. This is particular true for the externality criteria of environment and safety, due to the low relevance with pricing policy.

From the policy performance perspective, the indicator values from the aggregation sheet are displayed in the bar charts (

Figure 6.1 and Figure 6.2, for Singapore and Hong Kong respectively), for a direct visual reflection of the significance of impacts.

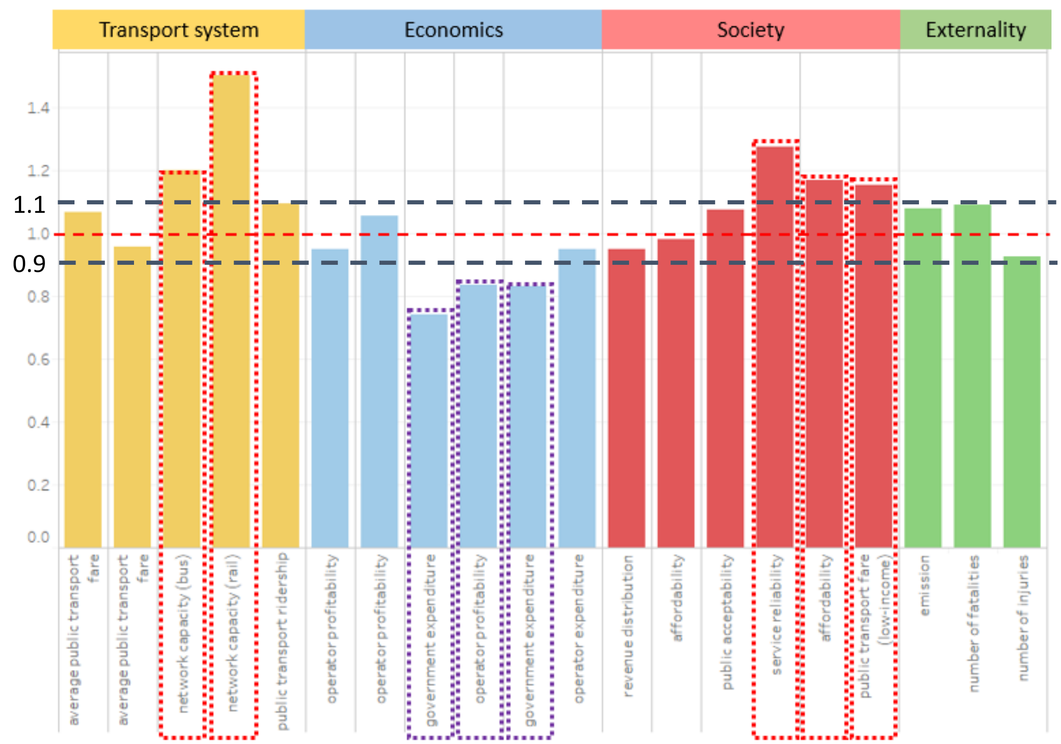


Figure 6.1 Performance indicator value for Singapore

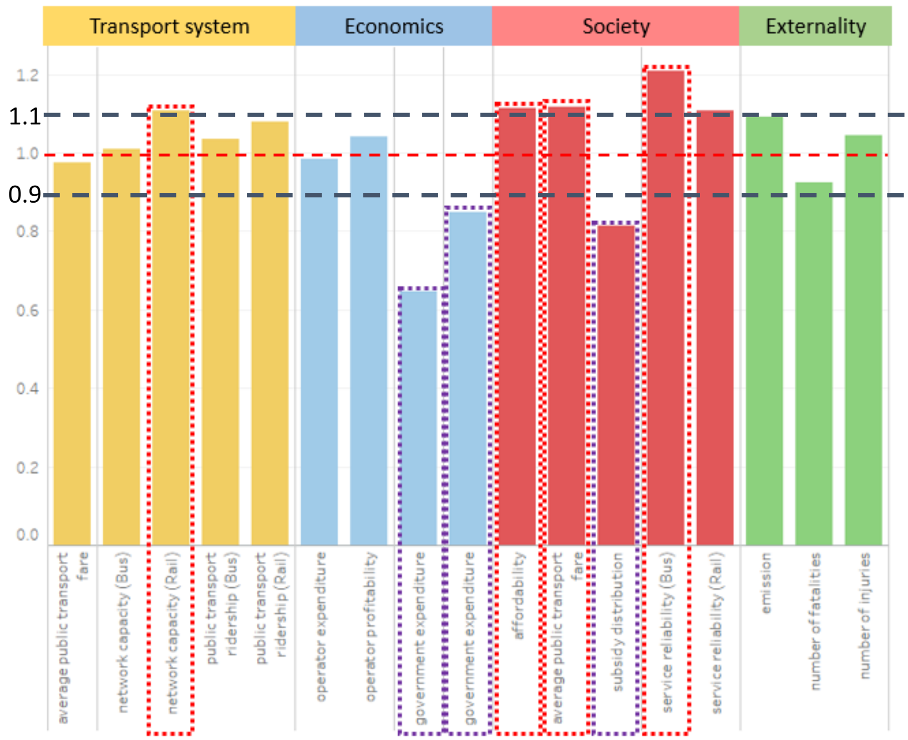


Figure 6.2 Performance indicator value for Hong Kong

The indicators are sorted according to the 4 categories, as indicated by colors and noted on top of the figures. Performance indicators' name is listed at the bottom. On the left is the normalized indicator values. A value more (less) than 1 means a positive (negative) impact. The 1.1 and 0.9 level line is added for the sake of comparison. Based on the height of bars, we can see the indicators of public transport fare and network capacity, service, public expenditure, operator profitability, and affordability, have more significant impacts for both Singapore and Hong Kong cases.

After aggregation and normalization, the above criteria score and indicator values are translated into the integrated score. Detailed values are listed in Table 6.2. The scores are arranged according to the 4-category, with implementation and performance scores for Singapore and Hong Kong taking separate columns.

Table 6.2 Comparison of integrated score for policy implementation and performance

Category	SG-Imp	SG-Pfm	HK-Imp	HK-Pfm
Transport	1.316	1.442	1.081	1.121
Economics	0.942	0.792	1.103	0.967
Society	1.143	1.183	1.297	1.385
Externality	0.600	0.583	0.519	0.527

Plotting the results, it can be visualized in the radar chart of Figure 6.3. The green line is for Singapore and the red one is for Hong Kong. The solid line stands for evaluation result of policy implementation, while the dotted line stands for performance.

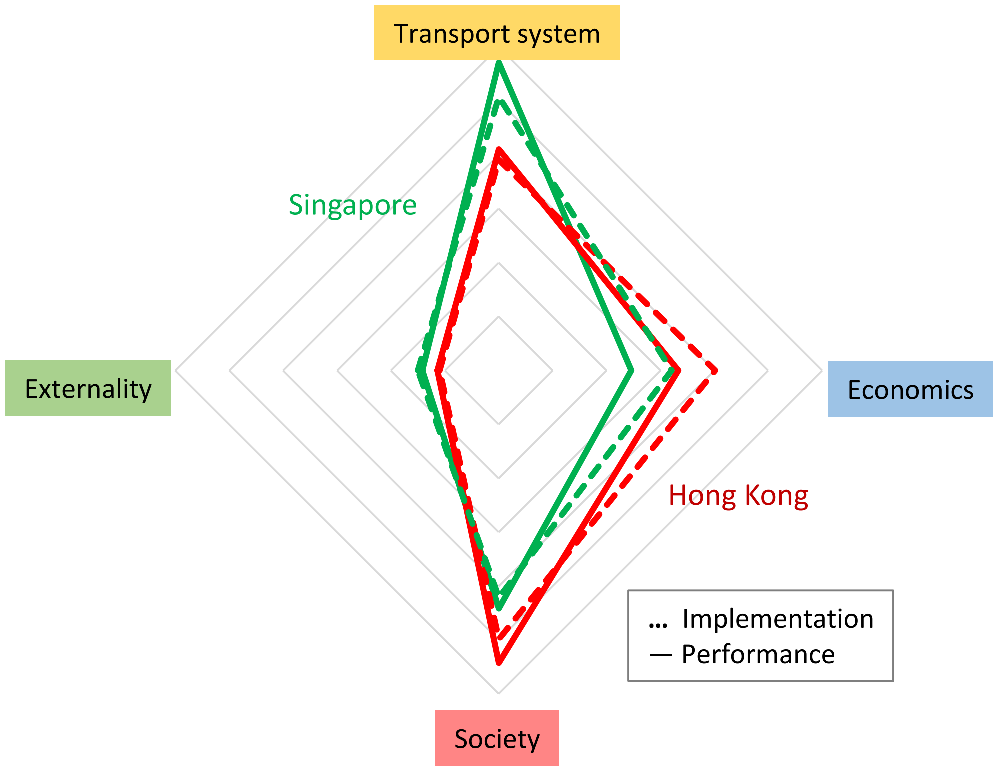


Figure 6.3 Comparison of policy implementation and performance

As can be seen from the score table, in terms of implementation, the priority order is:

Singapore: Transport > Society > Economics > Externality

Hong Kong: Society > Economics > Transport > Externality

This can also be observed by the shape of the diamonds that a higher priority will have a sharper corner. The direct comparison based on the output of integrated analytical framework tells that, the priority for Singapore is the improvement of transport system capacity, while for Hong Kong, it emphasizes the social need of affordable fare first.

In terms of performance, based on the outward or inward movement of implementation and performance diamonds, we have:

Table 6.3 Comparison of policy performance of Singapore and Hong Kong

	Singapore	Hong Kong
Transport	improved	moderately improved
Economics	worsened	worsened
Society	slightly improved	moderately improved
Externality	almost unchanged	almost unchanged

Based on the comparison, for Singapore, “transport” improved the most, while for Hong Kong, “society” is just moderately improved though it is the policy priority. For both, “economics” is worsened, and “externality” is almost unchanged, which shows the relevance between pricing policy and externality is low.

This comparative case study is based on the direct output (implementation criteria score and performance indicator value) of the integrated analytical framework. “What has been done” (or policy implementation) and “what has been achieved” (or policy performance) are clear. The gap between them is revealed as well. In the following causality analysis, the question of “How” and “Why” is addressed.

6.2 Causality analysis

The urban transport system often involves a complex set of inter-related variables, each of which can influence the final outcome, making it difficult to isolate the fraction of the observed impact that is due to the initial policy intervention. From the policy making perspective, it is important to appreciate how and why a policy can be expected to result in a particular impact.

Therefore, the causality analysis is introduced here to describe the causes and effects of a change in policy management, and to measure the link between policy interventions and outcomes. The objective of causality analysis is to:

- explain the gap between policy implementation and policy performance that identified from the integrated analytical framework;
- highlight the interactions and changes between policy intervention and outcomes;
- address pricing problems and derive implication for future policy making.

The causality analysis adopts a combined theory-based approach. Theory of Change provides the broad strategic understanding of implementation theory, while Realist Evaluation focuses on CMO configurations embedded program theory. Causality map is made as to the completion of causality analysis.

6.2.1 Theory of Change

The Theory of Change analysis adopts the form of intervention logic model that requires the input of context, intervention, short-term output, medium-term outcome, and long-term impact. Detailed analytical process is describe in 3.2. Chapter 4 and 5 are reviewed, to collect quantitative and qualitative evidences for the intervention logic model. The building blocks are identified according to their definitions, and then filled in the model, and finally linked based on quantitative and qualitative evidences. The quantitative and qualitative links differentiated by the solid and dotted patterns. Numerical label and red cross are added when applicable. Key factors that are highly related to the pre-defined pricing problems are highlighted with orange frames.

Theory of Change analysis is carried out for each individual pricing scheme. They are presented below, following the introduction order in Chapter 4 and 5.

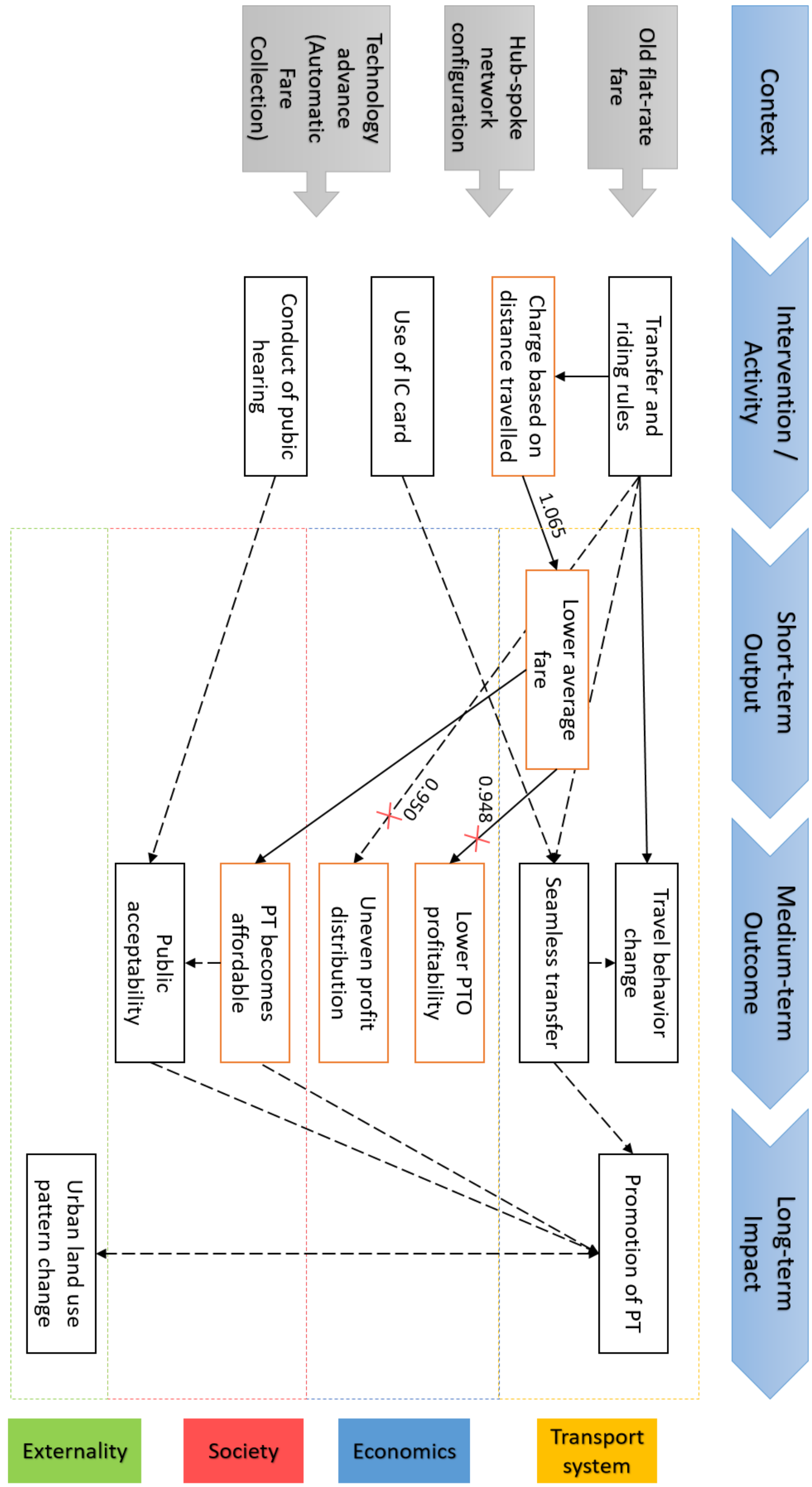


Figure 6.4 Theory of Change for Distance-base Fare Scheme in Singapore

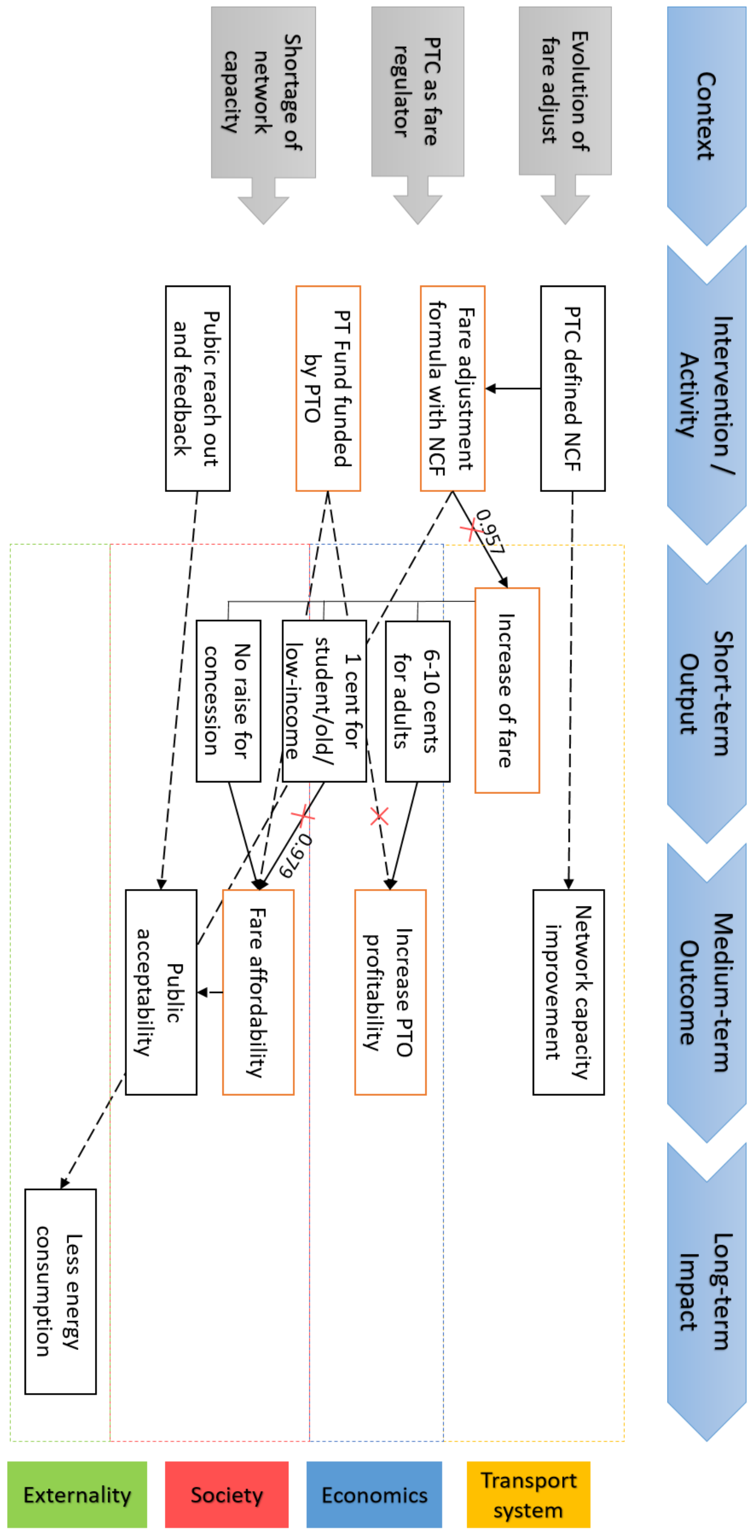


Figure 6.5 Theory of Change for New Capacity Factor Fare Adjustment Scheme in Singapore

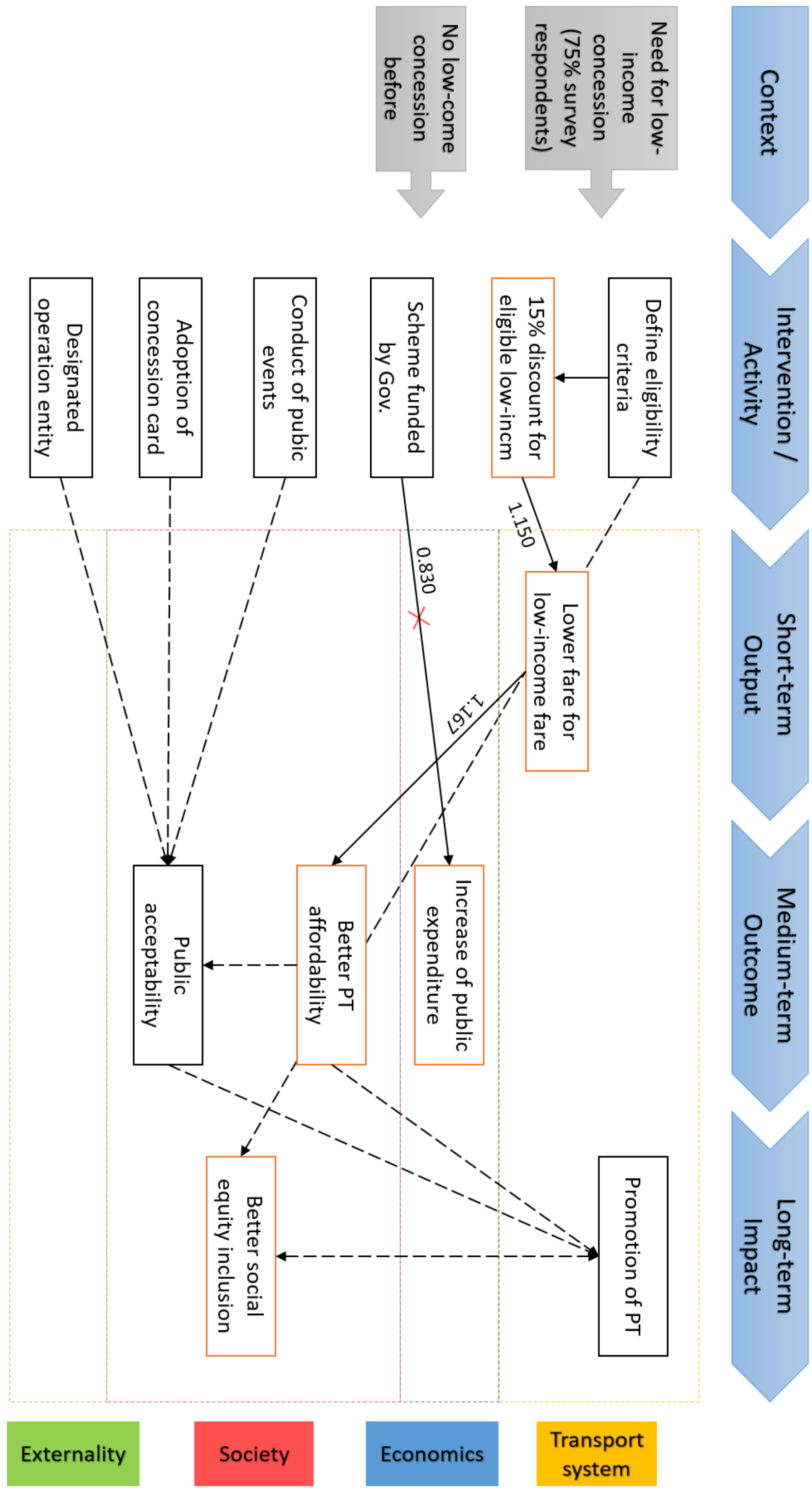


Figure 6.6 Theory of Change for Workfare Transport Concession Scheme in Singapore

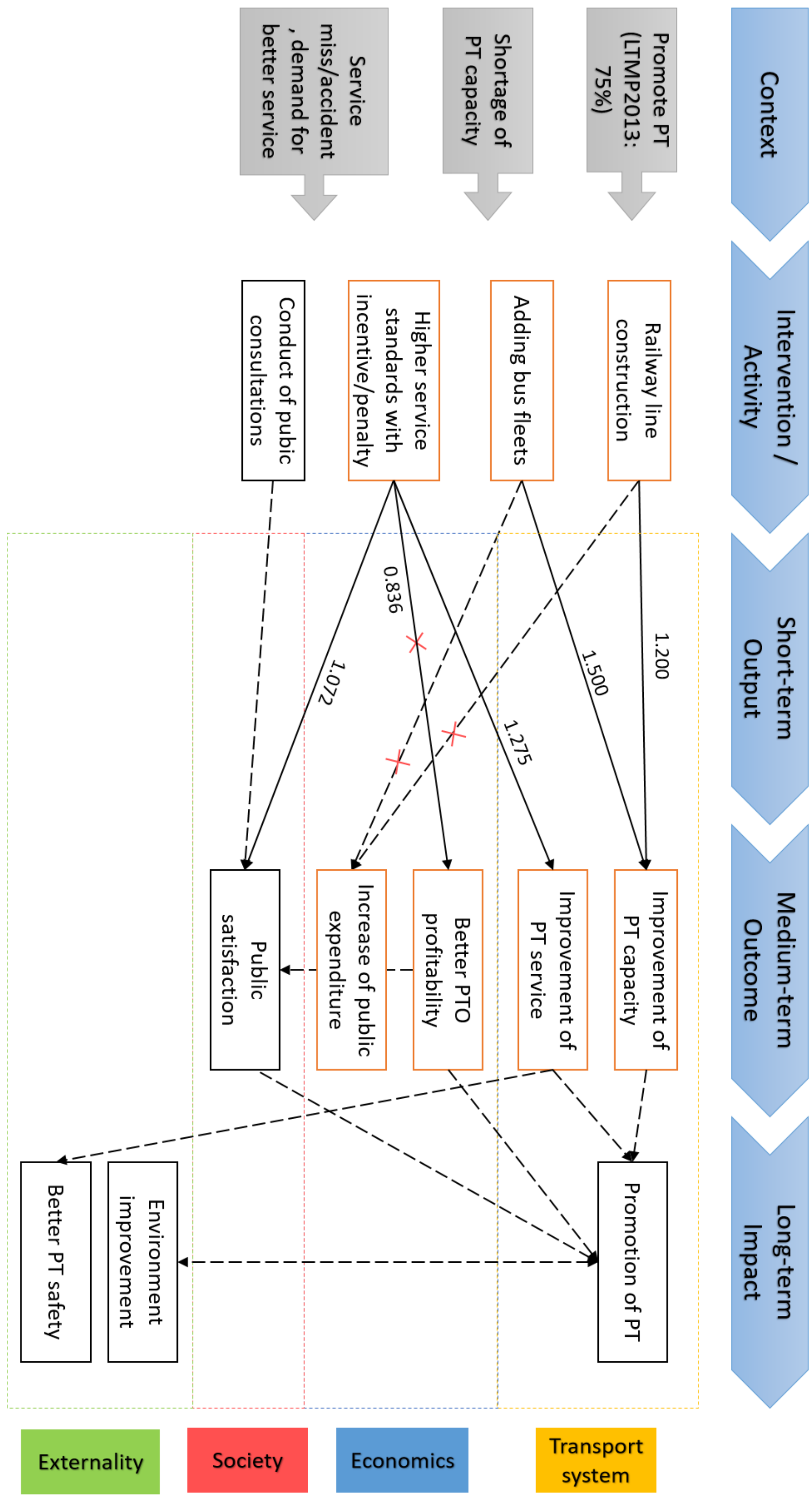


Figure 6.7 Theory of Change for Service Enhancement Program in Singapore

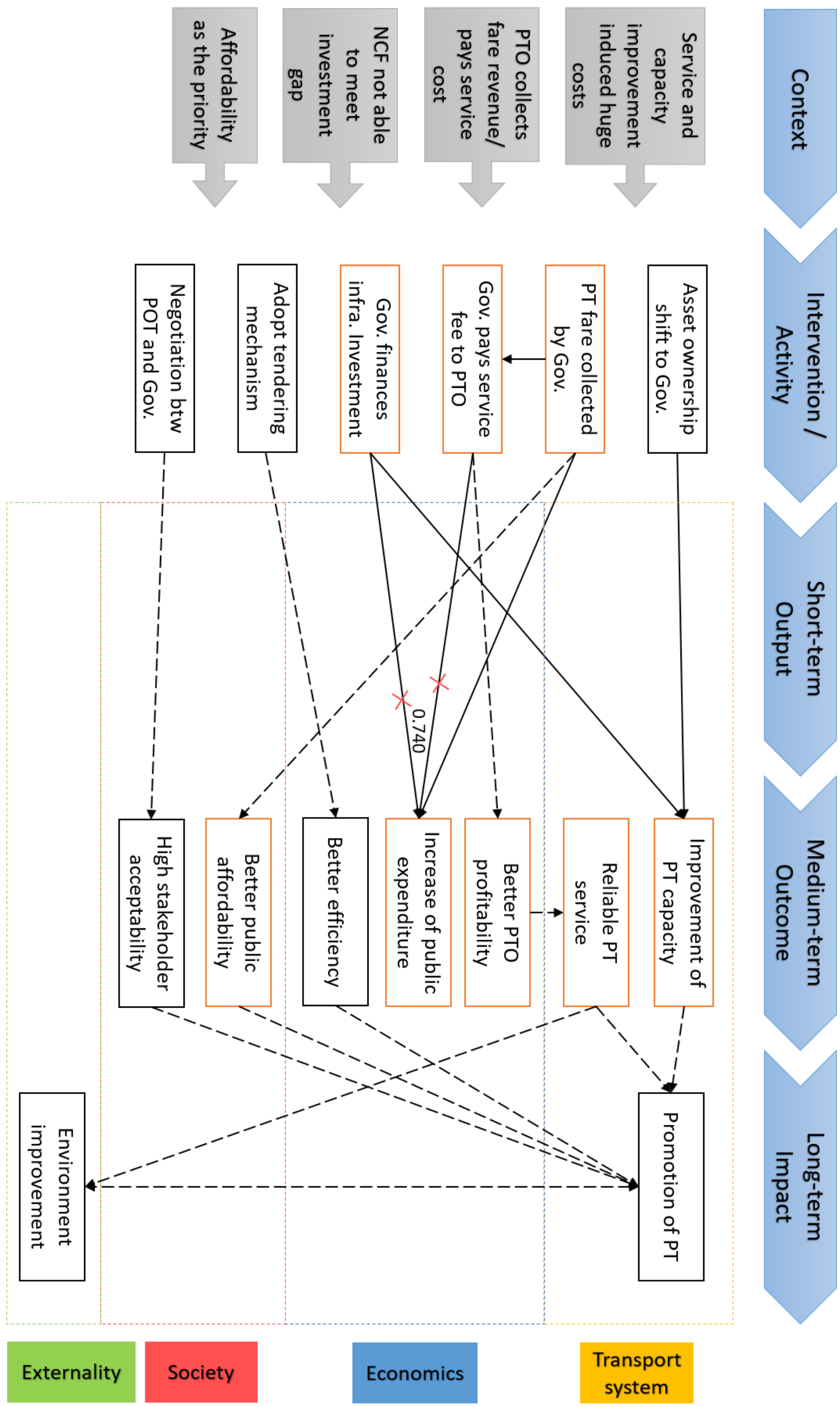


Figure 6.8 Theory of Change for New Finance Scheme in Singapore

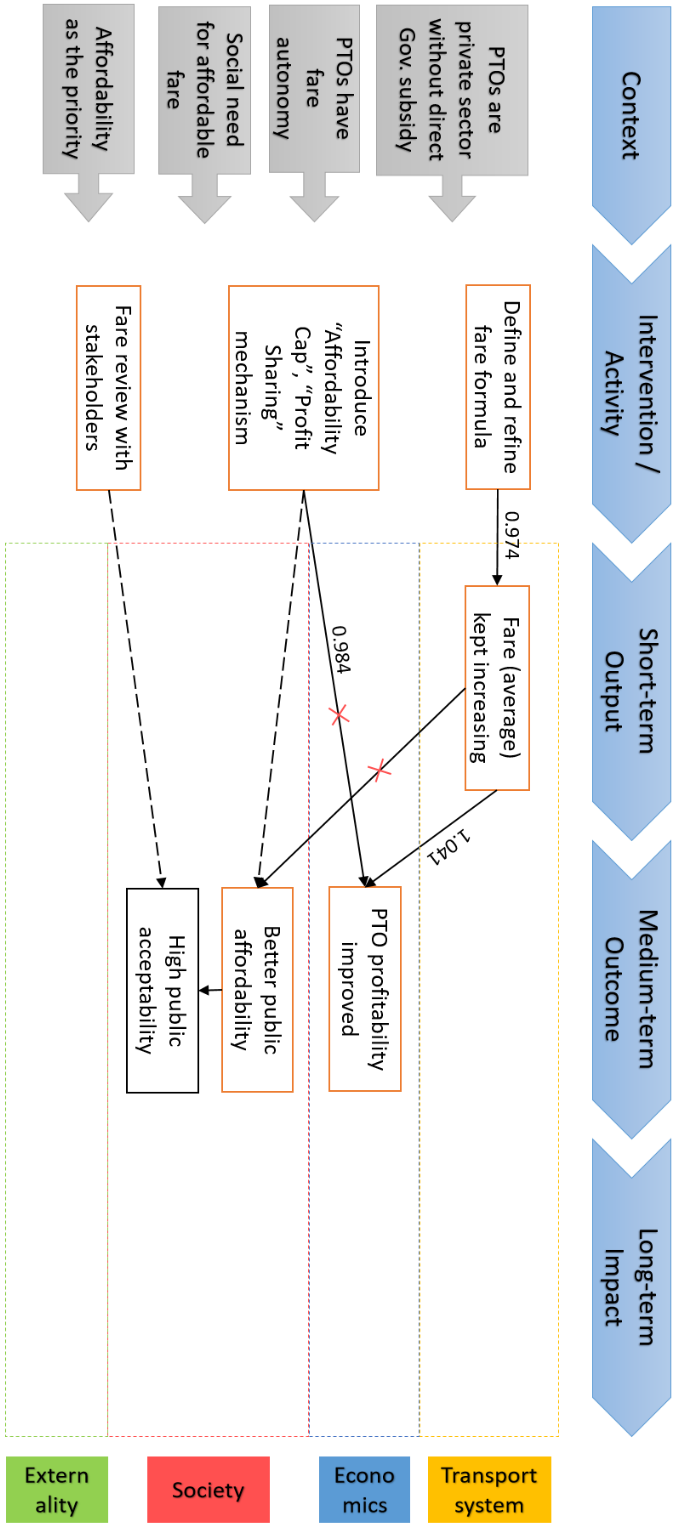


Figure 6.9 Theory of Change for Fare Adjustment Scheme in Hong Kong

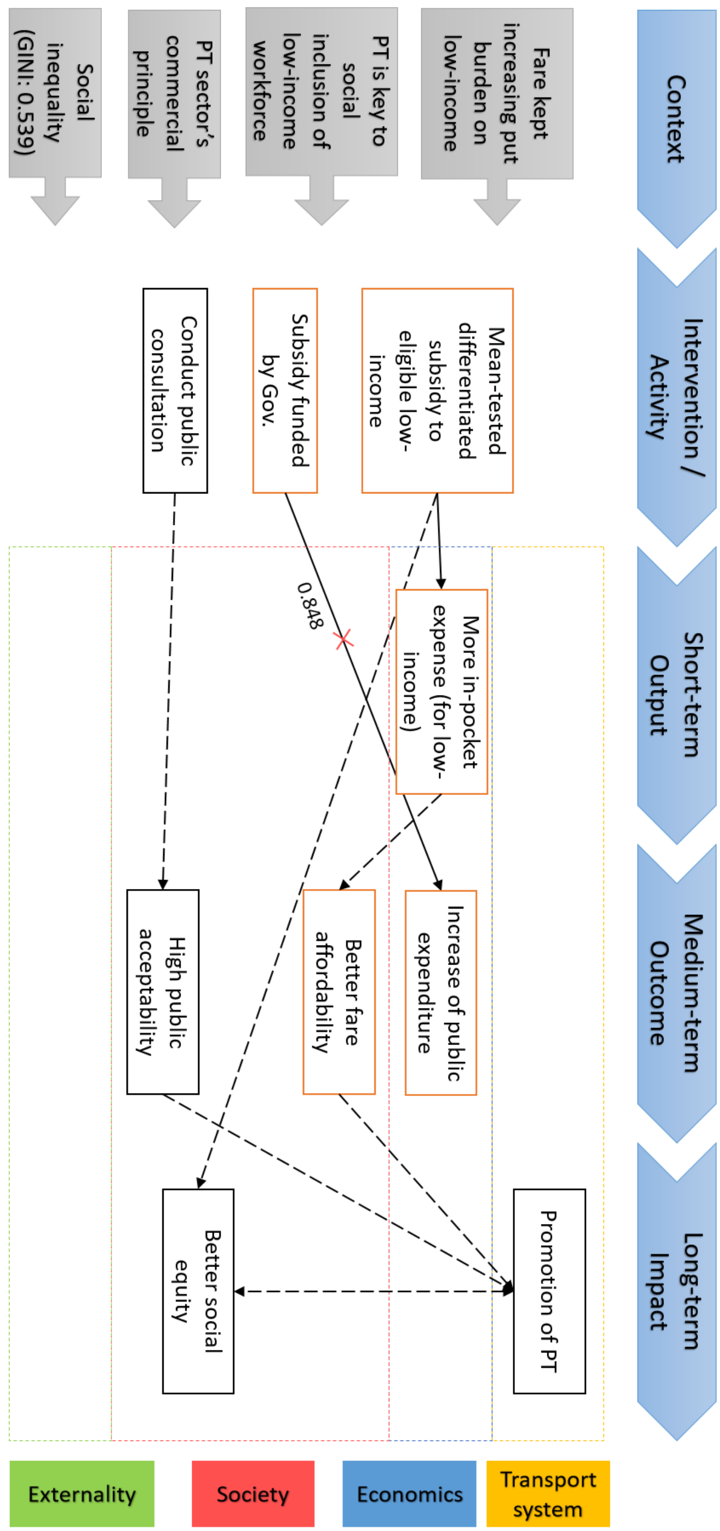


Figure 6.10 Theory of Change for Work Incentive Transport Subsidy Scheme in Hong Kong

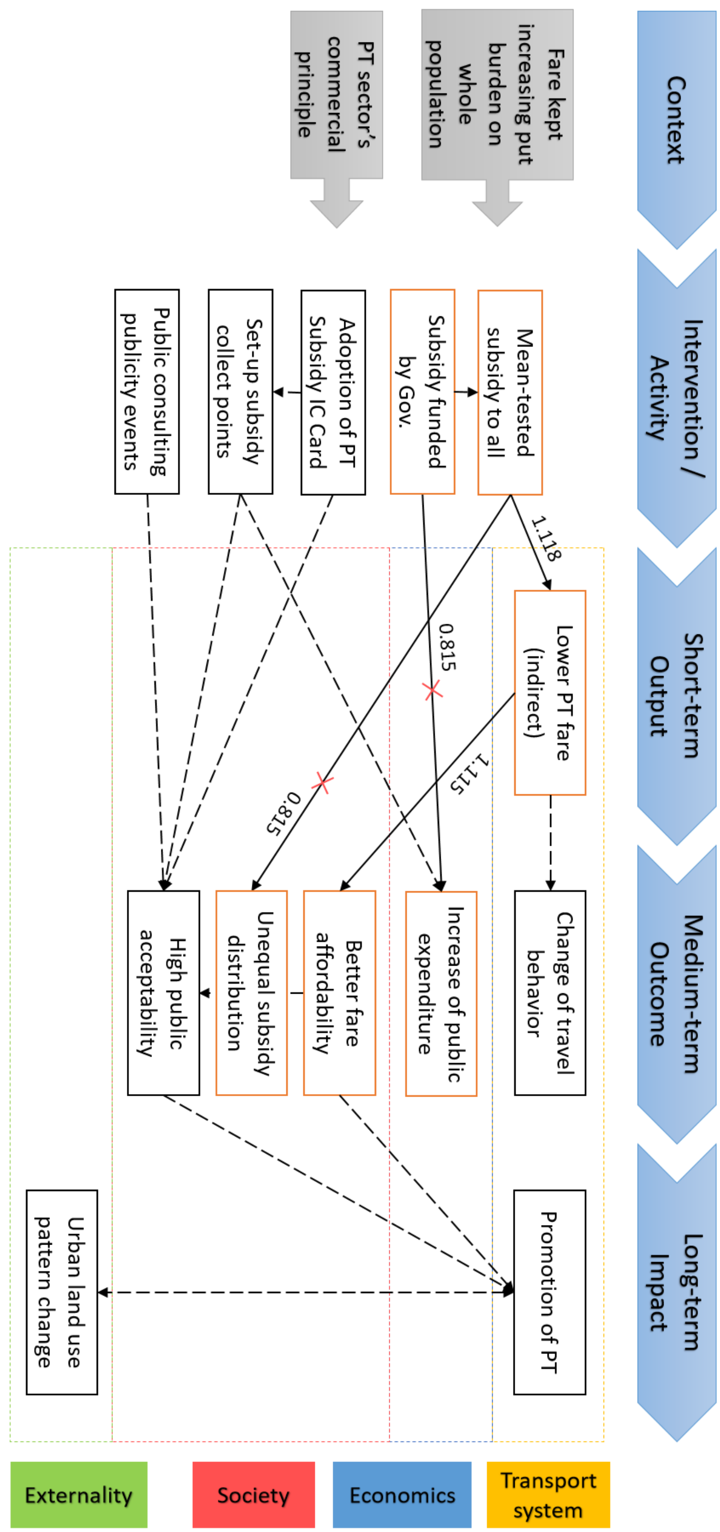


Figure 6.11 Theory of Change for Public Transport Subsidy Scheme in Hong Kong

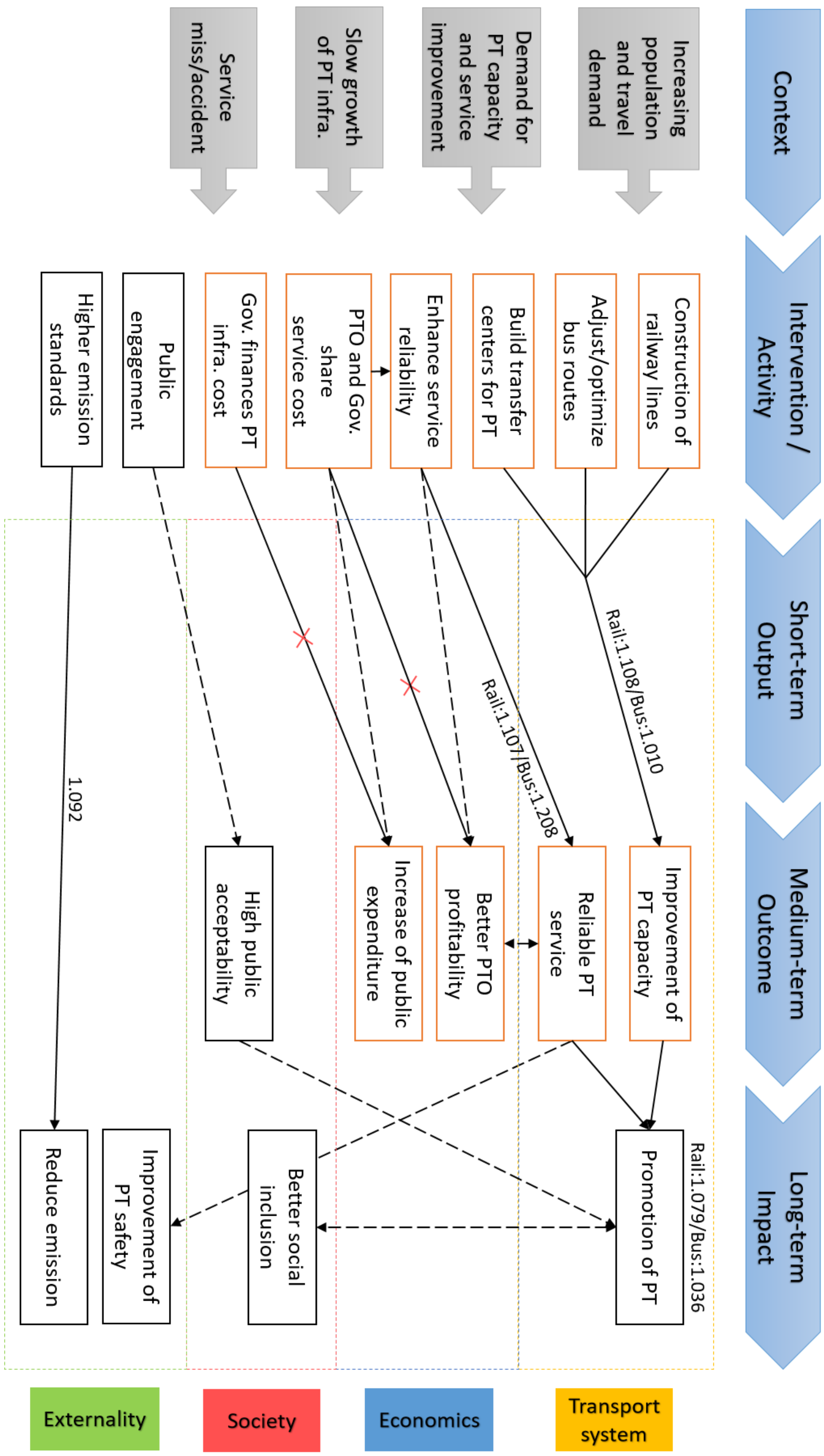


Figure 6.12 Theory of Change for Service Programs in Hong Kong

All pricing schemes (in total 9, 5 from Singapore and 4 from Hong Kong) are analyzed by Theory of Change intervention logic model. With multiple causal paths, these diagrams show how within a pricing scheme, particular intervention leads to a particular output, and how a particular output leads to particular outcome.

It is worth mentioning that key factors highlighted in orange frames are defined as components highly related to the pre-defined pricing problems. As illustrated in the conceptual multi-layer transport system, each layer stands for one category. Key factors of urban public transport system should have multiple connections with components in the same category, and sometime their influence can go cross multiple layers. Generally speaking, a key factor would have a high score if examined in terms of level of policy implementation, and a significant impact on the indicator value in terms of policy performance.

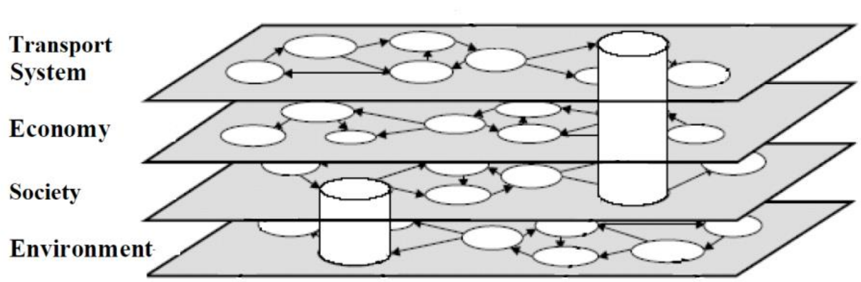


Figure 6.13 Illustration of key factors of public transport system

From the results of criteria score (Table 6.1) and indicator values (Figure 6.1, Figure 6.2), factors of fare, affordability, profitability, capacity, finance, as well as service are evident among others. This can be regarded as supporting evidence for key factor selection.

6.2.2 Realist Evaluation

Realist Evaluation imports the key factors and associated links from Theory of Change analysis with special attention on underlying contexts and mechanisms. For each link, there is a corresponding mechanism denoted. Finally, Realist Evaluation extracts the CMO configurations as the completion of causality analysis.

Realist Evaluation is carried out the policy package level. Individual pricing schemes are combined and compressed on the case basis. Thus, there are 2 Realist Evaluation diagrams, as shown below.

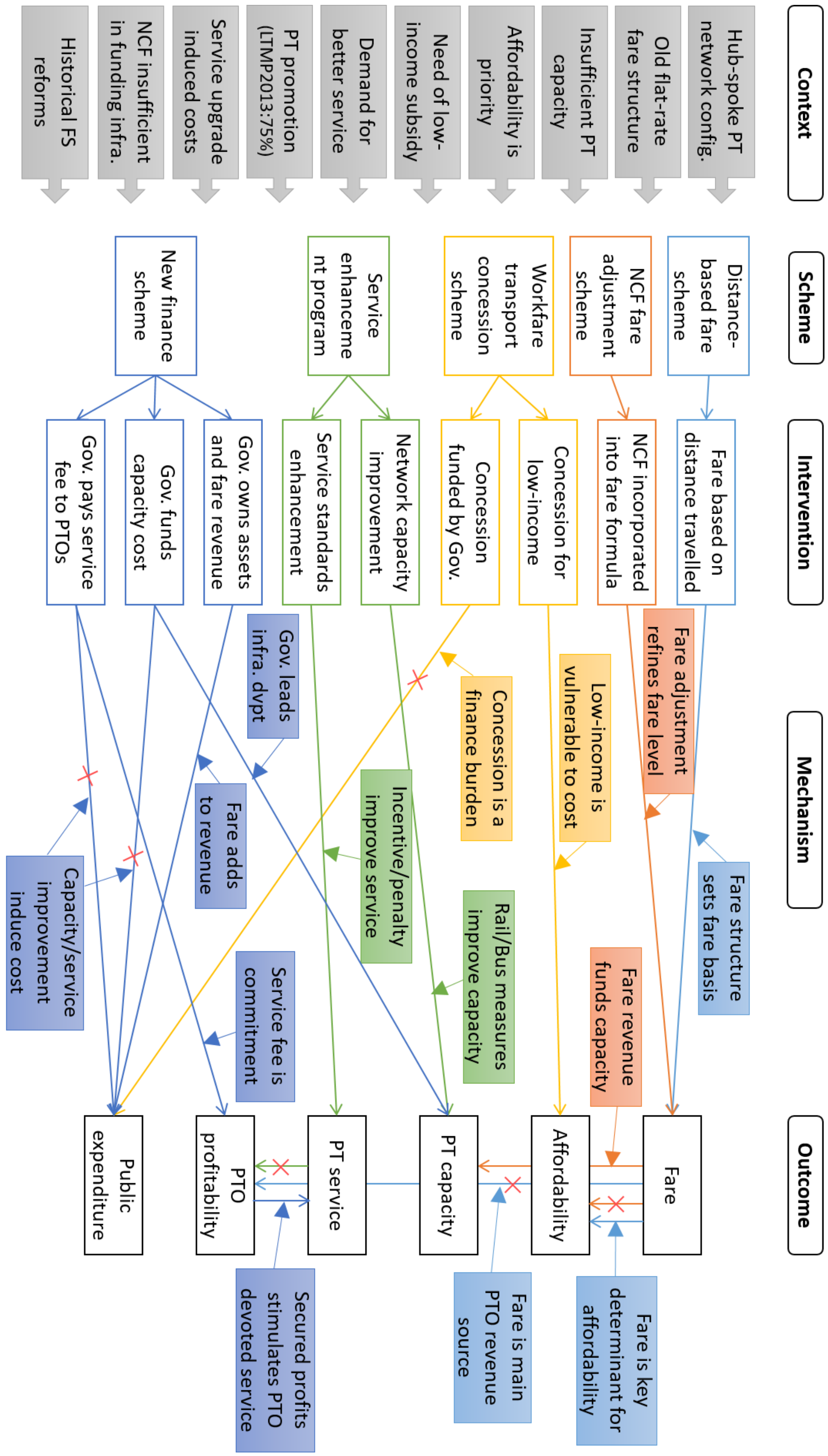


Figure 6.14 Realist Evaluation for Singapore

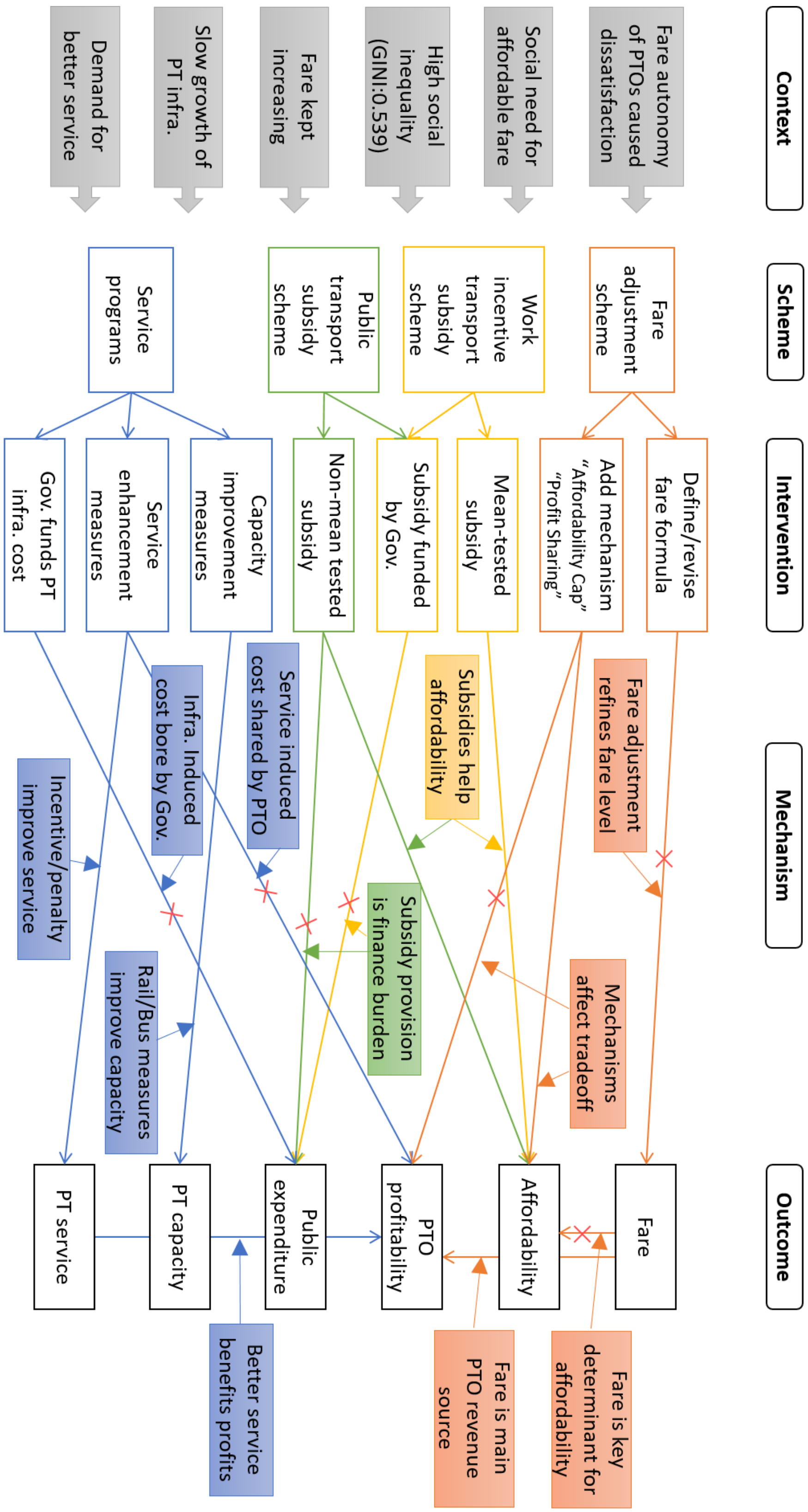


Figure 6.15 Realist Evaluation for Hong Kong

Realist Evaluation considers context as part of the mechanism. Sets of context-mechanism-outcome that revealed by the analysis are extracted and listed in the CMO configuration tables. The last column records the key factor that related to that particular CMO configuration. CMO configurations are the final output of Realist Evaluation.

Table 6.4 Realist Evaluation CMO for Singapore

No.	Context	Mechanism	Outcome	Key factor
1	Urban public transport network (hub and spoke network) with flat-rate fare structure (which needs frequent transfer at transit centers)	Distance-Based fare structure and NCF fare adjustment determines the basic fare structure and refines fare level	Fare charged based on distance traveled regardless of travel modes. In the long-term, public transport is promoted	Fare structure, fare adjustment
2	Low-income households spend higher percentage of income on public transport. Social need for affordable fare	Fare is the key determinant of affordability. Low-income group oriented mean-tested concession scheme provides fare discount. A social groups differentiated fare adjustment eludes low-incomes from fare increase	Public transport fare remains affordable in Singapore, even when fare is adjusted upward	Affordability, concession
3	Public transport network capacity is not sufficient	Construction of railway infrastructure and adding bus fleets improve network capacity	Capacity improved in both short- (bus fleets) and long-term (railway construction)	Capacity
4	Demand for better public transport service	Service regulations of incentive and penalty worked on public transport operators (PTOs); PTOs' concentration on service provision helps service efficiency	Service level improved. Public satisfaction with public transport increased	Service
5	Higher service standards put additional cost on PTOs; Affordability priority constraints fare revenue	New finance structure changes cost and revenue of stakeholders, service fee is paid by government	PTO's profitability is guaranteed while providing better services and keeping fare affordable	PTOs' profitability
6	Long-term planning (LTMP2013) to promote public transport (75% share in 2030); Capacity/service	Under new finance structure, ownership of public transport asset shifts to the Government.	At the cost of public fund, tradeoff of public affordability, PTOs' profitability,	Public expenditure, finance structure

	improvement induce huge costs; fare revenue only cannot meet investment gap; experience of structure transitions	Government takes the main role in infrastructure investment. Government collects fare revenue and pays service fee to PTOs	and improvement needs is relieved. In the long-term, the new finance structure promotes public transport development	

As summarized in the table, 6 sets of CMO configurations can be derived from Realist Evaluation. In the following, each set is explained in detail with emphasis on the associated contexts and challenges, as well as the interventions and impacts on key factors.

CMO 1

The urban transport system in Singapore is a hub-and-spoke design, which is an efficient model to bring commuters to a transport hub and then onwards to their destination. However, such a network with flat-rate fare structure would incur frequent transfers at transit centers, and commuters making transfers had to pay a boarding charge each time they board. This additional cost of making a transfer discouraged people from making transfers, and further from using it, which opposes the goal of the promotion of public transport. Singapore shifted the fare structure from flat-rate to distance-based. Under the new scheme, commuters only need to pay a fare based on the total distance traveled from origin to destination, regardless of the number of transfers they make. With the integrated fares, commuters have more flexibility and choice over the routes for their journeys with a better travel experience. The distance-based fare scheme improves the connectivity and integration of the public transport system.

Fare level is determined by fare structure and fare adjustment, where fare structure decides the base and fare adjustment refines the fare level. The NCF factor is added into the fare adjustment formula. Singapore is currently facing the network capacity shortage. Based on the NCF definition, the NCF fare adjustment would result in a raise in fare level, in order to fund the network expansion. As a result, the fare level increased.

CMO 2

Transport expense imposes a burden on commuters, especially for low-income households. Low-income households spend higher percentage of income on public transport and there is the social need for affordable fare in Singapore.

Fare is the key determinant of affordability. Low-income group oriented mean-tested concession scheme provides fare discount for such group. With the WTCS, Singaporeans who are low income workers depending on public transport to travel between their homes and workplaces, would benefit from reduced expenditure on fares through concessions. Social groups differentiated fare adjustment, such as the NCF fare adjustment scheme, eludes low-incomes from fare increase by capping the fare increase of only 1 cent for the Lower-Wage Workers.

CMO 3

There is the capacity shortage of public transport in Singapore, which can be reflected by the total length of rail network, and by the public transport share (public transport share in Singapore is 67%, compared to more than 90% in Hong Kong). The demand for improvement in public transport increased significantly over the last few years. The city strives to reach a public transport share of 75% by 2030 (LTMP 2013). The Singapore government released the LTMP 2040 (Land Transport Authority, 2019a), in June 2019, which reviews the past progress, and addressed again the necessity of improving public transport capacity.

With the construction of railway lines and injection of bus fleets into the system, the network capacity improved. The increase in rail network capacity has resulted in the steady increase in number of average daily passengers of MTR. The expansion of public transport network has allowed commuters to take more efficient travel routes, saving time and money.

CMO 4

In Singapore, the public transport network was affected by numerous service delays and disruptions in the past few years. Among them, some were quite serious, such as the North-South MRT line breakdowns on December 2011 that made passengers trapped in stalled trains and left tens of thousands of commuters delayed. Higher public transport service standards are also needed to reduce crowding and increase reliability and frequency of bus and rail services.

It is under this situation that the Service Enhancement Scheme was launched. Regulation frameworks are necessary to ensure the performance of service enhancements. This is due to the inherent tension between service quality and costs. It is not possible for the public transport operators to pay serious attention to service quality. With the fare adjustment scheme, particularly the component of productivity extraction and the fare adjustment cap in the fare adjustment formula, the operators could not easily pass on higher costs from high service standards to commuters. Therefore, operators have little incentive to provide comprehensive and reliable services, and to sufficiently provide socially important but relatively unprofitable services.

By setting standards for incentive and penalties, or simply the carrot-and-stick approach, Service Enhancement Scheme is able to improve the public transport service levels, including service quality, frequency and reliability, to encourage people to take public transport as their primary commuting option. As a result, the Public Transport Customer Satisfaction Survey on commuters' satisfaction shows the continuous increase in level of satisfaction with public transport.

CMO 5

The operation and service quality enhancements caused a financial burden to the operators, which is reflected in the operators' profitability. Under the old finance framework that operators collect fare revenue and pays costs, the public transport industry faced a deteriorating financial situation.

This situation created the necessity of finance scheme changes for public transport. With the introduction of Service Enhancement scheme to decisively and expeditiously improve network capacity and service levels, new finance scheme is implemented to sustain the development of public transport in the changing social and operating environment. The new finance scheme can secure the affordability without hurting the profitability of the operators. With the revenue guarantee from the Government, bus operators are able to focus more on operating the bus services and meeting service standards.

CMO 6

The improvement of public transport capacity and service that aim to promote public transport induced huge costs, which is above the finance capacity of operators. To meet the investment gap, the NCF Fare Adjustment Scheme was applied to reflect the capacity cost by slightly increasing the fares. However, the scheme does not recover the past operating costs nor infrastructure construction costs.

Under the new finance structure, the operating assets and responsibility of investing transferred from the operators to the Government. Infrastructure and operating assets are placed in the hands of the Government, while daily operation is still managed by operators. This change of assets' ownership would free operators from financial concerns and enable them to focus on rail service that the operators are obligated to maintain the service standards according to requirements made by the Government. It is also good for the Government to undertake integrated and long-term planning for the whole rail network. The change takes the advantage of ability of the central Government on quick response to changes in travel demand and service level expectations. For Singapore, such kind of asset transaction happened in 1998 as well, but from the Government to operators.

The CMO configurations from Realist Evaluation for Hong Kong is listed below.

Table 6.5 Realist Evaluation CMO for Hong Kong

No.	Context	Mechanism	Outcome	Key factor
1	PTO's fare autonomy caused social dissatisfaction	Fare adjustment based on explicit fare formula, PTO profitability considered (by formula components) in adjustment	Transparent fare adjustment, fare kept increasing	Fare level, fare adjustment
2	PTO is profitable; Social need for affordable fare	Mechanisms of "profit sharing", "affordability cap" affects PTO profitability and public affordability; effects depend on mechanism standards/criteria (percentage transferred to public transport fund is low; Introduce "affordability cap" based on Medium Household Income)	PTO remains profitable, fare kept increasing	Affordability, profitability
3	Geographical constraint on network capacity development; Demand for capacity/service improvement	Construction of railway and bus routes rationalization improve network capacity; Service enhancement measures introduced and functioned	Capacity improved, service enhanced	Capacity, service
4	Fare kept increasing; social need for affordable fare	Both mean-tested (for low-income) and non-mean-tested subsidy (for whole population) are introduced (as in-pocket money) and functioned	Affordability improved indirectly; non-mean-tested subsidy benefits	Subsidy

			high-income more	
5	Commercial principle of PTO	PTO profitability is emphasized in pricing policy making; PTO collects fare revenue; PTO is granted innovative finance sources	PTO is profitable, fare kept increasing	PTOs' profitability
6	Demand for capacity/service improvement; demand for affordable fare; Commercial principle of PTO	Government takes the main role in infrastructure investment and subsidy provision; PTOs collect fare revenue and provide services	Finance burden to public fund	Public expenditure, finance structure

The CMO configurations from Realist Evaluation on Hong Kong case is explained in detail with emphasis on the associated contexts and challenges, as well as the interventions and impacts on key factors.

CMO 1

In Hong Kong, the public transport service operators are private companies without direct government subsidy. They sustain the businesses with the fare revenue and conduct fare adjustment reviews regularly. Before 2007, the operators in Hong Kong were authorized to set and adjust fare according to company's financial situation and commerce strategies. The setting and adjustment were totally based on the company's decision, other than principles or mechanisms. The process was not disclosed and the public just passively accepted the changes.

In 2007, with the Fare Adjustment Mechanism, an objective and transparent formulaic approach took effect in determining fare adjustments, replacing the fare autonomy of operators. The fare adjustment formula takes into account of Composite Consumer Price Index, Nominal Wage Index and a pre-determined productivity factor. Based on the data of these objective indices under the Fare Adjustment Scheme, fares will be maintained, or adjusted upwards or downwards. The change enhanced the objectivity of the fare adjustment and enable minor tunes in accordance with economic conditions. Fare kept increasing under the scheme. With the increase of fare level, the revenue of operators also increased.

CMO 2

In Hong Kong, with fares keep increasing, the social need for affordable fare increased. Against this context, the operators in Hong Kong are profitable. Productivity Factor was introduced into the fare adjustment formula, which could moderate the fare increase. Other measures were proposed as well. For example, the "Affordability-Cap" set the ceiling for fare increase with no more than the year-on-year change in the Monthly Medium Household Income (MMHI) for the previous year. However, due to the calculation method of "Affordability-Cap" and the setting of Productivity Factor with emphasis on operator profitability, the fare still kept increasing and operators remain profitable.

CMO 3

The population and travel demand is always increasing in Hong Kong. This requires the expansion of the public transport capacity. However, there are constraints on network capacity expansion from the physical and spatial situation of limited urban area in Hong Kong. It is difficult to build new transport infrastructure. Service enhancement is also needed.

Service and capacity programs are implemented to improve operational efficiency, service regularity and quality of public transport service through programs such as Railway Development Strategy and the Bus Route Rationalization, to enhance the service standards and maintain the long-term and sustainable development. The construction work of rail lines is in progress. Improvement measures are taken place, including increasing train frequencies, upgrading of the signaling system, deploying platform assistants, and so on. Bus routes are rationalized with new routes introduction and cancellation, bus frequency increased or reduced, and route. Resources saved from cancellation were put to the introduction of new routes and enhancement of service.

CMO 4

Public transport fare in Hong Kong is increasing all the time. This situation is worse for low-income households who spend a larger portion of income on traveling and face the heavy financial burden. The government proactively introduces subsidy scheme to support commuters, without hurting operators' profitability. WITS Scheme is mean-tested subsidy scheme to help low-income workers reduce the cost of public transport. Public Transport Subsidy Scheme is a non-mean-tested scheme.

The schemes are financed by public funds. With subsidy, the cost of public transport is reduced. For WITS, a total of 101,746 applicants who are receiving the subsidy under the scheme from the government. It amounts to $1,298 million of subsidy paid to the applicants. For Public Transport Subsidy Scheme, the subsidy cost would be around $2.3 billion and over 2.2 million commuters would benefit from the Scheme.

CMO 5

Under the commercial principle of public transport sector in Hong Kong, the operators manage public transport and collect fare revenue. The intervention of the government into the public transport sector is constrained. Operator profitability is emphasized in pricing policy making. In addition, operators are granted the right to collect innovative finance sources. As a result, the operators in Hong Kong is profitable.

CMO 6

Due to the commercial principles in Hong Kong, public transport operators don't receive any direct subsidy from the government. They are authorized to collect fare revenue and their profitability is depending on the management of the private company. Under the background of increasing demand for capacity and service improvement as well as the demand for affordable fare, the government takes the main role in large investment on infrastructure and maintaining the fare affordable through the way of subsidy provision.

In summary, for each row of the CMOs table, the causality takes into consideration the context in which, and the mechanism why a particular intervention generates the observed outcomes. Next, the CMOs from individual case study is incorporated into the causality maps, and the comparison of causality maps reveals the differences of the 2 cases, based on which findings can be obtained. Following this generative causation process, the revealed sets of context-mechanism-outcome will be refined and eventually becomes valuable knowledge implications for policy making elsewhere.

6.2.3 Causality map

In this section, the causal mapping is carried out based on the result of previous causality analysis. Causality map is an intuitive and efficient presenting form in which the links between interventions and impacts represent causality or influence. Compare to the descriptive approach that builds the causality map on the subjective statement of “due to A is conducted, B is produced”, the theory-based approach that identifies causal links through Theory of Change and Realist Evaluation is much more plausible and credible. Actually, Realist Evaluation diagram (Figure 6.14, Figure 6.15) can be regarded as the complicated version of causality maps. To further simplify it, key factors and the policy interventions (schemes) are kept and systematically linked to form the causality map, which is easy to read and useful for implication discussion.

The legend adopted for causality map is shown below.

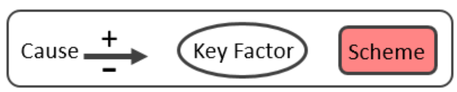


Figure 6.16 Legend for causality map

The arrow indicates the relationship between 2 factors that it starts from the cause and ends at the result. As the ex-post evaluation that focusing on pricing policy, the links are starting from the interventions and ending at the key factors. There may be positive and negative relationships, which is expressed by the plus and minus mark. Only the negative mark is labeled by default. In ellipse are the key factors, while in red rectangular is the scheme intervention.

A causal narrative is provided for each causality map. The narrative is supported by the quantitative evidence generated from the integrated analytical framework, by the causal pathways identified by Theory of Change analysis on each individual scheme, and by CMOs from Realist Evaluation. Each link in the causality map is quantified and can be traced back to previous study.

The causality map for Singapore is shown in Figure 6.17. With the New Finance Scheme, finance fund is injected into the system. Therefore, the link from New Finance Scheme to public fund is built, which is justified by the increase of government grant to Transport Department (Figure 4.15). Firstly, it helps the improvement of capacity (the link from public fund to capacity) by covering the cost of construction of new lines, and the provision of new bus fleets. As stated in the discussion of financial impact on Government (4.5.3), the Government subsidies for BCM would amount to $3.5 to $4 billion over the next five years starting from 2016, while the cost of rail operating assets for the next five years was expected to exceed $4 billion. Then, through the shift of finance mechanism, the operator profitability is guaranteed by the government, which delinks operator profitability from the fare revenue (compare Figure 6.25) and links the operator profitability with public fund. The evidence can be found in the tables of comparing the new finance scheme with the old one (Table 4.18 and Table 4.19). This would make the operators concentrate on the provision of service. Therefore, it is a positive link between operator profitability and service under the scheme, which can be justified by the service reliability indicators (with normalized value of 1.275, see Table 4.17). Lastly, through the Service Enhancement Scheme, the fund can be channeled to the upgrading of service levels (Table 4.17). Therefore, Service Enhancement Scheme is negatively linked with public fund and positively with service.

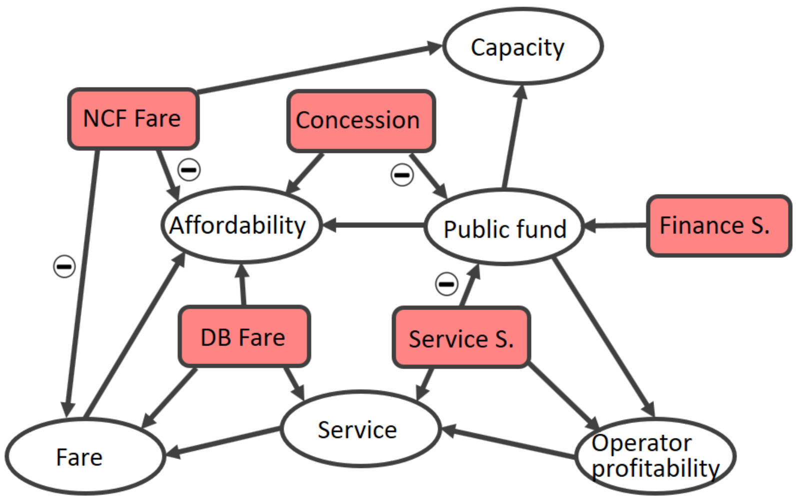


Figure 6.17 Causality map for Singapore

The Distance-Based Fare Scheme has positive impact on fare, affordability, and service. The immediate effect on fare is the lower-down of average fare. This can be seen from the average fare indicator that based on the before-after implementation comparison, there had been an immediate decrease of average fare from 0.98$ to 0.92$. A lower fare will, of course, benefits the public and improve the affordability, and the affordability indicator has justified this clearly. The scheme charges fare with only reference to the distance-traveled, this is helpful in creating the seamless service of public transport. As discussed in section 4.1.3, the Singapore transport statistics based on aggregated EZ-Link data shows that the average distance for single trip becomes shorter, and the number of transfers taken increases as well.

The New Capacity Factor Scheme considers the cost of capacity expansion by introducing a new factor into the fare adjustment formula. With the factor, the calculation output of the fare adjustment formula will increase, indicating an increase of fare, which finally causes the negative effect on fare and affordability, though the government has been very carefully in doing so in order to not impose heavy expenditure burden to low-income group (the scheme is designed to have only 1-cent increase for the low-income group). As the impact of the scheme, the average fare increased 4.3% with the implementation commence. The Concession Scheme address affordability issue through the direct discount of fare. It is negatively linked with public fund due to the annual $50 million from Government spending as the cost of implementing concession scheme.

Base on the analysis on Hong Kong pricing policy, the causality map can be drawn, as shown in Figure 6.18. The basic principle in Hong Kong is that the public transport is operated by private operators on the commercial basis. There is no direct subsidy from the government to the operators. In adjusting the fares through the Fare Adjustment Scheme, the profitability of operators is firstly concerned, and this positive impact is reflected by the continuously increasing revenue of the operators (Table 5.5). At the same time, fare level kept raising up as the result of the scheme (see Table 5.2 and Table 5.3), which decreases the affordability of users. Therefore, it is negative impact of the Fare Adjustment Scheme on fare and affordability.

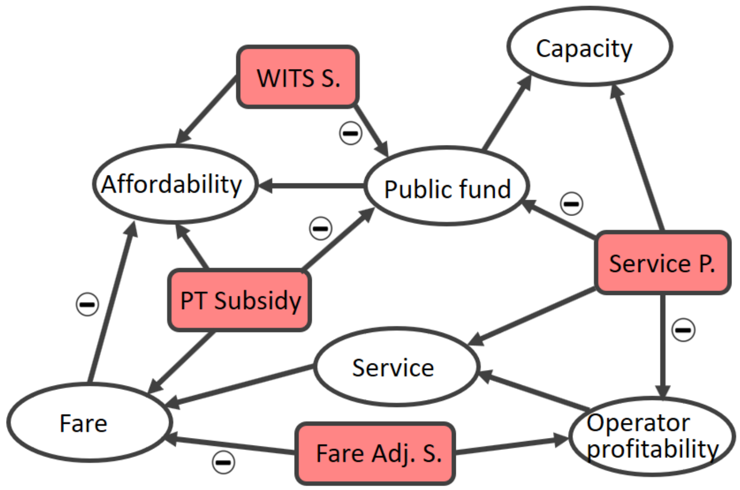


Figure 6.18 Causility map for Hong Kong

Two subsidy schemes are launched to address the affordability problem. Work Incentive Transport Subsidy is a mean-tested subsidy, which utilizes public fund to provide subsidy to eligible individual or household applicants and the way of spending the subsidy is the beneficiary's choice. The Government Budget Report says that the government expenditure on WITS Scheme for 2018-2019 is about $593.9 million, and it is estimated to be about $700 million for the year of 2019-2020. On the other hand, Public Transport Subsidy Scheme is a non-mean-tested subsidy, which calculates the subsidy amount based on the monthly expense on public transport fare recorded in transport IC card and subsidizes back according to the rules. It was estimated that the annual subsidy cost would be as high as $2.3 billion. Both of them have negative impact on public fund and positive impact on affordability. The Public Transport Subsidy Scheme reduces the average public transport fare in an explicit way (around 12% decrease as estimated), thus a positive effect is there.

The Service Programs are aiming at the improvement of network capacity and the enhancement of service standards, supported by the public fund and operator revenue. Basically, the cost of capacity expansion is bear by the government, while the cost of service upgrading is co-funded by public and private sector. Therefore, the links from Service Programs to public fund and operator profitability are negative. As the result of the Service Programs, capacity and service level of both rail and bus increased, which can be identified in 5.4.4.

The causality maps incorporate the qualitative and quantitative evaluation and allow different causes and impacts to be compared and integrated together to provide credible evidence. By clearly and explicitly describing the links between causes and effects among key factors and the policy interventions, this provides a firm foundation for implication and discussion.

6.3 Implication and Discussion

Based on the comparative case study and the causality analysis, implications can be derived. The comparative study of Singapore and Hong Kong cases have presented the differences and gaps between the policy implementation and performances. Causality analysis further analyzed and explained the impacts of interventions on public transport system, and on pricing-related problems specifically.

Understanding what policy interventions produce change in a given context will help policy makers decide how to tailor interventions to different situations so as to achieve the intended outcomes. Context-mechanism-outcome findings are generated based on the ex-post comprehensive case study. By incorporating more relevant cases, and by conducting careful contextual and documentary reviews, the findings, as well as associated assumptions and hypothesis can be strengthened and, where necessary, refined or revised. Logically consistent regularities and implications can be derived and applied elsewhere as long as context- and intervention- variations are comparable to predict and to explain outcome-variations.

In this section, implications are discussed following the order of pricing problems defined at the beginning of the research. Causality maps are utilized and certain causal pathways are highlighted to facilitate the discussion.

6.3.1 Fare and fare affordability

Fare level is determined by fare structure and fare adjustment, where fare structure decides the base and fare adjustment refines the fare level, as illustrated in Figure 6.20. The diagram synthesizes the findings from Singapore and Hong Kong cases, as well as other relevant cases.

Fare structure

In term of public transport fare structures, there are typically three schemes: flat rate, zone-based or distance-based (CH Chua, 2016).

Flat-rate fare implies that a fixed fare is charged for every trip made regardless of distance traveled. It may be suitable and would be more equal in situations where a majority of passengers travel approximately the same distance e.g. shuttle buses to airports from the city center. Cities such as Boston, Chicago and New York City, among others, have adopted such a scheme.

With a zoned-based fare scheme, the network is divided into zones and a fixed fare applies regardless of distance traveled so long as the journey is made within a given fare zone. Fares will typically change when a journey involves travel through two or more fare zones, even when the origin and destination are located within the same fare zone. The price to be paid by the passenger will depend on the number of zones crossed, though specific rules are adopted by different cities, such as London, Stockholm and Zurich.

In a distance-based fare structure, the fare charged will vary according to the distance traveled and a given price per km is usually applied. The price is calculated on the real distance traveled, which requires information on the distance between each pair of stations. For rail services, the fare system might enable station to station fares to be set that are distance dependent. For bus services, the concept of fare stages is used. A fare stage may be a single bus stop or a group of bus stops (where density of the network is high). Cities such as Beijing, Hong Kong, Seoul, Shanghai, Taipei and Tokyo have adopted this type.

Which fare structure to choose is highly dependent on the context of the city, as well as the pricing policy and its goals. Compiled from (KonSULT, 2016), the tentative impact of different fare structures on fare collection, efficiency, and society are briefly listed in Table 6.6.

Table 6.6 Tentative impact of public transport fare structure

Fare structure	Tentative impact
Flat-rate	Provide simplicity but may encourage longer journeys/ dispersed development patterns and can distort transport and property markets at the edge of the flat fare area. Also can be seen as unfair, inequitable and penalizing to short-distance or off-peak users. It is easy to collect fare and to control. It is also extremely easy for passengers to understand the fare.
Zone-based	Provides simplicity whilst avoiding the pitfalls of encouraging longer journeys/ dispersed development but can distort transport and property markets at the edge of zones. Also can be seen as unfair. It has a lower level of inequity. Good revenue collection.
Distance-based	Allocates capacity efficiently because fare reflects distance traveled. Avoids market distortions of zonal and flat fare systems. Perceived as fair by passengers. Difficult to collect and control. Very good in passenger attraction.

Source: Compiled from (KonSULT, 2016)

In Singapore's case, the fare structure shifted from flat-rate to distance-based fare. The change considered the context of urban public transport network, that a hub-spoke network with flat-rate fare structure would incur frequent transfers at transit centers. Distance-Based fare structure doesn't only reduce the number of transfers, but also promotes connectivity and integration of the public transport system, which is in line with the long-term planning of LTMP 2013.

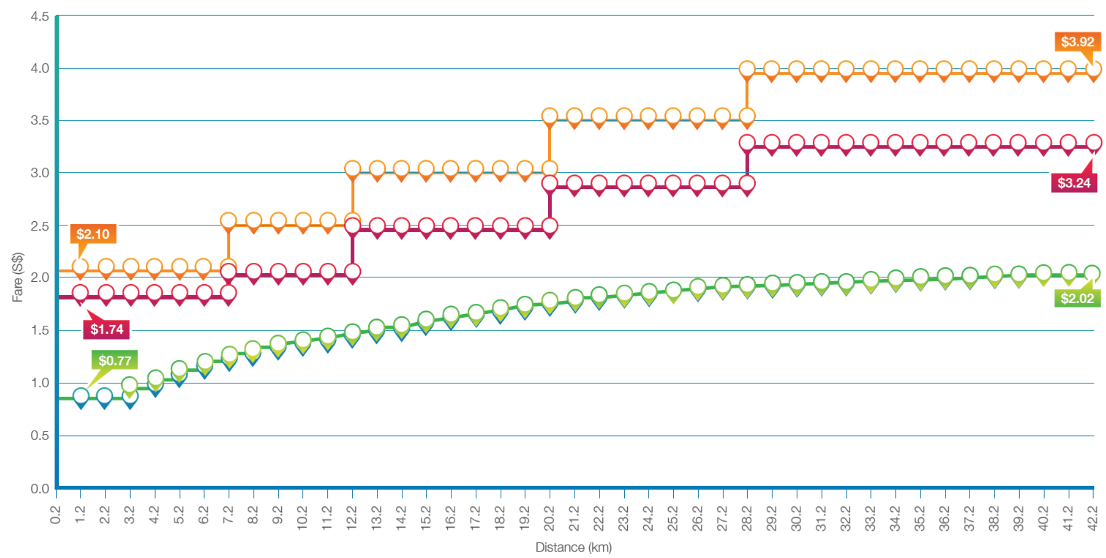
The choice of fare structure should consider the impact on social equity. Shifting to a distance-based fare structure can disproportionately favor or penalize different subgroups of a population based on variations in settlement patterns, travel needs, and transit use. A recent study (Farber et al., 2014) is carried out for assessing the social equity impacts of replacing flat fare with distance-based fare structures, through the GIS based simulation system. The analysis found that overall distance-based fare scheme benefits low-income, elderly. In light of the vertical equity (see 3.1.1) that compares mobility need and the ability to cover the needs, a distance-based fare scheme seems to better-off low-income and minority households. Such households often are characterized by short travel distances and high rates of transit usage (Yook & Heaslip, 2015). The equity impact is geographically uneven, and may be negative for members of these groups living on the urban fringe. If low-income riders have longer trips, then they are disproportionately impacted by differentiated pricing. Considering the fact that very often, low income lives in suburb, the scheme may result in a raise of out-of-pocket travel expenses for those low-income groups.

Furthermore, besides the spatial mismatch and the inequalities in fares paid by different demographic groups, higher fare for long-distance commuters may result in increased use of less sustainable modes of transportation, namely the private car. Such a change could lead to increased greenhouse gas emissions, more traffic accidents, and increased traffic congestion. The introduction of distance-based fare scheme must therefore be carefully assessed in order to avoid these unintended consequences.

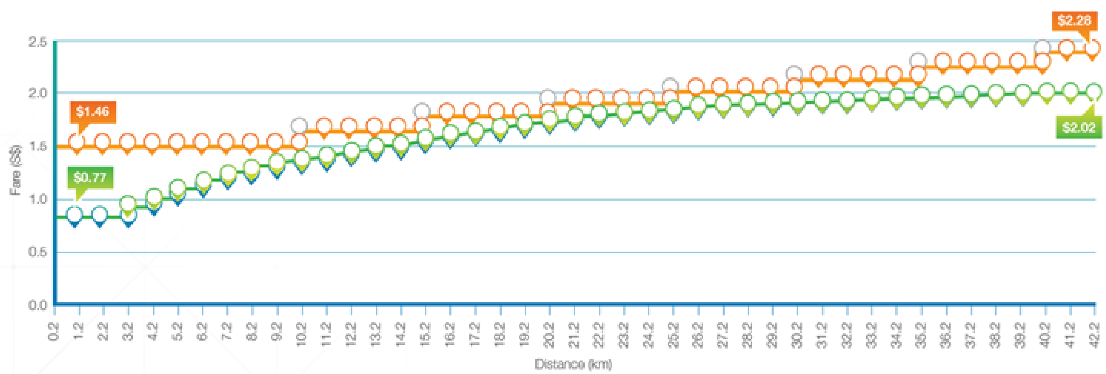
Under the same name of distance-based fare structure, different cities may behave differently. Rail fares structure in Asian cities with distance-based fare structures are compared (CH Chua, 2016), fare of Tokyo, Seoul, and Shanghai in comparison with Singapore is listed in Figure 6.19. Among these, Tokyo appears to have the highest. Fares charged for travel on the Seoul metro system are also relatively higher than Singapore fares. Fares charged for Shanghai is lower to Singapore.

In addition, by this comparison, it can be seen that the fare curve in Singapore is much smoother. This is probably because the LTA in Singapore (the designated entity for public transport management) is committed to the with advanced technology, against the much manageable political context in Singapore.

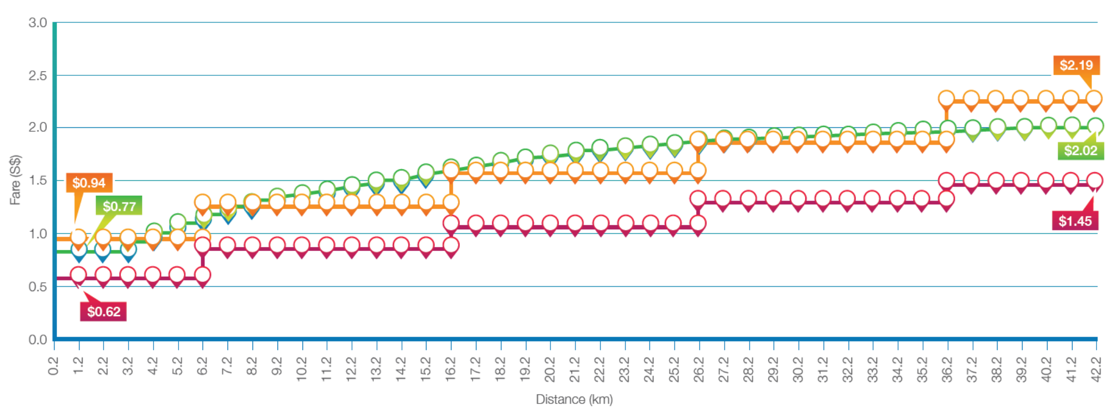
Singapore with Tokyo



Singapore with Seoul



Singapore with Shanghai



Source: (CH Chua, 2016)

Figure 6.19 International comparison of fares

Note: All fares presented are valid as at 31 October 2016. 2 types of fares are compared, based on Purchasing Power Parities (PPP, orange line) and Market Exchange Rates (MER, purple line), respectively.

Fare adjustment

The evolution of fare adjustment changes is illustrated in Figure 6.20. There was the price-cap model for the adjustment of public transport fares in 1997. The fare adjustment cap formula adopted was "CPI + X", where CPI was the change in the Consumer Price Index over the preceding year, and "X" was set ex-ante to compensate the operators for net cost increases beyond inflation (Looi & Tan, 2007).

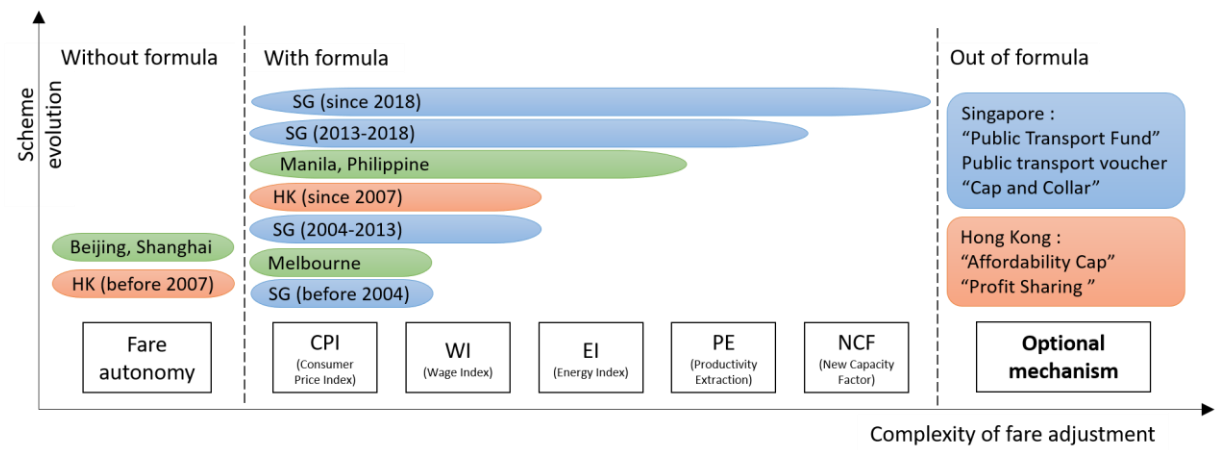


Figure 6.20 Fare structure and fare adjustment

In 2004, a new fare mechanism was introduced to capture the wage changes separately in the price index. This separation would improve the responsiveness of the formula to CPI and wage changes. Accordingly, the fare adjustment formula transformed into Price Index = 0.5(ΔCPI) + 0.5(ΔWI), where ΔCPI is the change in Consumer Price Index over the preceding year, and ΔWI is the change in Wage Index, defined as the average monthly earnings adjusted for any change in employers' contribution to the government's central provident fund (Looi & Tan, 2007).

Later on, an additional component of Productivity Extraction was introduced into the formula to make the fare adjustment formula more responsive and transparent by separating productivity from wage costs and other cost components. When the PTOs have a higher average productivity gain, the profit would be shared equally with commuters through this mechanism.

In 2013, the Price Index was modified by the new Price Index: 0.4cCPI + 0.4WI + 0.2EI. The new Price Index replaced the general CPI with core CPI (which excluded costs of housing and private transport), and incorporated a new energy index to track electricity and diesel costs for trains and buses, considering that energy costs account for a large proportion of total costs.

The latest one is the introduction of New Capacity Factor (NCF) in 2018 to better reflect cost induced by public transport capacity improvement. Therefore, it is clear that fare adjustment can be customized to cope with various challenges and fulfill different purposes.

In the case of Hong Kong, the adjustment considers the economic conditions and wage levels by the adoption of CPI and WI. The CPI reflects the macroeconomic environment and public affordability to a certain extent, whereas the WI reflects the labor cost. Since Hong Kong faces the affordability problem, one implication from Singapore's fare adjustment would be the inclusion of affordability components, such as a high PE component, to facilitate the solution of affordability problem. Hong Kong may also adopt a tighter price cap for fare adjustment, as what Singapore has done, considering the fact that fare kept increasing.

As to Tokyo, currently the fare adjustment is based on multi-cost estimations that submitted from operators, with a Price Cap to determine the maximum increase for one adjustment. One implication from Singapore and Hong Kong's cases would be the introduction of transparent fare adjustment formula. The formula can reflect the macro- and micro changes of economics situation. Normally, the formula-based adjustment has a higher public acceptability, compared to fare autonomy. However, due to the unique fare compensation system, there seems no apparent dissatisfaction with public transport fare from public, though the fare level is among the highest if examined globally.

The optimal mechanisms listed on the right of the diagram reveals the inherent tension between service quality and costs. It is not possible for the public transport operators to pay serious attention to service quality. With the fare adjustment scheme, particularly the component of productivity extraction and the fare adjustment cap in the fare adjustment formula, the operators could not easily pass on higher costs from high service standards to commuters. Therefore, operators have little incentive to provide comprehensive and reliable services, which is socially important but relatively unprofitable.

By incorporating service incentive and penalties, or simply the carrot-and-stick mechanism, it is able to improve the public transport service levels through fare adjustment. With the profit and risk sharing mechanism, if profits outperform, operators will pay an increased share to the Government fund; If there are changes to the operator's operating cost or revenue incurred by regulatory changes initiated by the Government, the Government may reimburse the operator, or vice-versa. The "cap and collar" mechanism keeps an operator's rate of return within a range.

Fare affordability

There is the explicit difference in affordability situation in Singapore and Hong Kong. Diving further into the topic, this section first compares affordability performance on a global stage, then discusses the rationale of affordability management.

To allow comparability of public transport affordability across the cities, researcher has proposed the affordability index (Li & Reza, 2018). It assumes a typical family with two working adults and two schoolchildren, and calculates the family's expenditure on public transport of 10-km travel based on the average fare of rail and bus, as a percentage of household disposable income. The result is shown below.

Table 6.7 International comparison of affordability index

City	PT Expenditure	Income	Index

San Francisco	3,519	85,507	4.1
Singapore	**2,750**	**57,802**	**4.8**
Taipei	4,246	72,219	5.9
Hong Kong	**3,277**	**53,456**	**6.1**
Beijing	2,140	34,790	6.2
New York	4,959	60,865	8.1
Paris	3,366	40,085	8.4
Sydney	5,317	56,733	9.4
Toronto	4,255	40,045	11
Seoul	3,640	29,272	12
London	5,270	36,114	15
Tokyo	5,913	36,559	16

Source: (Li & Reza, 2018)

Singapore was the second most affordable city on the list, with an index score of 4.8, while the index for Hong Kong is 6.1. Another study (Chia, 2017) covered 35 cities in Asia, Australia, North America and Europe had similar conclusion that Singapore had one of the lowest fares among those international cities, which is less than that in Hong Kong.

There is neither recommended level of affordability, nor admitted international convention, though scholars suggested standards. For reference, Armstrong-Wright and Thiriez (1987) concluded that a reasonable level of household expenditure on travel should not exceed 10% of their income or otherwise they would choose to walk as they are not able to afford public transport. Gomide et al. (2005) also suggested that the minimum spending of a worker when traveling between work and home should not exceed 6% of income, and whatever amount exceeds that limit should be borne by the worker’s employer (Chu, W. (2017). This provides guidance for government intervention into the affordability issue.

The way of affordability monitoring is also different. Since 2013, Singapore started to monitor the fare affordability for the second decile (represented by the 10th to 20th percentile) household income group, in addition to the general quintile group (represented by the 20th to 40th percentile). The difference is illustrated in Figure 6.21. Basically, Singapore is adopting a more dedicated formula and a more low-income group targeted affordability calculation method, which may cost more efforts but return with an accurate answer to ensure that fares remain affordable for all low-income households.

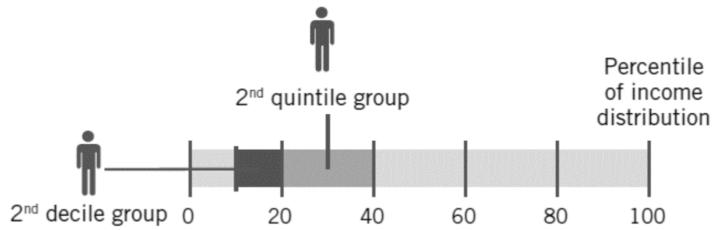


Figure 6.21 Second quintile and decile group for fare affordability

In terms of policy intervention into affordability, Singapore and Hong Kong have presented different rationales. Basically, Singapore government prevents the fare from increasing and bears the associated cost with public fund, while Hong Kong lets the fare increase first, but subsidized back to public.

In the case of Singapore, to keep public transport fares affordable, a deliberate Fare Adjustment Formula is in place and followed strictly. With the capacity expansion and enhancement of service, which are the goals of public transport development as described previously, there is the due increase of systematic cost. The incurred cost should be shared with the users through the fare increase, for a healthy public transport system. The Singapore government realized this, and introduced the New Capacity Factor into the formula to reflect the cost of capacity as the name infers. However, the raise was not enough to cover the cost due to the intention of keeping the fare affordable. With users paying less, more cost was assumed by the operators, which ultimately went to the government through the New Finance Scheme. Over the years, the Singapore government has been subsidizing public transport by public fund in this way, as highlighted in the causality map (Figure 6.22). The public in Singapore didn't feel much pressure on fare due to the behind-curtain spending of public money. With these pricing schemes, the Singapore government succeeded in managing public transport fares to be affordable while ensuring the public transport service financially sustainable at the same time.

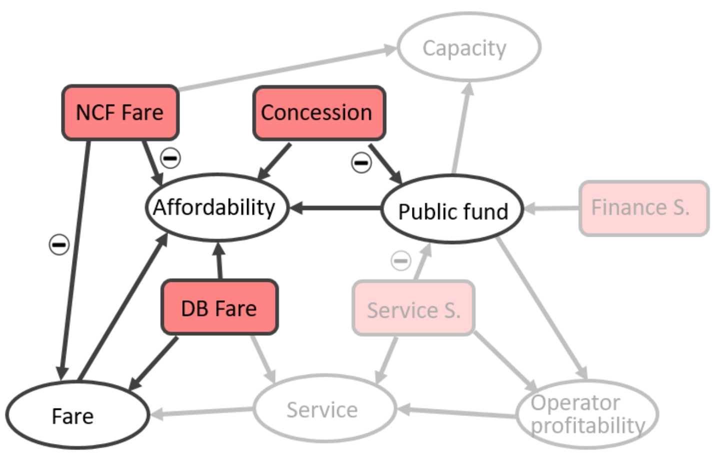


Figure 6.22 Singapore affordability rationale

Although Hong Kong also adopts a similar fare adjustment mechanism for rail and bus fares, the objective is different. The Fare Adjustment Scheme in Hong Kong is the product of negotiation between public transport operators and the government. The Hong Kong government has a weaker role in managing fares, compare to the Singapore government. For instance, the direct output of bus fare adjustment formula had fallen into a mere reference for final decision. Thus, with a Fare Adjustment Mechanism prioritizing operator profitability, the operators enjoyed a good revenue while the fares kept increasing. To address the social problem of fare affordability, the government launched 2 subsidy schemes, which are Work Incentive Transport Subsidy Scheme and the newly launched Public Transport Subsidy Scheme. The rationale is highlighted in the following causality map in Figure 6.23.

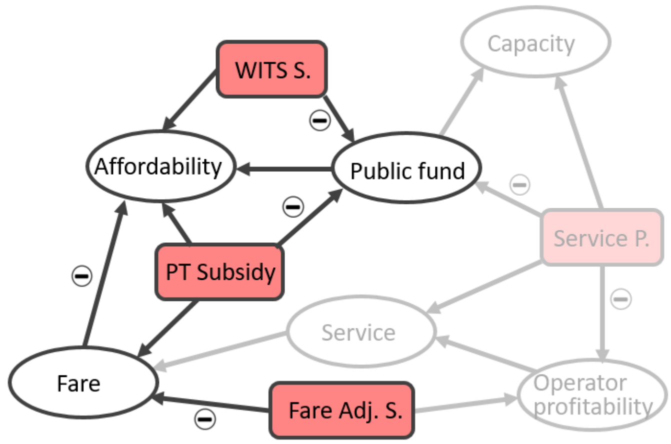


Figure 6.23 Hong Kong affordability rationale

Under different affordability rationales, Hong Kong and Singapore demonstrated different fare changes in past years, as listed in Table 6.8. It is clear that the fare raised about 25% in total for Hong Kong, contrasting with a slightly decreased fare in Singapore.

Table 6.8 Comparison of fare changes in Hong Kong and Singapore

Fare change rate (%)	Hong Kong (Rail)	Singapore (PT)
2010	2.05	-2.50
2011	2.20	1.00
2012	5.40	0.00
2013	2.70	3.20
2014	3.60	2.80
2015	4.30	-1.90
2016	2.65	-4.20
Accumulated	22.9	-1.6

From the discussion and comparison, we can see how Singapore and Hong Kong government adopted different rationales in keeping the fare affordable, while maintaining a subtle balance between development objectives under certain urban contexts. This difference of fare and affordability situation in Singapore and Hong Kong is contributed by the fare structure and fare adjustment schemes adopted, and is also deeply rooted in the fare affordability management rationale. When the issue of fare affordability occurs, concessions and subsidies are a useful means of solving the problem, which is discussed next.

6.3.2 Subsidy Mechanism

There are Workfare Transport Concession Scheme in Singapore, and Working Incentive Transport Subsidy Scheme and Public Transport Fare Subsidy Scheme in Hong Kong. Combining the subsidy schemes analyzed, as well as other international cases from literature review (Serebrisky et al., 2009), we have the diagram of public transport subsidy mechanism.

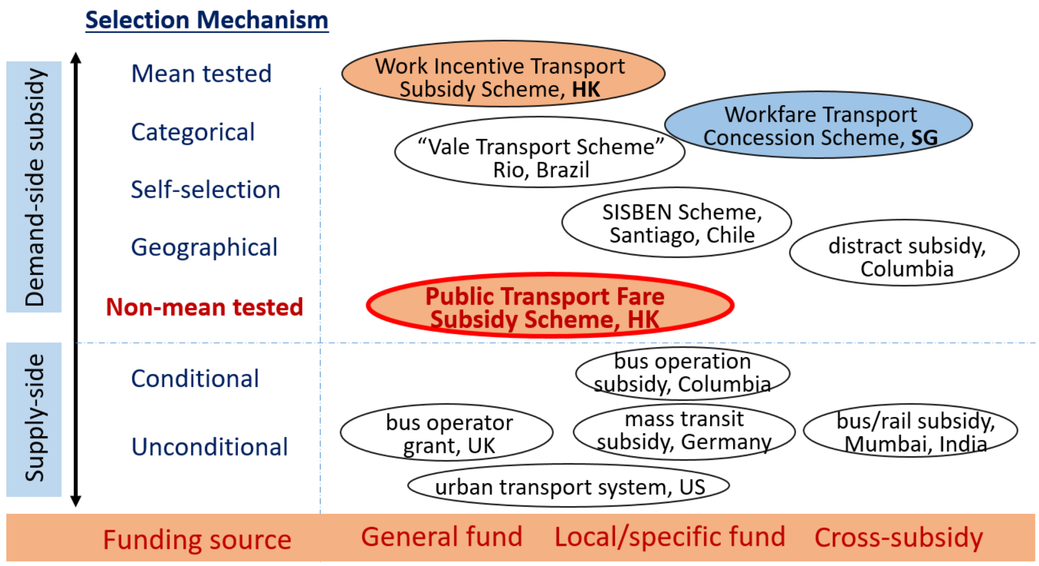


Figure 6.24 Public transport subsidy mechanism

The diagram is organized following the dimensions of funding source and selection mechanism. Generally speaking, conditional subsidy is higher than unconditional one and mean tested subsidy is higher than non-mean tested one, in terms of subsidy effectiveness. It is actually the tradeoff between subsidy effect and efforts made. This can be justified by the performance indicators of Hong Kong's new Public Transport Subsidy Scheme, which is the first non-mean tested subsidy. Based on the case study, the score of finance indicator is 0.648, indicating the huge cost of public fund. While the equity indicator is 0.815, meaning the unequal distribution of subsidy benefits. Basically, the high income groups are subsidized more, compare to the low income groups who have a heavier financial burden.

The concession scheme that discount the fare directly in Singapore has a higher efficiency, compare to the indirect subsidy schemes in Hong Kong. Hong Kong's subsidy should be provided in a direct way, and the non-mean tested subsidy can be revised from flat subsidy structure into differentiated subsidy structure, to save subsidy fund and make it better distributed among population groups. In the case of Tokyo, as mentioned in the review of pricing cases, there is the compensation convention that employer firms pay the public transport cost. It is a unique case that all the public transport cost to eligible commuters are subsidized, rather than a certain percentage. Put Tokyo in the above subsidy mechanism coordinate, it may locate at the upper-right, close to Singapore's case. It is a categorical subsidy that the compensation only applies to employees; its funding source can be regarded as a cross-subsidy that short-distance commuters are actually subsidizing the long-distance commuters. The compensate makes employees less sensitive to public transport cost, which promotes the ridership of public transport and improves the operators' revenue. The Japanese taxation system also favors the compensation that in calculating the corporation tax, this public transport subsidy is deducted.

6.3.3 Finance structure

The financing of public transport system, including the capacity expansion and service enhancement, generally comes from two main sources, the fare box and the government authority. Which way to choose is largely decided by who makes the decision to increase capacity and service levels, and the rationale behind the increase. If the decision is from the government side for the provision of social welfare, then the costs of improvement of public transport are likely to be assumed by government fund, or a combination of fare box revenue and subsidies from authorities. If the decision is made by the transport operator on purely commercial basis, then the operator is expected to cover the cost through fare box revenue. These 2 scenarios are the extremes of the adjustable space (imagine the slip line rheostat) and the final decision is the balanced option between them.

Simply speaking, Singapore took the first one, while Hong Kong falls into the second. Yet, they both made changes of finance structures during the process.

Context of public transport finance

Urban contexts of Singapore and Hong Kong are important to understand the differences of finance structure between them.

For Singapore, the demand for improvement of public transport increased significantly over the last few years. There is the capacity shortage of public transport in Singapore. In terms of the total length of rail network, as well as the rail length per capita, the level of Singapore is low, if compare to Hong Kong, as well as other megacities. In terms of the share of public transport, it is about 67% for Singapore, and the city strives to reach 75% by 2030 (LTMP 2013). As a comparison, the public transport share in Hong Kong has been over 90% for many years. The situation is partially created by the regulation on private cars that Singapore has a softer control on car purchase, possession, and parking.

Affordability is always prioritized in Singapore, as previously discussed in 4.3.3. This guideline had kept the fare at a relatively low level, and the fare box revenue was not sufficient to provide fund for the construction of new lines, as well as keep the profitability of the operators at a reasonable level. Under this situation, the operators were not able to maintain the service at a high level, due to the high cost associated with service enhancement. The following map explains how the situation was not sustainable before the introduction of new finance structure.

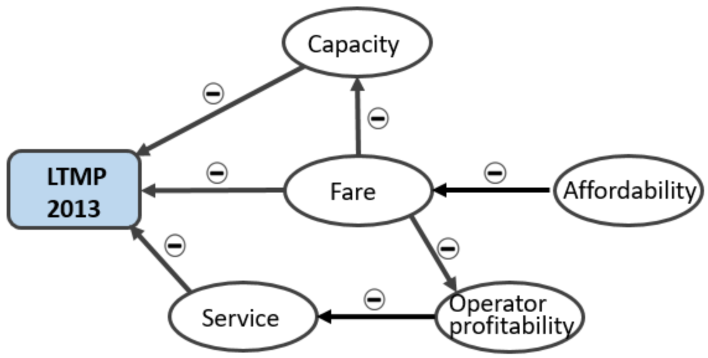


Figure 6.25 Situation in Singapore before new finance structure

This situation created the necessity of finance structure changes. By the simple comparison of causality maps in Singapore and Hong Kong, we could see the 2 schemes of New Capacity Factor Fare Adjustment Scheme and New Finance Scheme in Singapore (in blue dotted circle), are designed to serve network capacity improvement. NCF Fare Adjustment Scheme was applied to reflect the capacity cost by slightly increasing the fares, and to meet the public transport investment gap. However, due to the concern on affordability, the scheme does not generate enough revenue to cover the operating costs nor infrastructure construction costs. The operation and service quality enhancements caused a financial burden to the operators, and the public transport industry faced a deteriorating financial situation, which calls for the change of finance structure.

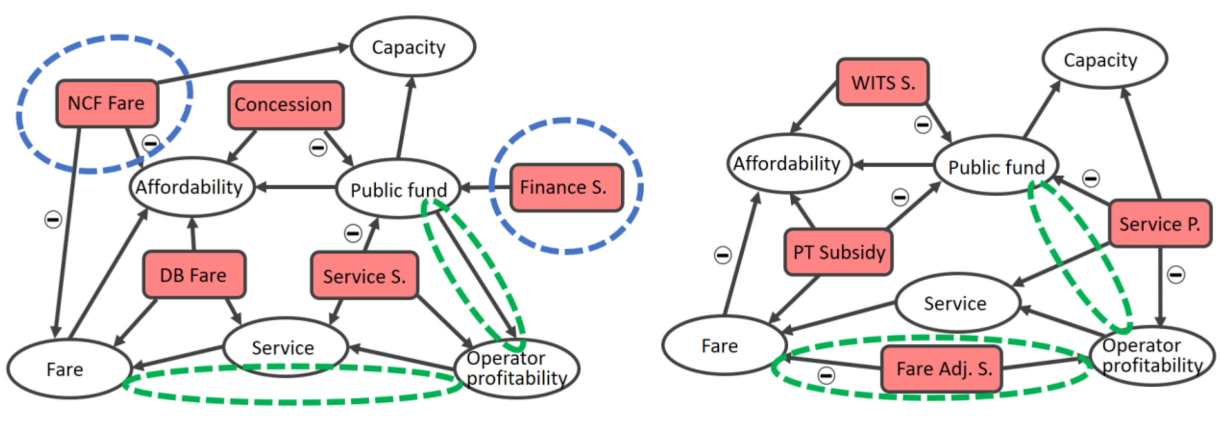


Figure 6.26 Urban context comparison by causality maps

Hong Kong's context and challenge is different. With a much mature network, Hong Kong's top issue is the continuously rising fare. The general context is the commercial principle between Hong Kong public transport operators and the government, which is reflected by the link between public fund and operator profitability, as pointed out by the green dotted ellipse. We can see the link from public fund to operator profitability in Singapore, but there is no such link for Hong Kong. Instead, operator profitability is linked with fare revenue, by the Fare Adjustment Scheme. Due to the commercial principles in Hong Kong, public transport operators don't receive any direct subsidy from the government. They are authorized to collect fare revenue and their profitability is depending on the management of the private company.

Difference of finance structure

In the case of Singapore, the New Finance Scheme (NFS) is introduced (Figure 6.27). With the NFS, operating assets are transferred to the Government. The government funds the infrastructure costs of the rail and bus networks, such as rail tracks and new bus fleets. For example, the Singapore government introduces the Bus Service Enhancement Scheme to purchase new buses for replacement to enhance bus capacity and comfortability to passengers. This finance structure change ensures that public transport operators are free from the financial burden of building the infrastructure and can be incentivized to be efficient in providing services to the public. At the same time, passengers are able to enjoy the benefits at no extra costs.

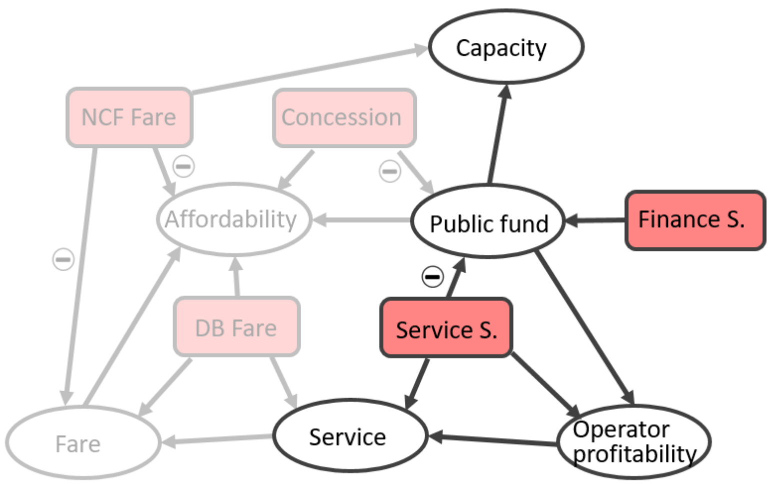


Figure 6.27 Singapore finance structure

The New Finance Scheme makes the public transport keep pace with growing ridership demand, more capable to support the investment and construction of transport infrastructure. With the new finance structure, the government ensures the public transport services are sustainable financially and fares are affordable by the public.

Hong Kong is one of the few cities in the world that has no publicly-operated bus service. Under the contracts between operators with government, the bus services and operation are regulated, monitored and controlled by the government. The public transport services are managed by the private sectors in accordance with commercial principles. Under this finance structure, the intervention of the government into the public transport sector is constrained, due to the legal, financial and commercial principles, which we already see from the discussion on affordability.

From the perspective of operator in Hong Kong, taking the MTR Corporation for example, it does not receive any government subsidy. For a self-financing public transport operator, to be profitable requires innovative approach. For instance, the Japan Railway Kyushu Company adopts a diversified business structure and utilizes the revenue from non-rail sector to maintain the company's financial sustainability

(Ishii, Xu, & Ram, 2019). The MTR Corporation managed to be a profitable company, due to the unique financing model.

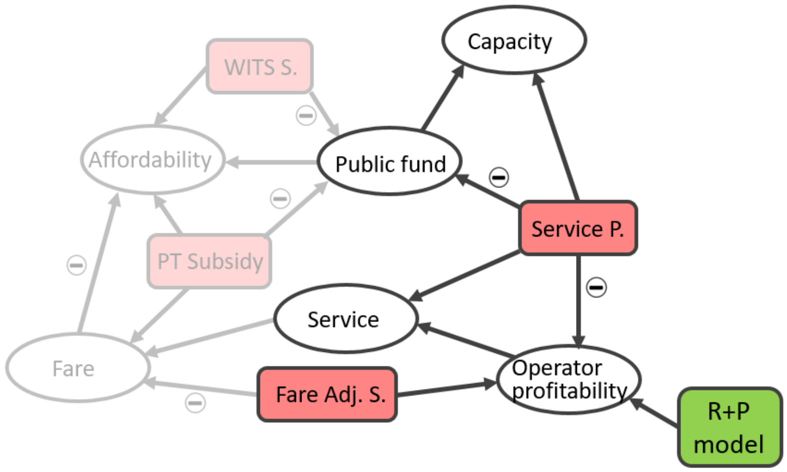
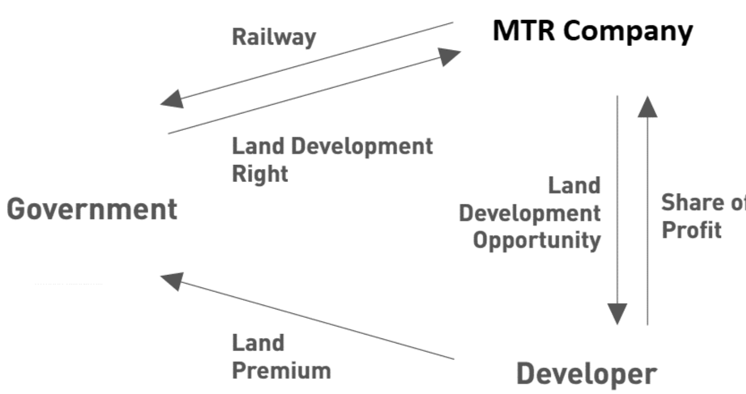


Figure 6.28 Hong Kong finance structure

The R+P model is the integrated railway and property development model. The MTR Corporation actively involves in real estate constructed over the stations. This business strategy allows the company to be not only a public transport operator but also a real-estate developer. As compared to the rail operating profit generated, the real-estate business has brought in substantial revenue from property development (Cervero & Murakami, 2009). To facilitate the financing model and coordinate the relationship between railways and land development, the Government grants the MTR Corporation exclusive rights for the property development of station areas. Therefore, the property-related revenue source is financing the construction and development costs of railways, and the government saves the direct subsidy to the operator. The finance structure is illustrated in Figure 6.29.



Source: (Cervero & Murakami, 2009)

Figure 6.29 MTR finance structure

Under MTR finance structure, the company acquires the land from the government at a low price before construction starts. When the construction is finished, the broader impacts from the infrastructure development starts to take place. The land price gets higher, and more business will open around the station area and along the lines. The MTR company manages the land and the associated business, especially the real estate and sales, and internalized the benefits. By doing so, the profits are brought back efficiently, which reduces the construction costs and finance burden.

However, the concurrent facts of continuously increasing fares and profitable MTR has arisen the general discontent from the public. "MTR should not increase fares while making handsome profits", as complained in one public consulting report[34]. It is suggested that the operation and maintenance costs should be compensated from the revenue earned from property development and other aspects of the business, rather than by increasing the fares.

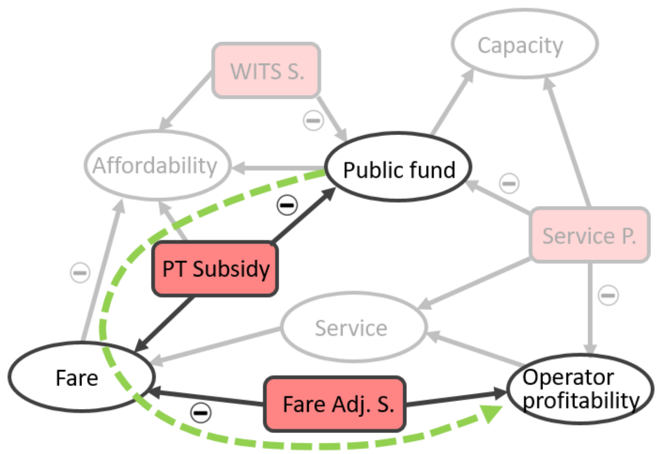


Figure 6.30 Capital flow from Government to Operator in Hong Kong

The Fare Adjustment Scheme sets the priority on operator profitability. When the scheme produces rising fares, subsidies are provided to public in a non-mean-tested way. This creates a route of capital flow, as illustrated in Figure 6.30 if we reverse the arrow direction of highlighted negative links, from the government to the operators through pricing schemes of Fare Adjustment Scheme and Subsidy Scheme, making the operators even more profitable. MTR is the sole railway operator in Hong Kong and a company with the Government as the majority shareholder. The company should fulfill its social responsibility.

From the comparison of Singapore and Hong Kong, we are able to see the difference between them. Singapore changed the finance structure through the New Finance Scheme to cope with the current demand increase and changing situation, while Hong Kong insists the commercial principle, and awards the operator the rights to innovate financing models, in order to keep the financial sustainability.

Singapore's development of public transport, not only improving network capacity and service level, but also maintaining the fare at an affordable level, are at the cost of public fund. Actually, this creates the unsustainable situation to Singapore. All infrastructure costs for the construction of new rail lines and other public transport infrastructure is backed up by the Government. Even the NCF Fare Adjustment

[34] Key views received from public consultation, https://www.thb.gov.hk/eng/psp/publications/transport/consultation/Key%20views%20received%20by%20the%20Government%20(Eng)(final).pdf

Scheme, which aims to reflect the capacity cost by increasing the fares, was not able to recover the past operating costs nor infrastructure construction costs. This actually makes the scheme meaningless. As the implication from Hong Kong to Singapore, Singapore government may increase the fare adjustment rate to cope with the changing situation, and release the financial burden assumed by the government. On the other hand, innovative financial model can be explored in Singapore. Due to the profit-seeking essence, operators may be reluctant to undertake capacity expansion and service enhancement, as well as response to growing demand actively. However, if additional incentives can be created, the situation would be different, as shown by Hong Kong's case.

In summary, an appropriate financing framework for public transport, either from fare box revenue, or the public fund, or combination of both, balances the Government's financial sustainability, the operators' profitability, the commuters' affordability, while keeping high service standards. A sustainable public transport system is the shared responsibilities of the government and public transport operators.

Public-Private Partnership for public transport

In public transport field, there is always the debate on relationships between the government and the operator, namely Public-Private Partnership (PPP). Put Singapore and Hong Kong's cases, and other cases on the PPP spectrum, we have Figure 6.31.

Figure 6.31 PPP spectrum and transport infrastructure projects

Singapore is a good example on shifting the PPP forms according to policy objectives. The relationships between the government and the operators in Singapore had went through the process of nationalization, privatization, and again, nationalization.

Before 1998, the public transport was operated by the government, which was the nationalized status. The privatization started in 1998, with the ownership of the rail and bus assets transferred to private companies, such as SMRT Limited. On July 2000, SMRT Limited was listed on the Singapore Exchange as SMRT Corporation. Since then, the company was operated on a commercial basis, with no direct operating subsidies from the Government. Fare revenue are the major source of revenue to the operators. As the independent company, the fares, advertisement and rental revenues need to cover operating and maintenance expenditure and depreciation. The situation continued until October 2016, when the second nationalization started.

In September 2016, the State Owned Company of Temasek Holdings completed a takeover of SMRT, which resulted in SMRT being delisted from the Singapore Exchange and returning to government control. All its operating assets were sold to the government through the New Finance Scheme. It is worth noting that the new nationalization is different from the old one (before 1998) that it leaves the daily operation licenses open for market competition.

For Hong Kong, it locates at the “private” side, with the clear separation of responsibilities among stakeholders involved: the government provides the basic transport infrastructure, commuters pay for the service, while the operators retain the fare box revenue within the regulated service standards.

The following table (Table 6.9) explains the advantages and disadvantages of Hong Kong and Singapore’s PPP form.

Table 6.9 Advantages and disadvantages of PPPs

	Hong Kong’s Private form	Singapore’s Public form
Advantage	Market competition	Long-term planning
	Operation and service efficiency	Large-scale infrastructure investment
	Operator profitability and innovation	Social welfare
Disadvantage	Social equity and affordability	Public finance sustainability

The essence of PPP, in terms of public transport field, is the choice of monopoly and competition. Competition is necessary to improve operational efficiency but wasteful competition, such as multiple operators compete on the same route, has to be avoided. Monopoly by larger operators can enjoy better economies of scale and balance unprofitable routes with profitable routes. When fares are regulated and controlled by government, it is more likely to be adjusted throughout the general population for certain policy purpose, such as improve network capacity (as the case of Singapore). Monopoly operator would need a watchful eye to ensure that service standards do not deteriorate and that fares remain affordable (recall the case of MTR in Hong Kong). Ultimately, the decision should be one that does not put the commuters at a great disadvantage.

6.4 Chapter summary

This chapter starts with the comparative study on the case of Singapore and Hong Kong. The comparative case study is based on the direct output of the integrated analytical framework to present the differences and gaps between the policy implementation and performances.

The causality analysis is carried out to appreciate how and why a policy can be expected to result in a particular impact. The causality analysis adopts a combined theory-based approach of Theory of Change and Realist Evaluation, with CMO configurations and causality map as the output.

With the causality map and the detailed comparison, implications are discussed in terms of fare and affordability, subsidy mechanisms, and finance structure. Causality maps are utilized and certain causal pathways are highlighted to facilitate the discussion. Based on the ex-post comprehensive evaluation, implications on the design of fare structure and fare adjustment, the effectiveness of subsidy mechanisms, as well as Public-Private Partnership, are discussed, which would be useful to for future policy making.

7 Conclusion

7.1 Conclusion

Conclusions of this thesis are into three aspects related to urban public transport pricing policy, which are in accordance with the research problems.

Fare and fare affordability

a) Fare structure. Fare level is determined by fare structure and fare adjustment, where fare structure decides the base and fare adjustment refines the fare level. There are three types of public transport fare structures: flat-rate, zone-based, and distance-based. Each has different characteristics and applicability. Fare structure should be in accordance with public transport network configuration. Singapore shifted the fare structure from flat-rate to distance-based, considering that a hub-spoke network with flat-rate fare structure would incur frequent transfers at transit centers and the shift can promote connectivity and integration of the public transport system. Attention needs to be paid, when making the structure changes, to the equity of different demographic groups and long-term impacts on land-use pattern.

b) Fare adjustment. The evolution of fare adjustment has shown the increase of complexity and functionality. Fare adjustment can be functional, by incorporating various components in formula to cope with various challenges and fulfill different purposes. For instance, Energy Index can be included to track electricity and diesel costs for trains and buses, which is account for a large proportion of total costs and sensitive to transport operators. The New Capacity Factor is introduced in 2018 to better reflect cost induced by public transport capacity improvement in Singapore. What is more, additional mechanisms can be included in fare adjustment scheme, to make the fare adjustment formula more responsive.

c) Fare affordability rationale. Singapore and Hong Kong have presented different rationales in the management of fare affordability. Basically, Singapore government prevents the fare from increasing and bears the associated cost with public fund, while Hong Kong lets the fare increase first, but subsidized back to public. This difference of fare and affordability situation in Singapore and Hong Kong is contributed by the fare structure and fare adjustment schemes adopted, and is also deeply rooted in the fare affordability management rationale. Keeping fare affordable needs to be balanced with finance pressure, as well as local development goals and urban contexts.

Subsidy mechanism

a) Mean-tested direct concession is basically efficient than non-mean tested indirect subsidy. This can be justified by the performance indicators of Hong Kong's new Public Transport Subsidy Scheme, which is the first non-mean tested subsidy. Based on the case study, the score of finance indicator is 0.648, indicating the huge cost of public fund. While the equity indicator is

0.815, meaning the unequal distribution of subsidy benefits. Basically, the high income groups are subsidized more, compare to the low income groups who have a heavier financial burden. Hong Kong's non-mean tested subsidy caused huge costs but ended with subsidy distribution problem. The concession scheme that discount the fare directly in Singapore has a higher efficiency, compare to the indirect (as in-pocket money) subsidy schemes in Hong Kong.

b) Generally speaking, there is the tradeoff between subsidy efficiency and efforts made in developing and conducting the subsidy. Supply-side conditional subsidy and demand-side mean tested subsidies require more detailed design in screening criteria, and more efforts in implementation, compare to unconditional and non-mean tested ones, which normally, have higher efficiency.

Finance structure

a) The finance of public transport system, including the capacity expansion and service enhancement, generally comes from two main sources, the fare box and the government authority. Which way to choose is largely decided by who makes the decision to increase capacity and service levels, and the rationale behind the increase. If the decision is from the government side for the provision of social welfare, which is the case for Singapore, then the costs of improvement of public transport are likely to be assumed by government fund, or a combination of fare box revenue and subsidies from authorities. If the decision is made by the transport operator on purely commercial basis, like the case of Hong Kong, then the operator is expected to cover the cost through fare box revenue.

b) Transformation of finance structure along Public-Private Partnership (PPP) spectrum is important to actively cope with development challenges. Transformation of PPP forms had been conducted earlier in Singapore and the relationships between the government and the operators had gone through the process of nationalization, privatization, and again, nationalization. Singapore shifted from "private" to "public" through the New Finance Scheme to cope with the demand increase and changing situation, while Hong Kong locates at the "private" side, with the clear separation of responsibilities among stakeholders involved: the government provides the basic transport infrastructure, commuters pay for the service, while the operators retain the fare box revenue within the regulated service standards.

c) Innovation of finance structure is important for maintaining public transport operator's profitability. Due to the commercial principle in Hong Kong, public transport services are managed by the private sectors with constrained the intervention from government. The operator is awarded the rights to innovate financing models, in order to keep the financial sustainability. The MTR company manages the land and the associated business, especially the real estate and sales, and internalized the benefits. By doing so, the profits are brought back efficiently, which reduces the construction costs and finance burden. Innovation of finance structure makes the public transport operator in Hong Kong as one of the few cases in the world that is profitable without receiving any government subsidy.

d) Supervision of finance situation is necessary to guarantee public transport attribute as social goods. Generally, private operator sets the priority on operator profitability and pays less attention on the social responsibility. In some cases, continuously increasing fares against profitable operator would raise the general discontent from the public. Private operator would

> need a watchful eye to ensure that service standards do not deteriorate and that fares remain affordable. Ultimately, the decision should be one that does not put the commuters at a great disadvantage. A sustainable public transport system is the shared responsibilities of the government and public transport operators. In summary, an appropriate financing framework for public transport, either from fare box revenue, or the public fund, or combination of both, balances the Government's financial sustainability, the operators' profitability, the commuters' affordability, while keeping high service standards.

Implications of the research are derived. Based on the comparison of Fare Schemes of the 2 cases, the fare adjustment has shown an evolution trend of increasing complexity and functionality. Fare adjustment can be functional, by incorporating various components in fare adjustment formula to cope with various challenges and fulfill different purposes. The implication from Singapore to Hong Kong could be the incorporation of the Profit-Sharing mechanism and Price Cap in fare adjustment scheme, to impose restriction on fare increasing and share certain amount of operator revenue with general public, so that affordability problem can be solved. Generally speaking, supply-side conditional subsidy and demand-side mean tested subsidies have higher efficiency, compare to unconditional and non-mean tested ones, indicating the tradeoff between subsidy efficiency and efforts needed in developing and conducting the subsidy policy. Hong Kong's subsidy should be provided in a direct way, and the non-mean tested subsidy can be revised from flat subsidy structure into differentiated subsidy structure, to save subsidy fund and make it better distributed among population groups. Transformation, innovation, and supervision of the finance structure are important to actively cope with development challenges, as shown by the Finance Schemes. Hong Kong's innovative financing model is implicative to Singapore, which may help release the finance burden of public fund, which is extensively used to address the network capacity and affordability problems. A sustainable public transport system is the shared responsibility of the government, public transport operators, as well as the general public.

This research addresses the urban public transport pricing problems through the ex-post comprehensive evaluation of existing pricing cases. It sheds light on how to set public transport fare and adjust fare to balance the tradeoff between operator profitability and affordability, how to maintain the fare at an affordable level with subsidy mechanism, as well as the finance structure that can support a sustainable public transport system. For potential policy makers, this research provides series of options for the proper design of pricing policy in terms of fare, subsidy, and finance structure. A discrete scale of fare adjustment formula components and optional mechanisms is presented, and a proper selection and combination of components and mechanisms would enrich the functionality of fare scheme. A subsidy coordinate with dimensions of selection mechanism and fund source is generated, which can guide the design of subsidy scheme with the consideration of constraints of budget, effort, and the expected effect. A Private-Public Partnership spectrum is in place with discussion on advantages and disadvantages of finance structures. The scale, coordinate, and spectrum are ready to be customized based on different urban contexts.

Methodology wise, the academic contribution lies in the ex-post comprehensive evaluation framework. The framework is constructed on literature review of existing evaluation theory and methods. Well-established methods and theories in policy evaluation domain, including Multi-Criteria Evaluation method, performance indicator-based evaluation method, Theory of Change, and Realist Evaluation, are comprehensively integrated into the framework for the objective of ex-post evaluation on pricing policy. Ex-post evaluation emphasizes on the concept of learning from the past and address the questions on “What” is implemented and achieved, “How” and “Why” the pricing policy produced changes. The ex-post comprehensive evaluation methodology framework integrates multiple functional packages. Each is with a specific evaluation purpose. The policy implementation evaluation (based on Multi-Criteria Evaluation method) and policy performance evaluation (based on performance indicator-based evaluation method) are carried out to address the “What” question. They are integrated by the integrated analytical framework to explicitly display the gap of policy implementation and performance.

The causality analysis adopts a combined theory-based approach of Theory of Change and Realist Evaluation method, to identify the causal links between policy implementation and policy performance, and to answer the question of “How” and “Why”. The theory of Change addresses “How” by highlighting the quantitative and qualitative links between interventions and outcomes. Further on, Realist Evaluation paid special attention on underlying contexts and mechanisms, to answer the question of “Why”. The causality analysis findings are summarized in the form of CMO (context-mechanism-outcome) configurations, based on which the implications for future policy making are derived.

These functional packages are not separated, but integrated. There is the horizontal integration of policy implementation and performance evaluation through the integrated analytical framework, as well as the vertical integration of Theory of Change and Realist Evaluation on the analysis of causality. Therefore, the methodology framework is the systematic integration of research methods and designed specifically for the purpose of the ex-post evaluation on urban pricing policy. The input ports are clearly defined, and the whole or part of the framework is ready to be adjusted, customized, and applied in a broader context.

What is more, in order to communicate with government decision-makers and interested public and share knowledge among relevant researchers, the output of the evaluation framework should be presented in a simple and intuitive form. The presenting forms of radar chart in showing the gap between policy implementation and performance, and the causality map in expressing the interaction between interventions and outcomes, are simple, intuitive, and efficient in highlighting findings and spreading knowledge.

7.2 Limitation of the research

As the case study based ex-post evaluation, more cases would result in more powerful CMOs, which would increasingly test and refine the CMOs obtained based on cases of Singapore and Hong Kong. Pricing policy evaluation for cities with different populations, geographies, economic development levels, and with different priorities, may reveal different attributes and novel CMOs. For example, developing regions are more challenged by the shortage of transport infrastructure to meet the basic travel demand and tend to have less pricing management experience, while developed cities are focused on the soft management of already established public transport system. Singapore and Hong Kong belong to the latter. The number of case studies is the limitation of the research. The understanding of urban context is important for the application of findings from this research.

Future research could include comparisons with more international cases, which enable us to produce more general knowledge and implications. Regarding this point, the proposed ex-post comprehensive evaluation framework can be customized and applied, to support the evaluation and comparison. The nature of ex-post evaluation requires “Do” first. The policy intervention is needed, so that the associated changes can be produced and investigated, based on which, knowledge can be derived. Therefore, cases with recent pricing policy interventions are preferable in employing this analytical framework.

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Appendix

Appendix A: Terms used

Input: the committed financial, human and material resources to produce the intended outputs and outcomes.

Output: the immediate effects of policy intervention.

Outcome: the medium-term effects of policy intervention.

Impact: the long-term effects of policy intervention, directly or indirectly, intended or unintended, positive and negative.

Context: features of the conditions in which the intervention is introduced, implemented, and functioned.

Mechanism: a logical description of how an intervention creates certain outcome under specific context.

Policy intervention: is defined as a regulation or enforcement action consistent with transport schemes or policy packages.

Policy scheme: collective noun used to cover systematic intervention.

Policy package: a series of schemes in a coherent and coordinated way in a defined area over a defined period of time in order to achieve a particular overarching policy objective.

Policy implementation: the extent to which pricing policy schemes are used and directed at a specific issue.

Policy performance: changes connected to an intervention, can be reflected by quantitative or qualitative factor or variable that provides a simple and reliable means to measure.

Appendix B: Modelling code

Corresponding to 2.1.2, this part lists the modelling code for long-term optimal capacity and toll.

Demand and cost function:

```
function y = demand_fun(x) % demand/benefit function
y = x.^(-1/0.35)*10^12;
end

function y = cost_time (x, K) %private time cost, the BPR function
y = 7.5*0.5*(1+0.15*(x/K)^4);
end

function y = cost_capa (K) %capacity cost
Ko = 4000; % inicial capacity
r = 1; % elasticity of capital cost
y = 7*Ko/Ko^r*K.^r;
end
```

Social welfare function:

```
function s = welfare (x,K)
%insert demand and cost function
demand = @demand_fun;
cost_t = @cost_time;
cost_k = @cost_capa;
s = -integral (demand,100,x) + x.*cost_t(x,K) + cost_k(K);
%welfare for fmincon
end
```

Optimal toll and capacity:

```
function y = op_toll(x,K)
syms p Q ; %first do the diff, then give value to function
u = diff (cost_time(p,Q),p); % partial diff to flow
v = subs (u,p,x);
w = subs (v,Q,K);
%substitute p into x, as a variable
y = x.* w ;
end


function y = op_capa(x,K)%welf_diff_K
syms p Q ;
u = diff (cost_capa(Q),Q); % diff to capacity of capacity function
v = diff (cost_time(p,Q),Q);    % partial diff to capacity of cost time
w = u + p.* v;     % let diff welfare to capacity equals to 0
m = subs (w,Q,K);
n = subs (m,p,x);
y = n;  %output is equation of partical diff of welfare, not a value
end
```

```
function y = w_diff_x (x,K)
syms p Q ;
v = diff (cost_time(p,Q),p) ;  % partial diff to capacity of cost time
m = subs (v,Q,K);
n = subs (m,p,x);
y = demand_fun(x)-cost_time (x, K)-x.*n;
%output is equation of partical diff of welfare, not a value
end
```

Long-term optimal toll and capacity (iteration):

```
function output_fun
K = input('input initial capacity:\n')
fileID = fopen('plan_1.txt','wt');
%fprintf(fileID,'%.2f\n', x); %disp('optimal_flow =');
for i = 1:30
    fprintf(fileID,'STAGE %d START\n',i);
    fprintf(fileID,'K = %.2f\n', K);
    x = fmincon( @(x) welfare (x,K),4000,[],[],[],[],4000,8000);
    fprintf(fileID,'optimal_flow = \n %.2f\n', x);
    optimaltoll = op_toll(x,K);
    fprintf(fileID,'optimal_toll = \n %.2f\n', eval (optimaltoll));
    fprintf(fileID,'time_cost = \n %.2f\n', cost_time(x,K));
    fprintf(fileID,'social_welfare = \n %.0f\n', - welfare (x,K));
    revenue_net = x.* (optimaltoll - 5.5785);
    K_increase = 0.1*revenue_net/7;
    K = eval (K+K_increase);
    fprintf(fileID,'STAGE %d FINISH\n\n',i);
end
fclose(fileID);
end

function output_fun2
K = input('input initial capacity:\n')
fileID = fopen('plan_2.txt','wt');
%fprintf(fileID,'%.2f\n', x);
for i = 1:30
    fprintf(fileID,'STAGE %d START\n',i);
    fprintf(fileID,'K = %.2f\n', K);
    x = fmincon( @(x) welfare (x,K),4000,[],[],[],[],4000,8000);
    fprintf(fileID,'optimal_flow = \n %.2f\n', x);
    optimaltoll = op_toll(x,K);
    fprintf(fileID,'optimal_toll = \n %.2f\n', eval (optimaltoll));
    fprintf(fileID,'time_cost = \n %.2f\n', cost_time(x,K));
    fprintf(fileID,'social_welfare = \n %.0f\n', - welfare (x,K));
    K = K + (5507.7-4000)/29;
    fprintf(fileID,'STAGE %d FINISH\n\n',i);
end
fclose(fileID);
end
```

Appendix C: List of data source

There are 4 types of data source:

- Report: Data collected through in-depth studies
- Legislation: Information from written documents
- Statistics: Quantitative information compiled by government institutions
- Survey: Information gather through general public

Detailed data sources are listed below, sorted by cities.

Source	Singapore
Report	Looi (2007). Striking A Fare Deal: Singapore' s Experience in Introducing a Fare Review Mechanism. Li, M. (2018). International Benchmarking Study of Public Transportation Affordable fares, sustainable public transport: The Fare Review Mechanism Committee Report. Leong. (2016). Improving bus service reliability: The Singapore experience. Land Transport Authority. (1996). A World Class Land Transport System. Land Transport Authority. (2018). Land Transport Authority Annual Report 2017/18. Land Transport Authority. (2019). LAND TRANSPORT MASTER PLAN (LTMP) 2040. Land Transport Authority. (2019). Performance of Rail Service Reliability.
Legislation	Ministry of Transport of Singapore. (2018). Fares & Payment Systems. Public Transport Council. (2018). 2018 Fare Review Exercise. Public Transport Council. (2018). Commencement of 2018 fare review exercise. Public Transport Council. (2018). Public Transport Council Annual Report 2017/2018. Ministry of Transport of Singapore. (2015). Workfare Transport Concession Scheme. Land Transport Authority. (2013). LTA Masterplan 2013. Land Transport Authority. (2018). Financial Statements of Land Transport Authority.
Statistics	Land Transport Authority. (2011). Singapore land transport statistics in brief. Statistics Department of Singapore. (2019). Key Household Income Trends 2018. SMRT Company of Singapore. (2016). Briefing to Analysts on the New Rail Financing Framework. One Singapore Organization. (2016). Welfare Schemes in Singapore.
Survey	Land Transport Authority. (2012). Public transport customer satisfaction survey 2012. Public Transport Council. (2018d). Public Transport Customer Satisfaction Survey.

Source	Hong Kong

Report	Transport and Housing Bureau. (2014). Discussion Paper on Railway Development Strategy 2014. Transport and Housing Bureau. (2015). Public Transport Topical Study on Franchised Bus Service. Transport and Housing Bureau. (2018a). Discussion Paper for Finance Committee on Public Transport Subsidy Scheme. Yeung, S. (2012). The study of transport subsidies in Hong Kong. Transport Advisory Committee. (2014). Report on Study of Road Traffic Congestion in Hong Kong. Transport and Housing Bureau. (2017). Public Transport Strategy Study Final Report National Surface Transportation Infrastructure Financing Commission. (2009). Paying Our Way: A New Framework for Transportation Finance.
Legislation	Legislative Council Panel on Transport. (2019). MTR Fare Adjustment for 2019. Legislative Council Panel on Transport. (2018). Implementation of the Public Transport Fare Subsidy Scheme. Government Budget. (2019). Head 186 - Transport Department. Hong Kong Transport Department. (2009). Review of Fare Adjustment Arrangement for Franchised Buses. Hong Kong Transport Department. (2019). Legislative Council Panel on Transport Fare Increase Applications. Transport and Housing Bureau. (2018). Public Transport Fare Subsidy Scheme. Labor Department. (2017). Proposed freezing of income limits under Work Incentive Transport Subsidy Scheme. Labor Department. (2018). Work Incentive Transport Subsidy Scheme. Legislative Council. (2017). Background Brief on Work Incentive Transport Subsidy Scheme.
Statistics	Statistics Section of Transport Department. (2019). Monthly Traffic and Transport Digest 2019. Working Family Allowance Office. (2019). Examination of Estimates of Expenditure 2019-20. Environmental Protection Department. (2017). Air Quality in Hong Kong 2017 Government Budget. (2019). Working family and student financial assistance agency.
Survey	HKSAR Transport and Housing Bureau. (2016). Public Consultation on the Review of the MTR Fare Adjustment Mechanism.

Appendix D: Fare changes in Singapore

Referring to 4.2.3, the detailed fare changes since the commence of distance-based fare (2010) in Singapore are provided below. They are compile from the website of Statistics Department of Singapore government.

Distance fare for card adult commuters

Distance (km)	2010	2011	2014	2015	2016	2017	2018
≤ 3.2	71	73	77	79	78	77	83
4.2	81	83	87	90	88	87	93
5.2	91	93	98	101	99	97	103
6.2	101	103	108	112	110	107	113
7.2	109	111	116	120	117	116	122
8.2	115	117	123	127	124	123	129
9.2	121	123	129	133	130	129	135
10.2	125	127	133	138	135	133	139
11.2	129	131	137	142	139	137	143
12.2	133	135	141	146	142	141	147
13.2	137	139	145	150	146	145	151
14.2	141	143	149	154	150	149	155
15.2	145	147	153	158	154	153	159
16.2	149	151	157	162	158	157	163
17.2	153	155	161	166	162	161	167
18.2	157	159	165	170	166	165	171
19.2	161	163	169	174	170	169	175
20.2	164	166	172	177	173	172	178
21.2	167	169	175	180	176	175	181
22.2	170	172	178	183	179	178	184
23.2	173	175	181	186	182	181	187
24.2	175	177	183	188	184	183	189
25.2	177	179	185	190	186	185	191
26.2	179	181	187	192	188	187	193
27.2	180	182	188	193	189	188	194
28.2	181	183	189	194	190	189	195
29.2	182	184	190	195	191	190	196
30.2	183	185	191	196	192	191	197
31.2	184	186	192	197	193	192	198
32.2	185	187	193	198	194	193	199
33.2	186	188	194	199	195	194	200
34.2	187	189	195	200	196	195	201
35.2	188	190	196	201	197	196	202
36.2	189	191	197	202	198	197	203
37.2	190	192	198	203	199	198	204
38.2	191	193	199	204	200	199	205
39.2	192	194	200	205	201	200	206
40.2	193	195	201	206	202	201	207
> 40.2	194	196	202	207	203	202	208