

Railway and Transport Strategy Centre

The Operator's Story

Emerging Findings
OECD ITF 2017, Leipzig
May 2017

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Community of Metros
CoMET



Acknowledgements

Metro Operators are the entities that deliver metro services to the customers who in turn comprise the residents, workforce, and overall human capital of modern cities. They often perform miracles every morning and repeat those again every evening. Their performance impacts on quality of life, access to jobs, and the competitiveness of cities, if not countries. This research has been possible because the 34 Operators that participate in the **Community of Metros (CoMET)** agreed to help tell the “Operator’s Story.” In particular, 10 Operators provided in-depth insights by hosting the authors for visits and interviews where they shared candid insights. Their intention is to open information to a much wider audience and in so doing to increase understanding of the Operator’s role and the frustrations they often face. The ultimate aim is to increase understanding for what makes metros successful so that government, authorities, planners, financiers, political actors, and indeed Operators themselves can take good decisions that ultimately benefit metro customers and their cities.

The Authors would like to acknowledge support for this work that was provided by the Government of Australia and the Government of the United Kingdom whose generous grants made it possible to tell the “Operator’s Story.”



This work was conducted upon a request from the Government of India under the supervision and assistance of the Ministry of Urban Development. Specifically, the Authors would like to recognise the kind assistance of **Shri Durga Shankar Mishra** (Additional Secretary, MoUD) and **Shri Mukand Sinha** (Officer on Special Duty, Urban Transport, MOUD).

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Special thanks as well to **Jose Luis Irigoyen** (Sr. Director, Transport and ICT Global Practice, WB) and **Karla Gonzalez Carvajal** (Practice Manager, South Asia Transportation, WB) for their support to facilitate the research presented here.

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The Operator's Voice...

"At the same time we are charged for our inefficiency, and told to do things that create inefficiencies"

"Don't do ½ a job [in project preparation]"

"The biggest mistake to make is to just let a load of contracts – and that's the easiest thing to do"

"Every night for 4 hours the patient has to go through brain surgery, heart surgery, then get up in the morning, run a marathon, and win."

"We decide where the metro goes so we are planning the city..."

"It takes longer to train a well-rounded rolling stock engineer than a brain surgeon"

"Annualised funding is catastrophic for assets that need long-term care"

"Don't kick your home team when they are down"

THE METRO OPERATOR'S STORY

Metro systems are often the centrepiece of sustainable cities, the engines of economic growth and enablers of a high quality of life. They represent the outcomes of mega-projects, that are usually mega-costly but with the potential to deliver mega-benefits. Success requires much to go right during implementation, and thereafter during a metro's operational life. A single fault can undermine viability which means that institutions around a metro must be strong and competent. Worldwide evidence demonstrates that the most critical element of all when it comes to a metro's performance is the institution in closest proximity to customers, metro assets, and the business of service delivery – the “*Operator*.”

Whether public, private, or something in between, the Operator's role is central to achieving a successful metro. However, Operators come into being and exist within an environment set by others. Most notably, the decisions, attitudes, actions, or inactions of central government and regional and municipal Authorities (together referred to as the ‘Authority’) shape the Operator's role and capacity to succeed, often irrevocably. A lack of Authority understanding of the complexities of metro systems and what makes operations successful can lead to unintended consequences that impair the Operator's ability to meet (the often rising) expectations for metro services. Such outcomes are in no one's interest. Many Operators wish, but are often unable to convey, critical messages to their Authority that has influence over them. Similarly, many Authorities wish to secure desired results from large metro investments but are ignorant about what would enable Operators to achieve them. Multiple organisations are sometimes frustrated by the outcomes simultaneously. Addressing these gaps is in everyone's interests – especially metro customers.

Metro systems are political objects as much as they are transport systems. They ought to be. Metros shape cities, local economies, and in some cases, national competitiveness. The significance of metro systems means that political actors have a role to play in metro development and sustainability. It is common to observe different views between a metro Operator and government authorities. This can be both a source of tension as well as an important strength. Successful metros are embedded within city development and transport contexts. This inevitably means that their success is a function of political decisions that affect other aspects of policy, planning, and urban development. The key challenge in all of this is to ensure that customers and the economies that benefit from metro services “win” from the interaction of Operators and the governments that enable them to be effective.

It is often the case that no-one notices the Operator, until things go wrong. This is a major problem for the Operator and a limitation for public policy. Operators, when properly enabled, can achieve objectives that others cannot. Authorities are therefore in a position where helping the Operator to succeed can also bring about a powerful tool via which they can better achieve their aims.

Research Objectives

The core objective of the research is to identify and document what makes metros successful, particularly from the Operator's point of view, by telling the “Operator's Story”. The research sets out to establish how both the Authority and the Operator can act to improve metro success. The central research hypothesis is that metro success depends upon both the sponsor Authority and metro Operator working together:

- The Operator cannot succeed without a supportive enabling environment that the Authority is responsible for putting in place; and

- Metros cannot fulfil their potential until the Operator applies best practices in metro development, design and operations.

The major factors that influence metro success were identified in two groups:

- Those created by the metro enabling environment (influenced by the metro Authority); and
- Those that the Operator could directly influence or control.

Research Team

The World Bank is a leading international financing institution providing policy advice, technical assistance and financing to developing governments and city Authorities worldwide. The World Bank Group's transportation practice provides policy advice, technical assistance, and financing to governments, municipal Authorities and metro Operators in the fields of urban transport strategy, public transport planning, metro identification/ appraisal and financing. The Bank's objective in this research is to assist the decision-makers in its client countries who wish to develop, expand, or improve metro services.

The Railway & Transport Strategy Centre (RTSC) at Imperial College London has over 20 years' experience in metro management and benchmarking. It has undertaken 100+ in-depth research studies into issues of concern to metro Operators, working with senior managers of 34 metros worldwide. These metros are members of the Community of Metros (CoMET and Nova) benchmarking groups administered by RTSC.

The Community of Metros wishes to share its experiences with the worldwide metro community, whilst protecting confidentiality and anonymity of metros where necessary, and it has strongly endorsed collaboration with the World Bank for this research purpose.

The results of this collaborative effort is intended to deliver the following outcomes:

- Metro's Authorities will better understand how they can work with Operators to increase metro success;
- The RTSC at Imperial College London will share its collective experiences enabling Operators to better meet their Authority's objectives;
- Client Authorities of the World Bank will benefit from its technical assistance and financing activities; and
- Metros that exist today, those under development, and future metros will be more successful - better achieving their Authorities' objectives, being more sustainable and serving their cities more effectively.

Benchmarking

The Community of Metros has been engaged in benchmarking metro systems in world cities since 1994. The process of benchmarking can be defined as "a structured approach to identify actions that lead to superior performance". Benchmarking is not merely a comparison of performance data or a creation of league tables. Performance measurements, for example, deliver little benefit on their own, but they stimulate productive questions and lines of enquiry for more in-depth analysis and research. Learning organisations, ones that participate in benchmarking, consistently demonstrate higher performance.

The public transport benchmarking groups run by Imperial College London provide a strong focus on results that can be implemented, performance improvement, and on informing strategy. The members undertake detailed case studies each year, identifying best practices in operations and management, others offering key insights that can drive strategy and policy and provide information to support better dialogue with city governments, regulators, and other stakeholders.

Evidence Base: Case Study Metros

This research is based on evidence learned from long-term benchmarking and 10 in-depth case studies of worldwide metro Operators; each telling a unique “Operator’s Story”. These stories illuminate how new and developing metros can be successful and avoid mistakes of the past by highlighting upstream decisions that have facilitated, constrained or affected their operations.

The research comprised in-depth visits to 8 case study metro Operators (Sao Paulo, London, Hong Kong, Kuala Lumpur, Barcelona, Washington DC, Toronto and Santiago), interviewing their key staff and probing the challenges they face and their relationship with key stakeholders, in particular with their governments, Authorities and regulators. There were also 2 smaller case studies of Guangzhou and Bangkok metros. The case studies have been written up, validated by the Operators and form an important resource that will be provided in Volume 2 to the main report.

The emerging findings of the research highlight three key areas that Authorities and Operators need to understand to deliver more successful metro projects:

1. The context of metros and the overarching goal of creating stability for both the Authority and the Operator;
2. Authority actions that enable Operator success; and
3. Operator actions that maximise success within the environment enabled by their Authority.

1. The Context

There are three important contextual factors that influence the success of metros and are often little understood. These are:

- The role of metros in city development;
- The financial sustainability of metros; and
- The metro’s (often turbulent) operating environment.

The Role of Metros in City Development

The most successful Authorities invest in and think of their metros as tools of urban transformation within a wider network; and the most successful metros do not succeed by chance, but by strategic, purposeful and effective planning by their Authority.

London: Urban Competitiveness and the Wider Economic Benefits of Metros

Major urban transport projects in the United Kingdom are now viewed not just in terms of solving transport problems but how they deliver wider economic benefits and improve urban competitiveness. This approach has been developed for the Crossrail 1 and 2 lines, and is now in practice more widely. Transport for London has been successful in achieving a strong consensus throughout government and the business community that improved transport connectivity is essential for the future success of London’s economy. The economic case for Crossrail 1, opening in 2019, included quantified estimates of wider economic benefits arising from increased firm productivity arising from accessibility improvements, in addition to conventional transport and travel time benefits. When convinced by the case and its quantified benefits, the business community became the major proponents lobbying government to approve the project on the basis that it would part-fund it. For Crossrail 2 the approach is being planned additionally to help solve a housing crisis by accessing land that will be used to build 200,000 new homes as well as catalysing 200,000 additional jobs in London’s commercial centre.

However, metros are high-risk and high-cost investments that do not automatically succeed in attracting high demand or result in high density development. A common lesson from international experience is that steady incremental development of the metro system pays off, particularly when the Authority focuses on the difficult task of integrating the metro within the transport system and city development. This is inherently a long-term challenge that is best viewed with a 50 – 100 year perspective of metro development. Figure 1 illustrates Barcelona metro’s development history. A key lesson for cities looking to develop new systems is to plan for a continuous development process that will likely outlast the people involved in the metro’s initial development. The strength of the institution(s) tasked to lead this process and their focus on long term integration with the urban fabric is a key element for success.

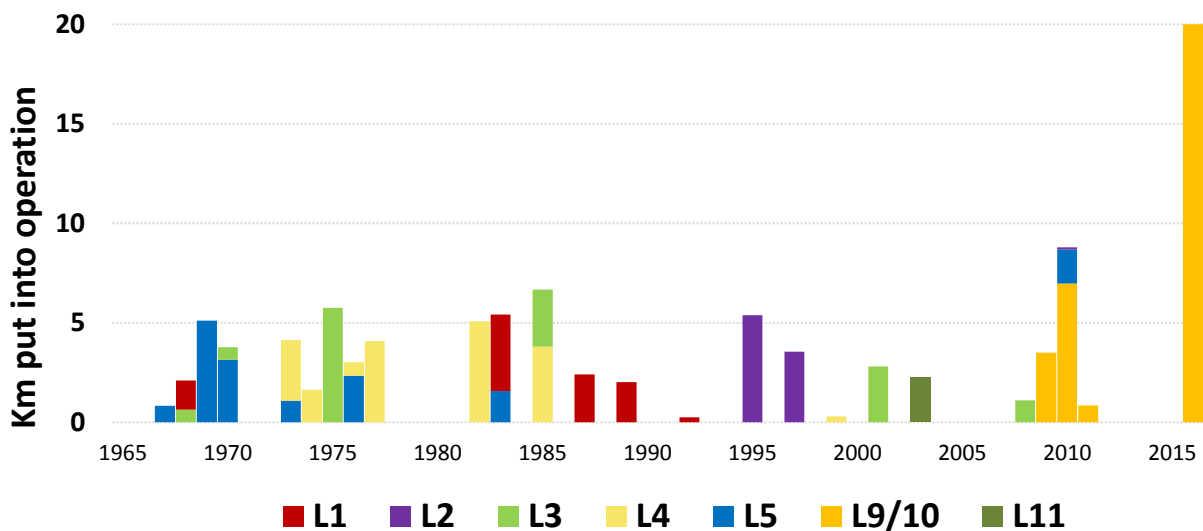


Figure 1: Long term game - evolution of the Barcelona Metro system by year and line

A further example of this is found in Hong Kong. It is impossible to disentangle Hong Kong’s unique, dense and sustainable urban from the high accessibility its metro provides. This was the result of exhaustive planning in a decision-making environment that facilitated success. The degree to which the metro in Hong Kong has catalysed ‘Transit Oriented Development’ (TOD) is pronounced given

scarcity of land and the inherent need for high density development above and near stations and depots, where accessibility is highest. However achieving this density has been part of a deliberate long-term strategy for maximising the viability of scarce land and also driving viability for the metro. One description of this during interviews is that *“when people come out of the metro, they are invariably already in their destination”*.

Financial Sustainability

A metro has wisely been described a capital investment project that never stops. The need for reinvestment to renew and enhance metro infrastructure is necessary to secure enhanced service and quality demanded by customers. The metro environment needs to keep pace with the ever-improving environment of customers’ homes, offices and shopping centres. Furthermore, assets age and require renewal and / or investments to extend their functionality between renewals. The clear message for Authorities and Operators alike is to plan a strategy for financial viability that looks beyond any one phase of metro development.

The financial characteristics of metros are brutal and simple – and also not understood. No metro has yet to demonstrate full financial independence. Initial capital, operating and asset renewal/enhancement costs even in the densest cities require some form of subsidy. The reason for this is that a large part of metro benefits are received by those who do not pay metro fares – other road users and the community at large, and the government pays a subsidy to secure these benefits.

Sometimes this is paid in cash by government authorities, or through additional land for development, grants in kind, or other forms of support. The nature of metro cash flows is also cauterised by uncertainty due to the nature of major projects, political economy considerations, and the complexity of metro assets. These facts have challenged the use of debt financing that would derive security for repayment solely from a metro’s immediate operating cash flows.

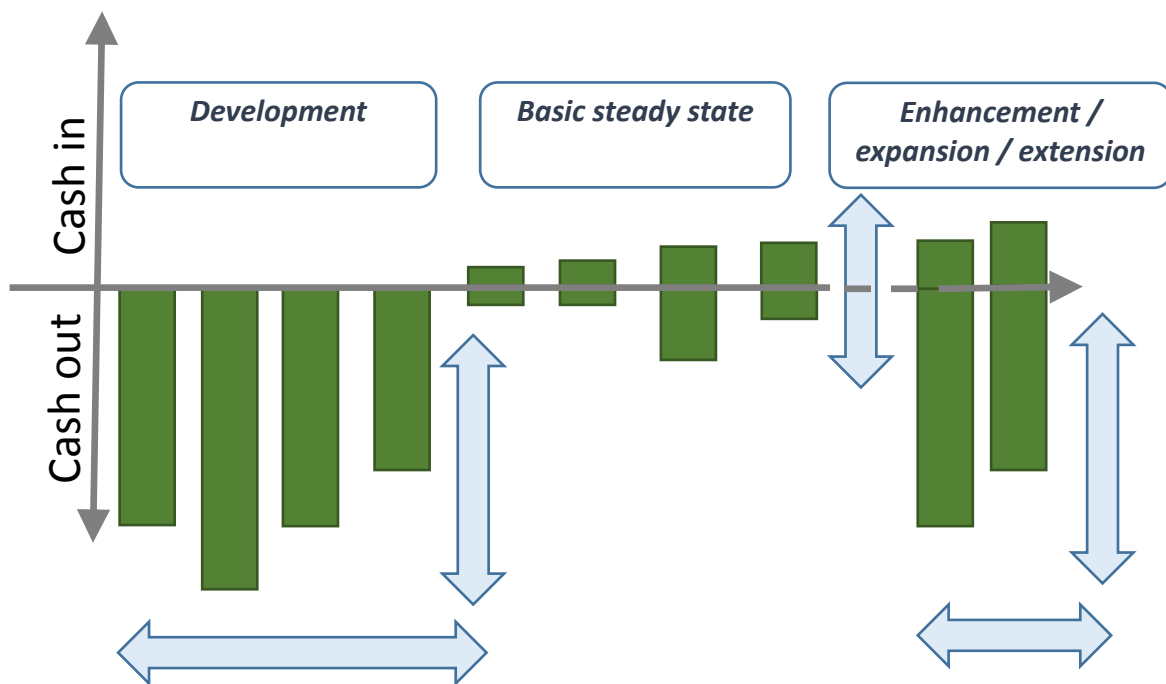


Figure 2: Examples of a metro’s cash flows (not including subsidy funding)

So a key question for Authorities and Operators alike is: How to pay for it? It is often important to segment this question into two parts:

- Upfront capital costs during the development of initial or new lines; and
- The cost of ongoing operating, maintenance, renewals, and enhancement of assets.

International experience shows that, when initial capital costs are excluded, some metros can sustainably recover sufficient funds to meet operating costs (i.e. the sum of operations, maintenance and administration costs), as well as long-term renewal, and enhancement costs. Approximately half of metros can at least contribute to ongoing renewal and enhancement costs. Evidence from Community of Metros benchmarking indicates that this operating surplus needs to be approximately 35% to 40% above operating costs over the longer term. Importantly, these rough estimates are subject to the extent of deferred legacy investment. Actual annual reinvestment rates of over 60% have been observed over many years in some metros which had previously experienced periods of little reinvestment. Most new metros have also been observed to spend money on enhancements much sooner than expected – for example to upgrade assets or passenger amenities and information, or to adapt to obsolescence risks. The success of a metro is often determined by the extent to which its long term funding strategy can enable an Operator to make investments at the right time such that service quality expectations are met.

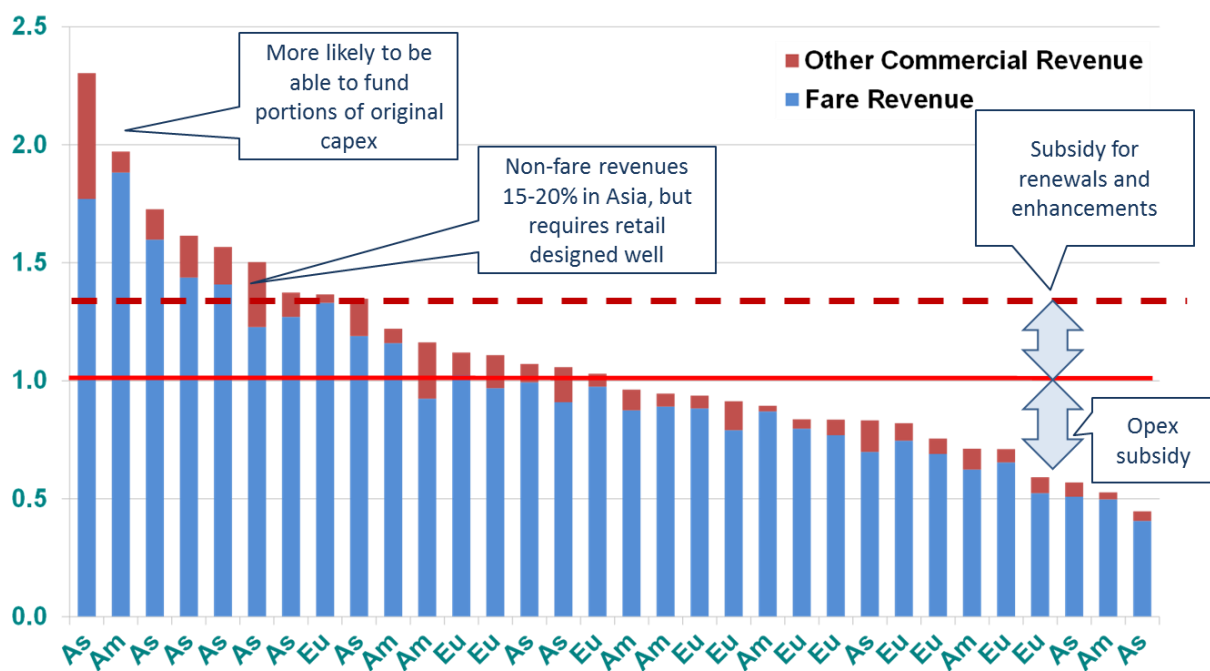


Figure 3: Farebox Ratios for Metros around the World
 (Source: Community of Metros / Imperial College London)
 Key: EU= European Metro; As = Asian metro; Am= American Metro

Regardless of the funding strategy that a metro pursues, there are ultimately only three credible ways to fund a metro’s costs:

- Fares paid by passengers;
- Non-fare revenues from concessions, advertisers and developers; and
- Subsidy payments by government on behalf of tax-payers.

The relative magnitude of these sources is important to appreciate. Figure 3, provided by the Community of Metros, compares the extent to which metros worldwide cover their annual operating costs through fare revenues and non-fare commercial revenues. Only half of the metros can cover their own annual operating costs and therefore half require some form of subsidy for the ongoing costs of administering, maintaining and operating the metro. Most metros require some degree of additional funding to support the ongoing renewal and enhancement of the existing metro.

The factors that govern an Operator's need for subsidy include:

- **Fares policy:** Fare levels may be kept lower than wider financial conditions would otherwise dictate to fulfil social policies, for example in many Latin American metros. Fare levels have also often been eroded by inflation – this is the case in many Asian metros where there has been a significant decline in real fares;
- **The rate of growth in unit factor prices:** Particularly important for metros are labour (wages) and energy costs;
- The ability of a metro to respond to fares pressures through **improved efficiency**; and
- **The extent to which metros and their cities can generate demand by:**
 - Delivering service quality and capacity;
 - Integrating the metro with other transport modes;
 - Extending the metro network to areas with major population and employment growth, and empowering the Operator to secure non-fare revenue opportunities, for example through advertising and retail concessions.

The Authority has a significant role in fostering success in every case, as international experiences demonstrate. In Hong Kong, upfront subsidy comes in the form of incremental land and development. The Operator monetises a fraction of this value during a project's initial phase through partnerships with developers. Some fraction of incremental development opportunity is also retained and monetised over the system's operating life in order to provide a continuous revenue stream and to provide greater control over the composition of that development. Other cities (e.g. Kuala Lumpur, Guangzhou, Santiago and Toronto) have adopted strategies whereby capital costs are funded directly by Authorities. There are also cities that have endeavoured to partially defer payment in part through bond issuances (e.g. Barcelona) albeit at the cost of additional future interest payments and potentially larger future subsidies from other sources.

"Bailing in beneficiaries" is also a strategy that Authorities are pursuing to fund upfront capital costs. A major rationale for metros is to secure the large external benefits derived by those who do not directly pay towards its costs – notably road users, businesses within the service area, and the community at large that benefits from the density and accessibility that a metro provides. This approach is currently being used as a funding strategy for the Crossrail projects in London where business and property purchases are providing a fraction of cash flow towards the project's development.

The Importance of Financial Stability

An important finding from case study interviews is that the modality for funding subsidy to a metro is an important determinant of the Operator's ability to make the right investments at the right time. In particular, there are benefits that accrue when an Operator's can make independent investment decisions. Stability of funding in particular can have a transformative impact on the Operator. Stable funding offers "economies of planning" that are made possible by extracting efficiencies from the

supply chain of suppliers and service providers that support a metro’s investment programme. Metro investment programmes span multiple years which can in turn create volatility in supply chain arrangements if annual funding allocations create uncertainty over sources of cash. Transport for London has estimated saving at least 15% on capital costs after transitioning to multi-year funding agreements which allow for smoother and more predictable execution of its capital programme.

An Operator’s ability to time investment and execute it when needed is enhanced when its management has the autonomy to make decisions without referring externally for approval. For example, agreeing upfront subsidy for major new build projects such as new lines and extensions results in a very different dynamic than needing to annually agree subsidies for keeping the metro in a state of good repair. One case study Operator summarised this latter scenario by stating that: *“Annualised funding is catastrophic for assets that require long term care.”*

The Relationship between Financial Sustainability, Operator Autonomy and Technocracy

Several case study metros, notably Hong Kong MTR and Metro de Santiago, demonstrate that financial sustainability affords the Operator a level of autonomy and independence. In the case of Hong Kong MTR, this provides the necessary independence to make decisions and reinvest in their network, to align with Authority-led policies. Metro de Santiago has gained significant influence over the planning and design of new lines and extensions, which it part-funds (historically 1/3rd of upfront cost).

Annualised Funding in Washington DC

WMATA’s experience highlights the impact on the Operator when it is reliant on annualised funding. Despite WMATA having one of the highest farebox recovery ratios in the United States, WMATA has no dedicated source of funding, and its operating subsidy (approximately 27% of operating costs) is reliant on annual negotiation between four funding jurisdictions: the States of Virginia and Maryland, the District of Columbia and Federal Government. Capital funding is affected by the same challenge. The result is that critical long-term measures needed to secure WMATA’s operations and growth by investing in asset renewal and preventative maintenance have not been delivered, creating multiple safety and operational impacts to customers. WMATA are constantly “catching up” with accrued investment needs, rather than delivering new value on their network.

The Turbulent Operating Environment

An Operator is impacted by numerous laws, policies, regulations, institutional systems, and political decisions that shape a metro’s operating environment. This complex of factors defines the metro Operator’s environment. The Operator has no control over some elements, for example, a city’s economy, size, structure, and external labour market. Similarly, land use, transport policy, regulation, and competition for transport services are often under the purview of other institutions. Other issues such as wages and union relations limit the Operator’s ability to exert control. The issue is that these factors define how effective and efficient an Operator can be. It is critical that Authorities appreciate its own role in shaping the operating outcomes that result from the environment they set. Where an Operator’s performance is lagging, improvements to the enabling environment should be part of the strategy for corrective action rather than faulting the Operator alone. As one case study metro put it

“Don’t kick your home team when they are down”. There is often a lot that public authorities can do on their side to help and Operator perform. Foremost among these is to put operational thinking and the Operator’s experience to work in shaping the laws regulations and policies that affect ability to perform.

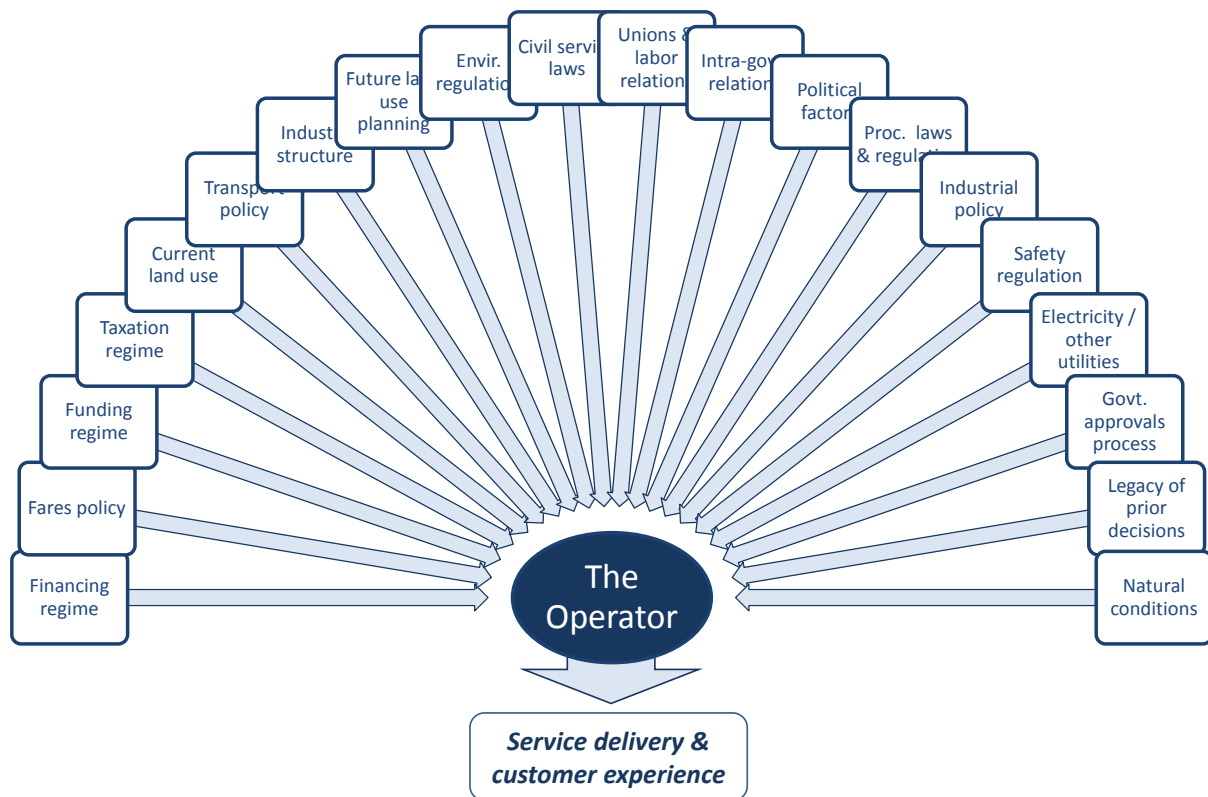


Figure 4: Examples of policies, laws, and regulation that impact on the Operator and customers

Authorities can also use a better understanding of the operating environment to shape what they ask an Operator to achieve. For example, in giving the Operator greater resources, flexibility, autonomy, or financial independence, an Authority may also ask for greater accountability for achieving performance targets. Toronto TTC’s use of daily performance tracking and reporting is one example of how improved accountability can also accompany increased political and financial commitment for a metro’s programme of improvement.

Internationally, there are also many examples of Operators rising to the occasion in order to meet unforeseen challenges when Authorities have put in place enabling frameworks that allowed them to do so. For example, case study metros have experienced and dealt with the following shocks in partnership with their respective authorities:

- Economic recession: Asian Financial Crisis (Bangkok, Hong Kong, Kuala Lumpur), and Global Economic Crisis (Barcelona)
- Natural disasters (Santiago)
- Rising energy costs (Santiago)
- The development of supra-national legislation (London and EU regulations)
- Shortage of skilled labour (Kuala Lumpur)
- Terrorism (London)

A key lesson from case study interviews regarding how Authorities set the operating environment pertains to the difference between an Operator's efficiency and its effectiveness. Effectiveness relates to the Operator's ability to meet customer and Authority expectations (e.g. safety, reliability, capacity, project delivery, etc.). Efficiency relates to meeting those expectations at a reasonable level of cost and with reasonable speed. Both considerations are indeed important. However, Operators reported frustration with being asked to achieve efficiency at the cost of effectiveness: a case study interviewee reflected this issue saying: *"At the same time we are charged for our inefficiency, and told to do things that create inefficiencies."*

Successful metros often "manage up" to influence their operating context. This goes beyond communication with an immediate Authority alone and in some cases involves the Operator engaging with local political leaders and even heads of national government. This was the case when Bob Kiley, Commissioner of Transport for London (2001 - 2006) together with then mayor Ken Livingstone, challenged the PPP approach being pursued for the London Underground's maintenance by then Prime Minister Gordon Brown's government. A separate case study has illustrated a less confrontational example where an Operator publically conveyed ideas that could then be adopted by politicians running for office. In this instance, the Operator publically identified the key measures that policy makers could take to improve the metro's performance. All but one candidates in the subsequent city council election adopted these recommendations as part of their electoral platform. An Operator's ability to engage upwards in shaping the operating environment will differ according to formal and informal norms. However, a common denominator of successful Operators is that they find ways to engage constructively in shaping their operating environment.

Hong Kong MTR: Invest in Stakeholder Management

Interviews with Hong Kong MTR revealed the importance placed on stakeholder management. This is particularly important and challenging to Hong Kong MTR because of its involvement in the full lifecycle of major project delivery and operation, as well as its wider role in commercial development. Hong Kong MTR advise that Operators spend substantial time and effort bringing people to a common vision, and proactively managing stakeholders. Although this may extend the time for front-end project development, it is likely to result in long-term buy-in and trust from the Authority and stakeholders, reducing long-term forecast constraints, risks and opposition.

Interestingly, Community of Metros benchmarking and case study interviews also illustrate that Operators themselves often do better or worse than their enabling environments would otherwise naturally imply. The implication is that many outcomes show the result of an Operator's leadership and capabilities as an organisation. A common denominator of Operators that outperform their environment is the commitment and knowledge of staff which is particularly linked to issues such as esprit de corps, compensation, job satisfaction, and overall quality of the working environment. Metro Sao Paulo in Brazil is an example of an Operator that outperforms its context as described below.

Control over the Operating Environment: London vs Sao Paulo

London and Sao Paulo are both effective Operators, established by performance benchmarking for factors they control. London is a story of government-supported success growing out of decades of under-investment and historic project failure; while Sao Paulo is a story of operational excellence in the face of substantial constraints with unintended consequences.

The contributing cause to these positions is the level of influence that these two Operators have over the factors that impact its success. London Underground has substantive control over all factors that impact its success, whilst Metro Sao Paulo has control over very little. Most of these factors, routinely recognised as necessary for a successful business – and metros are very large businesses - are absent in Sao Paulo. Part of the reason for the difference is external to the metro and city, but much is subject to the influence and control of the metro Authority.

Requirement	London	Sao Paulo
Clear objectives and risk	No contract, consensus	No contract, some consensus
Able to recruit / reduce staff	Yes	No
Predictable funding	Yes, with some future uncertainty	Insecure
Able to define and implement corporate strategy	Yes, with Mayor's support	No
Control over operating costs (e.g. labour, energy)	Yes	Yes
Control over revenue	Yes, with Mayor's support	Only for non-fare revenue
Influence over major projects	Yes	Modernisation only, subject to financing
Control over procurement processes	Yes	No

Table 1: Requirements for Operator success compared in London and Sao Paulo

For example Metro Sao Paulo is handicapped before it starts any procurement process by Brazilian law. None of the following are permitted in Brazil but all are permitted in London:

- Procurement against detailed specifications (by an “informed Operator client”);
- Market testing bid options to assess the appetite to take risk;
- Shortlisting of companies before bidding;
- Appointing on anything other than lowest cost to public sector.

2. Authority Actions to Enable Metro Success

The research has established 6 key enabling conditions for metro success that the metro Authority influences or controls. These are:

- Establishing an effective governance framework;
- Identifying the right metro system;
- Establishing the Operator with the capacity to succeed;
- Proactive engagement of the Authority with the Operator;
- Embedding the metro into the transport system and urban form; and
- Accessing private sector participation with care.

Together, these actions should stabilise the Operator's environment by creating greater predictability. Embedding technocratic, metro-specific knowledge within Authority organisations (including regulators) will improve the likelihood of the Authority and Operator achieving shared ownership and accountability for policy goals. This goal is often difficult to achieve due to the expertise and knowledge imbalance between the Operator, and its Authority/ regulator. Metros are hugely complex systems and the reality is while many Operators have almost complete knowledge about the systems and their interactions, rarely can an Authority or regulator even begin to approach this knowledge and expertise level.

The role of the private sector is often an issue. The considerable experience of Operators is that it should be engaged with care and consideration, building upon the lessons learned from many successes and failures of private sector participation in the metro and rail industries worldwide.

Establish an Effective Governance Framework

A governance framework provides the critical set of processes and decision-making responsibilities to ensure the metro is developed and operated effectively and efficiently. It is required to ensure the Operator acts responsibly and transparently in the Authority's interests.

An effective governance framework achieves substantial benefits for both the Authority and Operator:

- It enables the Authority to hold the Operator to account through scrutiny of proposals and application of regulation. The case studies reveal a wide range of practices, from rigorous administration of a contract, to no regulation;
- It enables the Authority to be held to account by central government decision-makers, who devolve decision-making and funding;
- It protects the Operator from volatile decision-making with long-term operational and financial impacts;
- It establishes lines of communication between the Operator with the Authority.

The evidence is that there is a wide range of practices and no one 'right approach.' Each case study is context dependent, although a common theme from metros is that investing effort into reducing bureaucracy and conflicts between decision-making levels is important. Governance frameworks varied widely throughout the Operators studied. Key features among the group included:

- **The presence or absence of regulators** for fares and safety. London's experience suggests that regulation either needs to be light touch (such as the Independent Investment Programme

Advisory Group, IIPAG) or very strong and knowledgeable. A middle solution (such as the Public Private Partnership Arbiter) runs the risk that the regulator may not have sufficient resources to get the necessary information to make decisions, although contractual requirements can assist with this. The level of accountability cannot be so intrusive as to lead to micromanagement, and the role of a regulator is affected by whether there is direct political leadership (as in London).

- **Levels of decision-making within the Authority environment;** the case studies reveal wide differences, for example:
 - In Toronto, multiple sponsor decision-makers (national, regional, city, and municipality) influence TTC's projects. This appears to be an inefficient process, given that decisions cannot be made simultaneously. Concurrent escalation through multiple decision-makers, dependent on criteria such as project cost, can add significant risk to TTC programmes. This is further complicated when multiple decision-making levels are of differing political affiliations. Interviewees suggested that this process had prevented major, value-adding projects from progressing.
 - In Kuala Lumpur, decision-making over the metro is centralised almost directly to the Prime Minister of Malaysia. Prasarana sits underneath the Ministry of Finance, directly headed by the Prime Minister. New megaprojects require the approval of the Board and the approval of the Prime Minister. This governance structure provides Prasarana with the political backing to effect change swiftly.
- **The creation, mandate and composition of metro Boards.** Boards can be bureaucratic/political, or technocratic. The political system should, in principle, hold sponsor Authorities to account and lead them to make decisions in their community's interest. In practice, however, there is a wide range of practices and approaches from technocratic to bureaucratic/political. London and Washington DC's board compositions present major differences that directly impact metro decisions:

	London	Washington DC
Board Composition	<p>14 Board members appointed by London’s Mayor for on the basis of their technical expertise. Includes experts in finance, property development, accessibility, logistics and critically, public transport, including:</p> <ul style="list-style-type: none"> ▪ Former Managing Director of train operating companies with 36 years’ experience in the rail industry; ▪ Former CEO of national rail infrastructure Authority; ▪ Former Chair of London’s passenger advocacy group; ▪ Former General Secretary of a major trade union. 	<p>8 members and 8 alternates drawn from political jurisdictions from the areas that the WMATA network covers. Each Director is entrusted with representing the “Laws of the State or political jurisdiction from which I was appointed” (WMATA Compact, 2009, p3):</p> <ul style="list-style-type: none"> ▪ Two members from Washington DC, who are appointed by the Council of the District of Columbia; ▪ Two members from Maryland, who are appointed from the Washington Suburban Transport Commission; ▪ Two members for Virginia, who are appointed from the Northern Virginia Transportation Commission; and ▪ Two members for the Federal Government, who are appointed by the Administrator of General Services. It is stated in the WMATA Compact that at least one of the members from the Federal Government should be a regular public transport user in the area.
Outcomes	<ul style="list-style-type: none"> ▪ Long-term holistic outlook on decisions; ▪ Technocratic decision-making based on experience and technical knowledge; ▪ Decision-making based in the metro’s best interest; ▪ Cross-sector views; ▪ Board of Directors with low turnover. 	<ul style="list-style-type: none"> ▪ Little technical or technocratic input, and no qualification for metro-related knowledge to sit on the Board; ▪ Decision-making based on political interests, fostering short-termism; ▪ Board of Representatives with a high turnover of individuals.

Table 2: Board composition and outcomes compared in London and Washington DC

Identifying the Right Metro System

The Authority’s necessary role in identifying and developing the right metro system involves the following activities:

- Preparing plans that guide development and can stand the test of time. These plans should help stabilise the otherwise very turbulent environment;
- Identifying, developing and funding the right projects (e.g. new lines);and
- Establishing and pursuing a continuous pipeline of metro projects.

Preparing Plans

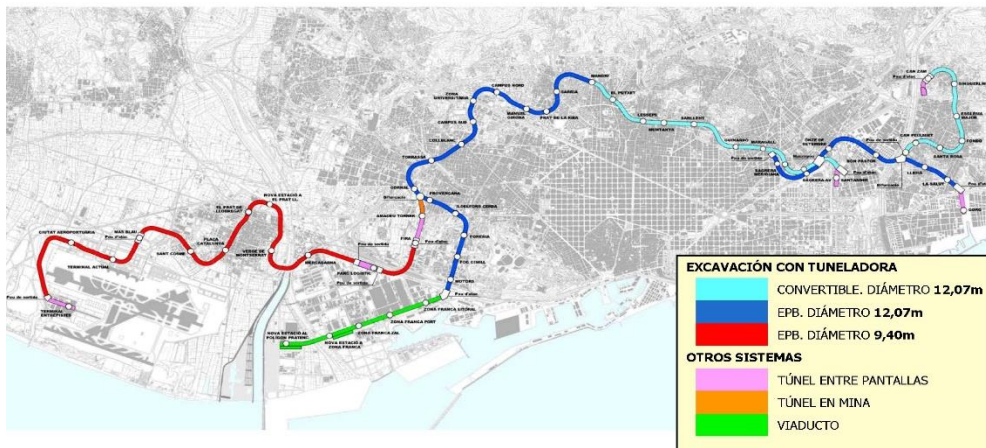
The Authority has responsibility for planning its city's future and articulating the vision for the city to its stakeholders and citizens. This is typically done through Development Plans, Transport Strategies, and Metro Plans. These serve the purpose of engaging with key stakeholders during their formation, and thereafter providing confidence of what will happen, because they are used when making important decisions. This is important – plans are useful only when they are used to inform important decisions.

Plans are particularly valuable because of the preparation process that analyses and appraises many possibilities against criteria such as policy outcomes, practicability and affordability. At the planning stage it is important to recognise that not every metro proposal is sound, and not every network is sound. Where uncertainty might be expected to be limited, it is best to develop 'master plans' and stage their implementation. However, when uncertainty is very large, then this approach is not possible, and the focus needs to be on incremental development from today into an uncertain future. The Authority will wish to ensure these plans are as resilient as possible.

Identifying, Developing and Funding the Right Projects

The Authority is responsible for identifying, developing, and funding the right projects that have robust expected performance and the potential to meet policy objectives. This requires validating cost and ridership forecasts against the known performance of similar projects in comparable environments. Attracting high demand, always necessary, is sometimes elusive. A single poor line can undermine a metro system, and an overly-ambitious network can create long-term intractable problems. Barcelona's Line 9 is an example of the former.

Barcelona: The Line 9 Experience



TMB is a trusted Operator within its Authority environment, recognised for its operational expertise. It is not, however, requested to advise on major network extensions that are funded and developed by the Regional Government of Catalonia. Line 9, now under construction, is a 48km fully automated line partly constructed in deep tunnel.

Line 9 has already had a major impact on TMB, diverting resources from other priorities and converting a positive farebox surplus into a deficit with a future requirement for ongoing subsidy. As of 2017, the southern and northern parts of the new line are open, but the central spine is not, owing to an overriding decision by the Regional Government of Catalonia to commence construction from the ends of the line towards the centre and the engineering challenges encountered in the centre section.

This experience demonstrates that major investment decisions should be kept close to the Operator so that its technical expertise influences the outcome. New lines should be constructed to serve the sections with greatest passenger demand from the outset. Although these sections will be the most costly to deliver, they bring greater benefits by creating critical interchanges, revenues and capacity relief early in the project's life.

Establishing and Pursuing a Pipeline of Projects

Setting up a predictable, continuous pipeline of projects is an important role for authorities who wish to ensure good value-for-money from their metro system. Operators have varying responsibilities for major projects - most modernisation projects, and many extension projects. Major project development benefits from economies of scale: each major project requires a mobilisation effort to secure the right resources. There is a learning curve and when there are successive projects major economies can be achieved. Metro Madrid achieved extraordinary delivery success using this model, applied over many years. However, a gap with 'no projects' causes key staff leave for projects elsewhere and the resultant loss in efficiency that may not be recouped for some time.

Each project requires major change for the Operator, especially when it is responsible for project development/ implementation; recruiting and developing the necessary skills for new projects and embedding the company's culture; then retaining key staff when workload drops. Delhi DMRC, for example, recruited 4000 employees to implement its Phase 3 network. Continuity of projects builds

Operator capacity and efficiency, which can be lost when there is a gap in projects, potentially causing future projects to be less successful.

Figure 5 shows the impact of the “feast-and-famine” project pipeline that Hong Kong MTR – an experienced project developer - has experienced. This Operator has experienced problems resulting from implementing five projects simultaneously.

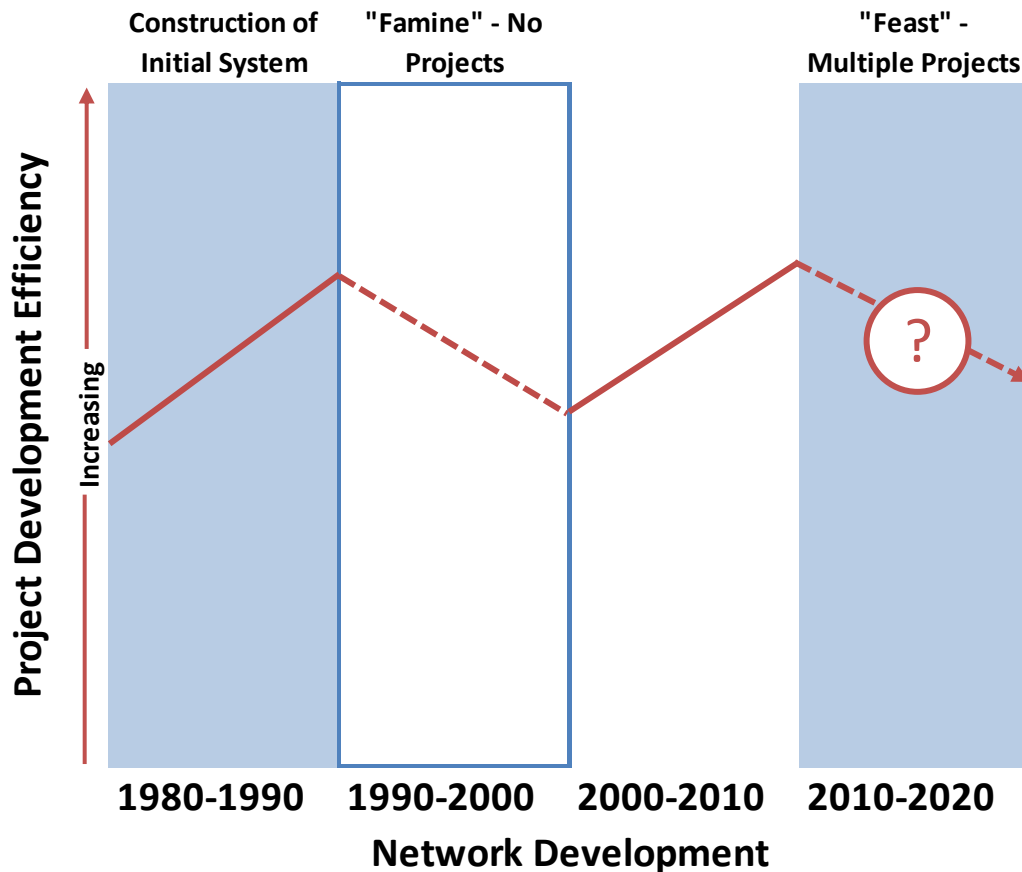


Figure 5: Impact of a Project Pipeline on Project Development Efficiency in Hong Kong

Future-Proofing Metro Design - with the Operator

The Authority should involve the Operator in all planning and design stages to avoid making costly mistakes that may also fail to optimise the potential benefits of the metro. For example, metros built with insufficient capacity, whether by design or due to unforeseen practical constraints, is highly common worldwide.

One Operator in a case study interview stated: *“There are only two types of metros in the world. There are metros that are empty, and metros that are full... If you can enmesh yourself into the city, you want every bit of capacity you can get. And if you’re not doing that, don’t build a metro!”* Another interviewee believes that the Operator should be bold enough to tell its Authority, *“I need **this** design to build the capacity that **you** need.”* Metros are expensive and value engineering can exert pressures to minimise short term capital costs at the expense of even medium-term benefits.

Maximising capacity helps to make the most of expensive metro infrastructure. Community of Metros research shows that metros usually have higher fixed than variable costs and have strong ‘returns to density’. Even if demand is lower in initial years, mistakes in designing for too-low capacity for the

long-term can be impossible or prohibitively costly to fix. For their most constrained lines, 75% of members of the Community of Metros want to operate more frequent services than is currently possible. Yet, research shows that passenger demand is highly responsive to levels of capacity and frequency. So, particularly for metros in larger cities, it makes sense to design metros that have the capability for longer, wider and very frequent trains. The benefits may substantially outweigh costs: in London, increasing peak frequency on the Jubilee Line from 30 to 36 trains per hour is calculated to deliver a benefit:cost ratio of 8.6 to 1.

Benchmarking has shown that many metros are achieving only half of their potential capacity. This is demonstrated in Figure 6 from the Community of Metros which has benchmarked the peak period capacity of metros' highest capacity line. A frequency of 40 trains per hour or more is achievable with good design and appropriate technology, yet a maximum of only 26 trains per hour has been observed in some Asian mega-cities due to poor terminal turnaround capacity. New metro lines and stations in large cities have been designed for only three car trains, arguably a missed opportunity.

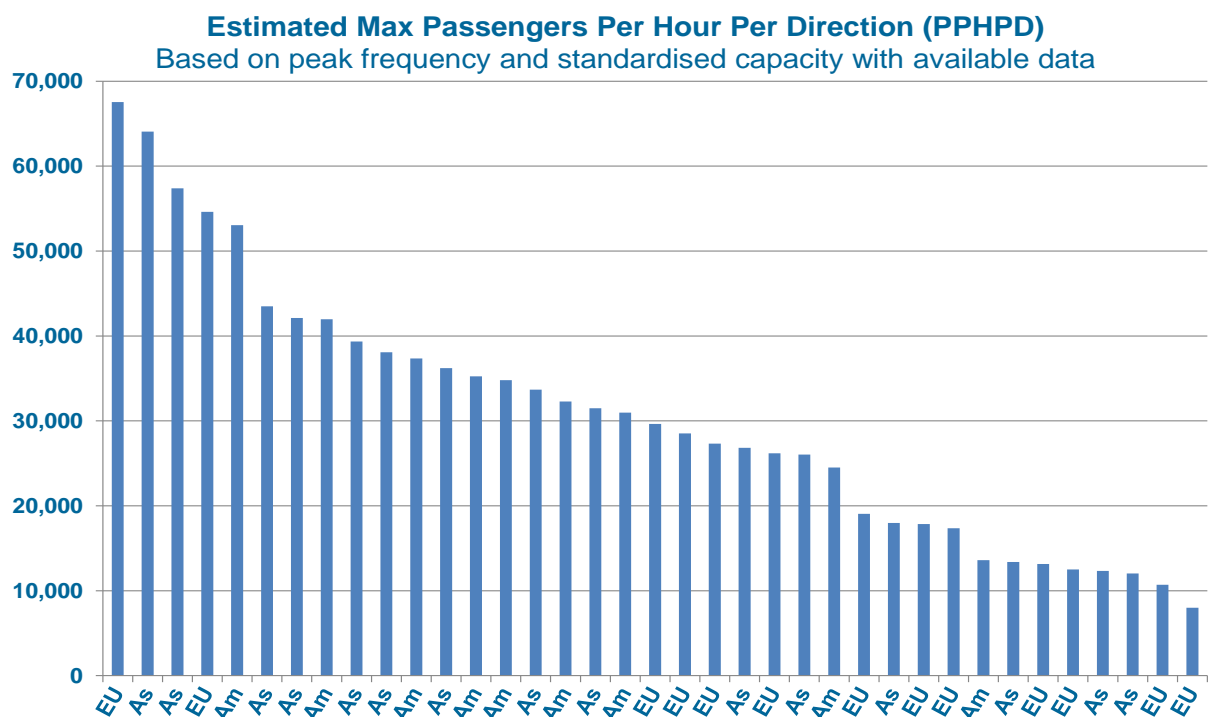


Figure 6: Maximum Metro Line Capacity - Maximum Passengers per Hour per Direction
(Source: Community of Metros / Imperial College London)
Key: EU= European Metro; As = Asian metro; Am= American Metro

A systems approach is essential when considering changes to a metro. This is because 'everything affects everything' and unless a holistic approach is taken to change, the result is often one of unintended adverse impacts. Figure 7 shows the factors that impact system capacity, many of which are determined by the original design of the metro.

An Operator decision to increase capacity needs to have regard to optimising all these factors. If this is not done there is a danger that the first obvious problem is tackled, only to create further bottlenecks that then need to be addressed. For example, if the line capacity is not yet fully utilised and extra trains are made available, the next limiting constraint could be signalling capacity or turnaround capacity. The Operator must understand which these limiting factors are and their sequence to avoid unnecessary reinvestment costs. For example, new signalling will not increase line

capacity if turnaround capacity is the next limiting constraint. Dwell time management for example (mainly under Operator control) can be significantly impacted by the original design of the metro through train design, station and platform capacity, which is under Authority influence. The Operator must then manage dwell time as far as possible to ensure trains depart on time, alongside strategies to minimise crowding such as real-time information provision and signage.

The specification and design of metro line capacity is a very good example of where the Operator and Authority must always work together. When the time comes to longer term renewal, the Operator inherently becomes more engaged in system specification, for example the choice of signalling, as the Operator has the most experience to make such decisions. This demonstrates the benefits of Operator involvement in the specification for new metros too.

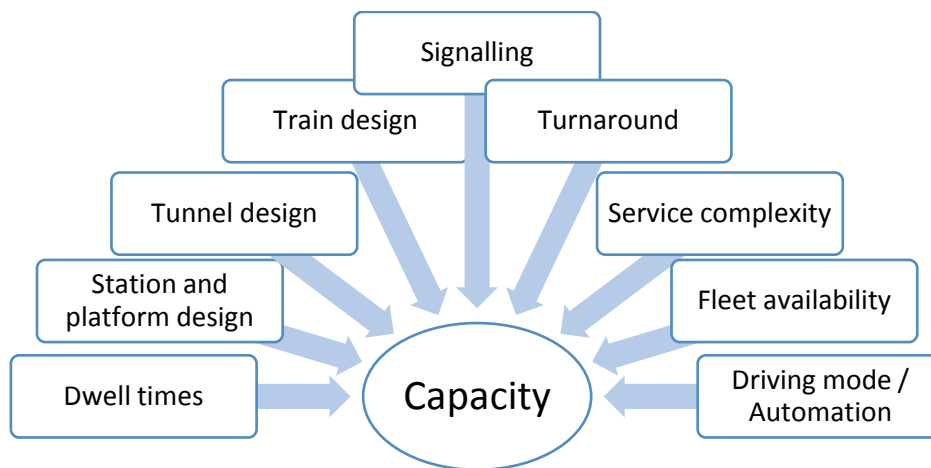


Figure 7: Determinants of Metro Capacity

Metro Sao Paulo World Best Practice: Designed for Capacity and For the Future

Metro Sao Paulo is a world-class operator. Line 3 trains are amongst the most loaded in the world. Following recent re-signalling, a frequency of 36 trains per hour is now achieved – a world-class level of service. This success is underpinned by the metro’s original high capacity design, including 3.2m wide trains, wide platforms, separate boarding and alighting platforms at key interchanges, and high-capacity terminal design, as shown below.

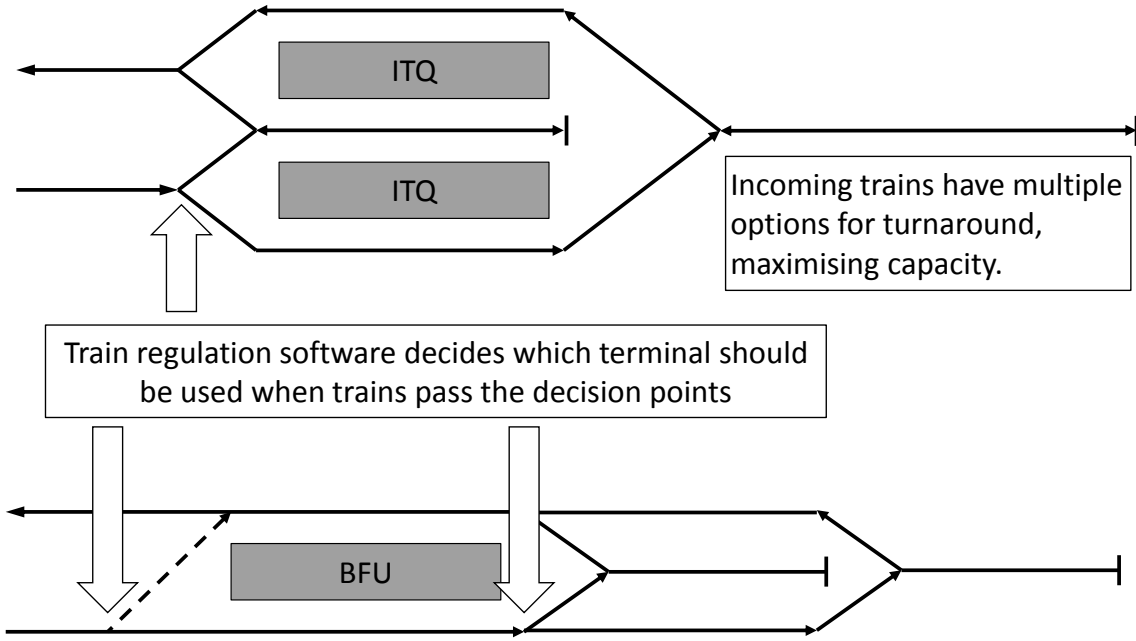


Figure 8: Turnaround design on Metro Sao Paulo's network
(Source: Community of Metros / Imperial College London)

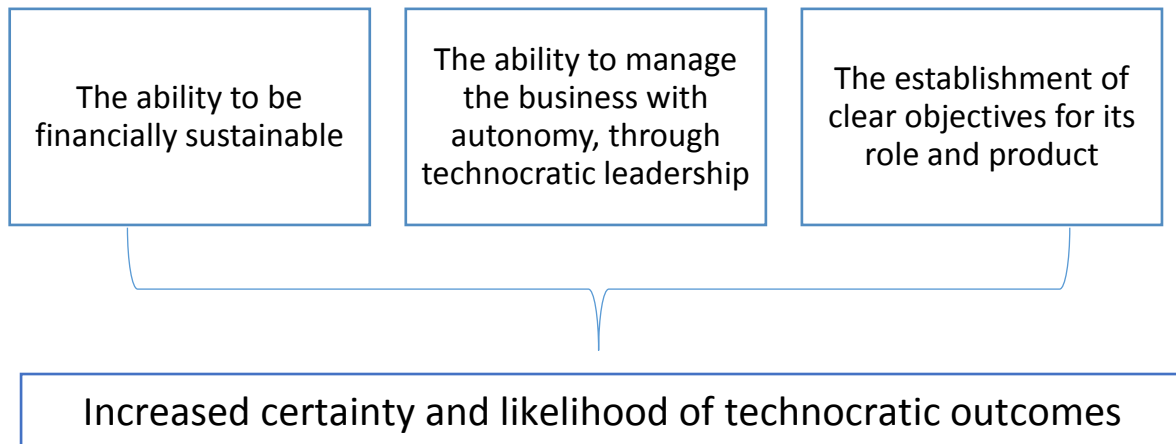


Figure 9: Se Station with Lines 1-Blue and 3-Red
(Source: Community of Metros / Imperial College London)

Establishing the Operator with the Capacity to Succeed

Many Operators are both customer facing service delivery organisations and mega-project managers by necessity. Almost all modernisation projects are developed and implemented by Operators, whilst maintaining the operational integrity of the system, and many are also given the role of developing and implementing major extension projects to expand the network.

There are three key factors that arise when establishing the Operator that impact its long-term potential:



The Ability to be Financially Sustainable: Fares Policy and Non-fare Revenue

No Operator can succeed unless it has been established with the prospects for financial sustainability. A sustainable fares policy is critical and arguably the most important element necessary for a metro's financial sustainability. This relies on regular adjustments to fares, at least in line with inflation and/or input prices (such as labour and energy). Without this the Operator finds proactive management problematic as a short-term outlook on finances makes effective long-term planning impossible. Keeping fares the same in nominal terms can result in a rapid deterioration in the financial position of the Operator, as surrounding operating costs rise with inflation and other economic trends.

Fare changes can be managed through fare adjustment mechanisms and formulae, present in several case study cities including Hong Kong and Bangkok. This involves establishing a framework for sustainable fare increases in line with inflation and where possible input prices where possible. This fosters the long term sustainability of the metro and affordability to the passenger.

Hong Kong MTR: Fares Formula

Hong Kong MTR have agreed a fare adjustment formula with the Hong Kong SAR, China Government whereby fare changes are defined each 5 years and then reviewed, offering the operator some dependability. The formula takes into account inflation and wages (the most significant cost base of a metro) but is reduced by a productivity factor which recognises that a good Operator should continuously improve its productivity. The Hong Kong MTR fare adjustment formula is shown as follows, where CCPI is inflation:

$$0.5 * \Delta CCPI + 0.5 * \Delta Wage Index - Productivity Factor$$

It is also important that the Authority enables the Operator to generate non-fare revenue, including income generated through commercial, retail, advertising, consultancy and other sector activity. Non-fare revenues allow the Operator some additional control over its financial sustainability. New stations should be designed to catalyse retail concession income. Retail activities also add to the customer's utility of their metro journey, increasing the attractiveness of the metro.

The Operator should continually seek new opportunities to maximise non-fare revenue, whilst protecting safety and service quality. The Authority must bear in mind that this additional income (typically adding 15% to fares income) is not a substitute for a poor fares and funding environment.

The Ability to Manage the Metro with Autonomy, Through Technocratic Leadership

The case studies provided examples of a range of leadership styles and cultures. Effective management depends, to a significant extent, upon the Operator's autonomy – its capacity to appoint senior staff with a technocratic outlook, set staff terms and conditions, make important decisions without external approval, introduce new business practices, change the service provided, integrate the service with other providers and change tariffs. A recurring theme from the case study cities is that the culture of the organisation is substantially determined by leadership, and prospects for a positive, motivated culture are more likely when the leadership team is technocratic and is given the time to embed the right culture and processes in the metro organisation. The best leadership builds a relationship with its Authority by repeatedly demonstrating success, embeds the right culture in the organisation and develops an ambitious corporate strategy. This takes time to implement, and some Operators face frequent changes in leadership. Good practice is to appoint the best CEO for the job and provide the necessary time to implement change and demonstrate success.

The Transformational Effect of Leadership at Toronto TTC

The transformative effect of leadership is clearly demonstrated in Toronto. With the appointment of a new CEO in 2012, a new strategy was created spanning the full range of TTC responsibilities. This strategy ranges from improving the company culture and professionalism through proactive engagement with its workforce, to a new focus on the company's asset management practices. It has demonstrated repeated successes against agreed objectives and has secured the \$1billion (USD 750 million equivalent) per annum the TTC needs to keep the system operating, rather than focusing company efforts towards securing new funding every year.

The Establishment of Clear Objectives for the Metro Operator's Role and Delivery

The Operator should be established with clear objectives and an understanding of the major risks it is required to manage. The objectives should define what the Operator is required to deliver in terms of service provision and major projects. This can be achieved through a charter (such as the Washington DC WMATA Compact, which provides a constitution for the public transit agency), or through regulatory frameworks and contracts. Amongst Community of Metros members, approximately half have been established with clear objectives and risk responsibilities clearly defined, while half of members have not.

Hong Kong MTR: Established with Commercial Prudence and a Role in Developing the City

Hong Kong MTR is a corporation with large Government shareholding. It was established in 1975 following exhaustive technocratic studies under Government control. Government required the Operator to be commercially-driven with a private sector ethos. Inextricably linked to this commercial outlook is MTR's ability to leverage non-metro-related activities to secure its financial sustainability. This business model has shaped the development of the city by locating high-density development where accessibility is high: above and/or adjacent to stations and depots.

Kuala Lumpur: A Simple Target

The Government's "Vision 2020" policy in Malaysia proposes a target of a 40% public mode share in Kuala Lumpur by 2030 (from approximately 21% in 2011). This widely accepted target has been adopted by Authority and Operator alike, and case study interviews highlighted that *"we are very clear in terms of what role we need to play to support the Government's agenda."* This shared target encourages both stakeholders to make decisions with the aim of achieving this goal.

Proactive Engagement of the Authority with the Operator

Proactive engagement by the Authority with the Operator is necessary for metro success. This should not undermine or conflict with the need to hold the Operator to account. The consequence of effective engagement is trust based on the Operator repeatedly delivering successful outcomes for the Authority.

The Operator's role varies from one city to another. All Operators 'operate' – that is to say manage operations, maintenance and administration of the system. But thereafter some metros do far more:

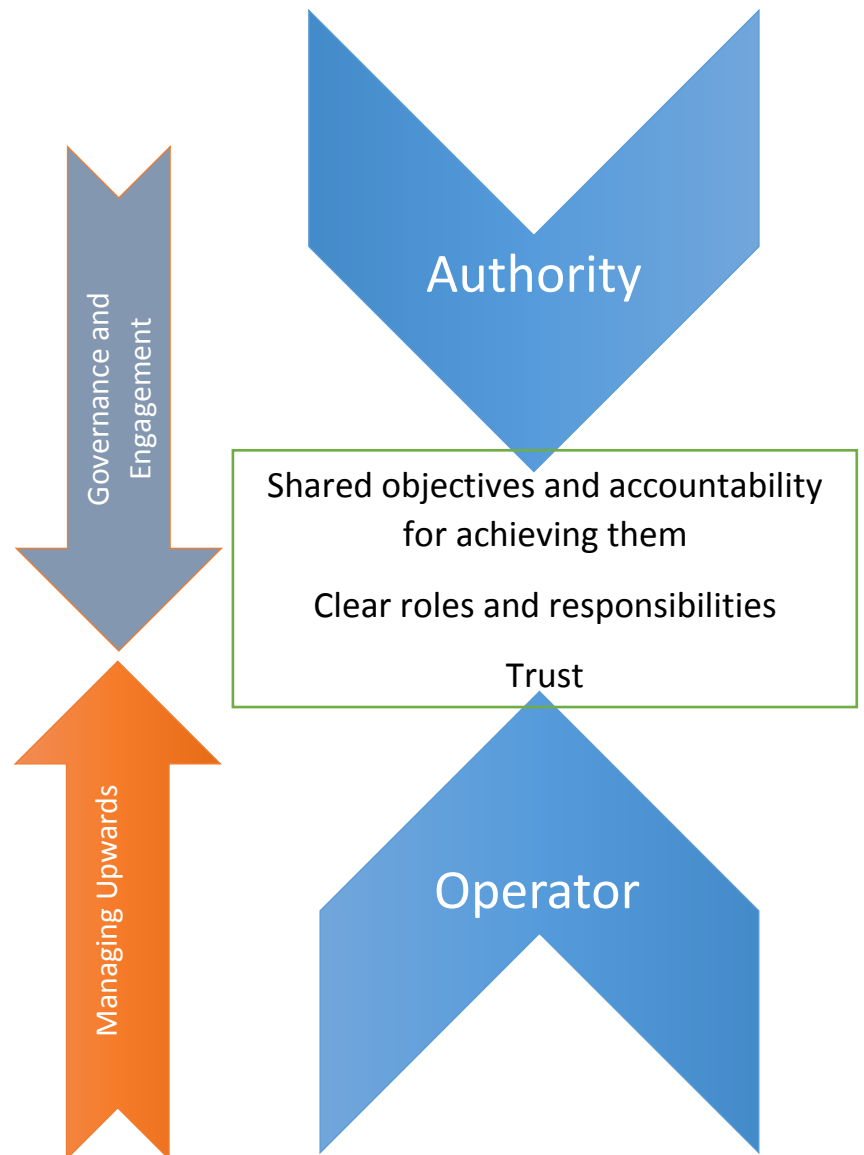
- Metro Sao Paulo is responsible for all rail planning in its State;
- Toronto TTC is a multi-mode integrated transit Operator (of buses, street cars and metro) and expert organisation advising the city on the need for modernisation and expansion projects and on technology issues;
- Metro de Santiago is responsible for identifying/ implementing modernisation projects, and it influences the identification and implements extension projects – funding one-third of their cost;
- Hong Kong MTR is unusual in doing almost everything: being involved in sector planning; while for major projects it identifies + raises finance + designs + implements them; and it 'builds communities' by integrating property development at stations and depots.

These added responsibilities are largely attributable to the trust these Operators have earned with their Authority

Following repeated success, Authorities may expand the Operator's role. This improves the quality of Authority decision-making and secures added value from the Operator.

Toronto TTC suggested that proactive engagement installs a long-term, sustainable view of metro operations within the Authority itself, creating a more technocratic and collaborative Authority environment.

An openness to engagement allows the Operator to manage upwards, in situations that may be valuable to the Authority, for example communicating the operational and customer implications of Authority policies / projects.



Embedding the Metro into the Transport System and Urban Form

The Authority is very often responsible for making decisions about new lines. When it makes decisions based on a sound development/ transport/ transit plan framework that sets out the Authority's priorities for city development, the prospects for metro viability are increased and surrounding projects that drive viability can be incentivised and co-ordinated. Integration can come in the form of:

- Modal integration, creating a whole journey customer experience, minimising distances between modal boarding and alighting points, single journey fares and branding; and
- Land use and transport integration, siting valuable land uses in areas with the greatest accessibility to public transport, and in turn creating a critical mass of demand for public transport that drives viability, a "virtuous circle".

Integration of a metro system into a wider public transport system and city structure is often assumed to be an inevitable outcome of developing new transport infrastructure. However, the case study metros demonstrated that effective integration is demanding to achieve and difficult to retrofit when it has been given insufficient attention during planning.

The Impact of Transantiago on Metro de Santiago

The powerful impact of bus-metro integration was starkly demonstrated in Santiago in 2007. The overnight implementation of the Transantiago project, which reorganised the bus network around the metro, resulted in a near-doubling of demand for the metro, as demonstrated by Figure 10 below. This city-wide initiative created many problems for the Metro that endure to this day, having adversely impacted the public perception of the heavily overcrowded Line 1 despite the Operator’s major efforts to mitigate the problems.

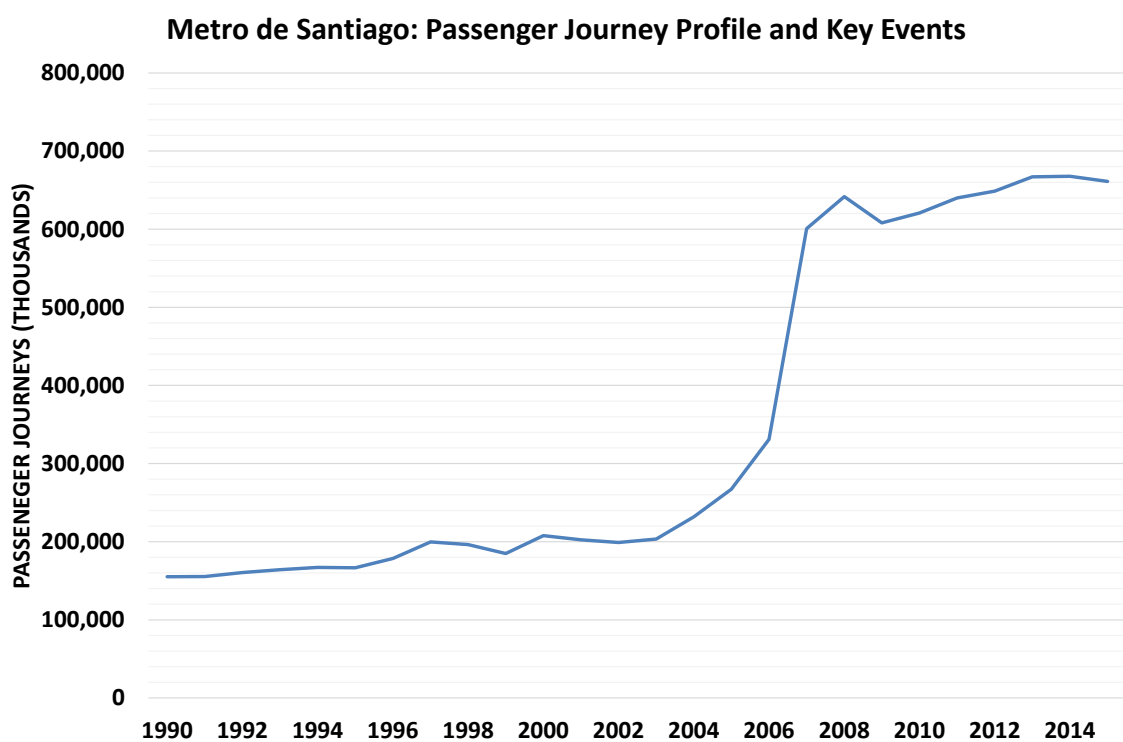


Figure 10: Passenger Journey Profile of Metro de Santiago (1990-2015)

Integration is the responsibility of the Authority from the outset when developing new metro projects. It requires a holistic view of the development trajectory of the public transport network. Consider the contrasting stories of the Toronto and Kuala Lumpur Operators:

- Toronto TTC has grown from its outset as an organisation that “thinks integration” and is understood to have the best last mile connectivity in the world. The system is supported by high-rise development above its stations and ubiquitous bus/rail transfer at subway stations.
- Kuala Lumpur is a public transport system developed by fragmented concessions that faced bankruptcy, with a nascent public transport Authority created to bring these isolated projects together. It retrofitted integration projects (such as single branding, covered walkways and wayfinding strategies) and created a single Operator, Rapid KL, which is responsible for bus and light rail / metro services.

Private Sector Participation and Outsourcing

The global experience of private sector participation in the development, operation, and maintenance of metro systems is mixed. Case study findings and experience from Operators in the Community of Metros demonstrates that success depends less on an Operator's public or private affiliation and more on what is in place around the Operator to enable and manage performance. Interestingly, case study findings have also shown that with a long view of outcomes, some PPPs that were successful in a contractual sense may have been less so in terms of the value that they actually delivered. In contrast, some PPPs that were unsuccessful in a contractual sense actually achieved remarkable feats of metro development, shifts in public policy, or improvements in sector governance that may not have otherwise come about but for their unintended consequences.

Good Outcomes When Things Go Wrong?

The most remarkable findings from case study examples that included PPP concerned the actions that policy makers took following the untimely demise of PPP approaches that were unsuccessful. For example, the cases of Kuala Lumpur and London show how actions to address failed PPPs can greatly enhance the enabling environment for a new or existing public Operator. The genesis of Kuala Lumpur's public Operator came from the need to operate fragmented individual metro systems after private Operators could no longer continue. The public Operator has subsequently achieved notable improvements in integrating these systems with each other and with buses by virtue of the role it was given to address failed PPPs. Similarly, London's asset management approach was developed for supporting the Tubelines and Metronet PPPs which ultimately failed. London's shift to multi-year funding settlements may owe its genesis to arrangements that were originally intended for the Tubelines and Metronet PPPs but later adapted to Transport for London itself. It is clear that failed PPPs in both of these examples destroyed extraordinary amounts of financial value. However, it is also worth considering whether their failures actually resulted in greater success through enhancements to the enabling environment that would not have otherwise have come about.

Sustainable but not Entirely Successful

Where PPP approaches have proved more stable, public authorities have also questioned the actual value for money that they achieved. London's Docklands Light Rail (DLR) system's experience with "infrastructure only" concessions combined with an operating franchise offers one example of this. DLR's three infrastructure only concessions have traditionally been considered a success in that they have been financially stable and also allowed for incremental system expansion without the need to terminate an incumbent monolithic concessionaire. However, the limitations of this model have also become apparent and Transport for London accordingly exercised an option to bring two of the concessions in-house early. A key reason for this was the complexity of having multiple maintainers of the network which one interviewee advised to "*avoid like the plague.*" Another interviewee noted that "*simplicity is definitely a preference.*" Transport for London has also found that their outsourcing arrangement for operations and maintenance needed to change in order to meet high levels of reliability required for the 2012 London Olympics. Prior DLR operations and maintenance contracts primarily relied on output-based specifications. However, Transport for London found the need to shift specifications toward input-based contracts as in-house staff had a better grasp of the scope of work needed to achieve these high reliability targets. Transport for London's approach to private participation on the Crossrail system's operations contract reflects this learning and focuses the

private Operator’s role primarily on areas where efficient management of the labour force adds value that Transport for London itself cannot achieve.

Using PPP and Public Operations in Parallel

An additional lesson from case study findings relates to the consequences of mixing PPP approaches within a network that also has a public Operator. On one hand this mix can provide a beneficial comparison. One interviewee described this as follows: “A mixed market gives you both an insight into the efficiencies possible from the private sector, and a sense of humility and reality as an Operator.” However, this mix can also have unintended consequences. One example from Sao Paulo illustrates how the introduction of a private Operator for Line 4 has exacerbated cash flow volatility relating to fare and subsidy revenues that flow to the public Operator. This arises because of the cash flow “waterfall” that places the private Operator ahead of the public Operator when in line to receive fare and subsidy revenue (see Figure 11). The intention of this structure is to provide security for debt payments and equity returns associated with private investment. However, the public Operator’s funding needs are met last when drawing from a common pool of fares and subsidy funding. Shortfalls are not shared evenly across Operators despite their similar responsibilities for service delivery. The public Operator accordingly experiences cash flow shortages with greater frequency and severity in order to ensure that the private Operator can pay its debt and equity returns reliably.

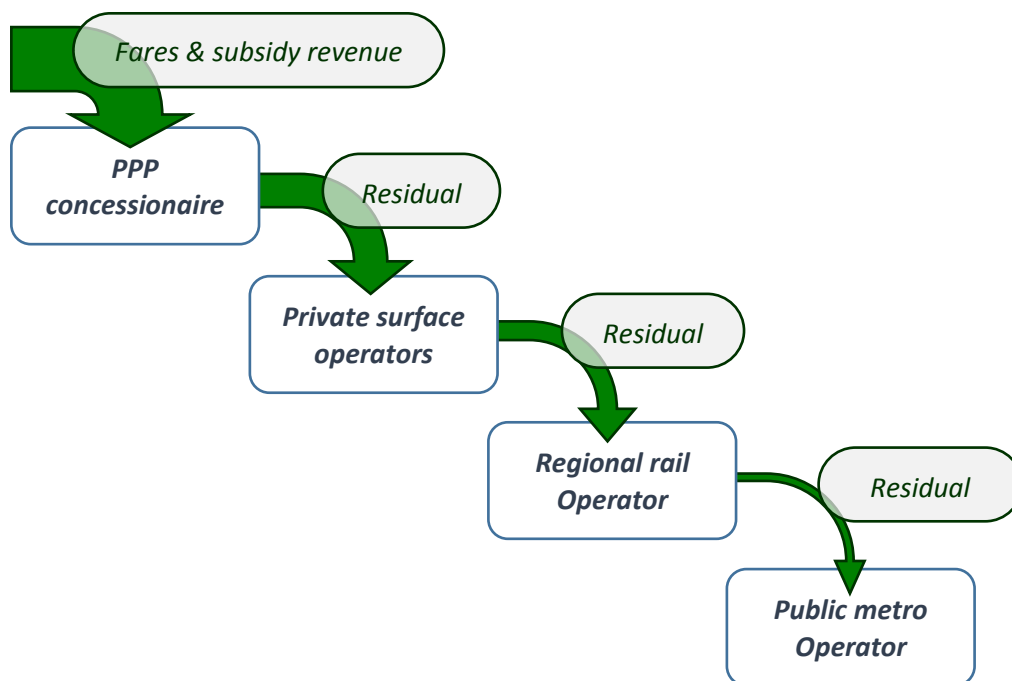


Figure 11: Metro Sao Paulo - last in line for cash, first in line for shortfalls

There is a fundamental truth in metro related goods, works, and services that an Authority or an Operator cannot efficiently outsource what it does not understand. Authorities that pursue PPP arrangements must retain knowhow as required to plan, execute, and manage outsourcing arrangements. In the case of Sao Paulo’s mixed model, this is done by tapping Metro Sao Paulo to support its State Government with regulating contracts involving private developers / Operators. In the case of Metro Sao Paulo, in-house staff know more about the metro’s assets and how to operate them than external parties which reduces information asymmetries that may otherwise prevent the State of Sao Paulo from regulating contracts effectively.

Case studies illustrate that a key determinant of private sector participation relates to designing contracts for what others are better at doing and where they may also fall short. Several successful metro Operators / authorities had aimed their outsourcing activities primarily at functions that could be commoditised and easily provided by multiple suppliers / service providers. Examples of this include cleaning, call centres, and operational functions where labour force flexibility offered significant cost advantages. This is the strategy that Transport for London has adopted in its strategy for private sector participation on the Crossrail project.

Managing the Supply Chain... Ruthlessly

Regardless of the modality for engaging private sector partners, there is an acute need for Authorities to guard bargaining power and exercise recourse when necessary. The systems, works, and services that make up a metro are often not common commodities. In addition to technical complexities that are inherently challenging the commercial model for metro supply chains often entails “lock in” strategies to maximise supplier returns. In some instances, locking into a supplier can be advantageous or the only reasonable option. In other cases, it can be a costly and irreversible mistake that ultimately affects metro customers negatively. In most instances, the determinant is the extent to which an Authority knows what it is getting into, has assessed the business case for / against particular supply chain arrangements, and has provisioned for appropriate recourse to ensure performance along the supply chain.

3. Action by Operators to Deliver Success

Enabling factors determine a great deal of metro performance. However, Operators themselves also have the ability to outperform or underperform their enabling environment. Some of the key actions by Operators have been shown to contribute to overall success include:

1. A commitment to safety and security, of both staff and customers;
2. Continuous improvement culture based on improving efficiency and productivity, as well as adopting appropriate technology;
3. Ability to demonstrate operational excellence, for example through delivering capacity, service performance, managing passenger flow and asset delivery and utilisation;
4. Use of effective business strategies, such as risk and asset management, to enable proactive management;
5. A customer-centric service and culture;
6. Applying a whole-life approach to major projects, including the identification, development and implementation of extension and modernisation projects.

Safety and Security

Every jurisdiction places safety and security as the first priority of every Operator. The Operator is responsible for embedding a pervasive and accountable safety culture within its organisation and business practices. At a minimum, the Operator must be able to:

- **Measure and monitor its safety performance:** To establish opportunities for improved performance. This could be supported by benchmarking and application of good practice in safety management - Safety Performance Indicators (such as incidences of derailments or falls from escalators) are reported as standard within Community of Metros benchmarking for example;
- **Enforce standards to balance safety and individual accountability:** External regulation also reinforces Operators' safety models, although internal processes for managing safety will ensure that the Operator does not simply conform to external standards, but becomes an organisation that effectively thinks and practices safety;
- **Ensure that safety and security is a priority in risk management processes;** and
- **Develop a procedure to investigate and learn from errors** in a transparent and objective manner.

Operators may also have to collaborate with safety regulators and change practice. For example in China, following a passenger-train interface incidents, metros have introduced additional manual visual checks between the train doors and the platform screen doors before the driver proceeds after a station stop. This new procedure increases station stop times but demonstrates a 'safety first' approach to metro management. There are various types of safety regulators ranging from metro and/or rail-specific, transport sector specific, to wider health and safety executives. It is critical that Operators effectively translate applicable safety regulation into internal policies, organisational behaviours and habits.

WMATA: Operating within an Imperfect Regulatory Environment

Several stakeholders have adopted responsibility for WMATA's safety regulation, but a universal challenge has been the absence of metro-specific expertise within the safety regulator, the Federal Transit Administration (FTA). Case study research highlighted that there does not currently appear to be an agency in the United States with the expertise or power to effectively regulate metro safety.

Metro-specific expertise is important in being able to address safety challenges and risks that arise from intensive service levels, a fundamental characteristic of metros. WMATA's current safety regulator, the Federal Transit Administration (FTA), is experienced in management of federally funded programme grants. A previous recommendation from the National Transportation Safety Board (NTSB) following a fatal incident in 2015 was that the Federal Railroad Administration (FRA) should have safety oversight, as it has an established railroad function.

Continuous Improvement Culture

'Good enough' performance is never enough – particularly where customer expectations and financial pressures tend to rise over time. Operators can benefit from programmatic approaches to measure and improve performance throughout different operational functions. Case studies findings have also shown that developing programmatic improvement initiatives can help metros transition from construction-focused organisations into customer facing and service delivery focused organisations. This transition has often proven difficult to manage given the different management systems and approaches needed for each.

WMATA: Highlighting the Transition from a Construction-focused Organisation to an Operator

The approval for the 103 mile WMATA system was provided in 1968, with a phased delivery of this system from 1976 through to 2001. Given the long construction period associated with the approved system, WMATA's focus on construction has been considered one source of arguably deprioritised maintenance and renewals. Attempts have been made to shift the organisational culture towards operations, including an organisational restructure in 2007-2008. However, this transition is not fully complete and may be a contributing factor to WMATA's ongoing operational challenges.

Guangzhou GMC and Barcelona TMB are examples of metros that have developed continuous improvement systems. In particular, these Operators have pursued technology solutions as part of their continuous improvement initiatives. In Barcelona, automated metro lines allowed the Operator to transform fixed staff roles into multi-functional staff alongside the deployment of technology to maximise efficiency, reliability and productivity while delivering improved customer service. Automation is sometimes viewed as a purely cost saving measure. However, Barcelona's Operator has used it as a level to transform its staffing model and improve its customer focus. Similarly to Barcelona, Guangzhou's Operator deploys multi-functional staff able to perform customer service duties as well as diagnose and fix common technical and engineering faults. This has reduced the need for task-specific training and creates a career progression that leads to greater staff retention and skill level.

Barcelona TMB: New Model of Operations

Barcelona TMB has developed and introduced an innovative staffing model consisting primarily of multi-functional roles alongside the introduction of increasing 'Grades of Automation' into their network. Automation has reduced the level of effort required to effectively carry out tasks and TMB has demonstrated their forward-thinking approach by introducing more multi-skilled workforce positions, relying less on traditional fixed roles. The company deploys staff in roles that "do whatever is needed to make the metro work", combining customer facing, operational and maintenance roles. Notably this has included the combination of station duties and train operation roles driving (TMB indicate that such multi-skilled staff are spending approximately 50% of their time on each task).

Barcelona TMB rank consistently highly on measures of staff productivity amongst Community of Metros benchmarking members. Key benefits of this New Model of Operations include:

- Reduced staff absenteeism and increased service reliability: Downtime due to internal causes reduced by 75%, as operational issues can be rapidly fixed by a number of staff, rather than waiting for staff particularly trained in the issue. Absent staff were more easily able to be replaced on the days that incidents took place owing to the multifunctional training amongst staff, and overall system reliability was also improved through increased driver availability;
- Increased customer and staff satisfaction: Customer satisfaction is highest on the automated lines, and staff satisfaction has increased significantly too, based on increased motivation, increased qualifications and range of responsibilities.

Benchmarking plays a key role in the continuous performance improvement of many Operators. In particular, benchmarking serves to identify best-in-class performance as well as the modalities that others may have already used to achieve it. This enables Operators to move forward with improvements with increased confidence and a clearer view of intended results. London Underground implemented findings from a study into escalator asset renewal and maintenance strategies to save approximately £100 million (approx. USD 127 million equivalent) over a 20 year period. New York City Transit's programme to improve dwell time management through the "Step Aside, Speed Your Ride" initiative was inspired by best practices from Hong Kong MTR for example, increasing capacity on New York's most crowded line by 4%.

Metro de Santiago: Lessons Learned and Benchmarking Outcomes

Metro de Santiago has demonstrated how to apply lessons from prior projects and international benchmarking. These include design and project management elements on Lines 6 and 3 future-proof capacity, implementing Unattended Train Operation (UTO) with Platform Screen Doors (PSDs) on new lines and designing modular stations to facilitate non-fare revenue concessions.

Demonstrating Operational Excellence

Operators must have the ability to earn trust from Authorities and the general public. This is particularly critical in environments that require greater amounts of subsidy funding. A key to securing this trust is demonstrating the capacity to deliver world class performance and to use public funds effectively. Below are examples of what that means for several of the Operators included in this research.

Service Quality

Metro Operators are frequently judged on the quality of the service provided. Metrics such as train punctuality, regularity, and reliability are typical in measuring time-based service quality. However, more advanced Operators are able to increasingly relate traditional reliability metrics to newer measures of customer impacts (e.g. passenger journey time reliability and passenger hours lost). The logic is that true reliability is about passengers, not trains and investment to improve services should be aimed accordingly.

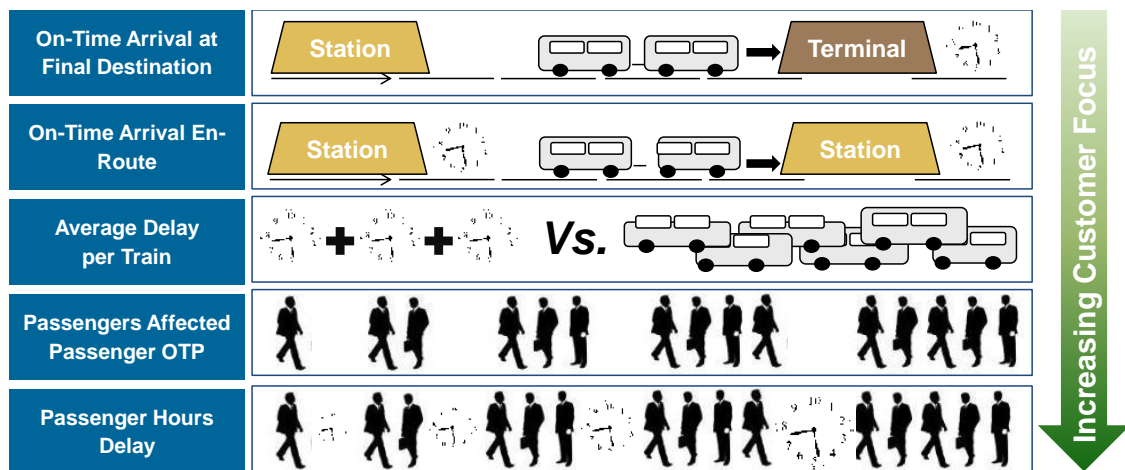


Figure 12: Delay measurement best practice
(Source: Community of Metros / Imperial College London)

Delivering very reliable service requires coordinating all aspects of operations and maintenance to ensure that staff and assets perform as planned, reducing incidents that cause delays or disruptions to a minimum. However, delays and service disruptions do occur, even in the most reliable metros in the world - whether due to random equipment failures, human factors (staff or passengers), or external events. In those cases it is critical that Operators are prepared with operational management strategies in place to respond and recover as quickly as possible.

Innovative Measurement of Reliability Performance as Experienced by Customers: Hong Kong MTR, Transport for London and Washington WMATA

Hong Kong MTR measures a 'Passengers Affected Ratio', representing the number of passengers on trains delayed by five minutes or more, employing data from the Automatic Fare Collection system (AFC) combined with train delay data from the signalling system.

The strong focus on measuring and valuing performance by Transport for London is based around detailed appraisal requirements for government funding. Detailed measurements include the Journey Time Metric (JTM) and Lost Customer Hours (LCH) used by London Underground. Lost Customer Hours (LCH) measures the total additional time (summed for all customers) resulting from all service disruptions of two minutes or more, due any cause.

In Washington DC, WMATA is a notably thorough operator in terms of its operational performance monitoring and management. WMATA has established big data systems using smartcard ticketing data to monitor passenger journey times and are measuring "Customer On Time Performance". The metric is inherently weighted by the number of passengers travelling, so operational issues in peak periods impact scores more severely than off-peak issues.

Managing Passenger Flow

It is essential to manage the flow of passengers through the metro system for smooth operations. Even if train service operates very reliably, passengers can be delayed in accessing stations, purchasing/using tickets, or passing through stations – and poor passenger flow on and off trains (e.g. passengers holding doors) can itself cause service to be unreliable. Passenger flows above 10,000 people per hour are not uncommon on the busiest metro platforms (possibly rising to as many as 40,000-50,000 at the busiest platforms in the world). A key challenge for Operators is that what is best for individual passengers is often not what is best for all passengers and the overall train service (e.g. a passenger standing in the train doorway). The four main actions taken by metros to improve passenger flow and behaviour include:

- **Engineering / planning based on modelled flows.** This approach was used by London Underground in the planning for the Northern Line Extension to estimate crowding levels on platforms, key interchange points and passageways. This include a number of future year scenarios to assess the effect of growth in demand on station conditions.¹
- **Campaigns,** where key messages about good behaviour are conveyed to passengers such as allowing alighting first, not holding the doors, and using all the space inside the cars. These work best when they are interesting, dynamic (i.e. changed frequently), and demonstrate to passengers why the desired behaviours are in their own best interest.
- **Signs/announcements** to reinforce passenger management techniques to customers. Many Operators are now using new technology and multimedia applications to engage with customers. For example, technology can now enable electronic platform signs or smartphone apps that show customers the real-time crowding on the next train.

¹ "Northern Line Extension Kennington Station - Report on dynamic modelling outputs - PM peak"
<http://content.tfl.gov.uk/appendix-c9-legion-modelling-report-on-kennington-station-2031-pm-peak.pdf>

- **Staff** are the most common and most effective strategy to manage passenger flow and behaviour, typically during peak hours. Staff can actively manage passengers entering stations and on platforms by making announcements and providing a variety of assistance (e.g. for mobility impaired passengers, to more quickly respond to incidents, etc.). Metros have found platform staff with mobile public address units to be very effective, in some cases requiring as many as one-two staff members per train door at key locations during peak hours.

Effective Business Strategies

Effective business strategies assist the Operator in maximising the potential for its own success within the constraints of the operating environment, and with managing upwards proactively. Professional and technocratic business management is likely to build trust with the Authority and demonstrates a readiness to address risks and opportunities. In preparing an ambitious and technocratic corporate strategy, Operators minimise uncertainty through creating control over labour deployment and employment, establishing the commercial principles by which the organisation will be managed.

A key success factor for corporate strategies is transparency over how business decisions are made. Best practices for decision-making within the Operator’s organisation are:

1. **Being led by a business case**, which quantifies costs and benefits, developed to an organisational standard and applied consistently. Transport for London’s “Business Case Development Manual” is a good example of this approach;
2. **Carrying out alternative analyses** on all proposed projects. In Hong Kong MTR, alternative analyses are retained to serve as future business cases in the event of changes in circumstance;
3. **Being informed by wider strategies**, e.g. planning, assets and risk;
4. **Establishing the implementation challenges** and requirements of the project, highlighting how short-term costs can be mitigated to secure long-term benefits;
5. **Establishing when decisions should be taken** between major projects and a change in business practices, for example with Barcelona TMB’s New Operating Model (see p37);
6. **Informed by the experience of others / benchmarking** to support a forward-thinking, innovative approach, to build in best practices, minimise cost and maximise benefits;
7. **People-led**, understanding the impact of decisions on the customer and the workforce.

In contrast, the absence of a transparent and objective decision-making framework is likely to result in ad-hoc, reactive outcomes.

Risk Management

Effective risk management is increasingly necessary as Operators are held to account for delivering successful services. Evidence from case study interviews showed that risk management is a universal priority, although current practice varied:

- Hong Kong MTR adopts a full Enterprise Risk Management approach, and uses this centrally to manage its business and take key decisions;
- Metro Sao Paulo is unable to apply comprehensive risk management, because it is unable to control most risks;
- Metro de Santiago manages major project risk through identification and mitigation, but does not yet adopt a long-term, business-wide view of risk.

Useful risk management must be at the heart of decision-making in the organisation and therefore requires a strong buy-in from the leadership. The business strategy needs to build-in the real world of uncertainty that faces the organisation, offering both opportunities and threats and requires a particular type of organisation and culture. An open, enquiring and purposeful culture is key, with excellent two-way communications from top-to-bottom and bottom-to-top to identify new emerging risks, and a strong embedded accountability for risk management amongst all staff. The characteristics of a good system are that:

- The process is mandated by the Board/ CEO whose leadership and buy-in is essential;
- Risks are identified, owned and managed by individual managers in Business Units;
- A central Risk Function [Risk Unit] facilitates the process, analyses new emerging risks and maps all strategic risks, keeping the Board advised of emerging risks;
- All key decisions should be risk assessed, proactively influencing the strategic objectives of the Operator. Comprehensive risk management is likely to enable changes to the corporate strategy when necessary.

Asset Management

Major decisions are required throughout the life cycles of the different asset classes. The Operator must frequently decide whether to replace an asset or extend its life. Asset management has been shown to transform the quality of Operator's decisions, based on in-depth knowledge and analysis of existing assets (and the cost of extending their life), customer needs and knowledge of the procurement options available. Asset management looks to balance service performance requirements, asset condition and costs throughout the asset life cycle.

A key challenge for Operators and their Authorities is the ongoing need to invest in high-cost asset management processes. In many cases assets and investment projects are hidden from the view of customers and stakeholders but are critical for the metro system to function (such as fan plants and power systems). As Toronto TTC noted: *"once you lose a state of good repair it's almost impossible to catch up"*. Emerging practice worldwide is that Operators are moving towards holistic, evidence-based mature approaches to asset management, moving the Operator away from rules-based, engineering-led decisions, and instead promotes a proactive, dynamic and analysis-based approach to planning. Community of Metro benchmarking research has demonstrated that major cost savings are possible when a rigorous, evidence-based approach to asset management is applied.

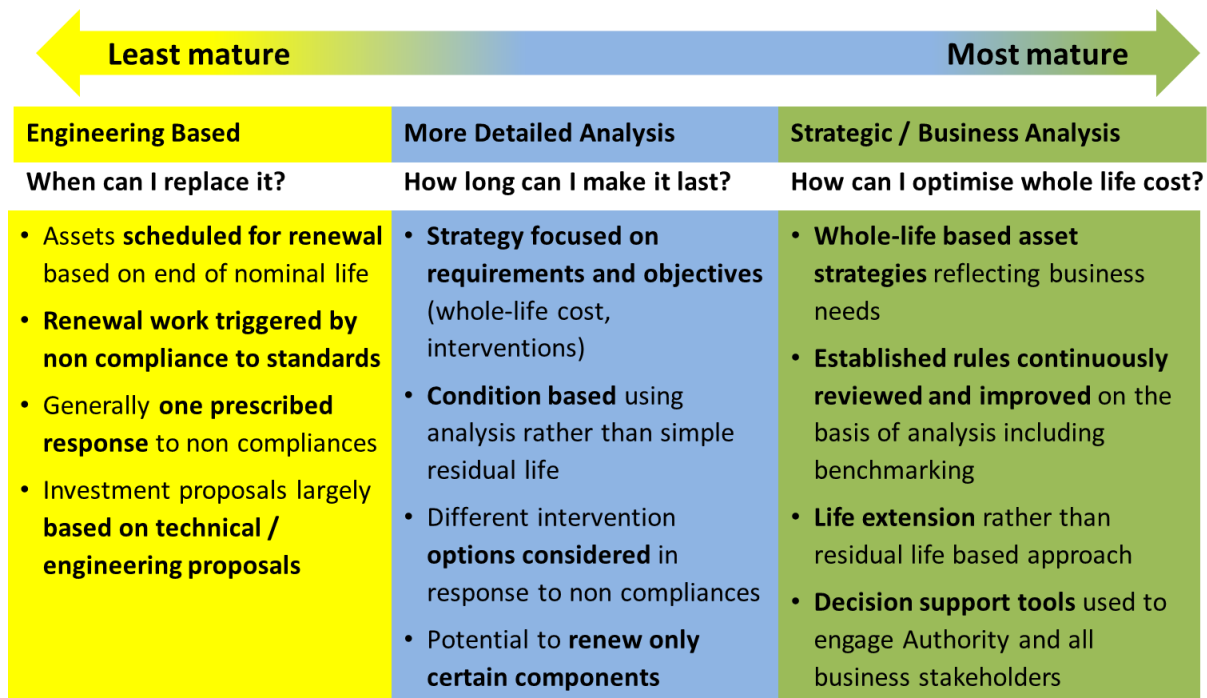


Figure 13: Asset management actions based on maturity of approach
(Source: Community of Metros / Imperial College London)

The following best practices are elements of a mature approach to asset management:

- **Starting asset management early at the design stage**, to ensure requirements for asset management are built into designs, procurement contracts and operational plans from the outset;
- **Knowing the assets through effective asset information**, itself an extremely valuable asset;
- Rigorous planning for asset management from a **whole-life/lifecycle cost** point of view;
- **Investing in predictive maintenance processes** and protecting an overnight maintenance window within service plans;
- **Business case ownership** and revision to inform decisions for major refurbishment, replacement and/or enhancement, and to review the periodicity and scope of major maintenance interventions, in the context of service and wider business priorities and financial circumstances;
- Developing a range of **decision-making support tools**, including scenario testing and the ability to consider and balance multiple factors;
- Ensuring that **plans and maintenance frequencies** are subject to continuous effectiveness review;
- **Understanding innovation in the industry** that is creating new products and capabilities. Some assets become obsolescent because they were not maintained well, or because the market demanded new assets to fulfil new demands;
- **Managing issues during the implementation of asset management projects**, for example, timely organisation of track possessions and equipment delivery, project planning which takes into account risk of overrun and impact to passengers and sufficient, long-term project management expertise.

Asset management analysis depends critically upon the availability of good quality asset information, which cannot effectively be outsourced. Comprehensive asset information management systems are an essential foundation for effective asset management. Structured benchmarking of peer railway practices can be an effective way both of supplementing available data, and also of identifying opportunities to test or challenge manufacturers' original recommendations and / or long established 'rules of thumb'.

Asset management balances the requirements of all elements of a holistic business. A number of more mature practitioners have found that decision support tools can provide a valuable and transparent basis for structuring analysis, and the key underlying assumptions made, whilst engaging all key stakeholder groups in improving asset management planning and decision making.

Asset Management in London and Hong Kong

London

London's asset management strategies are proactive, not just rules-based. It is understood that asset life can be extended indefinitely, if the economics suggest it is worth doing so. However, nominal asset lives are necessary for planning purposes. It is crucial to have a plan as a starting point, even if it is updated often, and asset management has grown into a strategic tool both for business planning and risk management. LU learned through their experience with previous PPP contracts that asset information is an asset in itself.

Hong Kong

Hong Kong is an increasingly middle aged metro that has made effective asset management central to its highly commercially-driven business approach. Whole life cycle analysis is applied to all 'decisions that matter'. Asset life and assurance studies have been undertaken covering the majority of key asset disciplines with many major opportunities generated. Condition analysis and assurance is at the heart of Hong Kong's approach with a range of analysis and research techniques. In several cases these have allowed Hong Kong to pinpoint critical components requiring replacement rather than premature renewal of complete sub systems.

A Customer Facing Metro

Benchmarking undertaken in the Community of Metros has demonstrated that Operators are transforming their approach from that of a technical, specialised Operator, to a service-oriented and customer-focused organisation. Operators are increasingly considering themselves responsible for customers' whole journey experience in terms of the quality of the metro trip (reliability, punctuality), safety, comfort and convenience, information provision, cleanliness, ambience and brand identity. This outlook is supported by insight into customer behaviour, increasingly possible through big data provided through ticketing and smartcard fare payment systems, and active consultation with customers. From a business perspective, a customer-focused approach delivers multiple Operator benefits: increased revenues through attracted trips, increased trust and support from the Authority and improving the Operator's reputation amongst its stakeholders. Customer centricity therefore deserves commitment from the Operator's leadership to ensure this culture is embedded throughout the whole business.

Within the case study metros, a universal feature of their cultures was the importance placed on the customer and the continuing ambition to improve their service to customers. Customer expectations appear to increase as incomes grow and wellbeing improves. This shift may happen quickly in a rapidly-developing context. What customers expect when a metro system is approved may be considerably different to what they will expect once the system becomes operational and mature.

Some key features of a customer-centric approach include:

- Establishing and sharing customer service performance targets within a charter, mission statement or vision that balances the customer alongside operations;
- Adopting a multi-functional staffing structure to deploy staff in the most useful positions to maintain service quality (for more information see p37);
- Deploying real-time information across the network to ensure customers are informed as to their journey choices.

Hong Kong MTR: Changing Customer Expectations

MTR has not only proved itself to be capable of adapting to rapidly developing customer expectations, but has also changed their expectations itself. This has been achieved through the use of the Octopus stored-value card, where customers are now able to integrate their travel, retail and leisure experience. This has also resulted in the growth of consultative processes during planning, including transparency, public review, planning for implementation and mitigating impacts, and environmental impact assessments. Greater customer expectations from service as well as planning can increase cost and programme risk, and MTR advocate taking the time to mitigate these at the outset of the project, rather than trying to solve them during the project's implementation.

Delivering Major Projects

Major projects are the means by which metro renewal, growth and modernisation take place. Projects are defined as 'major' when they could critically impact the Operator's strategic objectives and after the project is complete the Operator may be held to account for its success, even if development and implementation were led by another organisation. The Authority can support successful major project delivery by ensuring a predictable pipeline of projects (discussed in Section 2). The development of long term asset strategies and life extension analyses can also help both to smooth peaks in reinvestment funding required and also to identify opportunities to co-ordinate work tasks to maximise utilisation of engineering possessions.

All metros require assets to be replaced or enhanced (modernisation projects) and most metro networks are expanded to serve the growing city. Evidence from case study metros shows that the Operator is usually the leader for modernisation projects, but have varying levels of involvement with expansion projects. Major projects success is the result of the long sequence of decisions and activities undertaken from the time a project is first conceived to its entry into revenue service and thereafter managed. This 'project development process' needs managing to secure success.

Strategic challenges for the Operator posed by major projects include:

- **Reliably forecasting demand and benefits**, as major projects can impact long-term metro finances via capital costs, operating costs and revenue potential. This requires validation of all forecasts and estimates. Demand may not increase in a linear way in proportion to the

number of metro lines. For example, demand on one Chinese metro's network rapidly increased upon the opening of its third metro line when the benefits of connectivity and integration became strong attractors for new metro trips.

- **Avoiding legacy problems** resulting from procurement and technically integrating the new project with existing assets and systems. Successful projects avoid negative legacy impacts that are difficult, expensive, or impossible to change. Examples include sub-optimal station designs (too small or too deep), non-compatible mixtures of signalling that subsequently need replacement or expensive alternations, and mixed fleets. Metro operating costs can be affected when the metro is tasked with operating and maintaining infrastructure that is costlier to operate or requires more specialist skills than existing systems.
- **Mitigating operational disruption during implementation**, which may be lengthy. The evidence is that avoiding service disruption is hugely challenging, especially for Operators that have yet to experience modernisation projects.
- **Readiness for “windows of opportunity”** that open up the potential for rapid development of major projects. Similarly, readiness for events that unexpectedly and rapidly reduce viability for major projects (e.g. political instability) is important. Determined, collaborative working with the Authority to mitigate these two risks will increase predictability over major projects. The Operator must, through its governance process, resist political pressures to impose apparently attractive solutions if they are not actually optimal for operations, as far as possible.
- **Managing the project with its full length in mind**, from concept to operations – ensuring Operator influence early and continuously. For example, building very deep stations may be easier for line construction, but result in high energy costs for lifts and escalators, for its lifetime. Mixed fleets may result in additional operating costs as metros have to keep larger stockpiles of duplicate parts for different models.

4. Emerging Conclusions

Metros are strategically important urban transport infrastructure, essential for the sustainable development and functioning of large cities. Their development and delivery requires expert management within a comprehensive and high-quality public transport system. This is because metros are mega-costly with large upside and downside risks. When they are well developed and operated they can justify their Authority's expectations by delivering mega-benefits, most of which will occur when they are operational.

This research has explored the critical role of the Operator in achieving a successful metro system that supports the needs of large cities. Pivotal to this role is the environment in which the Operator must work, which is largely established and framed by the Authority. Long-term benchmarking of world metros in the Community of Metros alongside in-depth case studies based on interviews with 10 participating metros reveal the actions, challenges and plans that Operators are facing. Emerging findings from this research demonstrate that within these diverse range of issues, a common success factor is the **stability and predictability of the enabling environment**.

The Role of the Authority in Creating a Stable Enabling Environment

Successful metros require both the Authority and Operator to be effective. Most Operators can provide increased value when their Authority creates an enabling environment to facilitate this. Adopting this approach is a win-win strategy, increasing the viability of the metro system, to the benefit of the Authority and all citizens, and allowing the Operator to contribute maximum value.

The Authority is the critical stakeholder that sets the context for this stability through its decision-making, attitudes and actions. An effective enabling environment is likely to be created by the Authority through an embedded understanding of what makes metros successful. In turn, these factors should be in-built into emerging metro projects, the Operator's objectives and governance framework, and mandate for engagement, communication and influence.

This in-depth research highlighted where upstream decisions affecting the Operator have been successful or could be improved, forming key actions that the Authority should take to create an enabling environment geared towards long-term operational success:

1. **Establishing an accountable governance framework** by:
 - a. Establishing a regulator. Evidence shows that this is best achieved through a "light-touch" or strong, robust and knowledgeable independent body;
 - b. Minimising levels of decision-making between the Operator and ultimate decision-makers, particularly where these levels are political;
 - c. Establishing a metro Board with technocratic Directorship, which can make decisions in the best interest of the metro.
2. **Identifying the right metro project.** Not all projects are good, some fail to deliver expected ridership and development impacts. Good projects are identified as the result of robust planning, ensuring Operator influence throughout the development process and planning for a pipeline of projects. The right metro project will be one that satisfies and drives demand for public transport through service quality and associated land uses, and delivers value for money in terms of cost against expected benefits and policy outcomes.

3. **Establishing the Operator with capacity to succeed.** The Operator needs to be established with three essential abilities:
 - a. The ability to be financially stable. This is achieved through a sustainable fares policy and the ability to raise non-fare revenue;
 - b. The ability to manage its business through technocratic leadership; and
 - c. By establishing clear objectives for the Operator and defining the risks it requires to manage. This could be about its role, for example, defining that the Operator is responsible for implementing modernisation projects.
4. **Proactive engagement of the Authority with the Operator.** The quality of Authority decisions needs proactive engagement with the Operator, while holding it to account. When the Operator demonstrates success, consideration should be given to expanding the Operator's role, ensuring the Authority benefiting to the maximum. This will likely improve the quality of outcomes and create a more stable, technocratic enabling environment in the long-term.
5. **Embedding the metro into the transport system and urban form.** This is not an inevitable outcome of developing metro infrastructure. Instead, it requires a determined, strategic approach by the Authority to plan for modal integration to maximise the whole customer journey experience, and siting valuable land uses in areas with the greatest accessibility to public transport.
6. **Accessing Private Sector Participation with care.** This should be guided by a clear analysis of its intended role and evidence of what has been shown to work elsewhere; not by dogma.

The Role of the Operator in Maximising Stability and Performance

Operator strategies can result in markedly improved performance within its enabling environment, building long-term trust with the Authority. Implementing them requires that the Operator is established with the capacity to succeed, and by an Authority that wishes to engage proactively with the Operator – both actions that the Authority needs to put in place. The following good practices have been found effective:

1. **Demonstrating commitment to safety and security,** prioritising this throughout its strategies and systems. The Operator must work proactively and collaboratively with safety regulators, while monitoring and managing its safety performance, enforcing standards, including safety within risk management processes and ensuring transparent and objective procedures allow thorough investigation and lessons learned from incidents.
2. **Adopting a continuous improvement culture,** to drive efficiency and productivity in particular. This culture ensures that the Operator keeps pace with changing circumstances in its environment (such as the cost of labour and energy), and is able to respond to them in a timely manner through implementing organisational change, revising business strategies or delivering major projects.

3. **Demonstrating operational excellence**, delivering the highest-quality possible service to the customer. Key features of world-class systems include reliable operations, high levels of capacity and frequency and the ability to effectively manage passenger flow.
4. **Developing and implementing effective business strategies** through strong buy-in from Operator leadership and the development of an enquiring, purposeful and open organisational culture. Key activities include:
 - a. Risk management, placed at the heart of decision-making in the organisation. This should be supported by the Board and identified, owned and managed through individual managers in Business Units, facilitated by a central risk function;
 - b. Asset management, managed with a holistic, evidence-based approach. Community of Metros benchmarking demonstrates that its Operators are transforming from rules-based, engineering-led decisions to a mature approach that generates major cost savings.
5. **Being customer-centric in its approach**, which can deliver major benefits for the Operator, such as increased revenues through attracted trips, increased trust and support from the Authority and an improved reputation amongst stakeholders.
6. **Effective management of major projects**, notably through reliably forecasting demand and benefits, avoiding legacy problems resulting from obsolescence and procurement, mitigating disruption during the implementation of projects, being ready for “windows of opportunity” that may accelerate or threaten projects, and ensuring involvement from conceptualisation to operations.

Impact of Authority and Operator Good Practices on Operational Success

The research sought to identify all the factors that determine metro success. These fell into two groups: those that the Authority controls or influence – there were 26 of these in 6 groups; and those that the Operator can substantially influence or control – there were 20 of these in 5 groups. A simple analysis plotted the results on Figure 14 to reveal for each case study the impact of each set of factors on operational success.

The horizontal axis shows the quality of the Operator’s Environment created by its Authority, from poor to good; and the vertical axis the Operator’s effectiveness, from low to high. The diagonal shows the combined impact of both on operational success. Ultimately, it is to be expected that operational effectiveness will be commensurate with the quality of the Authority enabling environment, whether this is high or low. Operators 1 and Operator 3 demonstrate this: both are relatively balanced, with varying degrees of success, demonstrating that the quality of the Authority enabling environment has actively encouraged or constrained the Operator’s performance. In Operator 3’s case, this operational effectiveness is sustainable, as it is supported with a strong governance framework, the ability to be financially sustainable and the ability to proactively engage with its Authority, amongst other key determinants of a high quality enabling environment as presented in Section 2.

Operator 2, however, is extremely effective operationally, outperforming its enabling environment. This Operator maximises its stability within the areas it can control, such as modernisation and expansion projects. Operators that outperform their environment commonly have a management commitment to staff which is apparent in their esprit de corps, compensation, job satisfaction, and overall quality of the working environment.

Its enabling environment constraints however prevent it from achieving the level of operational excellence as Operator 3, even though Operator 2 has the technical ability to likely achieve it. The Authority in Operator 2's case must act to secure this level of operational performance through key actions presented in Section 2. While Operator 2 is already highly operationally effective, actively improving the quality of the enabling environment will ensure that this operational effectiveness is sustainable in the long-term.

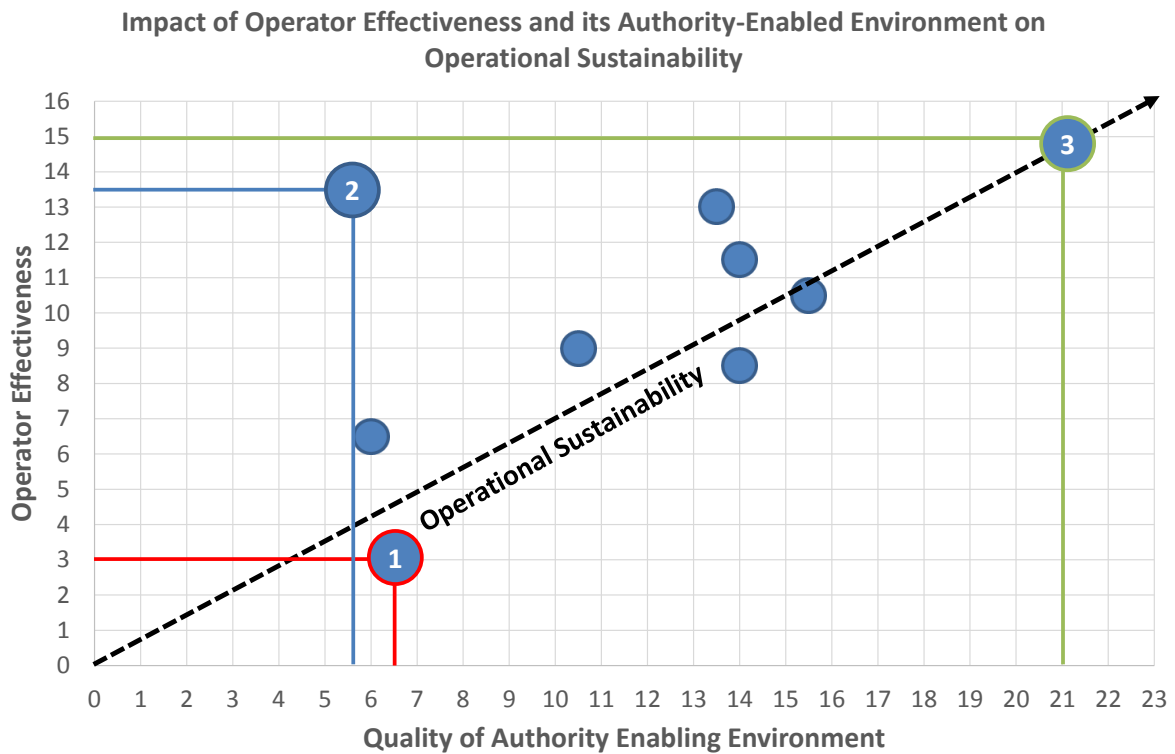


Figure 14: Operator Effectiveness compared with Quality of the Authority Enabling Environment in case study metros (anonymised)

Analysing Operator 2 on its operational performance would obscure the significant improvements to its Authority enabling environment that could substantially accelerate its operational sustainability. This demonstrates that metro performance cannot be judged by operating results alone, but must be clearly explored within its Authority enabling environment to drive both performance and sustainability over the long-term.

This central insight – that operational success does not ‘just depend upon the Operator’, but also on the metro Authority’s actions or inactions – might seem obvious. The case studies demonstrate a different truth however: many Authorities do consider that it is largely up to the Operator after revenue services commence. In other words they do not recognise their own critical role in ensuring the success of their metro system. Without their action, metro ridership, benefits, outcomes and sustainability will not be realised. They and their actions are central to ensuring operational success, and enabling the Operator to deliver this.

Next Steps

This report delivers the high-level, emerging findings from the Operator's Story research, supported by the key findings from 10 participating case study metro Operators.

The next stage of this research is to present these findings in detail alongside a wider range of Authority and Operator actions to achieve metro success. This will be supported by the full body of evidence collected from 10 case study metro Operators, demonstrating the range of roles, characteristics and experiences of these Operators. Investigation into the quality of these metros' enabling environments will be presented alongside an analysis of the implications for the Operator.

Appendix A: Key Findings from Case Studies

The following key findings are derived from each individual case study and supports the emerging findings from “The Operator’s Story” research. They are organised by Operator to highlight the key challenges, best practices and learnings from each city.

Barcelona: Transports Metropolitans de Barcelona (TMB)

Barcelona’s metro provides a highly interesting and multi-faceted case study on how metro success is fostered, and where less optimal governance has influenced metro success despite the presence of a competent and trusted Operator.

- TMB has developed and introduced an **innovative staffing model** consisting primarily of multi-functional roles, with proven benefits for productivity, efficiency, staff and customer satisfaction. This model is most effectively deployed when Grades of Automation (i.e. Grade 2 or higher) are applied on the network, as technology reduces the effort required to effectively carry out tasks on the network.
- **The public may be more receptive to fully automated trains** than is often pre-supposed. Barcelona’s new Line 9 trains operate without on-board staff (Grade of Automation 4), offering high levels of labour efficiency; despite initial reservations about the perception of a fully automated line, it was quickly accepted by the public in Barcelona.
- **Energy consumption** incurs both fixed and variable cost elements (e.g. stations and trains respectively) and may comprise a significant proportion of operating costs, depending on macroeconomic conditions. Another success factor has been how TMB has adjusted energy power procurement, point by point and period by period. TMB has demonstrated that by ensuring that the Operator thoroughly understands its energy consumption, is able to propose a prioritised set of interventions and thereby enable greater control over energy consumption and cost.
- TMB’s experience with Line 9 demonstrates that new lines should be constructed to serve the sections with **strong passenger demand from the outset**, particularly when lines need to open in sections. This may also be the most expensive element of construction but will create the critical interchanges, revenue and capacity relief earliest in the project. New lines with poor demand can negatively affect the Operator’s financial sustainability for many years.
- **High-quality integration** as a key strategic priority will significantly improve public transport mode share and limit private car use. TMB avoids excessive competition for trips between metro and buses by maintaining a high degree of integration between the two and the introduction of **multi-modal ticketing and fares integration** by the ATM in 2001 was seen as a great success.
- Having a **dedicated transport planning department** responsible for integrating planning between the bus and metro networks, with access to high-quality transport and land-use planning data, will help avoid piecemeal or reactive projects between the two modes and ensure that policies such as integrated fares and ticketing can be exploited.
- Where **major investment decisions** cannot be made by the Operator, it is prudent to keep that decision as close as possible to the Operator so that as much technical expertise as possible influences its outcome. The Barcelona Metro Line 9 experience of delayed implementation and prioritising outer alignment construction first is a consequence of the lack of Operator input into the process, a lesson learned from the Public Administration owner.

- **An economic downturn or recession** can have rapid but long-lasting impacts for metros and their authorities. This can impact major projects, such as Line 9 in Barcelona, but can also have long-term operational implications, such as through the introduction of a greater range of concessionary fares, which are very difficult to rescind. Barcelona TMB has successfully maintained metro service levels and quality during the economic downturn avoiding a 'spiral of decline' experienced in other cities. TMB suffered a decline in demand but maintained very good results in customer satisfaction surveys. Public Administrations have now committed themselves into a long term (2014-2031) loan supporting through the Authority (ATM) the TMB operations, due to the relevance & good performance of the metro and bus systems in the City of Barcelona and its metropolitan area.
- **Gross cost operating contracts** can provide greater certainty over funding and incentivise improved Operator performance if Key Performance Indicators (KPIs) are established contractually and monitored. A balanced set of effective KPIs covering a range of attributes such as service provision, quality and safety, with incentives and penalties clearly linked to these areas, is good practice.

Bangkok: Bangkok Expressway and Metro Public Company Limited (BMCL)

This is a case study of a private concessionaire delivering good service to its customers despite the quality of its enabling environment. Its importance lies in the trend in some geographies towards PPP for new-build metro projects, and because it offers new insights into the conditions for success.

- Public Private Partnership (PPP) is a **high-risk contract form** when it is applied without real understanding of the concept and risk-sharing from government. BMCL have experienced the difficulties of operating a private sector concession and serving customers without the institutional support necessary to make this contract form a success. The Blue Line concession form has not proved financially viable owing to lower than expected ridership and higher than expected operating costs.
- A **strategic long-term investor** in the metro can provide the longevity necessary to stabilise a turbulent environment with private actors. Arguably it is this stability in Bangkok that has kept BMCL afloat. The established Authority must have a public sector ethos with experience in metro operation to sufficiently understand the complexities of such a system. The Authority, as well as the Operator, must be learning organisations.
- **Collaborative working** and/or mergers between companies can be a great asset for the public transport system when the involved parties have expertise and experience in different areas: in Bangkok's case, merging parties were cash-rich and project-poor and vice versa.
- The experience of **decision-making** between the two concessionaires in Bangkok demonstrates that decision-making in the interest of the metro is likely to be more successful at a lower level. The City Government via BMA is more agile at decision-making, favouring BTS Skytrain's concessionaire, whereas BEM's decision-making takes place at the National Government level. This has proven to be an extremely turbulent environment following years of political instability and other decisions have crowded out the metro.
- A **lack of integration hinders ridership potential**: lines that are integrated with one another and furthermore, integrated with other transport modes, will drive ridership and public transport mode share. This integration needs to be prioritised while the metro is still able to materially shape the development of the city.

Guangzhou: Guangzhou Metro Corporation (GMC)

Guangzhou Metro is a notably innovative metro Operator, undertaking technological research and development, adopting a multifunctional staff profile and are actively innovating to improve the customer experience. Key messages from this case study relate to increasing the influence of the Operator on the Government and increasing the predictability of their environment for sustainable metro operations.

- An Operator must be able to **balance short-term public good against long-term company sustainability** (which is ultimately for the public good). For example, ensuring that good working conditions are in place to retain talent and prioritising investment in assets. The Authority must be able to understand this balance.
- The Operator must be able to **influence their Authority** to influence a more informed decision between available choices, for example when an option may disadvantage the metro. This should include communicating the implications of each choice, supported by evidence.
- **Demand may not increase in a linear way**, in proportion to the number of metro lines. There may be a point when demand suddenly increases as the benefits of integration and connectivity manifest. GMC advise that the metro will eventually need all the capacity it can get.
- *“Big is beautiful”*: GMC emphasise that a larger train and a larger station is better. The additional cost to **add capacity at the outset** will be insignificant in the overall scheme, but the benefits are hugely important to a world-class system and capacity is difficult to add retrospectively once the metro is operational.
- **Multifunctional staff increase labour efficiency** by providing a range of tasks required to maintain service. This could include customer service duties and engineering skills such as being able to diagnose and fix common faults. Multifunctional metro staff reduce the need for task-specific staff and training. It also creates a career progression that leads to greater staff retention and skilling of labour.

Hong Kong: Mass Transit Railway (MTR)

Hong Kong MTR provides insight into a reliable, efficient and proactive metro Operator with substantial influence, autonomy, business practices and operational outcomes. It has proved that the approach that delivers operational excellence is transferable and the case study key findings offer significant insight into how this could be achieved by other Operators.

- **Financial sustainability** affords the Operator a level of autonomy and independence which aligns with trust provided by the Authority. This provides MTRC with the necessary independence to make decisions and reinvest in their network at the time and place of their choosing so as to align with service goals that are in the Authority’s interest.
- An Authority providing a **predictable pipeline of projects** without a stop-start pattern of network development will retain talent and develop it in all areas of operation.
- MTRC has not only proved itself to be capable of adapting to rapidly developing customer expectations, but has also **changed their expectations** itself. This has been achieved through the use of Octopus for example, where customers are now able to integrate their travel, retail and leisure experience. This has also resulted in the growth of **consultative processes** during planning, including transparency, public review, planning for implementation and mitigating impacts, and environmental impact assessments. Greater customer expectations from service as well as planning can increase cost and programme risk, and MTRC advocate taking the time to **mitigate**

these at the outset of the project, rather than trying to solve them during the project's implementation.

- The **rail and property** funding and delivery model for public transport projects is powerful – both for achieving financial sustainability and achieving development aims associated with transport. A key to making this work involves **siting stations in the right place**, not just where is easiest, providing foundations for future development and starting by developing above depots. Developments are also carefully managed to ensure the mix of services that customers want. The result are developments that feed the railway in exchange for a railway that maximises the value of developments.
- **Over-station development** is achievable in a wide variety of environments. Because of the need to set out clearly the rights of owners at different levels, if there is a difficulty enforcing contracts then it is preferable for the Operator to lead and own the project as a single planner, designer, developer and landlord. This may be easier on greenfield sites. There is also a need for extensive engineering to make developments work around the operating railway system which involves isolation of noise, vibrations, fire suppression, etc.
- However, there is no single correct business/operating model for metros and it is important to **consider the specific project and the specific location**. If a PPP Operator is being procured to build capability, it is important that this is explicit: *“whoever comes in to help must have a remit to transfer know-how.”*
- When considering privatisation it is important to **differentiate between lowest cost and value for money** and to recognise that targeting lowest cost may not ultimately be the best way to serve passengers. In particular Governments should beware bidding contracts where the Operator's profits are based on ridership, as ridership is generally related more closely to GDP growth than metro service quality: *“do they want to give the contract to people who are ultra-aggressive in predicting GDP growth then hand back keys in a few years' time?”*
- **Proven technology** is a given and MTRC adopts technology only when it has been proved in similar environments. Standard industrial specifications provide a level of protection for Operators providing sufficient plans are in place for procurement, risk, investment and obsolescence. Reinvestment in assets is not a like-for-like replacement because technology develops during its operational life.
- The system should be designed for at least **50 years after it is opened**, considering growth, change in customer expectation, travel patterns and labour markets. This should include a thorough set of **alternative analyses** that can serve as future business cases should circumstances change, and should highlight short-term costs against longer-term benefits to prioritise network sustainability.
- Spend substantial time and effort bringing people to a common vision, and **proactively managing stakeholders**. This may extend the early part of project development but is likely to result in long-term buy in and trust from the Authority and stakeholders, reducing long-term project constraints, surprises and opposition.
- The Operator must communicate to its Authority what it reasonably can and cannot do and/or control. A good Authority will help to bring external opportunities within the Operator's control: *“Government should put in mechanisms to allow the railway company to help itself.”* A good starting point for metro success is to **reduce bureaucracy and conflicts between federal, state and local Governments**.
- The **Operator and Authority need to collaboratively plan** a coherent metro system that fits into a wider public transport system. This allows for design features that maximise the passenger experience; in Hong Kong SAR, China's system this includes world-class paired cross-platform

interchanges to be planned. These world-class design features are not possible with a line by line incremental approach.

- The **Authority need to have the right competence** to undertake a major project and be able to provide enough resources to the Operator. However, if dealing with a competent and experienced Operator, the Authority also need to be able to stand back from the project's development: *"If the rail company has enough expertise, I believe it's better for Government to stay off daily running."*
- MTR believe their **full vertical integration** is key to their reliability success. They can operate a closed-loop management system which gives them operational control, building on full control of asset management.

Kuala Lumpur: Prasarana

Kuala Lumpur provides lessons, both positive and cautionary, for public policy, Governments and Operators elsewhere. Government stepped in to proactively manage and integrate fragmented private sector concession into a public transport system. Prasarana now provides a strong and accountable institution to operate the system and develop new lines.

- The Prasarana system is **supported directly by the Prime Minister**, lending political might to decisions needed for project success. An interviewee noted that *"you need a strong leader to execute and get it done, that's why the Prime Minister is the one in charge"*. A key learning is that although the institutional gap between public transport operations and the Prime Minister is great, this level of political will is useful in a rapidly developing context, providing it is a priority.
- A **fares formula** from the outset of operations balances fairness against both the customer and the Operator, providing it is not deviated from without just cause. Sustainability depends upon **fares increasing to account for inflation**. Kuala Lumpur learned this lesson from 20 years of no fare increase.
- **Capacity, connectivity and competition** are three key influencers of rapid growth in demand. Notably, investing in wide trains to maximise proven returns to density, connecting isolated transport projects into a system, and competing credibly against the highway network.
- Prasarana have experienced a multimodal shortage of qualified personnel in design for example, and are now aiming to address this through the creation of a **railway-specific university institute feeding into roles at the company**. Operators must be able to plan for their labour needs, in particular the **level of skill required to deliver the product**. Even using consultants for major pieces of work requires some in-house knowledge and competence to provide effective oversight.
- A **simple target** – for example, Kuala Lumpur's target of **40% public transport mode share** by 2030 – can be used to create a common purpose with urgency at its core: *"we are very clear in terms of what role we need to play to support the Government's agenda."* The target must of course also be committed to by the Operator's wider Authority.
- **Operating requirements** must be a primary consideration in project design and the alignment must go as close as possible to passengers' destinations, not where is cheaper or easier. *"We call it public transport, so the interests of the public must be the first agenda", "you cannot build the line in no man's land"*.
- Planning should focus on the right allocation of resources between modes. The **regulatory framework** should be able to give one Authority **multi-modal decision power** and decide between priorities, including between stakeholder requests at the planning stage. An integrated land and transport planning Authority equipped with **accountability for integration** will create and embed interest in the positive development of public transport at the Authority level and will advocate

for it to Government. Proactive engagement is the way ahead – *“all stakeholders need to be involved at planning stage”*.

- **Transit Oriented Development (TOD)** must not be an after-thought and a long-term operating model can be sustained by establishing the right business and planning mechanisms so that the benefits of TOD can fund the metro system. The railway is paramount in successful TOD; as integrated transport and land use develops, protect and enhance the railway as much as possible.
- Prioritising integration from the outset of developing a system will create a more successful public transport network. Creating integration between lines, modes and commercial development opportunities retrospectively is difficult although Kuala Lumpur proves it can be done. Look for station integration, ticketing integration and also compatibility of systems (e.g. rolling stock).
- Good **corporate governance** is key to ensuring project success in a relatively young organisation: the processes, procedures, rules and regulations should be designed and implemented to support success. Prasarana have transitioned very rapidly from a new organisation, to an integrator of fragmented metro lines, now accountable for the development of this system. This transition has brought with it a role for Prasarana as an **urban development catalyst** in a rapidly growing and changing urban context. Prasarana advise to **learn by doing** and only become better with experience; do not expect to start high up the learning curve.

London: London Underground / Transport for London

London provides a range of experiences within its case study based on its history of operations, network development, involvement in PPPs, comprehensive business practices and involvement in policymaking. It highlights the transition of an Operator and a metro system from lagging performance (1980s) to a world leader (present) all within the context of public ownership, periods of economic prosperity and crisis, politics of a democracy, and the constraints that come with it.

- The unintended outcomes of PPP initiatives in London include both positive and negative outcomes from contracts themselves as well as the events that followed those outcomes. London’s urban rail PPP experiences are very much linked to the current shape and performance of public institutions. One benefit is the substantial improvement in asset management systems. Another is a clear message to Government on the cost of metro reinvestment, and the benefits of putting this money into the system.
- The evolution of asset management both as a technical discipline and as a strategic tool for business planning and risk management. London Underground’s current asset management system was originally developed to support the Tubelines and Metronet PPP endeavours. It has subsequently become a critical business tool for LUs investment.
- There has been a transition towards viewing and assessing urban railway projects as strategic urban competitiveness initiatives rather than just railways projects. This has been particularly important to the business case that underpins the Crossrail I and II projects. Private funding sources such as business rates and contributions from property developers help protect these valuable projects from cuts.
- London has experienced several “stops and starts” in developing its metro system and also experienced periods of volatile funding. London is now experiencing a shift from transport development that responds to existing demand, towards planning-led transport in which transport projects are planned to unlock development.
- Supra-national legislation (i.e. the European Union in London’s case) may impact the governance environment for metro operations. Most notably, these impacts relate to

regulatory mechanisms that apply to London Underground. London's experience suggests that regulation either needs to be light touch (like IIPAG) or very strong and knowledgeable.

Santiago: Metro de Santiago

This case study highlights the transitions experienced as a relatively modern metro ages and matures. The efficient operations of the Santiago's 'middle-age' metro have been shown to be critical to the capital city's functioning, and the density of its demand (the 3rd densest metro ridership in the world as measured by passengers/route-km) means that operational problems create significant and immediate disruption to the city.

- Historically, financial sustainability and its establishment as a public corporation in 1989 have provided Metro de Santiago with relative **autonomy** from government, fostering a substantially technocratic management style and a strongly performing metro.
- The metro Operator has won a relatively high level of influence with government and city authorities. **Effective financial practices** have created the credibility required to influence Authority decision-making and have allowed the Operator to adopt a **best practice, holistic approach** to metro management and operations. This influence and autonomy could be at risk if fares policy and exogenous, economic conditions undermine the metro's ability to cover its own costs.
- Metro de Santiago's ability to fund up to one third of the capital expenditure for extension projects has ensured that the metro Operator has had **significant influence over their design**, enabling Operator know-how to be designed into extensions and new lines, implementing good practices. This has meant that Metro de Santiago has become a valuable resource and trusted partner by Chile's government. It operates the third densest in the world (as measured by passengers/route-km), and is able to plan, develop, part-fund, and implement extension lines simultaneously.
- Government and Authority control should provide enough flexibility for the metro Operator to **supplement fare revenues**, and improve financial sustainability with non-fare commercial revenues including retail (ideally good retail space should be designed into new stations) and advertising revenue. This benefits all stakeholders.
- Metro de Santiago offers some **key lessons and good practices for the aging of relatively modern metros**, notably in relation to planning for assets (their degradation refurbishment, enhancement and renewal). Metro de Santiago has also managed increasing unit costs (wages, electricity), overcrowding, and transport mode integration effectively. Institutionally, they have also mitigated encroaching control from government, and loss of control over fares.
- Asset degradation can happen quickly or at an unexpected rate and investments made at the right time according to a **rigorous and proactive asset management plan** can avoid future corrective expenditure. This should include robust asset information and reinvestment plans that identify the consequences of delayed reinvestment and estimate future maintenance costs. Metro de Santiago's plans are already showing successes after one year of putting them into practice, including a significant reduction in delay incidents affecting passengers.
- Plans that prioritise **asset resilience** provide valuable future-proofing capacity in the event of rapid increases in demand, which could particularly happen in developing urban contexts. Metro de Santiago demonstrated the resilience of its network in adapting to Transantiago.
- Insufficiently planned or constrained land use development has concentrated demand around Line 1, resulting in severe overcrowding and a need to constantly quantify and co-ordinate new projects to manage the demand. It is possible that an **integrated land-use and transport**

plan would have mitigated these challenges by distributing development throughout the city more effectively.

- Crowding is the key reason why service frequency has reduced on Line 1 in Santiago. Having strong strategies and innovative tactics for **managing passenger flow and platform crowding** to ensure safe, unimpeded flow will help protect a high-frequency operation.
- The potential risks and **impacts of external events** (such as energy prices, security threats, natural disasters and the impact of wider governmental policies) are taken seriously at Metro de Santiago, having experienced the impact of such factors on operating costs and business continuity. Rapidly increasing energy costs due to droughts has led Metro de Santiago to seek 60% of its future energy consumption through renewable solar and wind power energy sources.
- Metro de Santiago has demonstrated that it is a **learning organisation** by implementing lessons from previous projects and outcomes from international benchmarking. These include design and project management elements on Lines 6 and 3 to **favour and future-proof capacity**. Metro de Santiago is also implementing Unattended Train Operation (UTO) with Platform Screen Doors (PSDs) on new lines and designing modular stations to facilitate non-fare revenue concessions.
- Through its experience with procurement, Metro de Santiago demonstrates (alongside other case studies) that an Operator must retain in-house competence and knowledge necessary to effectively oversee outsourced operations. The appropriateness of **outsourcing** tasks should be considered on a case-by-case basis, with care taken to avoid dogmatic outsourcing decisions.
- Metro de Santiago planners have access to city-level **transport models**, which they apply to project scenarios. This creates **efficiency in project planning** and supports Metro de Santiago's own strong business practices. , Metro de Santiago routinely applies cost/benefit analysis to support its decision making. Investment in transport planning delivers benefits by sizing investments and planning operations for resilience while avoiding overdesign.
- Major **public transport reform**, particularly where integration is increased or created, can have large and tangible benefits. The Transantiago project has dramatically demonstrated that **reorganising the bus network around the metro** can have a sudden, significant and sustained impacts on metro demand and consequentially operational performance. However, Transantiago's experience also shows that any ambitious and widespread reorganisation of the transport network should be introduced incrementally, to reduce risk, unexpected or unintended consequences, and to enable a careful assessment of the impact of change on operations and customer satisfaction.

Sao Paulo: Metro Sao Paulo

Metro Sao Paulo is in the rare position of being both the Operator and also the planning body for the metro system (Transport for London is another example). The city relies heavily on the metro, yet many of the qualities of their enabling environment do not support long-term metro success. Metro Sao Paulo's effectiveness is compromised by these constraints, regardless of how efficient the Operator is.

- A truly integrated metro system requires **integrated service planning and integrated ticketing**, even in a system with multiple Operators. A lack of integrated land-use, development and metro planning risks capacity optimisation and potentially concentrates demand, leading to long-term operational pressure.

- An **independent, system-wide regulator** may be able to mitigate the effects of an unsupportive enabling environment in areas such as contract design, funding, labour relations and planning.
- The metro should be considered as an **essential public entity** by its Authority and government, rather than considering it as a business-as-usual commercial enterprise. This may help reduce taxation spend for the Operator.
- The use of a **Public Private Partnership (PPP)** in São Paulo allowed for the creation of Metro São Paulo-designed new capacity, overcoming the challenge of limited public funding for metro investment. This provided Metro São Paulo with greater certainty over network development. The contract with the private sector Operator is managed through a comprehensive set of service, quality and financial indicators. A PPP framework is also being used for Line 6 – Orange.
- An **annualised funding regime** with separate budgets for operations and renewals hinders the Operator from developing a whole-life, long or medium-term view of asset management.
- Design elements should be included from the outset to favour **high capacity operations** in the long-term, for example, sufficiently large stations with double-sided platforms, moving block signalling, high-capacity terminals which allow for simultaneous train turnaround, long trains, etc. Metro São Paulo designed the system in this way and are also able to operate it to a world-class standard, using relatively high train speeds and achieving high passenger densities.
- Create a standard process for **major project benefits realisation** to guide future investment objectively, for example adopting benefit/cost ratio methodology, alternative analyses, benefits prioritisation and project success criteria. This will provide certainty to the Authority as to what major projects benefits will be, and will also help guide the Authority when it is the decision-maker on major projects. Although monorail technology in São Paulo is as yet unproven in terms of its benefits, new projects are being approved by the city.

Toronto: Toronto Transit Commission (TTC)

TTC is one of the world’s most integrated multimodal transit agencies within Canada’s major financial centre, but with an aged subway system that has received inadequate investment and now requires top-to-bottom modernisation. It has considerable autonomy and has demonstrated the significant impact of technocratic leadership. TTC now faces the imperative of both modernisation and expansion plans and securing sustainable funding for its future.

- Establishing new metros with **multiple levels of decision-making** creates vulnerability and volatility in the planning and financial environment. TTC’s Board, its first point of accountability, is essentially a political body composed of representatives of Toronto City Council. Above this, there are decisions affecting TTC that can be taken at the City, Provincial and national levels.
- TTC have proved adept at **engaging upwards within an intensely political environment**, partly through its strong leadership, and partly through its demonstrated technical competence. Its first point of accountability is essentially a political body which means that they have to engage at the political level in order to succeed. An example of this is TTC’s formulation of 9 prioritised, beneficial and implementable “quick wins” in 2014, all of which were accepted by the Board.
- Operator engagement with a **receptive Authority** benefits the city in question. This requires strong and proactive metro leadership. This type of engagement is likely to increase the prospect of predictable funding and install a long-term, sustainable view of metro operations within the Authority itself.

- The transformative effect of **leadership** is clearly demonstrated in Toronto. With Andy Byford's appointment in 2012, a new strategy was created spanning the full range of TTC responsibilities. This ranges from improving the company culture through proactive engagement with its workforce, to new focus on the company's asset management practices. It also includes increased effort to improve TTC's proactivity, professionalism and success in operations through securing the \$1 billion (USD 750 million equivalent) per annum it needs to keep the system operating, rather than focusing company efforts towards securing this funding on a repetitive basis.
- The shape of a city largely determines the right strategy for success. In the case of TTC, bus services are essential to feeding the metro system given Toronto's relatively low density of development. TTC "**think integration**" and understand that as an Operator, it provides efficiency, certainty, opportunity for non-fare revenue, as well as a much improved experience for the customer. Without this integrated network, it is possible that a metro in a city formed like Toronto may not be viable.
- There have been notable examples of **innovative funding** for transport projects and TTC note that the public are accepting of certain taxes if they understand its utility and benefit. For example, the Scarborough subway was planned to be part-funded by the City levying an earmarked 0.5% property tax over 30 years, and a 10-year Water Renewal strategy was also funded by the City levying a 9% earmarked property tax.
- **Asset management information** is itself an asset and internal asset knowledge cannot be outsourced. Managing asset management information across a common system avoids individual silos of fragmented information. It is important to recognise that asset information is easiest managed for assets that are standard and found within other industries, whereas it is most difficult for transit-only, such as tunnels and signalling systems. A positive view is that asset management is necessary from the outset of design. By using a Building Information Management (BIM) system from the beginning "*you're giving them a fighting chance from day 1 to run the system*".
- "*Once you lose a state of good repair it's almost impossible to catch up*". Not only do assets need to be rehabilitated but also enhanced and replaced. To understand the 'state of good repair', a **rigorous asset management system** is necessary and an understanding of the life-cycle of all assets. Metro Operators must be able to answer the question: 'How can the funds available have a major beneficial impact?'
- Doing projects in the wrong order will increase cost and cause constant undoing of previous work. These **economies of planning** are only possible if underpinned by guaranteed funding, particularly for later project stages within the modernisation portfolio. TTC observe that if people understand funding is going towards public transport, they are likely to be generally supportive, and as much flexibility as possible should be provided to the transport agency to allocate funding between projects according to a well-justified set of priorities.
- TTC recommend creating a special card for **travellers with discounts**, which could either be managed by the transit agency or a special prepay bank card programmed to charge discount fares. A special smartcard for passenger requiring discounts or concessionary fares could also be managed by the transport agency or via a stored-value bank card programmed to charge discounted fares.
- TTC's policy is to be **open and transparent** alongside Freedom of Information (FoI) legislation, their approach being: "*if it's public make it public*" (e.g. put it on the website). All operational data is now open data and accessible to anyone wishing to develop an App and information is available unless personal, although this does create a burden on resources. If this is going to be an organisational approach, resources must be planned to ensure an obligation to be open and transparent can be met.

Washington DC: Washington Metropolitan Area Transit Authority (WMATA)

WMATA's case study traces significant Operator constraints to the setup of its enabling environment and governance structure. WMATA highlights good practices within areas that the Operator is able to control, but its governance structure does not function effectively to maintain and operate its system. Its continuing objectives will be to address these institutional and governance challenges to be able to manage upwards and influence its environment, while continuing to build a strong operations, maintenance and safety culture.

- WMATA's experience demonstrate the critical importance of a **sound asset management plan** in place when the system is designed, incorporating good asset information, preventative and corrective maintenance plans and forecasting renewal, to ensure it is fit-for-purpose in the future. To support this, a dedicated overnight maintenance window allows ongoing maintenance and should be protected when setting operational hours.
- An organisation must be **adaptable to both construction and operation** of metro systems if it is to succeed in the long-term. This requires expertise in both areas, a predictable pipeline of projects to retain talent, and an organisational culture based on both areas. Despite this, it is important to note also that talent in both areas needs to be retained as the system starts operations. Systems that expand incrementally as projects are proposed and approved will continue to need this expertise, which is likely to become more refined with experience. Human capital is also an asset to the Operator alongside its physical assets, and neither should be allowed to degrade.
- **Organisational leadership** is critical in setting the direction for the Operator. An overly politicized environment will result in long-term costly implications for the metro which cannot easily be undone. Objectivity and longevity appear to be key for Board leadership. Focusing on short-term issues or delving too deeply into detail will risk the strategic direction a successful metro Operator needs.
- Long-term consideration should be given as much to the Operator's **governance structure** as it is to other operational areas. WMATA have ultimately outgrown the governance structure set out for them, established at the greenfield stage. WMATA are now in a position to materially influence the region and support its economic, social and environmental welfare. Their existing governance structure does not provide WMATA with the autonomy needed to plan such a system and disincentivises regional thinking fundamental to sustainable metro development.
- **Annualised funding arrangements** will not likely result in sustainable metro operations. Rarely is a single funding cycle adequate to fund major programs, particularly when this cycle includes both operating subsidy and capital funding, and the necessity of asking for funding annually may leave the metro vulnerable to wider financial pressures, threaten level of service and makes it very difficult to plan major, value-creating metro projects.
- An accountable, pervasive **safety culture** from the outset of the metro's creation should be the Operator's first priority. WMATA demonstrate that responding to incidents must be strategic as well as technical, to encompass the technical failures at play but examining more widely institutional issues that contribute to the operational failure, such as investment in assets and maintenance for example. A regulator with experience in overseeing metro operations will likely strengthen this culture.
- Coupled **metro development with TOD** and walkability to stations will maximise the potential ridership catchment and generate long-term demand. Urban areas are competing for talent, economic development and quality of life and a successful metro encourages all three. A legal framework for value capture that aligns the interests of the local Authority and the metro towards

TOD (e.g. the Operator captures the value increase and the local Authority captures tax increase) is valuable in prioritizing integrated development.

- A **distance + base fare regime** in areas with commuter-oriented travel patterns. This responds to the additional costs of operating a more widely-distributed metro.
- **Service quality** has a strong effect on demand and this must be taken into account when searching for cost efficiencies. Alongside existing service quality challenges, proposed service cutbacks on WMATA's network commencing in the 2018 financial year risks making the metro significantly less attractive to customers, particularly those with access to private cars, and this will be an ongoing area to monitor.