



**Imperial College  
London**

**Railway and Transport Strategy Centre**

# The Operator's Story

## **Appendix: Santiago's Story**

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Community of Metros  
**CoMET**



# **The Operator's Story: Notes from Santiago Case Study Interviews – February 2017**

## **Purpose**

The purpose of this document is to provide a permanent record for the researchers of what was said by people interviewed for 'The Operator's Story' in Santiago. These notes are based upon 11 meetings between 16<sup>th</sup> and 20<sup>th</sup> May 2016. This document will form an appendix to the final report for 'The Operator's Story'. Although the findings have been arranged and structured by Imperial College London, they remain a collation of thoughts and statements from interviewees, and continue to be the opinions of those interviewed, rather than of Imperial College London or the World Bank. Prefacing the notes is a summary of Imperial College's key findings based on comments made, which will be drawn out further in the final report for 'The Operator's Story'.

## **Method**

This content is a collation in note form of views expressed in the interviews that were conducted for this study. Comments are not attributed to specific individuals, as agreed with the interviewees and Metro de Santiago. However, in some cases it is noted that a comment was made by an individual external not employed by Metro de Santiago ('external commentator'), where it is appropriate to draw a distinction between views expressed by Metro de Santiago themselves and those expressed about their organisation.

## **List of interviewees**

Internal Metro de Santiago views:

- Ruben Alvarado Vigar, CEO
- Roland Zamora, Director of Planning and International Relations
- Daniel Schwarz, Deputy Manager of Studies
- Felipe Bravo Busta, Director of Maintenance
- Jaime Adasme, Director of Project Development
- Jon Brintrup, Deputy Manager of Operation Planning
- Hernan Vega, CFO

External commentators:

- Pablo Pizarro, Directorio de Transporte Publico (DPTM)
- Gisele Labarthe, Transport Planning Secretariat (SECTRA)

## Key Messages: Relevance to International Learning about Metro Operators

This case study illustrates a wide variety of international lessons about metro operations. The experience of Metro de Santiago highlights the transitions experienced as a relatively modern metro ages and matures. The efficient operations of the Santiago's 'middle-aged' metro are critical to the functioning of Chile's capital city. Experience has shown that operational problems create significant and immediate disruption to the city. Key lessons for operators include:

- 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 and is able to plan, develop, part-fund, and implement extension lines simultaneously.
- The metro's experience demonstrates that 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, Metro de Santiago has also mitigated encroaching control from government, and loss of control over fares.
- Metro de Santiago's asset management plans are already showing successes after one year of putting them into practice, including a significant reduction in delay incidents affecting passengers. Asset degradation can happen quickly or at an unexpected rate. Investments made at the right time according to a **rigorous and proactive asset management plan** can avoid additional 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 demonstrated the resilience of its network in adapting to Transantiago. 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.
- Insufficiently planned or constrained land use development has concentrated demand around Line 1, resulting in severe overcrowding and a need to constantly quantify and

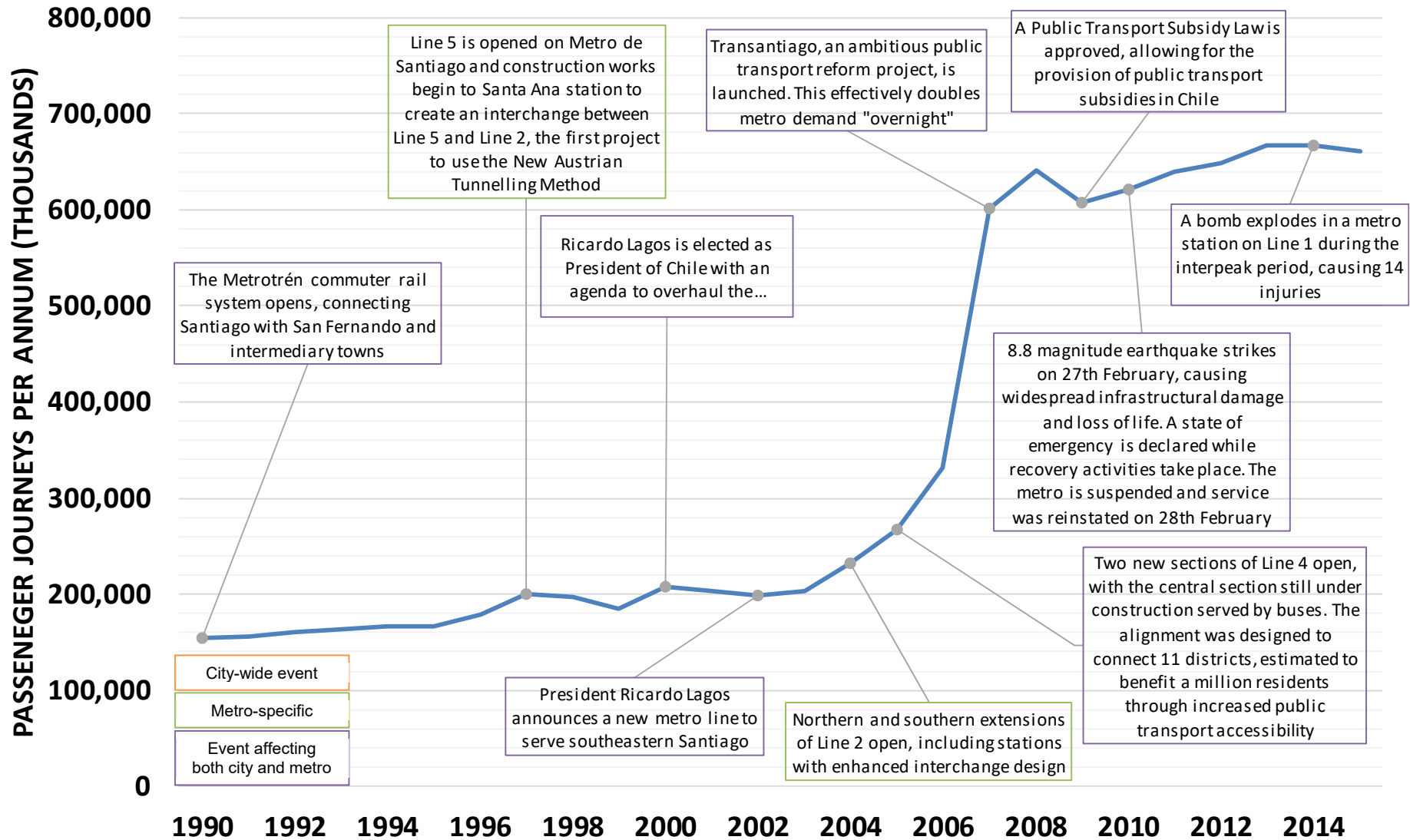
co-ordinate new projects to manage the demand. It is possible that an **integrated land-use and transport plan** would have mitigated these challenges by distributing development throughout the city more effectively.

- Crowding is the key reason why service frequency has reduced on Line 1 in Santiago. Having strong strategies and innovative tactics (such as “skip stop” operations) 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. This demonstrates the importance of an **effective risk management process** in managing metros. Rapidly increasing energy costs due to droughts has led Metro de Santiago to seek 60% of its future energy consumption in the future through renewable solar and wind energy sources.
- Metro de Santiago has demonstrated that it is a **learning organization** 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 in-house transport planning competence by the metro operator** delivers benefits by sizing investments and planning operations for resilience while avoiding overdesign. This competence helps to ensure that plans made by the authority are pragmatic and successful.
- 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.

# Transit Map



# Metro de Santiago: Passenger Journey Profile and Key Events



## General Summary of Metro de Santiago

GENERAL SUMMARY		
Background and history	<ul style="list-style-type: none"> <li>▪ First line opened in 1975 under Augusto Pinochet's military junta regime. Line 1 has experienced ongoing development, increasing demand but also increasing crowding issues on the line.</li> <li>▪ Two new lines are being constructed on the network: Line 6 and Line 3. This will add a further 37km to Metro de Santiago. Feasibility studies are underway for a potential new line, Line 7, which would relieve crowding on Line 1. An 8.8km extension of the network (5.1 km of Line 2 and 3.7 km of Line 3) are also being constructed.</li> </ul>	
Key dates and why they matter	1960s	Government let a tender for the development of an urban transport system. A proposal was approved, consisting of five metro lines.
	1969	Works begin on the first metro line for Santiago, facilitated by the General Directorate of Public Works' Planning Department.
	1970	General René Schneider Chereau is assassinated. He had been a constitutionalist who opposed military intervention in Chile's political affairs despite the Marxist affiliation of president elect Salvador Allende. The United States Central Intelligence Agency had involvement in pursuing a military led coup against Allende during this time according to documents declassified under the Clinton Administration's Chile Declassification Project.
	1973-1974	The Unidad Popular government is overthrown and Augusto Pinochet assumes power in a coup d'état. A military government was formed and the 1925 Constitution suspended. The new military government began implementing economic liberalisation policies, and banned trade unions.
	1975	General Augusto Pinochet opens Line 1, with service operating between San Pablo and Central stations.
	1974	A Decree Law is passed creating the General Directorate of the Metro, the "Metro Law".
	1977 - 1978	Line 1 is extended to Salvador station and Line 2 is opened in two sections: the first is opened in March, and the second in December.
	1980	Line 1 is extended to Escuela Militar, and the network consists of 25km.
	1980	The Santiago Metropolitan Region is created for administrative purposes.
	1980	A referendum is held in September to officially replace the 1925 Constitution. This referendum was approved by a majority and instated Augusto Pinochet as President for a further eight years. The Constitution promulgated after this referendum remains in force in Chile today, and has undergone several amendments as democracy has developed.
1982-1983	Economic crisis grips Chile following long-term overvaluation of the Chilean peso which had been pegged to the US Dollar. Rapid	

	subsequent devaluation of the Peso and high interest rates suppressed economic activity.
1985	Funding allocated to extending Line 2 and building a new Line 3 is reassigned to support reconstruction efforts after an earthquake.
1987	Operations begin on the Metrobus system across 11 routes in the city.
1988-1989	A referendum is held, ending President Augusto Pinochet's Presidency. Constitutional reforms were developed, introducing and strengthening democratic and participatory principles.
1989	Establishment of Metro de Santiago as a Public Limited Company. This means that the company became legally, administratively and financially separated to the Ministry of Public Works, and created a new governance structure overseen by a shareholder-appointed Board.
1990	The Metrotrén commuter rail system opens, connecting Santiago with San Fernando and intermediary towns. The system connects with Metro de Santiago's Line 1 and buses at Central Station.
1997 - 1998	Line 5 opens and construction works begin to Santa Ana station to create an interchange hub between Line 5 and Line 2. This was the first project where Metro de Santiago used the New Austrian Tunnelling Method which allowed for retaining tunnelling activities fully underground to minimise disruption at-grade while works were taking place.
1999	Metro de Santiago creates a Cultural Corporation to oversee art and media on the metro network. This builds on previous cultural work started in 1993 with the MetroArte project, which saw public art installations created across the emerging network.
2000	Ricardo Lagos is elected as President of Chile with an agenda to overhaul the transport system in Santiago. This included designing an extension to Line 5 and Line 2.
2002	President Ricardo Lagos announces the new metro Line 4 to serve south-eastern Santiago.
2004	Metro de Santiago develops their first underground crossing of the Mapocho River to open two new stations on a northern extension to Line 2. This is followed by a two-station southern extension to Line 2 and a two-station western extension of Line 5, also opened in 2004. These extensions were explicitly developed to ensure that new stations had improved interchange capability between metro and buses.
2005-2006	Two new sections of Line 4 open, with the central section still under construction served by buses. The alignment was designed to connect 11 districts, estimated to benefit a million residents through increased public transport accessibility. The central connecting section for Line 4 was opened in March 2016.  A further two-station northern extension of Line 2 is opened.



	2007	<p>A new extension of Line 5 to the west of Santiago and a three-station eastern extension of Line 1 is announced by President Michelle Bachelet.</p> <p>Transantiago is launched overnight in February. This was an ambitious public transport reform project aiming to increase integration between buses and the metro, renovate the bus fleet and introduce an integrated new fare structure and ticketing system. The project initially caused widespread confusion for customers and had a number of immediate operational and political impacts. Demand for the metro effectively doubled overnight as the bus network was re-designed to feed the metro and the new fare structure effectively made using the metro significantly cheaper.</p>
	2009	<p>A Public Transport Subsidy Law is approved, allowing for the provision of public transport subsidies in Chile if necessary. An independent expert panel is created as part of this law, responsible for establishing fare levels to ensure that an annual fare deficit does not exceed annual subsidy.</p>
	2010 - 2011	<p>Extensions of Line 1 and Line 5 begin operations.</p>
	2014	<p>A bomb explodes in a metro station on Line 1 during the interpeak period, causing 14 injuries but no fatalities. Service was suspended immediately after the attack and when resumed, the affected station remained closed. As a response to this attack, the Government invoked an anti-terror law originally dating from the Pinochet era to apprehend the suspect and any related parties. In addition, there has been an additional deployment of police on the metro which is being funded by Metro de Santiago.</p>
	2015	<p>President Michelle Bachelet announce a USD 4.2 billion plan for transport in Chile with a goal of improved productivity in Chilean cities. 70% of the spending in this plan is aimed to be invested in Santiago. This includes high-level support for Line 7 as a relief option for Line 1, although without a proposal for its alignment.</p>
Current ownership and oversight		<ul style="list-style-type: none"> <li>▪ Metro de Santiago is a public limited company established in 1989 under the company name of Metro SA. Its shareholders are the Corporation for the Promotion of Production (CORFO, 62.75%) and the Chilean Treasury (37.25%). CORFO is a government undertaking with a mandate to enhance Chile's competitiveness and economic diversification.</li> <li>▪ Transantiago Financial Administrator (AFT) collects all revenue from public transport in Santiago and distributes it to operators. Metro de Santiago's revenue is in the form of a "technical tariff", set by an independent expert panel.</li> </ul>
Complementary public transport and non-motorised transport services		<ul style="list-style-type: none"> <li>▪ <b>Buses:</b> Urban buses in Santiago are operated by 7 private operators and overseen by Transantiago since 2007. Santiago's bus fleet previously consisted of a collection of privately-operated routes.</li> <li>▪ <b>Surface trains:</b> Rail connectivity to Santiago is provided only from the south of the metropolitan region. Metrotrén, operated by Trenes Metropolitanos S.A. provides commuter rail services, connecting Metro de Santiago's Line 1 at Central Station with San Fernando and intermediary suburban towns. Inter-city rail service between Santiago and Biobío Region is operated by Servicio de Trenes Regionales Terra,</li> </ul>

	<p>also connecting to Metro de Santiago’s Line 1 at Central Station. Both of these rail operators are subsidiaries of Empresa de los Ferrocarriles del Estado, Chile’s national public railway company.</p> <ul style="list-style-type: none"> <li>▪ <b>Pedestrian infrastructure</b> is managed by Santiago’s municipal council, and is integral to the council’s Comprehensive Mobility Plan. This is confined to the commune of Santiago however, and not the full metropolitan region.</li> <li>▪ <b>Cycling:</b> SECTRA includes cycling schemes as part of their Master Transport Plan 2025. Santiago’s municipal council also consider cycling in the commune of Santiago within their Comprehensive Mobility Plan.</li> <li>▪ <b>Taxis and other ride sharing schemes:</b> Taxis are privatised in Santiago. Awto provides flexible access to cars and facilitates car sharing. Uber is also available. Colectivos are group taxis that run fixed routes between central locations and a number of destinations.</li> </ul>
<p>Technical and operational summary as of 2016</p>	<ul style="list-style-type: none"> <li>▪ 103.5km under management - 62% underground, 19% elevated, 19% at grade</li> <li>▪ 46km of new lines under development</li> <li>▪ 108 stations</li> <li>▪ 0km of bus routes managed directly, with 69 km of segregated bus only lane in the city</li> <li>▪ 670 million passenger journeys per year</li> <li>▪ \$258 billion (USD 385<sup>1</sup> million equ.) in annual farebox revenues (2016)</li> <li>▪ \$320 million (USD 479 million equ.) in total rev. / yr (2015/16)</li> <li>▪ 4007 staff in December 2016</li> <li>▪ 40.8km of network length opened between 2005-2015</li> </ul>
<p>Regulatory, oversight, and policy bodies:</p>	<p><u>National Government:</u> Makes final decision on capital investments and appoints the President of Metro de Santiago.</p> <p><u>Department of Metropolitan Public Transport (DPTM):</u> Created in 2003 and is responsible for policy, regulation and administering the Transantiago contracts and thereby manages the bus network in Santiago. The Transantiago Financial Administrator oversees the distribution of public transport revenue (net of the technical fare retained by the Metro).</p> <p><u>Fare setting:</u> Fares are set by an Expert Committee who are independent of Government, and whose decision is binding. This is based on the mid-term income and cost equilibrium of the system. A technical tariff called PPT (income per transported passenger), which determines the income of transport operators is different for each bus company and Metro, are adjusted each month considering a price index formula. In the case of Metro this formula is based on the USD exchange rate (24%), the Consumer Price Index (61%), electricity prices (13%) and the Euro exchange rate (2%). The technical tariff must cover debt repayments and the metro’s operating costs, including depreciation.</p> <p><u>Transport Planning Secretariat (SECTRA):</u> the lead technical agency for transport planning in Chile, including metro development.</p> <p>There is no safety or operational regulator in Chile.</p>

<sup>1</sup> Dollar value as of 31<sup>st</sup> of December 2016 = \$669.47

<p>Summary of legal and policy framework:</p>	<p><u>Decree Law 257 (1974)</u>: Establishes the General Directorate of the Metro as a branch of the Ministry of Public Works.</p> <p><u>Law No. 18,772 (1989)</u>: Transforms General Directorate of Metro into a public limited company called “Passenger Transport Company Metro SA”, otherwise known as Metro de Santiago. This Law was last updated in November 2016.</p> <p><u>Master Plan of Transport Santiago 2025</u>: Sponsored by SECTRA, this plan sets out plans to respond to growth within a budget of approximately USD 23 billion, and is agreed upon by a technical committee consisting of the Ministries of Transport and Telecommunications, Housing and Urban Development, Public Works, and Social Development, as well as transport stakeholders such as Empresa de los Ferrocarriles del Estado. The Plan includes extensions and two new lines (Line 7 to relieve crowding on Line 1, and Line 8).</p> <p><u>Public Transport Subsidy Law (2009)</u>: This law was reactively created after Transantiago to enable the Government to provide a subsidy to the system over five years. Prior to this, there was no instrument to facilitate state subsidy of public transport systems. Existing subsidies have been determined according to this Law until 2023.</p>
<p>Other Key stakeholders:</p>	<ul style="list-style-type: none"> <li>▪ Unions: Union of Workers of the Transport Company of Passengers Metro SA were formed in 1990 and are the main union for Metro de Santiago employees.</li> </ul>

## Summary of Key Views from Interviews

Santiago de Chile is a middle income growing city with a population of approximately 6.5 million people, expected to grow to 8 million people by 2025. Since 2013/2014 Chile has undergone a period of difficult economic conditions arising from low commodity prices in particular. The government faces competing priorities in other sectors (particularly education and development of other major regions in Chile) and scarce financial resources. Funding for transport in Santiago is a key issue amidst these challenges.

Transport in Santiago has faced challenges arising from poor integration of land use and transport planning. Private developers have historically built where profitable, subject to regulated maximum floor area ratios. A consequence is that the upmarket areas are steadily moving eastwards and social housing is located in city fringe areas. There is no City Development Plan in Santiago, and an interviewee commented that there is no meaningful integrated transport strategy, leading to abundant parking for private vehicle users. This approach of permitting market-led development around metro growth has arguably over-concentrated demand around Line 1. The public transport system in Santiago has developed from a largely privatised bus network, characterised by aspirational private car ownership, bus network under-performance, fragmentation, and poor road safety. Buses were the backbone of public transport in the 1990s. This system was generally characterised by a low-quality fleet and by relatively informal private operators. Integration, both physically and in terms of fares, was not prioritised as the metro developed in Santiago. The legacy of this history was a historic travel pattern where the majority of trips were made wholly either on buses or by rail. Transantiago, an ambitious public transport reform project implemented in 2007, aimed to restructure this system to create travel patterns consisting of integrated trips (discussed in detail on p18-19).

The greater Santiago area is not overseen by any single entity and in practice all important decisions are taken by the national Government<sup>2</sup>. In practice this can complicate decision making. Chile has Presidential elections every 4 years and each new President selects a new CEO for Metro de Santiago. According to interviews, turnover among top management is reportedly disruptive and often difficult to manage. The next Presidential elections will be held in 2017.

## Metro de Santiago

Metro de Santiago opened its revenue operations in 1975. The organisation as it currently stands is a Government Corporation created in 1989, formerly a branch of the Ministry of Public Works. It is owned 63% by CORFO (Economics Ministry) and 37% by the Chilean State (Finance Ministry).

### Governance and Autonomy

It is now a 'middle-aged' metro at 41 years old. As an organisation, Metro de Santiago has considerable management and decision-making autonomy. It seeks to operate as a learning, technocratic, and professional undertaking with a 'private sector' culture and ethos amongst a workforce recruited by merit. Interviewees suggested that this ethos derives from Metro de Santiago's establishment as a corporation in 1989, which legally, administratively and financially separated it from the Ministry of Public Works to which it formerly reported. Establishing Metro de Santiago as a corporation, regardless of the fact that it is still government-owned, subjects the organisation to similar procedures required for private

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<sup>2</sup> There is a Santiago regional government, but this has little influence. It comprises 6 provinces and 52 communes. Its main influence is on matters of environmental acceptability/implementation.

companies. For example, its Board comprises 7 members and is established by representatives of the Government at an Annual Shareholders' Meeting. This meeting is a requirement under Chile's Companies Act Law (Law No. 18,046). The Board operates across four strategic Committees: Project Management, Operations, Auditing, Finance and Risk, and a Technical Committee (which has no formal decision-making power, but scrutinises technical issues of ongoing projects). Officially, the Board delegates powers to the CEO of Metro de Santiago, who implements the Board's strategic plan through ten directorates.

Metro de Santiago's autonomy derives from its long history of financial sustainability. Farebox ratios (fare revenues as a proportion of operating costs) have consistently been capable of covering both operating costs, and asset replacement. Historically, it has also been possible to provide a third of the necessary contribution required to build new projects using revenues derived from fares and non-fare commercial revenues, with the remainder provided by the Government.

Officially, Metro de Santiago's role is to be the metro Operator, and the organisation has a vision, strategy, and corporate plan that looks forward through the next 5 years. Its current vision is: "to be a company that all citizens feel proud of". The implementation of this vision involves both physical investment as well as institutional modernisation projects. For example, this included an organisational restructure in 2013 moving from a function-based structure with business areas such as Maintenance, Finance and Commercial, to a line-by-line-based model. This approach intends to increase accountability for performance through a General Manager who is assigned to each line. There is also a vision that this will facilitate continued sound management as the network grows further. The management strategy for the organisation is centred around five key values: customer orientation to deliver the "*best service in the country*", safety and security, operational excellence (a key focus in 2015 following high-impact disruptions in 2014, discussed on p21), collaboration and transparency.

## **The Transport Sector in Santiago and its Institutions**

Interviewees suggested that the attractiveness of public transport is paramount in Santiago and that there are currently no meaningful policy deterrents to owning a car. Deregulation across the rail sector in Chile in the 1970s created the possibility for foreign car imports, increasing competition between public and private journeys. A continuing key challenge for public transport entities is to counteract perceptions regarding wealth, modernity, and car ownership. It was suggested that creating more public transport capacity, as well as improving the image of public transport, may help to achieve this.

### **Perceptions of Public Transport**

According to interviews, perceptions of rail transport in particular have been largely negative, creating a possible tendency within decision-making institutions to overlook the role of an effective suburban rail network in Santiago's development. Development in new areas of Santiago that are farther from the city centre is driving viability for a suburban rail network as well as wider integration of the public transport system. Previously, rail projects had been ineffectively planned: interviewees suggested that previous ineffective engineering assessments of rail projects had led to significant cost escalation, and that poor community engagement led to low support for rail projects. Empresa de los Ferrocarriles del Estado (EFE), the national railway operator in Chile, is currently planning for suburban rail projects in Santiago and Metro de Santiago considers itself to be wholly integrated in this planning process. Metro de Santiago is looking for opportunities for integration within these plans, for example a future extension to Line 6 to create an interchange with a proposed suburban rail line, estimated to cost approximately USD 110 million. It is estimated that suburban rail projects will add the capacity for an additional 10,000 passengers per hour when complete.

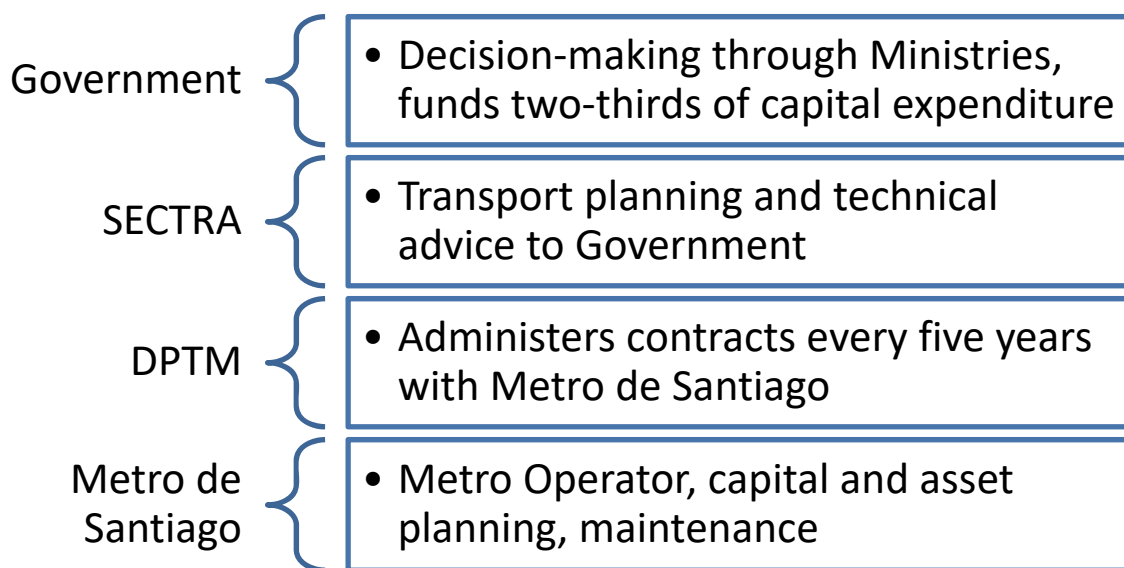
Furthermore, interviewees suggested that the metro system will consider longer distances between stations in the future to expand the reach of metro in the city, for example, stations are spaced approximately 600-700m apart on Line 1, but new lines may have 1.4 – 1.5km between stations.

Interviewees generally expressed support for development of a long-term spatial plan formed through collaboration between the ministries responsible for public transport and housing. A city-level authority could also assist in sustainable development, although interviewees suggested that this authority would be too influential in Chile, because Santiago is such a significant city for the country's economy.

### Institutions

The key Government Ministries that interact with Metro de Santiago are the Ministry of Transport and Communications, the Ministry of Social Development (MSD) who approve funding releases to the Ministry of Finance (MoF). Decision-making is taken at the national Government level. Ideally this process would be informed by SECTRA, who in turn would take inputs from Metro de Santiago. In practice, priority plans and projects reflect the political priorities of different governments.

It was noted in interviews that Santiago, and Chile more widely, enjoy a reputation for high levels of competence in transport planning. There are currently concerns that this competence may be weakening due to excessive outsourcing. Aside from diminished technical skill, a key concern relating to this is reduced collaboration amongst institutions to deliver public transport.



### Transport Planning Secretariat (SECTRA)

The Transport Planning Secretariat, otherwise known as SECTRA, is the lead technical agency for transport planning in Chile. This mandate includes metro development. SECTRA was established in 1983 under the Ministry of Planning. Its key responsibility was to carry out independent technical analysis for Chile's transport sector, and to recommend priority projects.

SECTRA's responsibilities include:

- *Transport Planning:* It is responsible for developing Santiago's (non-binding) Transport Plan which is currently called 'Plan Maestro de Transporte Santiago 2025'. It also is responsible for transport plans in all medium and large cities in Chile through its offices in Santiago and most regional capitals covering all the country.
- *Project appraisal:* SECTRA carries out professional project appraisals of public transport proposals using the latest data, models and appraisal methods and considers itself to be "*modally agnostic*". It prepares pre-investment/ feasibility studies prior to engineering design and implementation. SECTRA states "*To date we have never built a white-elephant project*". Metro de Santiago are able to use SECTRA's transport models for optimising plans: a best practice for carrying out extensive evaluations of proposals. Interviewees suggested that the quality of data in current models is good, based on a city-wide household survey undertaken in 2012 and origin and destination data from the BIP! smartcard fare payment system.
- *Facilitating project decision-making with stakeholders:* SECTRA identifies "socially profitable" projects and submits these to its Ministries for consideration. Strategically important projects are discussed at Ministry level to identify which ones will offer funding.
- *Collaboration:* SECTRA coordinates closely with the Ministry of Housing and Social Development and is collaborative in its approach – "*we work with Metro*".

Interviewees suggested that SECTRA is a capable organisation that has had a relative degree of independence and autonomy since its creation in 1983. However, interviewees also suggested that its influence has fluctuated over time. In 2010, SECTRA was transferred to sit under the Ministry of Transport and Communications, signifying a loss of independence and a loss of its historical ties with the housing sector. Interviewees at Metro de Santiago suggested that SECTRA is currently the best stakeholder within the existing structure to provide the central, holistic view necessary to deliver an integrated vision for Santiago.

According to interviews, the environment it works within is necessarily incremental (i.e., project development occurs at a relatively slow pace), to allow for a suitable level of planning, appraisal, collaboration and engagement. Interviewees suggested that more politicised decision-making will dilute SECTRA's ability to produce the technical analysis needed to promote sound projects, leading to gradual loss of competence over time. Chile has historically been a hub for expertise in transport planning, a significant benefit for the sector, although this has been pitched against a fragmented land use planning system.

### **Metropolitan Public Transport Directorate (Directorio de Transporte Público Metropolitano)**

The Metropolitan Public Transport Directorate (DPTM) has three key responsibilities. Firstly, it is responsible for defining, co-ordinating and monitoring the various public transport actions amongst public and private actors. Secondly, it is responsible for the Public Transport Infrastructure Master Plan and can theoretically influence the regulatory environment in the region. Thirdly, DPTM is responsible for administering the Transantiago contracts that are signed by the Ministry of Transport and Telecommunications (MoTT).

DPTM was created in 2003 without a legislative act. The Minister of Transport and Telecommunications is the President of DPTM, supported by the Minister for Housing, Minister for Public Works and the Mayor of Santiago's metropolitan region. According to interviewees, the fact that DPTM was established without a basis in law creates a weakness for the agency,

particularly when compared to the metro, with its long-standing establishment as a Government corporation.

Metro de Santiago has signed their 2016-2020 contract with DPTM, and a new contract is required approximately every 3 years. Metro de Santiago describe their contract arrangements as light touch. Contracts specify services that Metro de Santiago is accountable to deliver and the critical incentive is to transport more people (as measured by in the form of persons per hour per direction (pphpd) by line) as this increases compensation paid to the metro. There are no service quality incentives or defined penalties, but Metro de Santiago is very aware of the repercussions of underperformance. As discussed later in this report, incidents between 2014-2015 had a major impact on the company's reputation and consider underperformance to be *"more a moral issue than an economic issue"*.

Metro de Santiago's future contractual priorities are focused upon changing what is called the "technical fare," to generate the revenue necessary for long-term investment, and immediate funding for the new Maintenance Plan and security costs. DPTM describe their relationship with Metro de Santiago as necessarily collaborative:

- *"We adapt to their operation";*
- *"They pay themselves and afterwards we get what is left. It's how it's always been. There is no issue"*<sup>3</sup>;
- *"It's all to do with budget. He who has most budget (i.e. Metro) decides"*.

The DPTM also administers the contracts with private bus concessions that span between 7 and 12 years, an arrangement that has been functioning for nine years since the Transantiago project. At present, these cover 7 operators who own 6,500 buses and serve 371 routes. In contrast to Metro de Santiago's contract, bus contracts do include penalties for poor performance.

### **Relationship with Government**

Metro de Santiago is a public company but operates with independent directors and appears to have substantial autonomy: *"they trust us", "when things go well Government steps back. In 2014 there was a big problem. Then Government pays attention"*. Metro de Santiago is fortunate in being autonomous for decisions that do not involve funding from Government. Interestingly, Metro de Santiago is the only stakeholder within Santiago's public transport structure to not report to the Ministry of Transport and Communications.

Interviewees described a positive relationship with Government and a recognition of the social benefits that the metro offers in Santiago, which help achieve wide-ranging Government policy goals. According to interviews, a key requirement for Metro de Santiago is that Government seeks to retain a technocratic ethos when making decisions that affect public transport and its stakeholders, considering that there is little in-depth metro expertise within Government itself. Interviewees suggested that there are several ways in which the Government could better assist Metro de Santiago in facing its operational challenges:

- It could expedite financing for the prepared maintenance programme – funding of USD100 million and USD20 million per annum has been sought for this Maintenance Plan but 18 months of negotiation has not produced a final funding solution;

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<sup>3</sup> A summary of Metro de Santiago's income can be found on p23.



- Government could fund the extra security incurred after the 2014 bombings on the metro. Currently, interviewees noted that the extra 100 police are required as they create a feeling of stability and security for passengers;<sup>4</sup>
- Major expenditure is required to remodel the busiest stations.

Interviewees suggested that Metro de Santiago also considers they could assist Government more if given the opportunity. For example, a law was passed in 2015 (Law No. 20,877) allowing Metro de Santiago to expand its scope of business to include surface transport. Although the current bus system is overseen by Santiago, a future opportunity for Metro de Santiago could be to buy new buses for the concessions and lease them to private operators, at a much lower cost.

## Regulation of Metro

There is no explicit regulation of Metro de Santiago's contract and a regulatory or policy authority was not created as part of Transantiago public transport reform project in 2007. However, all public companies in Chile are required to submit performance metrics to their relevant Government Ministry with KPIs that include customer satisfaction. According to benchmarking, Metro de Santiago's customer satisfaction is constrained largely by its ability to supply demand for metro services. Recent customer satisfaction scores are, for example:

- 2012 63%
- 2013 51% (before new trains)
- 2014 52%
- 2015 58%
- 2016 58%

Chile's Metro Law constrains Metro de Santiago only to activities that are metro-related. Land can be developed if necessary for the metro (including bus interchange), but it prohibits development above stations: *"our Charter is transport. This is the law and we cannot go against it. London has legislation for it to get into real estate. We would like to do this (but cannot)"*.

There is also no safety regulator for transport in Chile and interviewees suggested that Metro de Santiago acknowledge that controlling safety risks on the network is entirely their responsibility out of necessity. According to academic literature, a long-standing explanation for the absence of regulation is that a publicly-owned monopoly on transport operations would not require a regulatory body, although this view does not take into account transport reforms and privatisation projects that have taken place as part of Chile's deregulation of transport services since the 1970s (Soto, 2014<sup>5</sup>). According to OECD's Economic Survey of Chile (2003), the Santiago Metro can be described as a "legal monopoly"<sup>6</sup>. According to interviews, a safety regulator may assist Metro de Santiago in ensuring that all scenarios are properly accounted for.

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<sup>4</sup> Post-interview, Metro de Santiago's new contract resolved the issue of expedited financing for the prepared maintenance programme and funding for additional security on the network, a significant support for Metro de Santiago.

<sup>5</sup> Soto, R (2014) Chapter 6: Rail Transport in Chile. In: Findlay, C (ed.) *Priorities and Pathways in Services Reform: Part II - Political Economy Studies*. Singapore: World Scientific Publishing Co. Pte. Ltd, p129-150

<sup>6</sup> Organisation for Economic Co-operation and Development (2003) OECD Economic Surveys: Chile. Volume 2003/17, p194

## Transantiago, and its impacts

*“This was a Big Bang, a humongous change that affected hundreds of thousands of people. The companies, payment system and routes were not ready. There were only 4500 buses – a huge deficit (there are 6500 now)”.*

“Transantiago” has meaning as a project, an organisation, and a brand. Originally proposed in 2000, Transantiago intended to create a modern integrated public transport system in Santiago. Now, it is recognised as the collective name for public transport in Santiago, and the organisation has 156 staff of its own. Essentially, Transantiago is responsible for managing the public transport system on behalf of the Government.

Transantiago was the outcome of an ambitious reform plan for the public transport industry and network and was originally expected to be self-funding. The plan included several elements of change, and Metro de Santiago acknowledge that change was necessary: *“Transantiago was clearly such a true need... there was such chaos”*. Few changes related to infrastructure, and instead the focus was on various ways in which public transport integration could be created, including through:

- *Fares:* Fare payment reform through the use of stored-value smartcards, usable on both metro and buses. Transantiago Financial Administrator (AFT), was created as a clearing house organisation to collect fares and distribute revenue to operators.
- *Bus network restructuring and fleet modernisation:* The plan was for a network of feeder and main bus routes to serve the metro network, perceived as the “backbone” of transport in Santiago, rather than a series of direct origin-destination routes. This previous structure resulted in an overprovision and underutilisation of buses as customers were able to make direct trips between a large variety of origins and destinations. The city was divided into zones and main and feeder routes operated within these zones. Overlap between routes was minimised as far as possible. Furthermore, a renovation of the fleet from previously low-quality and high-polluting buses was planned, with a minimum environmental standard set.
- *Bus and metro interchange:* Metro de Santiago estimate that 8% of journeys experienced an interchange before Transantiago. Post-Transantiago, this increased to 50%.

This new system was introduced on one day in 2007 and caused widespread confusion, public anger and political impact. This was followed by public demonstrations and a decline in the national Government’s public approval rating. Although Transantiago’s primary changes were to the operating model and structure of the bus network, its system-wide impacts had strong effects for the metro. Its ‘overnight’ implementation created the following issues:

- Fare payment technology was not fully functional and customers were able to use transport for free for several days. The Government reactively froze public transport fares at its existing single charge of 380 Pesos, with a 40 Peso charge for transferring to the metro from buses. It became clear that the system, expected to be self-funding, would yield a significantly lower amount of revenue in the long-term than forecast;
- The immediate bus network after Transantiago was implemented did not provide passengers with the same level of reliability and frequency that the metro could offer. Metro ridership accordingly grew from 1.3 million to 2.3 million passengers per day. This is also as a result of metro journeys becoming effectively cheaper under Transantiago. The new fare including surcharge was 420 Pesos, a reduction of 40 Pesos from the previous fare. Crowded trains became the new basic travelling

condition on the metro and Metro de Santiago describe an environment of “enormous efficiency challenges”, adding “I don’t know how many companies had such a shock of doubling of demand in one year”;

- Total public transport travel and waiting time increased considerably owing to overcrowding both on the buses and metro and the increased requirement to interchange between the metro, feeder and main bus routes.

Rapid changes to the bus system were required to mitigate these unintended outcomes. Changes included expanding the bus fleet to ease crowding, increasing headways, and investing in bus priority. Bus contracts with private operators were renegotiated to create structured incentives and penalties. The system also proved itself to be financially unsustainable and required a five-year subsidy of approximately USD 1 billion, resulting in the eventual establishment of the Public Transport Subsidy Law in 2009. Metro de Santiago also made changes to cope with elevated demand. For example, this included a skip-stop operation, increasing fleet cars, and operated kilometres. The experience of Transantiago has demonstrated Metro de Santiago’s adaptability, operational resilience and technical capability, even under extremely strained circumstances. The key issue raised by interviewees on the impact of Transantiago is that Metro de Santiago was fundamentally unprepared for the scale of change caused by its sudden implementation: “the main problem was that metro was not prepared and no matter how professional you can be, nobody can accept that level of change – it’s impossible”. There are still tangible major impacts today, such as:

- The post Transantiago fare system (discussed on p22) introduced means that Metro de Santiago effectively receives 40% less income than the fare the passenger pays (Metro receives a ‘technical tariff’ set at 40% below the fare paid by passengers). The balance of fare revenues cross-subsidise bus operators. An independent body adjusts fares according to a formula. Metro de Santiago effectively has little control over 80% of its revenues which are derived via customer fares according to this regime;
- The revenue potential of a doubling of demand was significantly repressed by the system, and led to a considerable loss of autonomy for the metro;
- Metro Line 1 continually runs at its peak capacity, with severe overcrowding at peak times making travel uncomfortable and challenging and placing major demands on all Metro systems and assets.

## Operations

Metro de Santiago’s ridership characteristics are as follows<sup>7</sup>:

Total mode trips/day	18.5 million, of which 38% non-motorised.
Total public transport ridership	4.2 million trips (5.6 million stages)
Metro average ridership	2.2 million passengers per working day
Public transport trip length	16 km – 80% of journeys are < 45 minutes

<sup>7</sup> Comparing survey data with contactless fare validations highlights the issue of fare evasion on Santiago’s bus network in particular. By the end of 2016, the fare evasion rate was 34.6%, meaning 1 out of 3 passengers on buses did not pay a fare for their journey. Metro de Santiago’s fare evasion rate was very low in 2016, at 0.25% of passengers avoiding paying a fare.

Growth in metro ridership	Growth of 100% since 2006 (pre-Transantiago): "we've been coping with huge demand since 2006", although demand appears to have stabilised
Public transport mode share according to SECTRA's Origin Destination Household Survey (2012)	22% metro only trips 26% integrated (bus and metro trips) 52% bus only trips
Public transport mode share according to contactless fare validation (2015)	36% metro only trips 25% integrated (bus and metro trips) 39% bus only trips

Metro de Santiago is currently investing in one of its most major expansion programmes since its introduction with the development of Lines 6 and 3, which will open in phases from 2017. Previous major expansion has taken place during short accelerated periods as follows:

Period	Route kilometres opened	Comment
1970-1980	25	First operations 1975
1980-1990	2	
1990-2000	13	
2000-2010	54	Major expansion programme commenced
2011-2015	9	
2016-2020	46	Further major expansion - mainly Lines 6 and 3 (60% complete)
<b>Total</b>	<b>150</b>	

According to interviews, the organisation also understands that the metro system is a unifying aspect of many citizens' lives, and that integrating culture into system improves the quality of customer journeys. Metro de Santiago regulate musicians across the network and operate "Bibliometro", a free book loan service located in various stations on the network.

### Capacity

One of Metro de Santiago's defining characteristics is the density of its network demand. Santiago is ranked 3<sup>rd</sup> in the CoMET benchmarking group for density of demand, attracting 6.5 million people per direction per km.

This demand is concentrated heavily on Line 1, which achieves a capacity of approximately 50,000 people per hour and direction. It is the most crowded line on the network, particularly between the Lines 2 and 5 interchange stations. Although Metro de Santiago calculate frequency based on crowding density standards, the metro essentially uses all of their available fleet in the peak and have upgraded Line 1 with CBTC signalling. However, further capacity increases through operational management are constrained by extended platform

dwell times resulting from crowding. The surge in demand caused by Transantiago exacerbated these challenges.

According to interviews, the installation of CBTC signalling should have provided the system with the same level of capacity as it had pre-Transantiago. However, train frequency since Transantiago has actually decreased on account of the constraints that Line 1's operations impose. Specifically, limited ability to increase passenger flow further on Line 1 prevents increased frequencies on other metro lines that feed into Line 1. Passenger flow management on Line 1 is therefore critical along with communications and efforts to allow passengers to board trains immediately rather than waiting for subsequent trains.

According to benchmarking results, one of Metro de Santiago's key innovations has been to deliver more capacity on its network using "skip-stop" operations on Lines 2, 4 and 5 in peak hours. Under this approach, trains stop at every other station, meaning all stations are served, but fewer trains are required to do so. Skip-stop operation reduces dwell times by halving the number of boarding and alighting events that trains make along the network. Metro de Santiago estimate that skip-stop operation has increased capacity by 1 train per hour per line, saving the purchase of 5 trains (and avoiding the cost of maintenance and energy costs). Passengers have also responded favourably; it is estimated that previously affected customers' journeys are 3-5 minutes faster on average.

### **Incident Management**

A key focus for Metro de Santiago according to interviews is improving its resilience against long-term changes in travel patterns and demand (such as was caused by Transantiago). This also includes managing real-time incidents on the network. According to interviews, the impact of suspensions in service owing to disruptions on Metro de Santiago's reputation has been significant, although it did have the lasting benefit of emphasising the criticality of metro service in Santiago. A network improvement plan has been developed based on prioritising operational resilience. It includes an objective of improving reliability and availability of the metro by focusing on failures that will have significant impacts on service. Metro de Santiago have developed their own Key Performance Indicator to measure the significance of a failure through the following methodology:

- Identifying where the failure takes place and at what time of day;
- Identifying the number of passengers affected;
- Calculating the number of people unable to enter the station;
- Calculating the number of people unable to use the line (based on business-as-usual load calculations); and
- Calculating the number of people affected by the failure already in the station or train (based on business-as-usual load calculations).

Total number of passengers affected by the failure are multiplied by the time the failure lasts to form a KPI on the severity of the failure. This is one of the mechanisms used when communicating with the Government. Metro de Santiago consider themselves to be at the limit of capacity following Transantiago and the resulting operational adaptations needed to meet the new travel profile of Metro de Santiago's passengers. A key implication of this situation is that a single isolated incident may severely and quickly affect Santiago's transport network. According to interviews, there has been an increase in understanding amongst key stakeholders of how precarious this situation is, after Metro de Santiago's aggressive communications campaign over the last two years.

## Finances

Metro is rated by Standard & Poor's at A+ stable and by Fitch at A stable, both 1 notch below Chile's rating. In practice, Metro is considered by investors to have quasi-sovereign risk. It started issuing bonds in 2014 on the New York Stock Exchange raising USD0.5billion. Metro de Santiago has a (mainly long-term) debt of USD 2.2 billion.

Historically, an amount equivalent to 15% of Metro de Santiago's EBIDTA has been allocated to capital expenditure and additional funding has required negotiations with Government. Depreciation is also considered to be an operational cost, for all assets with a life cycle of up to 40 years.

Interviewees suggested that the "private sector ethos" of Metro de Santiago dates back to approximately 1990 when the company started preparing and formalising plans to address their operating practices and debt to gain credibility. By 1995, this was already perceived to have had a tremendous effect on the company's finances, particularly through the development of non-fare revenue opportunities alongside fare revenue. It was suggested that the gradual cultural shift away from the perception of the company as a "public administration" assisted the development of a commercial culture, and the company organises itself through what it considers as private practices in line with Chile's Companies Act Law (Law No. 18,046), through shareholder-appointed board meetings and contract management.

### Fare Setting and Value

Nearly all fares in Santiago are paid by means of the BIP! card (named after the 'beep' sound it makes when tapping-in). BIP! is a stored-value card and allows for free transfers between transport modes.

Fares revenue is received via a 'technical tariff', set according to Metro de Santiago's contract. The Government appears to be amenable to adjusting the technical tariff to ensure that Metro de Santiago's funding is sustainable, and an adjustment can be implemented on a monthly basis according to the following formula:

#### *Technical tariff adjustment*

$$\begin{aligned} &= \text{Change in Consumer Price Index (61\%)} \\ &+ \text{change in USD exchange rate (24\%)} + \text{change in electricity prices (13\%)} \\ &+ \text{change in Euro exchange rate (2\%)} \end{aligned}$$

Fare adjustments are binding, as the increase is solely based on the formula variables that are outside of Metro de Santiago's control. The technical tariff must cover debt repayments and the metro's operating costs, including depreciation of all assets with a life cycle of up to 40 years. It is not adjusted to make up for shortfalls in resources for Metro de Santiago's operations, although consideration is given to its long-term ability to contribute a third of the cost of extension projects (or other major projects approved by the Government). Adjustment is materialised as soon as projects are finished and resume operation. According to interviews however, operating expenditure over the previous 6-7 years has exceeded the increase for which the adjustment formula allows; for example, labour costs increasing significantly.

The evolution of the technical fare is as follows:

Year	Value of average technical fare in Chilean pesos	Value of average technical fare in USD
2007	271	.41
2008	278	.42
2009	277	.41
2010	291	.44
2011	297	.44
2012	301	.45
2013	300	.45
2014	335	.50
2015	360	.54

Fares are currently structured as follows (in Chilean Pesos):

Fare type	Flat fares, not distance-based. Fares depend on the time of day travel takes place and what interchanges between modes are used
Passenger pays	<p>Average 700 + 100 for bus/metro transfers. Actual:</p> <ul style="list-style-type: none"> <li>• Metro 740 (USD 1.11 equ.) in peak, 660 interpeak (USD .99 equ.) and 610 (USD .91 equ.) off peak</li> <li>• Bus 640 (USD .96 equ.)</li> <li>• Transferring from the metro to the bus and vice versa within a 2 hour period after tapping in is free</li> <li>• BIP! Card costs 1500 (USD 2.24 equ.) upfront</li> </ul>
Concessions	On the metro, students and elderly pay 210 (USD .31 equ.). Children up to age 5 are free
Metro receives a technical fare of	384 (USD .58 equ.) for a single passenger carried
Government subsidy	Approximately USD 700million per annum (to Transantiago)

Approximately 79% of Metro de Santiago's income is generated by fares revenue. The bulk of non-fare revenue in Santiago is generated from selling BIP! Fares, for which Metro de Santiago receive a small fee, with a relatively lower amount generated from retail, advertising and telecommunications<sup>8</sup>.

<b>Revenue Source</b>	<b>Income in 2015 Financial Year (Thousand Chilean Pesos, with USD equivalent noted)</b>	<b>Income in 2014 Financial Year (Thousand Chilean Pesos, with USD equivalent noted)</b>
Passenger transportation services (fares, without fee from selling fare)	238,225,349 (USD 363 million equ.)	223,723,300 (USD 348 million equ.)
Fees from selling fares	40,878,106 (USD 62 million equ.)	36,771,646 (USD 56 million equ.)
Lease of commercial stores, spaces and advertising	13,551,700 (USD 21 million equ.)	12,341,618 (USD 19 million equ.)
Lease of intermodal terminals	2,026,857 (USD 3 million equ.)	1,960,514 (USD 3 million equ.)
Other	6,266,498 (USD 9.5 million equ.)	6,492,758 (USD 9.9 million equ.)

### **Pressures on Operational Cost**

Operating costs on the metro are high; both interviewees and benchmarking results suggest that this is a result of high passenger loads and deferred maintenance. Furthermore, actions outside Metro de Santiago's control cumulatively escalated operating costs rapidly, for example:

- Energy costs from the National Grid have increased (owing to el Nino droughts and climate change). In 2015, the Chilean President Michelle Bachelet announced that Metro de Santiago will cover 60% of its energy consumption through renewable sources from 2018. The provision of renewable energy has been agreed via a contract for 15 years, offering some protection to Metro de Santiago from volatility in energy prices as well as continuing Chile's transition towards sustainable energy production to avoid expensive imports of non-renewable energy sources. Previously, Metro de Santiago negotiated with energy providers as annual increases took effect, and secondly by trying to be as efficient as possible in terms of consumption;
- Terrorist/ security threats have led to increased security costs borne by Metro (following bombings in September 2014). This was a recent point of negotiation for

<sup>8</sup> According to Metro de Santiago's 2015 Financial Statements, accessible at <http://www.metro.cl/minisitio/memoria2015/english/ma-cap-8-eng.php>



Metro de Santiago's 2016-2020 contract, with the Government agreeing to fund additional security;

- Remedial actions following Metro incidents (see below) and natural disasters (the 2010 earthquake);
- Labour reforms introduced by the Government have introduced a minimum wage and impacted many of Metro de Santiago's employees. Four main unions represent metro workers with negotiations ongoing.

### **Major Financial Risks Facing Metro**

According to interviews, Metro de Santiago's main risk is developing the mitigation needed to ensure that it can deliver its long-term financial commitments. An optimisation process is underway, looking at every aspect of organisational and operational management to find efficiencies. Metro de Santiago is also reprofiling its debt to make sure interest is as low as possible. The differential between fixed and variable rates in Chile has been low; Metro de Santiago has historically opted for variable rates which has proven to be a successful choice.

Transantiago created potential revenue risk for Metro de Santiago through the introduction of integrated ticketing. It also introduced some controls to minimise this risk, including an indexed fares formula against RPI, the exchange rate, and energy prices. In addition, Metro de Santiago sells a high proportion of Transantiago tickets and receives non-fare revenue for doing so. According to Metro de Santiago's 2015 Financial Statements, income from ticket sales totalled approximately 13% of revenue. Metro de Santiago have historically suffered with high energy costs, which constitute approximately 18% of total operating costs.

### **Major Projects<sup>9</sup>**

Metro de Santiago is very influential over the form of major extension projects. The network has achieved a size and level of demand where connectivity, integration and resilience are its key objectives. New lines are identified that relieve congested lines and stations are located where bus feeder services can increase the metro catchment. Stations are located where demand is high and integration necessary, and are sized on the basis of two sets of forecasts. The first of these come from a strategic model of the network. The second comes from a bottom-up model based on land uses in the station vicinity using a regression model. Cost-benefit analysis is undertaken based on a defined methodology by the Ministry of Social Development.

Metro de Santiago are able to carry out their own forecasting for future passenger demand, and these forecasts have historically been good. For example, Transantiago metro boardings were forecast at 717 million passengers per day compared with the 630 million passengers handled in the first full year following the implementation of Transantiago, approximately 8% lower. The Line 5 Extension forecast was for an average of 63 million passengers per annum – and after 3 years of operation, ridership had grown from 41 to 53 million, a difference of 10-15%. The major differences between forecasts and actual demand primarily relate to off-peak periods.

Lines 6 and 3 are major extension projects that are expected to have over a million beneficiaries. These new lines have been designed using lessons learned from previous Metro de Santiago experiences, incorporating:

- Unattended Train Operation (UTO) with Platform Screen Doors (PSDs) will be used. Platforms will be 120m in length, served by 5-car trains. The platform length will allow 6-car trains to be used in future if necessary.

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<sup>9</sup> The 2014 Major Projects case study included visit notes to Metro de Santiago.

- Using steel-wheeled rolling stock with greater width and capacity and strong supplier competition for the fleet and spare parts (some of Metro de Santiago's existing rolling stock fleet uses rubber wheels, restricting capacity increases because of tyre load constraints);
- Modular stations facilitating non-fare revenue concessions and services (e.g. retail and libraries). 6 stations will be small, 8 medium, 10 large or interchange, and 4 terminals;
- Good risk management using a probability impact matrix, identifying key risks and offering mitigation;
- Sound project management processes, with contracts awarded using International Competitive Bidding. The construction accident rate has been an issue however, at more than 4.5 workers per 100 in 2015, although this has been reduced considerably reaching an average of less than 3 by the end of 2016;
- Benefit quantification, for example, the lines are expected to reduce air pollution in Santiago by 1%.
- Further bus route rationalisation sponsored by DPTM, to increase integration with the metro and following defined principles that avoid direct competition.

Interviewees also described an incremental approach to projects that creates enhancements to the system over time, for example, gradual project implementation as part of the transition to creating universal accessibility on the network by 2018.

## Asset Management

*"It is important to maintain assets in good condition. Make investments in the correct moment - today we pay for investments not made at the right times. It is important to realise the Metro is critical to the City.... resilience is critical. The situation is now extreme...The system is at the limit of congestion. If something happens...this becomes a political problem".*

Metro holds approximately 70,000 assets and importantly, the majority of these assets have reached a critical age. According to interviews, Metro de Santiago has recently recognised that it is not investing in asset replacement adequately for sustainable operations. It has the autonomy to make its own decisions for asset management however and autonomy over how capital expenditure is allocated, so planning for immediate and future asset management needs is a current organisational priority.

### Asset-related Failures and Outsourced Contracts

The metro has experienced several asset-related failures in 2014 and 2015. These incidents were examined for lessons learned. A key learning identified during this process was a lack of clarity and efficiency in letting and managing outsourced contracts. One incident that caused suspension of service for a whole day was traced to a track failure; when investigating, Metro de Santiago felt they had insufficient information about the state of their tracks (particularly steel tracks that were installed in 2008), having previously outsourced this task.

Seven days after this incident, a failure of the Operational Control Centre (OCC) caused the metro network to lose its energy supply. Service was able to continue until batteries and back-up generators lost power, and ultimately the system lost power. Cleanliness on the network was also an outsourced task that proved to be insufficiently overseen: a further electrical fire caused garbage on the line to catch fire, significantly exacerbating disruption.

These problems cumulatively had severe implications for Metro's reputation and exposed the level of investment needed to maintain a resilient network. There was an increased realisation that *"metro is critical to the operation of the City"* and that *"buses were not an alternative"*. Although it took a short period to identify the immediate underlying causes of the incidents, over 6 months was needed to understand and improve the maintenance and early incident detection processes, carried out by an expert group. Metro de Santiago has learned that a

holistic view of why seemingly isolated failures occurred is necessary and therefore investigations take time: *“today we understand why the failure happened and what we need to do... you need to understand completely the state of the asset and must not lose control of the condition and information of the asset”*.

Metro de Santiago took immediate and wide-ranging action: organisationally, there was an acknowledged need for more recent and robust asset information and more involved, risk-aware management of outsourced asset contracts. Operationally, Metro de Santiago changed their strategy for outsourcing maintenance of tracks and fully adopted all track maintenance tasks. Metro de Santiago will continue outsourcing contracts on a case-by-case basis, noting that *“there is no recipe”* for outsourcing. Decisions on outsourcing will however be based on a clearer strategy following these incidents, noting that full internalisation of these functions creates vulnerability to unions. The most important tenet of this strategy is that Metro de Santiago must be an informed client first and foremost, by improving the quality of internal knowledge about assets to be able to effectively manage outsourced tasks. Metro de Santiago estimate that, by 2016 (approximately a year after major incidents took place), asset-related failures have reduced by 50%.

### **Asset Management Plan**

Metro de Santiago believes that the drive for effective asset management processes needs to come from the top of the organisation and advises new metros that *“asset management should start when the company comes into being”*. It has developed a 20-year Asset Prediction Plan and a 5-year Asset Management Plan. The 20-year Asset Prediction Plan highlights which assets require the greatest attention, based on several factors including impact on passengers and cost of various asset scenarios (enhancement, renewal, replacement, etc). Metro de Santiago are able to more effectively distribute their capital expenditure according to these priorities, and interviewees suggested that the cost of asset management is increasing significantly (particularly for train and track investment).

The plans are considered to be more achievable and realistic than previous plans because Metro de Santiago have invested significant effort in increasing the quality of information about assets; *“You cannot change the maintenance plan without knowledge about asset condition and detailed studies”*. The Asset Protection Plan identifies studies required during the next 5-years. The Asset Management Plan provides a year-by-year programme of activities. A key focus on both plans is maintaining high levels of reliability, although a key risk facing both plans is the level of funding required considering the age of Metro’s assets.

After Year 1 of the current Asset Management Plan, considerable successes have been achieved. There have been 40% fewer incidents affecting passengers and 60% fewer passenger-hours impacted. Major asset renewal is underway with the installation of CBTC signalling for Line 1 and rolling stock replacement are due in 2020.

### **Procurement Model**

According to interviews, major procurement in Santiago’s context can be politicised and Metro de Santiago must defend its recommendations to its stakeholders. Before entering negotiations over procurement, Metro de Santiago ensures its approach is technocratic, pragmatic and conservative, aiming to mitigate risk during the planning process. Metro de Santiago contracts out some of its function, and retains others: *“Why contract some things and not others? There is no recipe for this”*.

Metro de Santiago has tested different models for rolling stock procurement including:

- New trains with maintenance in house;
- New trains with 10-year maintenance;

- Steel wheel trains with 10-year maintenance (Line 4);
- New trains with 20 year maintenance.

Overall, interviewees suggested that Metro de Santiago would not need to resort to PPP to import expertise on metro design, construction and operation. An interviewee described Metro de Santiago' approach to this through an example at Baquedano station on Line 1, an interchange station with Line 5. Metro de Santiago's key concern at this station is that trains do not arrive at the same time to ensure regularity of service. Managing this requires a holistic view of the network (as many of Metro de Santiago's services are co-ordinated around the successful operation of Line 1) and fine-tuning to achieve this result. Metro de Santiago believe that outsourced management of this operation would not be capable of producing such fine-tuned optimisation of services. Furthermore, interviewees suggested that a PPP model for delivering a new metro project may risk good integration with the wider public transport network and the speculative spend to prioritise long-term integration (such as building extra capacity into key stations to cater for future demand); one interviewee noted that *"a concessionaire may not have the interest to work for the system"*. Instead, the President of Chile has suggested Public Private Partnership (PPP) may be suitable for the proposed Line 7, primarily because it is unlikely that public funds will be available. According to interviews, PPP has been previously examined for maintenance, operations and Design, Build, Finance and Operate (DBFO) contracts.

However, Metro de Santiago are interested in appraising the applications of PPP through international experiences currently underway in Sao Paulo and Lima. Interviewees suggested that the introduction of competition into the network could drive improvements and innovation.

## **Conclusion: Strategic Challenges Facing Metro**

Metro de Santiago's level of service offered, as well as its long-term participation in international benchmarking, proves that it is a capable, reliable, relatively productive and financially self-sufficient metro amongst operators. According to interviews, key opportunities for the organisation include expansion of non-fare revenue opportunities (in property for example) and optimising processes to gain greater management and operational efficiencies.

### **Lessons Learned from Transantiago**

Metro de Santiago has faced immense change in a short period (11 years) since Transantiago increased its ridership almost overnight by 77%. The defining feature of this change was that did not benefit from full input from Metro de Santiago, meaning that the Operator was unable to put in place the necessary operational changes to absorb such a dramatic increase in demand. However, Metro de Santiago notably demonstrated it was able to adapt quickly to unexpected changes.

When asked how this reform project could have been better implemented, interviewees suggested that incremental introduction of measures into the public transport system would have allowed for refinement of the measure itself and the mitigation developed by Metro de Santiago. This could involve introducing measures within a certain area of the city first (e.g. where impacts on service are less disruptive), carrying out more experimental pilot projects *"because things are going to fail, for sure"*, and having robust contingency plans for unexpected impacts: *"you need a plan B and a plan C"*. Metro de Santiago believe that engagement with the Operator is fundamentally important to making such an ambitious project successful: *"if I was planning again, I would take the knowledge and wisdom of the existing operators – they know the origins, destinations and the current demand"*.

### **Metro Autonomy**

*"Everyone wants a metro.....the main restriction today is precisely budgetary"*.

Financial sustainability has been critical to Metro de Santiago's autonomy and influence. This has been enabled by historically sustainable fares, access to liquidity, market credibility, and to access to low-cost financing. Strong leadership and an incentivised, high-performing staff have helped use autonomy and influence for the benefit of metro customers. Metro de Santiago has a rare position as an operator when compared to its benchmarking peers: it takes a holistic view of metro management operations because their autonomy allows them to do so, encompassing capital projects, construction, operations and business management.

The historic model for funding extensions (i.e. one third from Metro de Santiago's operational surplus) may not be able to support Metro de Santiago's further development. In particular, aging assets and cost pressures associated with energy and investments needed to achieve high reliability have put pressure on operational surpluses. One implication is that future metro investments will may require greater funding from Government which could increase the role of political factors in decision making with a loss in efficiency due to reduced autonomy for Metro de Santiago.

According to interviewees, Metro de Santiago's business model is operating at its limits. Competing Government priorities in other sectors and regions have strained public funds. Realistically, either fares have to increase or operational costs need to fall, or the capacity of public funding needs to expand in order to further support Metro de Santiago's development. Extra funding is required to maintain aged assets and implement a rehabilitation/ replacement programme. Metro de Santiago is currently constrained in its ability to secure integrated development profits at stations/ depots. This is reflected in international benchmarking of non-farebox revenues, although legislative modifications to allow these business activities would not transform Metro de Santiago's prospects on their own.

### **The Gap between the Operator and the Government**

It is important to note that there is a large gap between the national Government and Metro de Santiago. There are no intermediary organisations or regulators in between Metro de Santiago and the Government, as SECTRA are close to Metro de Santiago in terms of their scope and level of technical knowledge. Although Metro de Santiago adopt a holistic view of metro management and operations, communicating with Government and safeguarding long-term outlooks on the metro's future is a risk. Government control, for example through the Metro Law, constrains Metro de Santiago's capability to invest in other areas that would contribute to its organisational expertise, maturity and financial sustainability.

### **The Impact of Line 1**

Line 1 carries over 60% of Metro de Santiago's demand, is severely overcrowded and any disruption to Line 1 affects the entire metro network. As a result, all network operational and capital decisions need careful co-ordination with Line 1. This is arguably a product of Chile's planning regime for land development, which may have exacerbated a concentrated pattern of rapid development around Line 1. A lesson for greenfield metros in particular is that an integrated land-use and transport plan could help avoid this scenario by distributing development throughout the city more effectively and allowing the metro to secure its demand through increased accessibility to different districts.

Furthermore, Metro de Santiago expressed the importance of building network resilience throughout interviews. A key challenge is ensuring that bus operators also build network resilience through their operations and infrastructure (i.e. through bus priority, high-quality bus corridors) so that the city of Santiago is able to continue functioning more effectively when incidents occur on the network.

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## Quotations

Quote	About
"Metro is critical to the operation of the City" and "buses were not an alternative"	Role of metro in Santiago
"Everyone wants a metro.....the main restriction today is precisely budgetary".	Practicalities of delivering metro projects
To deliver the "best service in the country"	Organisational vision and purpose
"To date we have never built a white-elephant project"	Effective transport planning techniques
"We work with Metro"	SECTRA's collaboration with Metro de Santiago
"...More a moral issue than an economic issue"	Performance in the context of few contractual KPIs
"We adapt to their operation"	Collaboration between DPTM and Metro de Santiago
"They pay themselves and afterwards we get what is left. It's how it's always been. There is no issue"	How DPTM perceive the budget is split between public transport stakeholders
"It's all to do with budget. He who has most budget (i.e. Metro) decides"	
"They trust us", but "when things go well Government steps back. In 2014 there was a big problem. Then Government pays attention"	Relationship between Metro de Santiago and Government
"Our Charter is transport. This is the law and we cannot go against it. London has legislation for it to get into real estate. We would like to do this (but cannot)"	The constraints of the Metro Law on Metro de Santiago's non-fare revenue opportunities
"Transantiago was clearly such a true need... there was such chaos"	The need for public transport reform
"This was a Big Bang, a humongous change that affected hundreds of thousands of people. The companies, payment system and routes were not ready. There were only 4500 buses – a huge deficit (there are 6500 now)"	The impact of Transantiago on Metro de Santiago
"I don't know how many companies had such a shock of doubling of demand in one year"	
"the main problem was that metro was not prepared and no matter how professional you can be, nobody can accept that level of change – it's impossible"	
"If I was planning again, I would take the knowledge and wisdom of the existing operators – they know the origins, destinations and the current demand".	Importance of engaging with Operator to mitigate risk (Transantiago)
"It is important to maintain assets in good condition. Make investments in the correct moment - today we pay for investments not made at the right times. It is important to realise the Metro is critical to the City.... resilience is critical. The situation is now	Importance of asset management

extreme...The system is at the limit of congestion. If something happens...this becomes a political problem”	
“Today we understand why the failure happened and what we need to do... you need to understand completely the state of the asset and must not lose control of the condition and information of the asset”	Analysing previous asset-related failures and a key lesson learned
“You cannot change the maintenance plan without knowledge about asset condition and detailed studies”	The importance of asset information
“Why contract some things and not others? There is no recipe for this”	On outsourcing of contracts
“Asset management should start when the company comes into being”	Advice on asset management for new metros
“A concessionaire may not have the interest to work for the system”	Risk of future PPP engagement
“...because things are going to fail, for sure”, and “you need a plan B and a plan C”	Asset management and mitigating risk