DESIGNING SUSTAINABILITY INTO MASS TRANSIT

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abstract: This paper evolved out of the author's consulting work in 1996 to re-structure a heavily-indebted but traffic-rich LRT system in Manila. The study was initially conceived as a financial re-engineering effort, but grew into broader attempt to establish a sustainable urban rail mass transit system. It draws from that study certain desiderata to enduring transit viability. Going beyond the premise that government or urban authorities will keep the system going through thick and thin, the paper proposes that sustainability be planned and built into the system as early as possible. Efficiency in system operation and maintenance is a vital element of sustainability, but it often entails privatization, fare liberalization, and explicit public subsidy. The economic benefits are used to justify a subsidy, but the political climate may not be as kind to operating cost subsidies – which tend to hide performance inefficiencies -- than to capital grants. Build-Operate-Transfer schemes have become popular, but they do not obviate government intervention, aside from needing careful formulation because of likely imbalances of risks between the government and the private sector. The paper ends with a suggested template on sustainable mass transit with general applicability to other urban areas.

1. THE SUSTAINABLE PARADIGM

1.1 Definition

The term "sustainable" is often associated with low-cost non-motorized transport, and not with capital-intensive rail mass transit systems. It has become a buzzword in the development literature as well because of the growing acceptance of environmental concerns. In either context, the metaphor is derived from nature's capacity to renew itself. Sustainability is a system's capacity to negate entropy (Katz and Kahn, 1966).

1.2 Objective Function

Following this dynamic framework, a mass transit system that continuously loses money or exhibits declining patronage is undergoing the entropic process, and can be considered as moving on a non-sustainable path. Conversely, one that is growing and able to renew its fleet is on a sustainable steady-state path. This paper dwells on urban rail transit system -- which is often cast in more difficult circumstance than other mass transit modes -- and the factors that ensure its sustainability. The thesis is formulated as:

$$S = F(U, C, R, M, O)$$

where S (= sustainable mass transit) is a function of U = urban and transit scale, C = capitalization, R = regulation of the transit market, M = subsidy or external funding, and O = ownership and management.

1.3 The Predicament

Urban rail transit is enjoying a renaissance in the First and Second World, and increasingly becoming a fixture among large urban centers of developing countries. Equated with modernity, they get built on the automatic assumption that the system can be afforded and will be supported by public money. The reality, however, is that maintenance becomes a challenge in an environment lacking in supportive technology and financial means. Operating deficits lead to skimpy maintenance and to annual competition for public funds, compounded by poor performance caused by government bureaucracy. The result: an entropic mass transit system whose problems only get worse with every expansion. This was the situation faced by Manila's LRT Line 1, which was built in the early 1980s.

Usually, the introduction of mass transit in urban areas is preceded by technical and economic feasibility studies that considers **U**, but ignores or assumes **C, R, M**, and **O**. Also, conventional theory says that users should pay (Walters, 1968) and bear the full cost of the mass transit system. Unfortunately, price invariably exceeds the marginal cost of rail transit. Charging higher fares offers no relief, especially under a transit-competitive and price-elastic setting.

2. URBAN CONDITIONS AND SCALE

Mass transit is seen as and intrinsic element of large urban cities. The doctrine regarding the social function of transit equates into a belief that its availability is intrinsic for the functioning of an urban society and manifests into direct government control and funding with cross-subsidization. On the other hand, smaller cities, could avoid the large expenditures on mass transit (Armstrong-Wright, 1986). Many cities in Europe and USA are small, with population less than five hundred thousands, but show extensive network of rail transit. In Asia, Africa and Latin America, cities are large with more than one million residents, and yet do not have rail transit systems. Size, therefore, is not a definitive criterion, since the shape and land use patterns also influence transport demand. Nevertheless, the bigger the size, the higher the density and the more congested the streets, the more desirable mass transit becomes. Feasibility studies can be relied upon to configure an appropriate mass transit to respond to unique urban conditions and growing demands. Where this **U** factor is ignored in the capital investment decision, sustainability becomes doubtful *a priori*.

3. FINANCIAL STABILITY

3.1 Capital Deficiency

A necessary condition for sustainability is financial stability, which depends on the capital structure of a mass transit system and its annual financial performance – what is defined here as the **C** variable. A highly leveraged project with marginal or negative incomes will sink deeper into debts, a situation experienced by Manila's LRT Line 1 (Price Waterhouse,

et.al., 1997). Figure 1 shows its operating results, where losses have accumulated to P3.7 billion (~US$147 m) in 10 years of operation, despite the paradox of high ridership (3rd highest in the world on a per route-km basis).

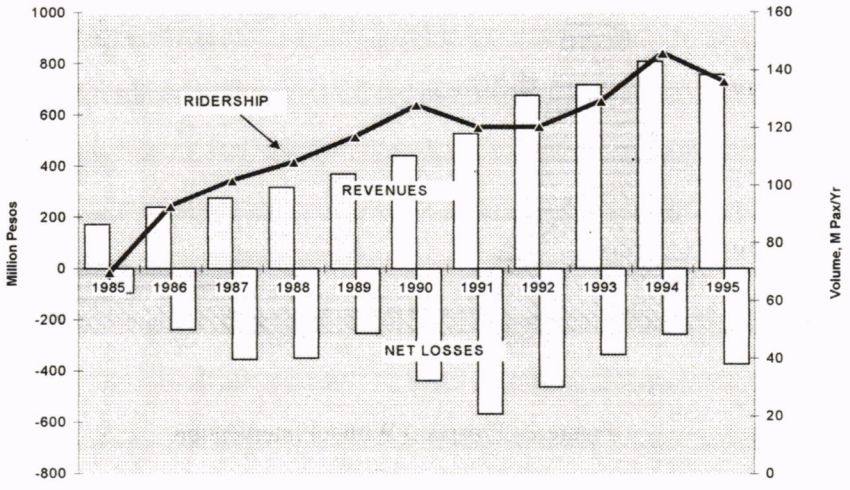

Fig. 1 - Revenues, Net Income and Ridership

Other urban rail transit systems in developing and developed countries probably share the same experience. Had Manila's LRT been a private undertaking, it would have already been declared bankrupt several years ago. That it continues to operate is due to the yearly blank checks issued grudgingly, but without fail, by the national government to cover its foreign debts. The red ink on the financial bottom line was anticipated in the feasibility study (Santiago, 1986), but no plans were made to fill up the yearly gaps.

A transit system that loses money every year is not necessarily inefficient, but financial hemorrhage eventually saps the system's ability to renew itself. It may take longer for systems with large front-end equity, shorter for those with bigger debt burdens, but the end-point is the same: bankruptcy. Conversely, a transit system need not be profitable in order to survive; provided the cash flows remain positive. The cash support comes from commercial activities, external grants and/or government subsidies.

3.2 Infusion of more capital

The future predicament of Manila's LRT is illustrated in figure 2, where net incomes and cash flows are forecast to remain negative especially with the addition of LRT Line 2 by year 2000. Combined cash receipts of Lines 1 and 2 would amount to P37.6 billion (internal cash generation of P15.2 B plus loan proceeds of P22.4B) but cumulative disbursements would reach P49.8 billion (P18.6B for debt service plus P31.2B for capital expenditures) from 1996 to 2010. The net effect is a projected cash shortfall of P12.3 billion over 15 years. About 81% of this deficit would have to be pumped in on or before year 2000, otherwise the construction of Line 2 would falter. The option is to cover the P12.3B deficit with additional equity and/or with outright capital grants.

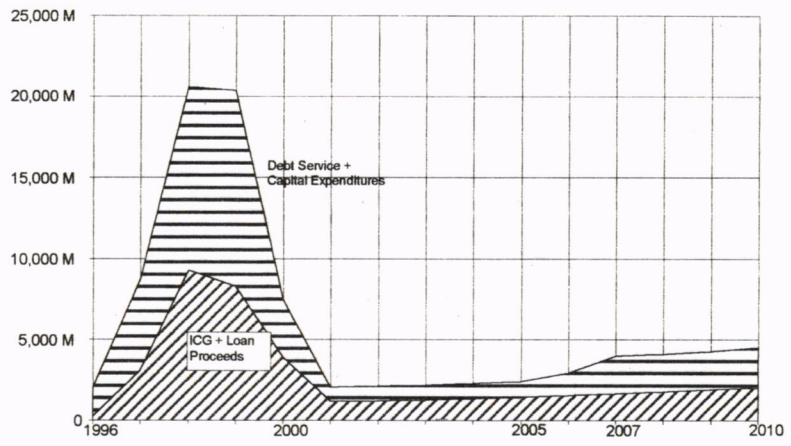

Figure 2 - Prospects Without Intervention

3.3 Required Subsidy

Subsidy to mass transit systems, the **M** variable, is justified on the argument that it is a merit good with external benefits not captured fully at the farebox, or one whose price is deliberately set below production costs for reasons other than financial.

Operating subsidy is not required by Manila's LRT because of the high patronage. It can cover operating costs adequately, especially if fares are adjusted periodically to keep up with inflation as well as reflect its true value to commuters. Financial simulations (Price Waterhouse, et. al., 1997) of LRT Lines 1 and 2 indicate that a substantial part of the capital costs can be funded internally. When the cost (inclusive of the loans) of the track infrastructure, or what constitute the permanent ways, are picked up by the national government, i.e., subsidized, the system becomes financially self-liquidating. In the case of LRT Line 3, the concessions (guarantee on foreign loans plus 16 hectares of land for depot and commercial development) granted by the government translate into a capital subsidy of an undetermined value.

There are several advantages why an explicit capital subsidy is suitable for Manila's situation, viz., : (a) it is a very transparent and made known up front; (b) allocation of public funds for such a subsidy is politically-efficient (Jones, L.P., 1993), in the sense that expenditures can be associated publicly with a visible project; (c) it does not mask operating inefficiencies; (d) it insulates the transit agency from the vagaries of the annual budget process, and hence permit a more stable environment and encourages a long-term orientation; (e) it can be applied to LRT projects implemented on BOT schemes as well as those on conventional financing mode.

3.4 International Comparison on Transit Subsidy

Information culled on other urban transit systems show that nearly all are subsidized (Bushell, 1996). Subsidy to all urban rail systems in the USA averaged 50% of total operating costs. In the Netherlands, the comparable ratio is 52% of operating expenses on top of full capital subsidy. Figure 3 provides the range of operating subsidies recorded at selected urban centers. On this yardstick, Manila's LRT system is exceptional, since its revenues exceed running costs and capital is only partly subsidized.

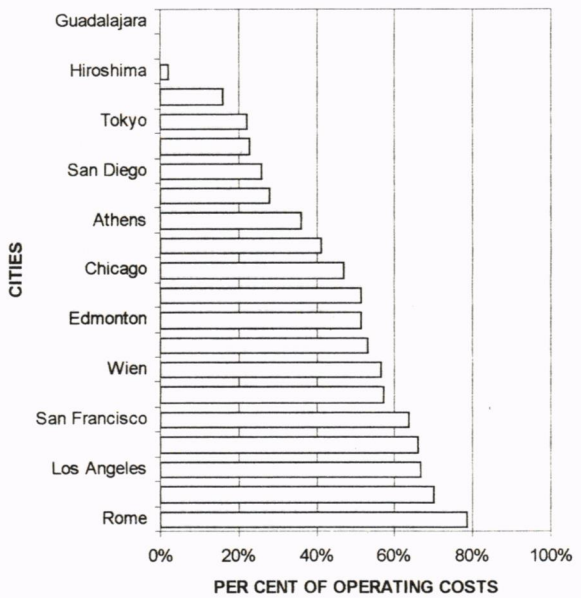

Figure 3 – Comparative Subsidy Levels

Capital rather than operating subsidy was initially the norm in the USA. The US Urban Mass Transportation Act of 1964 (Berechman, 1993) authorized federal funding of transit capital expenses. This was amended in 1974 to include transit operational expenses as well. Nevertheless, capital subsidy remained the dominant form – by a factor of about 4 to 1. Japan has a more elaborate system of funding urban railways. Seventy percent of subway construction costs are repaid equally in 10-year installment subsidies by the central and municipal governments (Morichi, 1993). Railways for new towns could also secure capital subsidy up to 36% of qualified construction cost. Capital subsidy up to 44.9% of qualified construction cost is also available to monorails and automated guideways. Japan also boasts of a Railway Development Fund, in existence since 1991 (Ryuzaburo, I. and Takashi, Y., 1993).

Although subsidy can be justified, the fiscal and economic issues remain: where to source the money and up to what extent? In many countries, the national and local governments share in the fiscal burden. In small countries like Holland, Ireland and Israel, subsidy funds come almost exclusively from the national coffers. In federal countries, e.g., Germany, USA, and Switzerland, subsidy comes from the federal, state, and local governments. Some have specific or dedicated sources of funding assistance -- like tolls, sales tax, betterment levies, and fuel tax. The most common source is a surcharge on fuel. Baltimore has a Transportation Trust Fund, not unlike Japan. In the Philippines, a dedicated fund for

mass transit is likely to be opposed because of the government's policy of a one-fund concept. Much more doubtful is financial support from the beneficiary cities, whose contributions to less costly infrastructure projects are minimal.

4. OPERATING EFFICIENCY

4.1 Good Management Does Not Just Happen

Manila's LRT had not been running efficiently as desired (Price Waterhouse, et.al., 1997). Fleet availability is lower (around 75% vs. 90% norm) due to lack of parts, inadequate materials planning, and bureaucratic constraints. It was planned from the beginning to be under private management, precisely to overcome the constraints of public sector management. For a while, management was in private hands. However, the contractual relationship between LRTA (the owner, administrator and regulator) and Metro Inc., (the operating management entity) became ambiguous and blurred when the latter became a subsidiary of the former in 1989. The results: diffused responsibilities, unnecessary work (and hence excess staffing), funding cutbacks unrelated to needs, and deferral of preventive maintenance works. The only sustainable solution called for the re-privatization of Metro Inc., but under a new concession framework rather than a cost-plus management contract.

4.2 Privatization: key to good management

Occasionally, and for short bursts of time, government surprises itself and is able to manage well. But good performance, somehow, could not be sustained. The **O** factor regresses with time, especially in "soft states" where the public administration is not known for operating efficiency. This is where privatization comes in, to ensure that **O** improves. Regardless of the ability of public authorities to manage transit, the global trend is towards divestment by government of many responsibilities it had assumed in the past. In 1995, more than 8,500 state-owned enterprises in more than 80 countries have been privatized (Kikeri, Nellis and Shirley, 1992). A detailed study of the World Bank of 12 cases in 4 different countries showed clear benefits, such as: a) higher investments, b) higher productivity, c) higher output prices, d) win-win to local/foreign investors, consumers, workers, and government.

4.3 From Monolith to Network Organizations

However, "privatization is not a blanket solution for the problems of poorly performing SOES" (Kikeri, Nellis, and Shirley, 1992). The huge price as well as poor returns would deter private capital from buying in. Segmenting the rail transit into several entities, aside from separating ownership from function, could make the concession attractive. This kind of fragmentation was demonstrated in the famous privatization of the British Rail, which, previously, was a monolithic rail organization. In the recommended re-structuring of Manila's LRT, the government rail transit authority will end up as the owner of the rail assets with planning and regulatory responsibilities. The commercial activities will be transferred to private operating entities. When multiple lines are in operation, two other corporate entities can be formed -- one for ticketing and another for track maintenance.

4.4 The Return of Private Capital

The current rage in infrastructure development is the Build-Operate-Transfer (BOT) scheme that impacts simultaneously on the **C**, **M**, and **O** factors. Except for the name, BOT has a back-to-the-past quality: private finance were characteristics of railway investments in many countries - notably North America - for much of the 19th century (Eichengreen, 1995). The historical data also revealed that it did not eliminate government guarantees, subsidies and foreign finance.

Manila's pre-war tram system was privately funded (Iwata, S., 1993). The BOT option, therefore, is not a novelty when it comes to rail transit projects. What is new is the division of risks between the private proponents and the public sector. An analysis of 11 urban mass transit projects on the BOT track in various countries -- LRT 3 of Manila included -- concluded that those with low private sector risks have taken off quite speedily. In contrast, those that suffered delays (Bangkok is the best case in point) have all the risks borne by the private concession holders. Asymmetrical assignment of risks may provide comfort to commercial lenders, but BOT contracts in that mold are susceptible to premature termination after a change in government. To overcome the natural reluctance of private capital to take on mass transit projects, government may guarantee fully or partly private debts, grant land concessions, and assume commercial risks. All of these were given to the Manila's LRT Line 3 Project.

5. GOVERNMENT REGULATION OF TRANSIT

5.1 The urge to regulate

Public regulation of transit is the **R** factor of a sustainable system. It influences, if not dictates, the value of the **O** variable. Regulation, financial support, and state ownership are usually rationalized around three principles: economic efficiency and equity, political ideology, and social role of transit.

Economic theory justifies government regulation for reasons of *market failure* and *income distribution* (Berechman, 1993). The first aspect, *market failure*, arises from externalities, public goods, natural monopoly and imperfect information. Mass transit usage is said to reduce traffic congestion and thus benefits also car-riders and other road users. Conversely, the free use of the roads encourages car-based trips that exacerbate air pollution and congestion. The public good argument is predicated on the absence or inadequacy of transit supply, when left entirely to market forces. Rail transit is claimed to be a natural monopoly where scale economies are present to justify regulation. Transport is said to be a "merit good" whose provision at affordable prices is supposed to assure access for the disadvantaged and the poor.

The political circumstance of the country determines how pervasive government interventions would be. Thus, a strong free-market ideology leans toward deregulation and private sector production of transit services. In centrally-planned and socialist economies, the ambit of government involvement is often larger and conceded. Institutional weakness (Jones, L. P., 1993) also leads to regulatory failure (inability to obtain necessary information) and

regulatory capture (susceptible to manipulation), with consequent deviations between *de jure* and *de facto* transport policies.

5.2 Setting the Price

Transit price is the favorite instrument of government control. The instruments vary in terms of their incentive power and administrative complexity. Incentive refers to the motivation for the firm to act like a true profit maximizer in minimizing costs. At one end of the spectrum is the ex-post cost-plus arrangement that gives the firm no incentive to economize. At the other extreme is the fixed price cap, where the firm gets to retain all the gains from cost reduction. Those on the cost-plus end are deemed low-powered in their ability to induce efficiency (but rates high on equity), while those on the price-cap end are termed high-powered.

The freedom to adjust fares is something that private capital prefers, but a regulated one is tolerable provided a fare adjustment method is agreed beforehand. Price cap methods (e.g., RPI-X, parametric formula) provide the confidence that fares can be adjusted in a timely fashion. This confidence is lacking under a fare regime that puts a ceiling on profits and requires prior application and public hearings.

6. IMPLICATIONS AND CONCLUSIONS

6.1 A Sustainable Path for Manila's LRT

Metro Manila is now experiencing the simultaneous implementation of several LRT lines. The existing Line 1 will expand capacity by 50%, effective 1998. Line 3 is under construction, via the BOT route, and will be operational by 1999. After a failure in 1987 to get Line 2 on the BOT track, it is now being implemented through conventional financing and should be operational by year 2001. An unsolicited BOT proposal for Line 4 is under evaluation, and may be awarded by 1998. Another private group has formed to pursue Line 6, while Line 5 has been integrated with the Northrail rapid rail project. All will demand resources from, and incur liabilities for, the government, despite the fact that majority of them are being undertaken on BOT arrangements. Are all of these sustainable?

Financial simulations of the recommended re-structuring (Price Waterhouse, et.al., 1997) measures point the way to sustainability, and the results are shown in figure 4. The base case assumes no restructuring and no government absorption of transit's capital or operating costs. It is clearly a continuation of the past, and is not sustainable. With partial (i.e., cost of track infrastructure is off balance sheet) subsidy, the cash flows move into the positive range beginning year 2000. The recommended package for Manila's LRT consisted of the following:

- A capital subsidy *after-the-fact*, through conversion of debts incurred in Line 1 into equity;
- A capital subsidy *before-the-fact*, through assumption of financial responsibilities for the track infrastructure of Line 1 and future lines;
- Award of long-term and separate concessions to private entities, via public tender, who will operate Lines 1, 2, 3, and 4, respectively;

- Hands off policy on the setting of fares, or adoption of a high-powered and simple formula called RPI-X.

Eventually, a rail or mass transit fund should be set up with contributions from fuel levy as other sources.

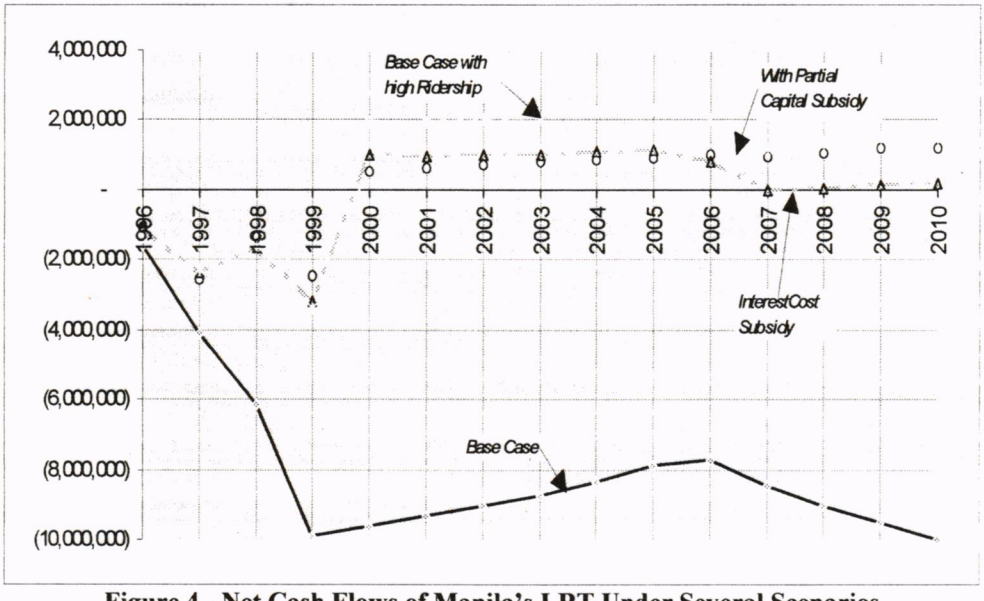

Figure 4 - Net Cash Flows of Manila's LRT Under Several Scenarios

6.2 Applicability to Other Cities

Certainly, the situation faced by Manila's rail transit system is not unique. There are three major determinants that shape the present and future of any rail transit system. These are: demand factors, production characteristics of service supply, and regulatory and subsidy conditions. Of these, only the latter components are susceptible to public policies. A suggested template – identifying the factors and the range of choices --to design sustainability into mass transit is summarized in Table 1. On a scale of 1 to 5, with the higher rating for greater contribution to sustainability, the situation of Manila's LRT is depicted. The template can be applied to other cities.

Table 1 – DESIGN TEMPLATE ON SUSTAINABLE TRANSIT

FACTOR	VARIABLE	LOW-END	1	2	3	4	5	HIGH-END
Demand	City Size	Small					◆	Large
	Urban Form	Dispersed			◆			Compact
	Density	Low				◆		High
	PT share	Low, car-based					◆	high share
Operations	Efficiency	Low		◆				High
	Systems	Sophisticated, high-tech	◆ Line 2			◆ Line 1		simple, low-tech
	Organization	Government						private enterprise
Financial	Profitability	Negative	◆					Positive
	Cash Generation	Expenditures > cash receipts				◆		cash receipts > expenditures
	Subsidy policy	Not defined, but assured	◆					pre-set, with conditions
	Source of subsidy	General fund	◆					special transit fund
Regulation	Fare control	Set by regulator	◆					set by operator
	Market entry	Unrestricted			◆			Competition is curtailed
New Line or Service Development	Commercial risks	Borne fully by private operator					◆ Line 3	Assumed fully by government
	Planning	Left to BOT proponent	◆ Line 3					Plans prepared by government
	Manner of award	Concession won secretly, by negotiation		◆ Line 3				Transparent, awarded in open tender

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