Rethinking Transport Baselines to Make Better Project Investments

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Abstract

*Transport investment requirements are growing rapidly with transport demand. In developing countries, majority of transport infrastructure is yet to be built. With growing investment needs, making appropriate decisions on transport investment is more critical than ever. In the realm of project decision making, the option of '**doing nothing**' or '**no project/investment**' is considered as the baseline of the projects. Potential benefits of the project are always compared to a 'do nothing or do minimum' option before a decision is taken. However, this 'do nothing' concept is a myth – 'do something else' is a reality. In absence of a particular project or an investment, a suitable alternative would be found and implemented by the authorities. Thus, baselines need to be redefined and 'without project' scenario should not be just considered as 'no improvement' but, should ideally be considered as to what would 'most likely' happen if this project is not executed. By making this change in baseline, fundamentals of transport investment can be strengthened and this can lead to paradigm shift in transport. Considering BRT and Metro projects, assessment of transport expansion in the baseline was estimated and found to be a gamechanger in the economic analysis.*

Keywords - Baseline, economic analysis, project appraisal, infrastructure, cost-benefit analysis, transport emissions

1. Introduction

Global transport annual investment is estimated to be around 2 to 3 trillion[1]. Countries need to ideally reserve 3-4% of the GDP for facilitating transport, however, many countries are finding it difficult to match investments with increased demand. Road transport demand is outpacing GDP growth in many developing countries[2]. China in 2013 invested nearly 20 billion USD[3] in building its transport network while India is planning to invest 20 billion USD annually till 2030 [4] in urban transport. Clearly, projected increase in transport investments is both a challenge and an opportunity.

While main challenge for developing countries is to match investments with increased demand, the opportunity for developing countries is to build its transport system with the foundation of sustainable transport policy options. Transport investments with sustainable transport foundation requires less investment to cater for same transport demand while mitigating emissions and generating higher economic outputs. With growing transport related externalities costing 5-10% of the GDP, economic and environmental consequences of bad transport investments can be irreversible.

Transport infrastructure can be very expensive and time consuming to build. However, once built, transport infrastructure is difficult and costly to modify and have long lasting impact. Considering limited resources, possibilities of recession and austerity, need for balanced investment in different scales - local to national and multidimensional pull from different sectors for funds, *it is more important to invest rightly in transport than to invest more in transport.* This is most important especially in developing countries where both underinvestment and overinvestment in transport will not provide best economic and social returns to the investment. With growing investment needs and growing transport externalities, making appropriate decisions on transport investment is more critical than ever.

Many of transport plans, strategies and investments are executed in form of infrastructure projects like access roads, expressways, urban mass transit system like metro or BRT, intercity railways etc. Before deciding to invest on a particular infrastructure, analysts often compare project benefits and alternatives with *a baseline which is an appropriate counterfactual to the project investment* in order to understand the overall implications of the investment. It is a hypothetical scenario that would prevail in the absence of the project. All the benefits of the projects and its alternatives are generally compared with a **'no build' / 'without project'/ 'doing nothing'** scenario. This comparison of 'With project' and 'Without project' forms the foundation of transport projects' economic and environmental assessments from past many decades.

This research is conducted at the intersection of transport economic and environmental assessment. This research is a marked departure from a great many different types of research on economic, multi-criteria and multimodal assessments, tools for economic evaluation, cross-sectoral approaches, socio-economic impact, stakeholder consultations to improve transport decision making process. Here, transport baseline is at the crosshairs.

In this research paper, first, transport baseline is discussed and followed by discussions on various benefits of transport projects and importance of fuel savings are established. Next, BRT and Metro projects are discussed with examples. The quantum of infrastructure expansion in the baseline is established by considering Singapore case. Next business case for costs and benefits of including ''infrastructure expansion' in the baseline is established. Though, only infrastructure projects are discussed in length in this paper, technology and energy efficiency projects can also be a good example for reconsidering and redefining baseline.

2. Transport Baseline in Projects

Constructing the transport baseline is probably the most critical task in the appraisal process as all project cost and benefits are compared with this baseline. In general, there exists three types of possible baseline counterfactuals.

1. 'Do Nothing': This scenario does not consider any improvement and investment in absence of proposed project which often results in a pro-bias towards projects as the baseline describes a deteriorating scenario where facility is unable to meet demand.
2. 'Do Minimum': This scenario considers minimum investment to keep the existing capacity operational for full length of analysis. This scenario does not envisage high comparable investments in absence of proposed project.
3. 'Do something else': This scenario envisages an alternative project in absence of proposed project.

Further, 'without project' baseline can be segregated into static or dynamic baseline. Static baseline scenario considers 'without project' scenario at a single point in time (e.g., before construction or date of commissioning). Dynamic baseline considers change in various transport drivers and other exogenous factors that are not directly dependent on the investment. However, in both the cases, no investment is considered in the baseline.

Generally, all transport economic and environmental assessment guidelines propose comparison with 'do nothing' or 'do minimum'. It is hard to determine when exactly 'without project' was first used as a reference for project evaluation, but it is being used from early 1960's in transport sector when cost-benefit analysis gained prominence. 'Without project' was essentially used since there was a need for a standard datum against which project benefits can be compared with. Below table provides a summary of various guidelines and publications on baseline definition. In general there seems to be high level of consensus on 'Do Minimum' as the baseline option. Though, some guidelines like Asian Development bank (ADB) (below table) argue to reconsider 'most likely' scenario in absence of project to prevent rigging of the analysis in favour of the project. This aspect is further explained later. However, for simplicity, in practice, transport baselines in economic and emission quantifications is always considered by analysts as *'do nothing' or 'do minimum'.*

Does *'do nothing' or 'do minimum' really describe the counterfactual or the scenario of* what would have happened without the project?

There is lot of ambiguity and misconception with regards to the transport baseline. No city has managed to sustain 'doing nothing' as the cornerstone of its policy making. In case a particular type of project is not implemented, a suitable alternative, strategy or funding would be found by the authorities. For example, in Bogota, authorities had an option between 'Inner Ring Expressway' or ' to improve public and non motorized transport' at a fraction of the cost [5]. The inner ring road project was estimated to have an economic internal rate of return of 14.7 percent and highly feasible to implement. Authorities took a decision which contradicted outputs of a transport model-driven planning process and the decision became a trendsetter. The main issue with transport project selection is the way baseline is defined and established which incentivizes traffic-centered approach where traffic growth is matched with large infrastructure projects.

'Do nothing' concept can be examined in simple terms: if the total ridership of a proposed Bus Rapid Transit project (BRT) is 10 million over 20 years lifecycle, the baseline would be the same amount of trips (neglecting induced traffic) travelling in different modes without the project. However, the 'same passenger trips' in both with and without scenarios actually signify additional investment in expanding roadways. It is illogical to assume that the same amount of existing roads would accommodate such a drastic increase in traffic volume without subsequent expansion or addition of a suitable alternative. Thus, in traditional practice the 'do nothing scenario' actually implies 'doing something' – increasing supply to sustain the projected traffic movement. Historically, many cities have been using this argument and expanding roads to accommodate increasing vehicle traffic, without any sustained success over time.

Table1 : Transport baseline in different economic and environmental assessment guidelines

Guideline/Study	Baseline
UNECE [6]	a realistic do-minimum scenario is the one in which the transport network is as it would be if the project in question was not implemented. The do-minimum scenario is meant to include a realistic level of maintenance and a minimum amount of minor improvements where absolutely necessary, to avoid the transport network deteriorating - a pure do-nothing scenario would lead to unacceptable transport conditions so is not useful as a base for appraisal.
CDM (AM0031, ACM0016) [7]	Baseline emissions are those that would occur if passengers used conventional (nonproject) modes of transit to make the same trip as they perform in project modes
GEF [8]	The baseline 'no-project' scenario should incorporate analyses of the sector's current static conditions as well as growth trends of transport behavior, different technologies, mode shares, carbon-intensity of fuels, fuel economy of vehicles, etc. This measurement must forecast emission values for the specific market that would occur without the GEF or co-financing intervention over the period of the intended project. Baselines should contain a description of the market's likely development and transportation activities as they would evolve without investments from the GEF or co-financing. The baseline should also include all non-GEF interventions that would be introduced to the sector by the implementing agency.
World Bank [9]	The 'do minimum' scenario needs to be a realistic base case against which the project/policy options are assessed therefore appropriate definition and selection of the alternatives for consideration is crucial.
OECD/IEA [10]	A baseline is a measure of the emissions that would have occurred in the absence of a project. This means that the baseline for a certain variable does not vary with the project being planned to affect that variable.
EBRD Greenhouse Gas Assessment Methodology[11]	The Baseline or Reference Scenario emissions are the hypothetical emissions that would prevail in the absence of the project. For projects not seeking CDM accreditation, a static baseline is considered adequate. An assessment should therefore be made of the emissions that would have continued to occur in the absence of the project at a single point in time at or near the time of project commissioning.
CTF [12]	All estimation of GHG benefits will have to be measured by establishing the differences between a without-project scenario and the anticipated project scenario. Any expected improvements in vehicle fuel- and emissions-efficiency over the modeling period in the project and without-project scenarios should also be determined and applied to the base year's locally calibrated figures.
JICA [13]	The baseline emissions for various types of vehicles are estimated by multiplying their shared number of passengers with their CO2 emission factors per passenger before the project starts
EIB [14]	For capacity expansion projects, comparison is done between the 'do something' with a 'do minimum'. For rehabilitation projects, comparison is done between the 'do something' with a 'do nothing'.
ADB Economic Analysis [15]	The without project situation is that which would prevail without the project. It is not the implementation of the next best alternative, unless there is clear evidence to suggest that this is most likely to be the case. Without project scenario is not the same as before project situation as the productivity levels would change due to non implementation of the project.
UNESCAP [16]	Traffic which would have developed without transport improvement should be considered in baseline.
Transport Canada [17]	A base case option, reflecting the best that management can do without significant investment, is essential as a reference point against which to compare the other options.
FHWA [18]	The base case represents the continued operation of the current facility under good management practices but without major investments. Under these 'do minimal' conditions, the condition and performance of the base case would be expected to decline over time.

This paper tries to argue in favour of incorporating the measurement of **'most likely'** step in the baseline for evaluation of sustainable transport projects for a start.

Based on traditional investment patterns in developing cities, 'most likely' step would be infrastructure expansion and considering this additional infrastructure requirement in without project scenario could change the project evaluation dynamics. The cost of additional infrastructure prevented by the project is a benefit to sustainable transport investment. Incorporating this 'supply increase' concept in the baseline has the potential to radically alter the project evaluation approach of transport options as many public transport improvement projects would automatically become feasible and their implementation faster. In the context of the challenges described, baseline aspect has been scoped in detail in this paper with many examples from BRT and Metro systems. BRT and Metro systems are considered as many methodologies and toolkits exist to determine economic and environmental feasibility of the project.

3. Tiers of Transport Benefits

From early 1960's, transport projects are being prioritized based on primary yardstick of economic efficiency. Transport project appraisal is based on establishment of economic efficiency based upon a valuation of all costs and benefits in monetary terms. Safeguarding of the environment was more of a reactive approach until growing externalities from transport switched public discourse. Transport benefits now can be generally categorized in three tiers -

1. Tier 1 - 'generally quantified' and traditional such as travel time savings and fuel savings
2. Tier 2- 'sometimes quantified' such as emission reductions and road safety improvements and
3. Tier 3 - 'acknowledged and appreciated but often not quantified' such as noise reduction, land use impacts, health benefits, improvement in quality of life, improved economic opportunities, increased jobs, increased revenue, fuel security, etc.

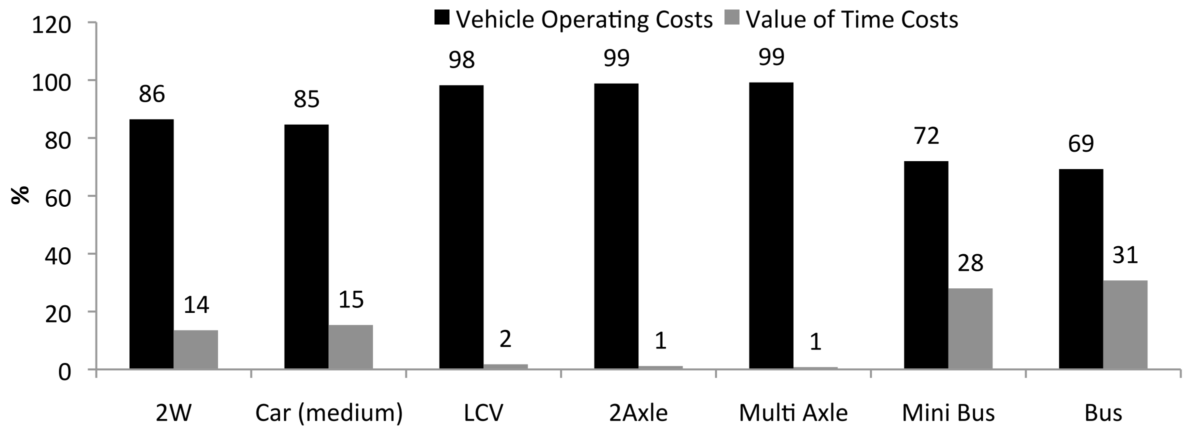
In traditional project implementation cycle, Tier 1 benefits (often called as direct benefits) are quantified and compared against project costs during economic feasibility stage of the project. In case the project is being financed partly by development banks or through carbon finance mechanisms, quantification of CO_2 savings becomes critical (tier 2). Methodologies in Tier 1 and Tier 2 for calculating fuel consumption and carbon emissions are not actually very different from each other as once fuel savings from a project are estimated, calculating CO_2 emissions is a simple multiplication of carbon content of fuel. However, acknowledging this aspect creates a paradox. For example, many now acknowledge that high speed highways are not sustainable in terms of carbon emissions. However, many such roads continue to be built based on promise of savings in fuel consumption. Baseline assumption is a primary driver of this contradiction. Let us try to dissect this argument more.

In majority of road projects, the common assumption is to compare 'with project' and 'without project' with same intensity of traffic in both the cases (neglecting induced traffic). For example, ADB special evaluation study [19] after reviewing ADB transport portfolio over 2000-2009 documented that traffic saturation and induced traffic is often neglected by project officers. This creates a perfect 'gaming' situation. Since the comparison is being made of same volume of traffic but once in a deteriorating condition (large volume of traffic travelling in constricted space leading to high fuel consumption and travel time) and once in an ideal condition (similar traffic in ideal speed with no congestion), large benefits of fuel and travel time savings are observed making the baseline inflated and turning the project into an ideal case for investment.

However, what if the traffic does not grow due to congestion in without project case? what if the project was invested after few years?

Let us try to understand the implications of these questions.

Figure 1 - Comparison of vehicle operating cost savings with travel time benefits



It has been observed that road projects economic feasibility is evaluated primarily using vehicle operating costs savings, travel time savings and accident savings. Based on a World Bank review of forty-four road projects in developing countries [20], it was found that majority of road projects were based on premise that they reduce vehicle operating costs. This study reinforced importance of vehicle operating costs especially fuel costs as established earlier by world Bank in 1987 [21]. However, this finding is in contrast to earlier findings from Britain where travel time savings accounted for around 80% of the monetized benefits within the cost–benefit analysis (CBA) of major road schemes [22]. It is important to note that both fuel costs and travel time costs are dependent on speeds whose determination depends on baseline selection. However, in developing countries where fuel costs are comparable to developed countries, wage rates lower, fuel efficiency of vehicles low and travel speeds low when compared to developed countries, fuel and vehicle operating costs are significant drivers of project feasibility. Fuel cost constitute a significant component of vehicle operating costs and thus many road projects are economically feasible based on calculations that justify fuel savings. Since, fuel cost constitute nearly 30-75% of vehicle operating cost, many massive infrastructure projects like expressways are built based on the premise that they provide fuel savings when compared with 'without' project scenario. If these projects provide fuel savings, they should provide CO_2 reductions.

But the general consensus is that such projects do not provide any carbon emissions reduction and not even a single expressway project in the world has been built using climate finance. This means that fuel savings establishment in the projects is a suspect. This contradiction is due to lack of clarity on baseline.

Analysis of an ADB national highway project [19] provides a valuable insights on impact on CO_2 emissions when traffic saturation is considered. In this case, saturation in traffic growth has been established at volume-capacity ratio of 3 and 1.5 and the CO_2 emission savings from project drop from 16000 tons/km/year (saturation at V/C 3) to 3000 tons/km/year (saturation at V/C of 1.5).

By differentiating traffic in with and without project cases, ADB found that Expressways lead to increased carbon emissions when compared with 'without' investment scenario. Once, CO_2 increase has been established in the project, the direct implication is that project increases fuel consumption when compared with 'without' project scenario (baseline). However, many such massive capacity expansion projects gets constructed on false promise of fuel savings. The main barrier in effectively analyzing the project impact is in the 'baseline' assumption as this paper will try to prove in the next sections. Furthermore this research argues for reconsidering transport baselines as defined by many investment agencies i.e. 'no build" / 'without project'/ 'doing nothing'.

4. The Case of BRT and Metro Project Benefits

For past two decades, public transport systems like BRT and Metro are expanding fast. Globally, more than 160 cities have adopted Bus Rapid Transit systems with over 4,000 BRT lane kilometres [23] are already in operation. Metro systems exist in nearly 190 cities with over 11,200 km of rail kilometers [24]. Globally, based on the total infrastructure built and ridership carried, on an average a metro carries 3.6 million passengers/km/year while a BRT system carries around 2 million passengers/km/year. However, the cost to achieve this mobility comes at a different price i.e. typical metro costs 50-300M$/km while a BRT costs 3-10 M$/km. Certain corridors may dictate a specific solution depending upon the demand but over a big range of transport demand (5000-50000 persons per hour per direction), there exists an opportunity to evaluate different options and take appropriate cost effective decisions.

A BRT or Metro system can provide benefits via:

1. Improved fuel-use efficiency through efficient public transport
2. Mode switching due to the availability of a more efficient and attractive public transport system;
3. Occupancy increase;
4. Speed Increase;
5. Potentially a fuel switch to low carbon fuels

Increased demand for Metro and BRT in cities around the world is mainly due to high benefits generated by the system. Benefits of these systems are often due to mode shift and efficient travel in terms of occupancy and speed. By shifting the projected vehicular trips to more efficient modes and comparing it without any project case (BRT or Metro), savings such as travel time, fuel and emissions are established. In case the BRT/Metro would not have been constructed, the users would have been forced to use the existing modes and thus the savings results from comparing both with and without BRT/Metro cases. However, key aspect missing here is the new capacity required in baseline to accommodate such increase in transport demand over the lifetime. Recognized methodologies for BRT and Metro projects' CO_2 emissions such as CDM, TEEMP, JICA, CTF etc. (table 1) emphasize mode shift impact calculations without clarifying how people would travel in 'without project' with limited road space for baseline computations. Currently all these projects do not consider this aspect.

a) Reduced Motorized Travel due to BRT and Metro

Let us consider four BRT and Metro projects in order to understand the capacity expansion in the baseline to facilitate same travel without the projects

1. BRT Projects - Ahmedabad & Pimpri in India, Cebu in Philippines and Guangzhou in China
2. Metro Projects - Chennai and Bangalore in India, Manila (MRT3) in Philippines and Ho Chi Minh in Vietnam

Of the four BRTS considered, two systems are already in operation (Ahmedabad in 2009 and Guangzhou 2010) and two under implementation (Pimpri under construction and Cebu has just been approved). Both Ahmedabad and Guangzhou systems are considered as Best Practice case studies for rest of Asian developing cities.

Of the listed Metro systems, Manila is already in operation, Bangalore and Chennai are in active construction and Ho Chi Minh is ready for construction.

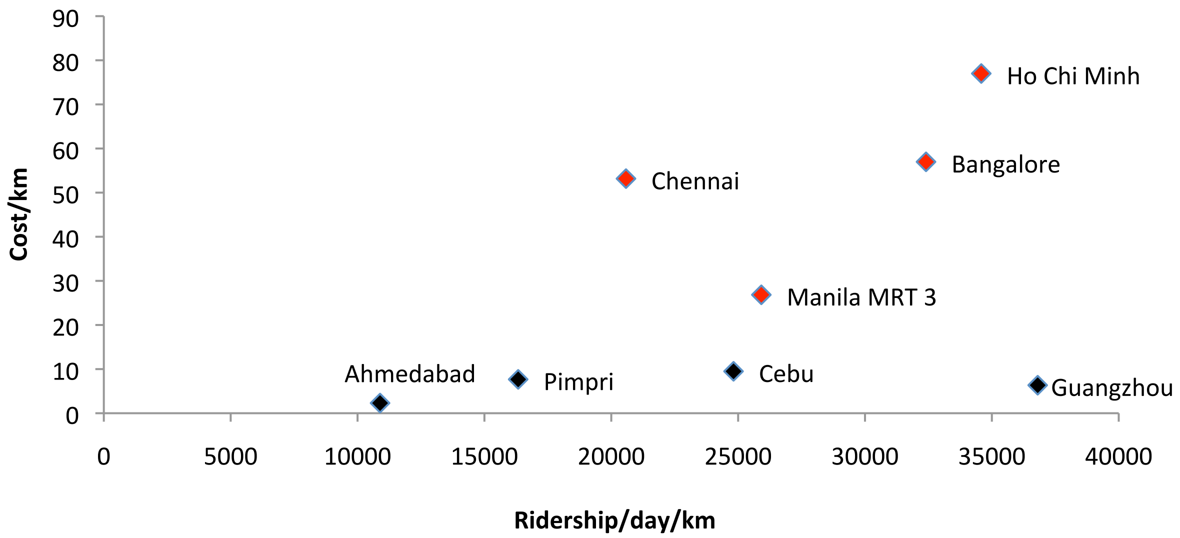
Table 2 : BRT/MRT length and costs

BRT	Country	Length (km)	Financed	Cost Million USD
Ahmedabad	India	59.0	Indian Government	106

Cebu	Philippines	16.0	Co-funded by Climate Technology Fund	152
Guangzhou	China	23.0	Chinese Government	146
Pimpri	India	19.2	Co-funded by GEF	147
Bangalore	India	31.6	Indian Government, JICA and ADB	1800
Chennai	India	43.8	Indian Government and JICA	2329
Manila (MRT3)	Philippines	5.7	Private Sector	153
Ho Chi Minh	Vietnam	12.3	Co-funded by Climate Technology Fund	944

The average ridership per day/km and cost/km of projects are shown in below figure and it makes a very interesting reading with regards to capacity and costs.

Figure 2 : BRT/MRT daily ridership/kilometer



In case the BRT/Metro would not have been constructed (no project scenario), BRT/Metro riders would have been forced to use the existing modes throughout the twenty years of project lifecycle. Since the shift because of the project is from low occupancy vehicles to efficient modes with higher occupancy and travelling at higher speeds, the savings generated in time and fuel costs are primarily quantified. These projects have been analyzed using TEEMP methodologies by Clean Air Asia with partners for ADB (Guangzhou, Bangalore, Manila, Ho Chi Minh), World Bank (Ahmedabad, Pimpri), Chennai Metro Rail (Chennai) and French Development Agency (Cebu) [25].

Analysis of these projects using TEEMP models for twenty years of lifecycle yield following results.

Table 3 : Modeshift, trip length and occupancy values at starting year

	Metro Starting Year											
	Bangalore			Chennai			Manila			Ho Chi Minh		
	Mode Shift	Trip Length	Occupancy	Mode Shift	Trip Length	Occupancy	Mode Shift	Trip Length	Occupancy	Mode Shift	Trip Length	Occupancy
Cars	8%	6.6	1.8	10%	8.3	1.8	19%	5.7	1.6	7%	8.4	2
2W	33%	6.6	1	20%	8.3	1	1%	5.7	1.2	89%	5.8	1.1

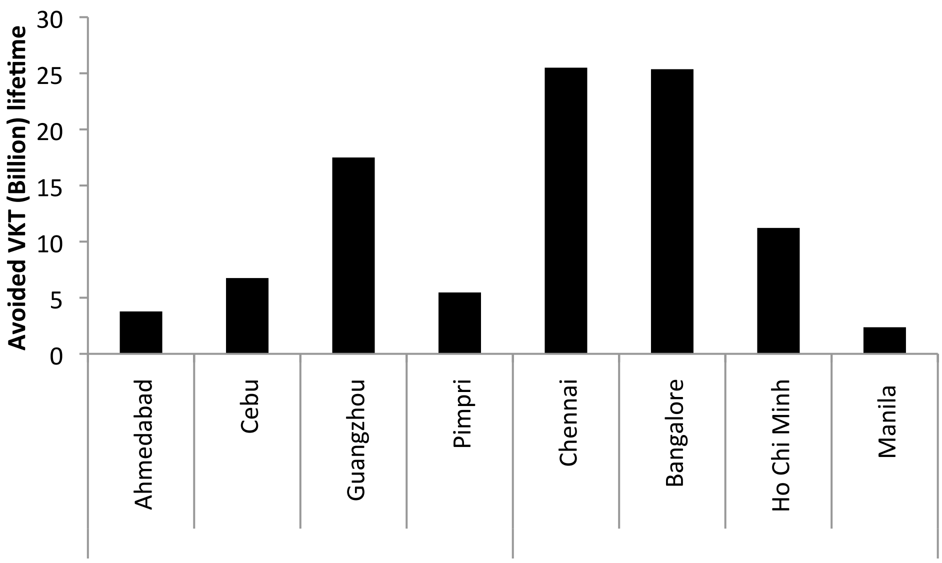
3W	10%	6.6	1.8	8%	8.3	1.8	14%	5.7	2.5			
Taxi	3%	6.6	1.8		8.3		6%	5.7	2.5			
Bus	46%	6.6	45	31%	8.3	45	18%	5.7	25	4%	10.2	18
	BRT Starting Year											
	Ahmedabad			**Cebu**			**Pimpri**			**Guangzhou**		
	Mode Shift	Trip Length	Occupancy	Mode Shift	Trip Length	Occupancy	Mode Shift	Trip Length	Occupancy	Mode Shift	Trip Length	Occupancy
Cars	2%	11	1.1	14%	6	2	2%	6.4	1.42	20%	20	2
2W	12%	5.6	1	18%	6	1	12%	6.4	1.09			
3W	38%	5.3	3				38%	6.4	1.9			
Taxi				5%		2				7%	10	3
Bus	47%	12	28				47%	6.4	35	72%	12	45
Minibus				63%	6	16						
Cycling	1%						1%	6.4		2%	7	
BRT/Metro		8	45		6	40		6.4	45		12	54

The modal shift data provided above is for the first year and it does not consider the impact of future motorization in absence of the project. Avoided motorized vehicle travel due to these projects range from 2 to 25 billion vehicle kilometer travel for twenty years of project analysis .

In the baseline i.e. city without effective and prioritized public transport system, this increase in traffic would lead to slowing of traffic speeds, congestion and this would subsequently force cities to widen roads to cater for increased traffic growth. This aspect is neglected currently in the baseline calculations as it is assumed that people will keep travelling the same way in the future irrespective of the infrastructure.

Since, past road widening experience is not available from these cities due to lack of data, in order to make most conservative calculation of this infrastructure requirement in absence of BRT/Metro, Singapore is considered as a case study.

Figure 3: Vehicle Kilometer Travel Savings



b) Road Expansion Experience in Singapore

Singapore does not follow the traditional approach of increasing road space with increasing congestion. From 1991 to 2012, vehicles have increased by 2.7% annually while vehicle kilometer travel has increased by 2.2% and road supply (lane kilometers) have only increased by 1% as per the statistics of Land Transport Authority-Singapore [26]. Roads currently take up 12% of total land area in Singapore. Singapore has limited land supply, so road widening is only carried out when all other options fail.

The major emphasis is on curbing travel demand by road pricing, controlling ownership, better and effective public transport facilities. Let us consider Manila as an example. The Philippines Development Plan-2011-2016 [27] quotes speed improvement as a primary indicator in measuring success of Metro Manila's transport strategy as summarized below

1. Decreased travel time from 2.17 min/km to 1.57 min/km in 2016
2. Increase in travel speed from 27.79Km/hour to 38.2 km/hour by 2016
3. Increased occupancy due to reduction of city buses - air-conditioned from 40 to 65, non-air-conditioned from 37 to 45.

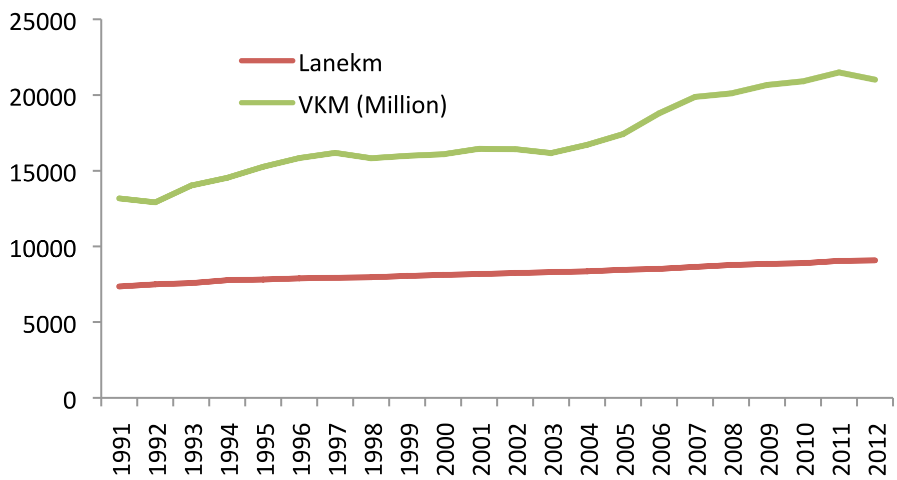
In contrast, Singapore's Master Plan 2013 targets

1. 8 in 10 households living within a 10 min walk from the MRT station
2. 85% of public transport journeys less than 20km completed within one hour
3. 75% of all journeys during peak hour undertaken on public transport

Thus, Singapore explains a conservative example of road expansion within a city. By considering Singapore's experience with road supply increase and translating this ratio on projected vehicle travel in project baseline for BRT/Metro would allow conservative computation of infrastructure increase in absence of BRT/Metro project.

In Singapore, each lane kilometer accommodates around 5600 VKT/day/Lane. This ratio is translated to above projects and considering the lifetime vehicle travel reduction, infrastructure requirements are estimated.

Figure4: Singapore Infrastructure Expansion with Growing Traffic Movement



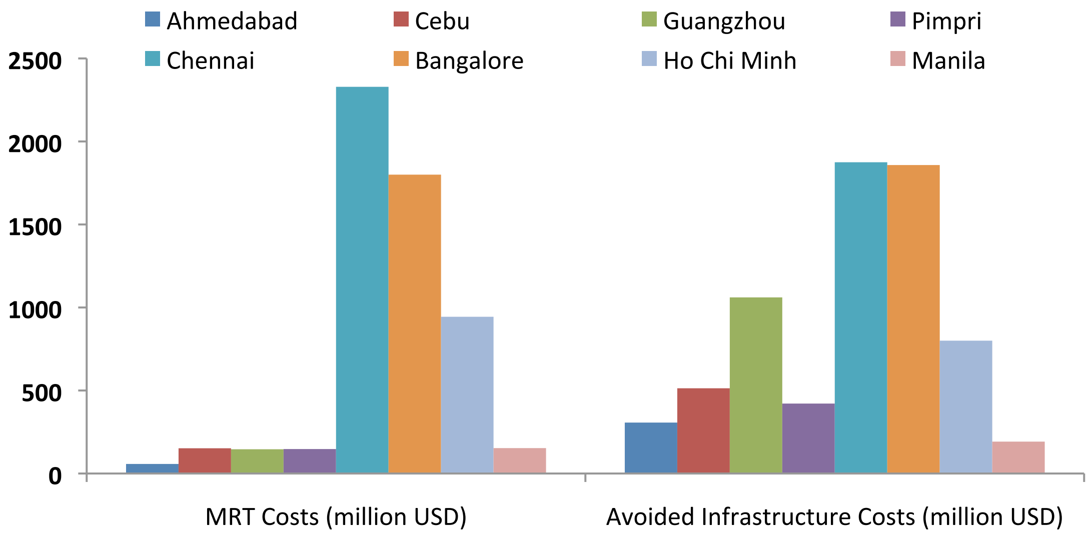
c) Benefits of BRT and Metro

Considering appropriate infrastructure expansion in the baseline, considering a cost of 2 million USD/Lanekm for urban roads without considering inflation and infrastructure maintenance costs, following results are obtained

1. For the entire BRT corridor length, each project helps prevent construction of 6 lane, 16 lane, 10 lane and 23 lanes for the twenty years of travel demand in Ahmedabad, Cebu, Pimpri and Guangzhou respectively. On an average, avoided road space by a BRT is **2 square meters per rider**.

2. For the Metro project, each project helps prevent construction of 21 lane,29 lane,33 lane and 17 lane for the twenty years of travel demand in Chennai, Bangalore, Ho Chi Minh and Manila respectively. On an average, avoided road space by a Metro is **3 square meters per rider**.

Figure 5: BRTS and Avoided Infrastructure Costs



3. BRT's turn out to be cost effective as the alternate cost of road expansion in the without project scenario exceeds BRT construction cost. This cost can be considered as conservative as urban land is scarce and expensive and hence the roads which would be built would be either underground or elevated which may require 5-10 times more investment. Thus, considering only the costs (neglecting all the other benefits), BRT's are economically feasible when compared to building more roads.

4. Metro construction is often considered to be very expensive. However, comparing metro costs with the alternate roadway expansion costs reveal that there is not much of a difference in terms of the cost between metro and roadway expansion.

5. Based on earlier comparison between the ridership and costs, in many of the corridors and cities, BRT's and Metro's can compete with each other in terms of capacity and demand.

6. In without project scenario due to road expansion, additional motor traffic is induced as public transport deteriorates and new roads with extra capacity attract more use of vehicles. This leads to a vicious cycle of motorization. Avoiding this vicious cycle of induced motorized travel by high penetration of BRT/Metro network would have exponential impacts on the quantification of co-benefits and these should not be missed out. Currently without factoring this impact, a BRT and a metro on an average provide a saving of 2900 and 5500 tons of CO_2/km/year respectively. This should be a very conservative estimate as road expansion impacts on the baseline is not considered. Expansion of roads would result in increased induced traffic thereby increasing the carbon footprint over the baseline. ADB [19] has estimated that in general, expressway

projects increase CO_2 emissions by one-fifth to one-half or more over their 20-year lifetime compared with business-as-usual because of effects on induced travel that overwhelm the short-term benefits of curbing low-efficiency congested traffic. Clearly, the benefits of the BRT/Metro projects would multiply considering induced motorized travel increase in without BRT/Metro project scenario.

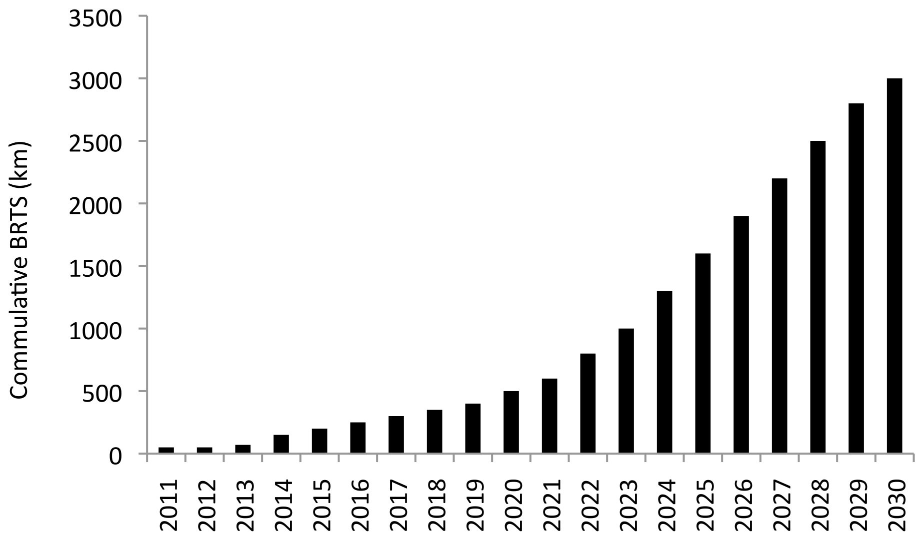
It is also significant to note that avoided infrastructure costs not only exceed BRT/Metro construction costs in many cases but are also comparable to many traditional benefits like fuel and travel time savings as summarized below

1. In Ho Chi Minh metro, the cost of avoided infrastructure (800 M$) is comparable to vehicle operating cost savings (936 M$)
2. In Chennai Metro, the cost of avoided infrastructure (1875 M$) is comparable to travel time savings (2000 M$)
3. In Cebu BRT, the costs of avoided infrastructure (500 M$) exceeded not only other benefits such as fuel savings (445 M$), Health Impact (100 M$), travel time savings (81 M$) and avoiding traffic fatalities (37 M$) but also the project costs (150 M$) [28]
4. None of the projects had considered this benefit while all of them had considered mode shift analogy. In absence of MRT projects, none of the projects had considered capacity expansion but had assumed people will keep traveling in their usual mode without the project.

5. Scaling Up Benefits at National Level

Let us consider India to understand the impact of scaling up avoided infrastructure analysis. India is urbanizing very fast and it has been estimated that the India's urban population would exceed 550 million by 2030. It is also expected that share of economic activity in urban areas would increase from 56% of GDP in 1990 to about 75% in 2020. Such high impact of raising income in urban areas and urbanization on motorization is pronounced with experts suggesting increase in vehicle ownership levels in the coming decades with the growth nearly twice as fast as per-capita income in India [29]. Government of India (GOI) in order to provide a new direction and vision for the policy makers and increased attention towards urban transport implemented the National Urban Transport Policy and Jawaharlal Nehru National Urban Renewal Mission (JnNURM) scheme. Under this scheme, cities developed the comprehensive mobility plan and have planned for 1100 km of BRT over the next twenty years. It has been estimated that a total of 400 billion USD or annually 20 billion USD [4] is required to provide mobility in Indian cities till 2030. Nearly 3.3% of the investment is proposed for BRTS, 24% for Metro and 70% for roads under business-as-usual scenario.

Figure 6: Alternate BRTS Scenario in India



Let us consider an alternate scenario where cities aggressively improve public transport and build 3000 km of BRTS by 2030 (figure 6). By considering the BRT indicators developed earlier, it is observed that by 2030, cities could benefit from a reduction of 8.7 million tons of CO2 and reduced need for 42000 lane-km of urban roads approximately costing 84 billion USD. Considering BRT costs, this is a net saving of nearly **70 billion $** which is a significant reduction from the baseline investment (18% reduction from baseline). Clearly, transport investment can be tailored to provide maximum co-benefits at a fraction of the cost.

6. Conclusion

'Without project' scenario should be ideally considered as to what would 'most likely' happen if this project is not executed.

With growing investment needs, making appropriate decisions on transport investment is more critical than ever. There is lot of ambiguity and misconception with regards to the transport baseline. Transport economic and environmental assessment guidelines propose comparison with 'do nothing' or 'do minimum' baseline. However, 'do nothing' or 'do minimum' does not really describe the counterfactual in absence of project. The problem of lack of clarity in what the baseline could be overcome by assuming that cities would continue with the investments as in the business-as-usual. Investment in the base-line would be the *'most likely'* investment in absence of project investment based on past history of investments and current policy framework. By making this change in baseline, good transport investments would be more accurately judged while bad investments could be prevented. Lack of clarity in baseline is dearly costing transport and the environment. By redefining the baseline, many expensive transport investment mistakes can be easily avoided. It was found that the magnitude of savings in infrastructure can sometimes exceed project costs and traditional benefits when appropriate baseline is assumed. It was found that a BRT and Metro project prevents road expansion in the range of **2-3 square meters per rider.**

For paradigm shift in transport, baselines need to evolve in order to serve these changing needs.

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