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Urban Transport in India: Not so Fast for the Nano Car

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Urban Transport in India: Not so Fast for the Nano Car

[1]As urbanization gathers pace in India, personal transport is among the priorities (for access and mobility), especially since mass transport is often not available or is of poor quality. Two wheelers - with the father driving, the elder child standing in front and the wife behind holding a baby – is very much the norm in this country. In an interview after unveiling the cheapest car, the Nano[2], to the world, Ratan Tata said that this two-wheeler image is what got him thinking that Indian families need a safer form of transport.

Safety on roads is the number one priority.

With more vehicles on road, safety is an issue for the person riding, other drivers, and the people walking, especially when a family is on the motorcycle. Is driving a car safer than driving a motorcycle, especially given the condition of roads or the regard for traffic management? An analysis of the roads and transport in India is presented in the Seminar Magazine[3] in November, 2007.

Introduction of the cheapest car in the world had some heads turning and critics talking. Since unveiling of the Nano car in January, 2008, there has been an increased media attention towards possible traffic congestion problems and an increased number of articles projecting the serious impacts of a new fleet on road, and consequently on air pollution and health (see an article in Wired Magazine[4] summarizing some of these arguments).

Also see "India's Nano and the World's Climate" [5] aired on On-point by host Tom Ashbrook on January 22nd, 2008.

However, the lingering questions, before we conclude that the introduction of the world's cheapest car is going to congest the road and deteriorate the air quality; bad for the energy scenario, are

- How is the current travel demand being met?
- Do economics justify the modal shift expected from the middle class families riding motorcycle to Nano cars?
- Who will buy the Nano at what price?
- What are the possible environmental implications, different from current trends?

The Nano was expected to be in market by the end of 2008, but due to some political constraints, the production site was shifted from the state of West Bengal to Gujarat, and the new arrival date is sometime in 2009.

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[1] This article first appeared in August, 2008 @ http://urbanemissions.blogspot.com/2008/08/nano-car-nomics-in-india.html

[2] Nano Car by Tata Motors - http://www.tatapeoplescar.com/tatamotors/

[3] Seminar Magazine, New Delhi, India - http://www.india-seminar.com/2007/579.htm

[4] Wired Magazine on Tata Nano - http://www.wired.com/cars/coolwheels/magazine/16-07/ff_tata?currentPage=1

[5] India's Nano and World's Climate - http://archives.onpointradio.org/shows/2008/01/20080122_b_main.asp

Understanding Travel Modes in India

People use a car because it is convenient and comfortable. In India, many people (who can afford to) prefer using cars to public transport for everyday travel - for work and leisure. Reasons are plenty – starting with safety on the road, breathing less pollution in the car (though car is breathing out gases and particulates), and more importantly lesser access to public transport. As a result, this decade, cities across India are experiencing a jump in private passenger vehicles and consequently deteriorated air quality, long tailbacks on the motorways and health complains[6].

Mumbai Metro Rail System[7] | Delhi Metro Rail System[8]

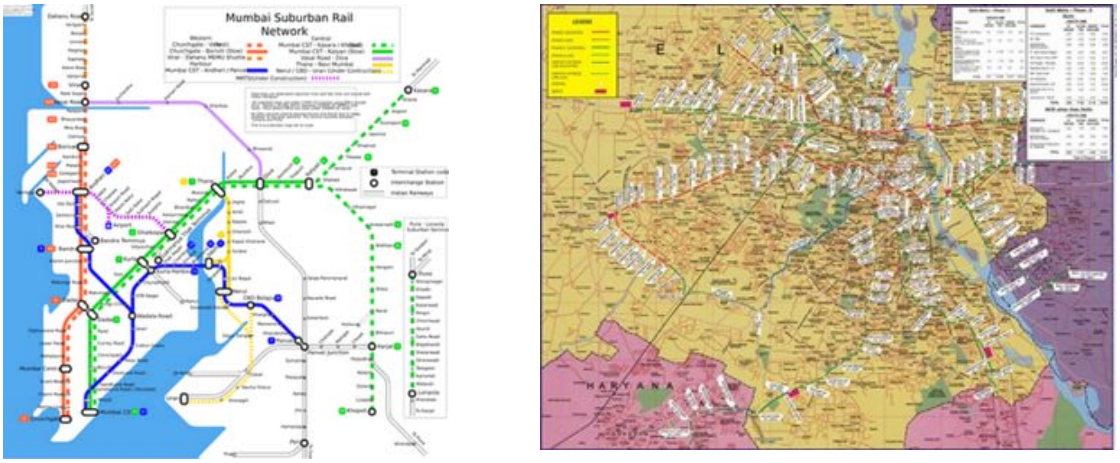

Figure 1: Metro rail systems in Mumbai and Delhi, India

Travel demand is growing rapidly due to continued economic success and is densely concentrated in certain parts of the networks and at certain times of the day (rush hours). Scenarios are different in different cities. For example, Mumbai depends on its subway system (**Figure 1**) as much as it does on road transport by buses and taxies; Hyderabad[9] and Chennai are a mix of bus and private vehicles; whereas Delhi and its satellite cities are dominated by private transport. Delhi also operates ~3,000 CNG buses, the largest clean fuel fleet in the World[10]. It is important to note that Delhi will be more connected with public transport as soon as the metro system is fully functional.

In case of public transport, bus rapid transport (BRT) is a growing trend[11]. The cities of Bogata and Curitiba are revered examples for BRT[12] and while Latin America cities have been the BRT pioneers, the technology is spreading to the rest of the world. **Table 1** presents a list of cities currently operating or preparing to implement BRT systems in India. While the BRT is effective in improving the traffic conditions and creating opportunities to shift

[6] EE & CC Considerations for On-road Transport in Asia - http://www.cleanairnet.org/caiasia/1412/articles-70656_finalreport.pdf
[7] Mumbai metro rail system - http://en.wikipedia.org/wiki/Mumbai_Suburban_Railway
[8] Delhi metro rail system - http://www.delhimetrorail.com/index.htm
[9] Andhra Pradesh State Road Transport Corporation - http://en.wikipedia.org/wiki/APSRTC
[10] Delhi Transport Corporation - http://dtc.nic.in/
[11] Bus Rapid Transport Center - http://www.gobrt.org/whatis.html
[12] BRT systems in Latin America - http://thecityfix.com/brt-systems-in-latin-america/

people from personal to public transport, one should consider if by just increasing the bus fleet and improving the inspection and maintenance program might create the same opportunities. There is a lot of interest in this intervention, due to its appeal to the politicians and the public, but it is important to better understand the system for effective and speedy implementation[13], especially to avoid the failures of Pune, India[14] and Delhi, India (2008)[15] [16].

Table 1: Bus Rapid Transit in India[17]

In Operation (2)	In Planning (12)	
Pune, India	Ahmedabad, India	Vizag, India
Delhi, India	Bangalore, India	Hyderabad, India
	Bhopal, India	Indore, India
	Surat, India	Jaipur, India
	Vijaywada, India	Pimpri-Chinchwad, India
	Mysore, India	Rajkot, India

So, a limited access to affordable and clean public transport is one of the causes for shift to personal mode of transport. The Nano car has demand here.

According to a report[18] (May, 2008), Ministry of Urban Development has a series of programs in place to check this issue, and hosting a national level workshop on Urban Mobility[19] in December, 2008, to disseminate these policies for sustainable transport in India. Also see SUMA program[20] by Clean Air Initiative for Asian Cities.

The demand for mobility and access is increasing and the growing trend for personal space and vehicles is leading to more cars on the road, increasing congestion and idling, hot spots of pollutants – likes of pollutants and ozone, and increasing greenhouse gas emissions. If left unchecked, the secondary cities, such as Pune, Indore, Mysore, Baroda, Vizag, and Chandigarh, will incur the rising cost of congestion, air pollution, and health impacts.

According to an article by Dr. Narain of CSE[21], the average speeds on road reduced to 10 km/hr in 2006 compared to 30 km/hr in 1997. On an average, Delhi and Pune are registering ~1000 vehicles per day[22], compared to Hyderabad at ~600 vehicles per day. The trend continues in other large and small cities. A cheap Nano might mean more cars on the road, but not so fast. The existing demand for cars, in-use vehicles, and traffic conditions are already high enough to worsen air pollution.

[13] Taxonomy of Delhi and Sao Paulo BRT - http://thecityfix.com/towards-a-better-brt-taxonomy/
[14] Pune's BRT stumbles at the start - http://indiatogether.org/2007/jan/eco-brtpune.htm
[15] Delhi BRT, as good as scrapped - http://www.itdp.org/index.php/news_events/news_detail/brt_as_good_as_scrapped/
[16] Delhi BRT trial stirs public furor - http://www.itdp.org/index.php/projects/update/delhi_high_capacity_bus_trial_stirs_public_furor/
[17] Source: Modified from presentation by Dr. Cornie Huizenga, Executive Director, CAI-Asia, Manila, Philippines
[18] Transport Policies and Strategies for Urban India - http://www.urbanindia.nic.in/moud/programme/ut/main.htm
[19] Urban Mobility India Conference, December, 2008 - http://www.urbanmobilityindia.com/
[20] Sustainable Urban Mobility in Asia - http://www.cleanairnet.org/caiasia/1412/propertyvalue-27072.html
[21] The Nano-flyover Syndrome - http://www.downtoearth.org.in/editor.asp?foldername=20080215&filename=Editor&sec_id=2&sid=1
[22] Cars in urban India - http://www.cseindia.org/AboutUs/press_releases/press_20070726.htm

Emissions & Air Pollution from Transport

Emissions from the transport sector are a significant and growing contributor to primary air pollutants such as particulates, sulfur oxides (mainly from diesel fleets), nitrogen oxides, and greenhouse gas emissions, and the emissions are expected to grow in the coming decade mainly due to increase in the shear number of vehicles in use (CPCB study[23]). While the greenhouse gas emissions impact long-term economic growth by contributing to global climate change, the local pollutants are most critical and harmful to human health in the short-term. Among the air pollutants, PM is the primary pollutant associated with health risks.

In the Indian cities, the ambient concentrations of primary pollutants of PM, SO_2, and NO_x, increased significantly. In 2006, annual average PM_{10} (PM with aerodynamic diameter less than 10 micron meter) measured in major Indian cities[24] ranged between 50 micro-gm/m^3 to 150 micro-gm/m^3, with some daily highs of ~300 micro-gm/m^3, and exceeding the daily and annual average limits set by World Health Organization[25].

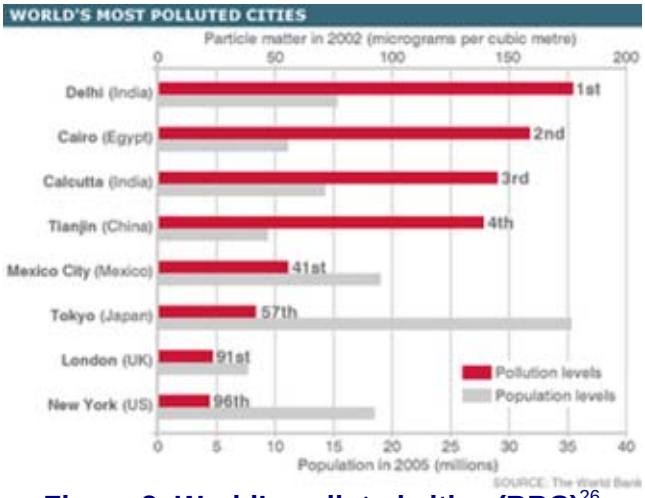

Figure 2: World's polluted cities (BBC)[26]

Increased vehicular activity on roads mean, increase in the direct vehicular emissions (especially from diesel operated heavy duty vehicles and passenger vehicles) and indirect fugitive road dust - representing a significant source contributing to the generation and release of PM into the environment at the human breathing level. The Central Pollution Control Board (CPCB) has compiled an extensive list of emission factors for major vehicle categories – Motorcycles (MCs), 3-Wheelers (3W), and Passenger Cars (P.Car). This list is representative of emission tests conducted by Automotive Research Association of India[27] and a summary of the emission factors is presented in **Table 2**. The Nano is expected to

[23] Six city source apportionment study - http://cpcb.nic.in/Source_Apportionment_Studies.php
[24] National air quality monitoring program - http://www.cpcb.nic.in/air.php
[25] WHO guidelines - http://www.euro.who.int/InformationSources/Publications/Catalogue/20070323_1
[26] BBC Urbanization - http://news.bbc.co.uk/2/hi/science/nature/5072642.stm
[27] Automotive Research Association of India - http://www.araiindia.com

comply with Bharat III standards, ~Euro III standards[28]. Although the PM emissions per car are small, the total number of vehicles on road will impact the net rate in emissions. This is true for any new car entering the market.

Table 2: Average Emission Factors (in gm/km) for Indian Vehicles[29]

Vehicle Type	CO	HC	NOx	CO2	PM
Scooter 2-St Post 2005 >80cc	0.16	0.86	0.02	38.5	0.057
Scooter 4-St Post 2005 >100cc	0.40	0.15	0.25	42.1	0.015
MC 2-St Pre 2000 >80cc	2.96	2.44	0.05	24.2	-
MC 4-St Post 2000 <100cc	1.65	0.61	0.27	25.0	0.035
MC 4-St Post 2000 >100cc	1.48	0.50	0.54	24.8	-
MC 4-St Post 2005 >200cc	0.72	0.52	0.15	45.6	0.013
3W 2-St Post 2000 <200cc	1.37	2.53	0.20	62.4	0.045
3W 2-St Post 2005 <200cc	1.15	1.63	0.16	71.5	0.043
3W 4-St Post 2000 <200cc	1.97	0.84	0.40	62.7	0.030
3W 4-St Post 2005 <200cc	2.29	0.77	0.53	73.8	0.015
3W Diesel Post 2000 <500cc	2.09	0.16	0.69	173.9	0.347
3W Diesel Post 2005 <500cc	0.41	0.14	0.51	131.6	0.091
3W CNG-4S Post 2000 <200cc	1.00	0.26	0.50	77.7	0.015
3W CNG-2S Post 2000 <200cc	0.69	2.06	0.19	57.7	0.118
3W LPG-2S Post 2000 <200cc	1.70	1.03	0.04	68.2	0.130
P.Car Petrol Pre 2000 <1000cc	4.83	0.58	0.65	98.6	0.019
P.Car Petrol Post 2000 <1000cc	1.30	0.24	0.20	126.4	0.004
P.Car Petrol Post 2000 >1400cc	2.74	0.19	0.21	142.9	0.006
P.Car Petrol Post 2005 >1400cc	0.84	0.12	0.09	172.9	0.002
P.Car Diesel Pre 2000 <1600cc	0.87	0.22	0.45	129.1	0.145
P.Car Diesel Post 2000 <1600cc	0.72	0.14	0.84	156.8	0.190
P.Car Diesel Post 2005 <1600cc	0.06	0.08	0.28	148.8	0.015
P.Car Diesel Pre 2000 >1600cc	0.66	0.25	0.61	166.1	0.180
P.Car CNG Pre 2000 <1000cc	0.85	0.79	0.53	149.4	0.001
P.Car CNG Post 2000 <1000cc	0.06	0.46	0.74	143.5	0.006
P.Car LPG Pre 2000 >1000cc	6.78	0.85	0.50	130.9	0.001
P.Car LPG Post 2000 >1400cc	2.72	0.23	0.20	140.0	0.002

Besides the direct exhaust emissions, a major source of PM is the fugitive dust due to vehicular activity on the road. This dust includes the wind blown dust which settles on the road, wear and tear of tires and the dry deposits of other pollutants. While we discuss transport sources, this is the source of most importance (especially in the developing countries, see Dust Busters[30]) and forms the significant portion of the transport sector PM emissions.

Estimating the road dust emissions is not an easy process. Assuming that the car weighs an average 2 tons and an average slit loading of 100 grams per square meter on the paved

[28] International Emission Standards @ http://www.dieselnet.com/

[29] "Emission Factor development for Indian Vehicles" - http://cpcb.nic.in/DRAFTREPORT-on-efdiv.pdf

[30] Dust Busters - http://www.cleanairnet.org/caiasia/1412/article-58207.html

Indian roads, following empirical methodology presented in USEPA's AP-42 manual[31], an average of 30 gm/km of resuspended PM_{10} emissions.

This implies, every new car on road traveling for 30 km a day, 6 days a week will resuspend 0.28 tons of PM_{10} annually. Please note that this is assuming an average silt loading of 100 gm/m^2, which could be a high number for a clean urban road or low for a rural unpaved road. Download the v-dust, vehicular fugitive dust calculator, to better understand the parameters involved in these calculations.

vapis Vehicular Air Pollution Information System [32]

v-dust Vehicular Fugitive Dust Calculator [33]

Figure 2: Transport emissions calculators

This when compared to an emission rate of 0.05 gm/km of PM (for a petrol based car with less than 1000 cc engine - see CPCB Emission Factors) is ~600 times more (=30/0.05). So, adding a car to the in-use fleet - Nano or another - is not the problem for air pollution, but the possible dust emissions due to an extra car on the road is.

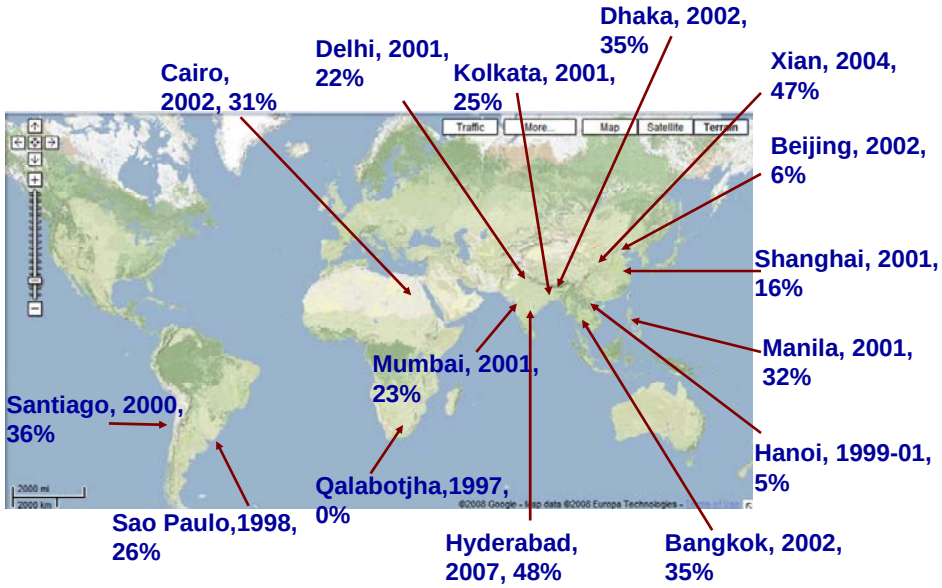

Figure 3: Summary of PM source apportionment results, presenting the year of study and share of transport to measured ambient air quality[34]

PM, especially the fine fraction with aerodynamic diameter less than 2.5 micron is associated with a range of adverse health effects including hospitalization for lung and heart

[31] USEPA's AP-42 Manual of emission factors - http://www.epa.gov/ttn/chief/ap42/

[32] Vehicular Air Pollution Information System (VAPIS) - http://urbanemissions.info/simair/VAPIS1.01.xls

[33] Fugitive vehicular dust calculator (v-dust) - http://urbanemissions.info/simair/Dust1.01.xls

[34] Guttikunda, S. K., and Johnson, T., et al, 2008, Handbook of Source Apportionment Techniques and Results, The World Bank, Washington DC, USA – http://www.urbanemissions.info/pmsa

problems, increases in emergency room visits for lung problems, increases in days of restricted activity in adults and school absenteeism in children, increases in respiratory symptoms, and to some extent the increased risk of premature death[35]. Irrespective of the vehicular type, any form of increased fossil fuel combustion will lead to increase in ambient concentrations and heightened health risks.

The air pollution problems are already persistent in the developing countries and megacities are already under scrutiny for their compliance and exceedances to health guidelines (see the coverage on Beijing air quality[36] for the 2008 Olympic Games and Delhi is next for the 2010 common wealth games)[37]. **Figure 3** presents a summary of share of transport to local air pollution, based on a series of source apportionment studies in the megacities across the world. These represent only the direct emissions from the vehicles and not include the fugitive dust from paved and unpaved roads due to the vehicular activity

Introduction of a new model car (cheap or expensive) is expected to add to the growing trend, but how much? The trend is expected to be any different, if it wasn't for the Nano, since the cities are already registering in excess of 600 vehicles per day?

Who Will Buy the Nano?

It is highly speculated that the majority of the buyers for Nano (expected now in 2009) will come from the motorcycle users. But, this may not be as much as it is anticipated, purely from the energy and pricing structure involved[38]. Energy and transport experts are in no doubt that in a growing Indian economy; demand for cars through 2015 will be persistent at ~14% a year, maybe a little less in the megacities with saturation[39].

The Nano car will be a success (similar to Maruti 800[40] when it arrived in the 80's). However, as the experts predict, it is inconclusive to say that the cheapest car in the world will be the new mode of transport for the middle income group and a majority of the motorcycles will shift to buy the Nano, especially in the immediate future. There is also some discussion of Maruti 600 (and other manufacturers) in competition to the Nano in the similar price range.

A comparative operational assessment between motorcycles and the Nano cars is presented in **Table 3** below. This is an assessment for a family traveling 30 km per day, six days a week and 52 weeks a year.

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[35] Literature review of Outdoor Air Pollution - http://pubs.healtheffects.org/view.php?id=3

[36] Articles on Beijing air quality during the 2008 Olympic Games
http://urbanemissions.blogspot.com/2008/07/air-pollution-in-beijing-china.html;
http://urbanemissions.blogspot.com/2008/08/beijing-still-hazy.html;
http://urbanemissions.blogspot.com/2008/08/sensing-air-quality-at-2008-olympics.html;

[37] Delhi 2010 Common Wealth Games - http://www.cwgdelhi2010.org/

[38] Fuel pricing and transport by the City Fix - http://thecityfix.com/easing-the-pain-caused-by-high-fuel-prices/

[39] Transport demand analysis by SIAM - http://www.siam.in/

[40] Maruti 800cc Car - http://www.maruti800.com/

Table 3: Economics of a Motorcycle and a Nano Car in Operation

Indicator	For Motorcycle	For Nano (Petrol)
Fuel mileage (km per lit)	60	20
Petrol market price (Rs. Per lit)	50.00	50.00
Fuel expenses (Rs. per km)	0.83	2.50
Fuel expenses per day (Rs.)	25.00	75.00
Fuel expenses per year (Rs.)	7,800	23,400
Annual income per family (Rs.)	1,80,000	1,80,000
% fuel expenses	**4 %**	**13 %**
Average cost of Vehicle (Rs.)	40,000	1,25,000
Average with loan interest (Rs.)	55,000 for 5 years	1,60,000 for 10 years
Annual payments (Rs.)	11,000	16,000
% loan payment expenses	**6 %**	**9 %**
Total annual share of transport expenses on a family shifting from motorcycle to a Nano car	**10 %**	**22 %**

These are conservative estimates. On an average, new motorcycles perform at 75 km a litre of gasoline and given the road conditions and congestion stats, cars are known to perform at no more than 15 km per litre of gasoline or diesel. Based on the fuel price alone, we are looking at 3-5 times higher expenses for a family converting from a motorcycle to car.

In India, on an average, a middle class family with a motorcycle earns between Rs.10K to Rs.15K per month. Above calculations reflect the higher end of Rs.15K per month. From the Table, the three times difference (4% vs. 13% between the operational costs of a motorcycle and a Nano) will be the main deciding factors for car purchase. This is no chump change and a big jump in family expenses.

Note that this does not account for the price and interest difference they incur for 5 or 10 years on loans, insurance, and maintenance. As an already paid motorcycle is being replaced by a car, we are looking a 4% transport expense vs. 22% (includes payments). Also, the price included in the calculations is 1 Lakhs + 25% taxes and extras, which is for the base model only.

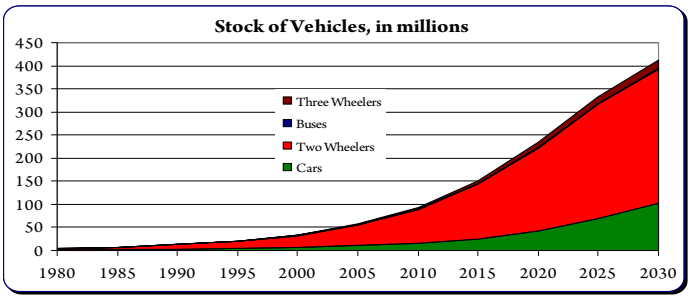

Figure 4: Estimated vehicular stock in India

Motorcycles are by far the largest in the country and will remain so for the coming decades (**Figure 4** presents an estimated vehicular stock for India[41]). On the other side, with a good price differential and extra tax for cars, the Nano car (or any of the other smaller and efficient models) could shift some people away from buying larger cars and utility vehicles; which mean fuel savings and less local and global emissions.

Overall, the Nano will eat into some of the high-end motorcycle/scooter market, and to some extent the low/high-end car market –depending on the fuel efficiency and the fuel prices in the coming years.

It is also expected to create a niche market of its own which did not previously exist with any of the big manufacturing companies. We can only hope that the niche market is not for the second or third car for the family as witnessed in the West.

Supply & Production Costs

The Nano car production hasn't started yet; the plant is still under construction and not expected to deliver the cars till 2009 or early 2010; although a large number of orders are already in place. However, it is important to note that the current production capacity is only 250K a year, which is nothing compared to the number of in-use cars on the road today. According to the WIRED magazine article[42], company won't give an estimate of demand for Nano's.

"*Eight million Indians currently own cars, according to the Mumbai-based credit-rating agency Crisil. Another 18 million have the means to buy one. However, the Nano could increase that pool of potential auto owners by as much as 65 percent, to 30 million, the organization reports*." - this stat is still years from now and the production capacities are not there yet, and this is not necessarily due to introduction of the Nano car; it could be any the possible cheap cars (relatively) in the future.

The Nano is cheap at 1 Lakhs[43] per car, which is approximately USD 2,200.00. This is the base model and with taxes and shipping charges, an extra 25% is added. Given the heat and humid conditions, the owners are expected to add some features like air conditioner, extra wipers, a radio, and a couple of other things, which will bring the car value to anywhere between 1.5 to 2 Lakhs. At the end, 1 Lakhs figure is just nominal.

According to an article by TIMES Online[44] (August 5th, 2008) the final production costs are expected to be much higher than what was quoted in January, 2008, as surging raw material costs scramble its low-cost business model, according to industry insiders.

Ratan Tata, the chairman of Tata, has admitted that he faces a dilemma. "If we pass on all costs to the consumer, it will affect demand, and if we don't, it will affect margins," he told investors recently.

[41] By Mr. Shyam Menon (2006)
[42] Wired Magazine on Tata Nano - http://www.wired.com/cars/coolwheels/magazine/16-07/ff_tata?currentPage=1
[43] 1 Lakhs = 100,000
[44] Price Tag on Tata Nano - http://business.timesonline.co.uk/tol/business/industry_sectors/engineering/article4460258.ece

Ian Fletcher, of Global Insight, said: "I can't see the 100,000 rupee price being maintained for more than three months, largely to let Ratan Tata keep his price promise, before the company raises it."

It will be interesting to see what the final production cost will be.

In Conclusion

Considering the rapid increase in private vehicles, both cars and two-wheelers, combined with the poor public transport system - traffic experts forecast that vehicular speed will drastically reduce in the coming decade, unless a new course of action is decided fast. Problem lies with the growing demand for vehicles, safety, and convenience. For middle & lower class populations (especially in the growing secondary cities), basically fight for "Access to Mobility".

Cars are not bad, but more cars on road make it worse. The current economic trend will not stop the consumer market from buying cars (the Nano or any other) and outcome of such life style (an increase in the social status) could be very sad for environment.

Could the public transport be a simple solution for these issues (like the Bogotá System[45])? As we argue about cars and motorcycles, we have to keep in mind the lack of "public transport" to meet the current travel loads and convenience. This is not to undermine the current infrastructure and urban planning programs to further promote the public transport in the big cities. In Mumbai, share of public transport via metro and buses is the largest and same is true for cities such as Kolkata and Hyderabad. In Delhi, a 100 percent CNG bus fleet is the single largest clean transport in the world[46].

To encourage people from using public transport, certain improvements must be implemented, like: increasing of frequency, especially during the rush hours, better travel comfort and accessibility. A good public awareness campaign is necessary - explaining what the expenditures are - in terms on money (principle, loans, parking), time (behind the wheel on road, idling in congestion), and health (impacts of vehicular emissions and road dust).

To summarize, public transport and its clever use could bring us many advantages - it reduces air pollution, reduces traffic congestion, and makes life healthier. These benefits could be achieved by encouraging people to use urban transport together with improved service quality and ameliorating comfort of passengers; irrespective of the introduction of the people's Car, the Nano.

[45] Transmilenio in Bogota - http://thecityfix.com/why-is-transmilenio-still-so-special/
[46] Impact of CNG Buses in Delhi - http://www.rff.org/Publications/Pages/PublicationDetails.aspx?PublicationID=17476