Funding eligibility for non-motorized transport projects from environmental donor agencies

The indian cycle rickshaw improvement project

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1. Introduction

The Indian Cycle Rickshaw Improvement Project is focused on modernizing the Indian cycle rickshaw. It is a joint project of the Institute for Transportation and Development Policy and the Asian Institute for Transport Development, with the cooperation of Lokayan, a social organization, and the Indian Institute of Technology-Delhi. It was funded by the U.S. Agency for International Development through their Energy, Environment, and Enterprise Program, or "E3". To our knowledge, it is the first time that US AID has agreed to fund a project focused on modernizing human powered vehicle technology. Similar projects have been supported in the past by the Indian Government, Canadian CIDA, the Swiss (via SKAT), and the ILO. None of these previous efforts were funded explicity for environmental reasons, but rather were focused on poverty alleviation.

The Indian Cycle Rickshaw Improvement Project grew out of a joint initiative between US AID and US EPA to protect the "Cultural Heritage of Mankind," ie. out of a concern that the Taj Mahal was being permanently damaged by air pollution, much of it from motor vehicles. The same program at US AID is focused primarily on the promotion of electric and alternative fuel vehicles, many of which have had only limited success.

The vast majority of transport sector projects supported by environmental funding agencies have been targeted to electric, hydrogen, CNG/LPG, natural gas, and other alternative fuel vehicles. While the nature of the programs has been to subsidize technological innovation and commercialization of alternative fuel vehicles, minimal environmental funding in the past had gone to modernizing human powered vehicles. The UNDP's Energy Efficiency Program, the Global Environmental Facility, the Energy Foundation, the W. Alton Jones Foundation, and US AID's E3 program have all spent millions of dollars on developing hydrogen fuel cell vehicle technologies, electric vehicles, and other technological change in motor vehicles.

The reasoning follows from logical framework analysis: 1) Identify the Problem: Cars, trucks, motorcycles and buses make a lot of pollution. 2)Solution: reduce their pollution through changes in the vehicle technology. In other words, millions of dollars in grants are being given to the automotive industry in subsidies precisely because they are the cause of a major environmental problem. Meanwhile, the bicycle industry, the human powered vehicle industry, which currently generates no pollution, was deemed ineligible for environmental grants precisely because it wasn't a problem.

Perhaps, to be more cynical, one could point out that if hydrogen, electric, natural gas, and other alternative fuel vehicles prove to be economically feasible, the private companies that are likely to dominate these technologies (Daimler-Chrystler, Ford, and Shell) would be U.S., Western European, and Japanese-dominated multinational corporations. Bicycles, by contrast, could be manufactured in most countries. While most bicycles are manufactured in Taiwan, Japan, India, China, and Indonesia, manufacturing exists in the US, Western Europe, and many African and Latin American countries as well. Work tricycles, cycle rickshaws, animal carts, hand carts, and other human powered vehicle technologies, by contrast, are almost entirely produced by local manufacturers in developing countries. In fact, were people able to bicycle safely or take cycle rickshaws safely, they might not need to spend billions of dollars on imported motor vehicles and fuels.

Is the objective of this environmental funding, then, primarily about saving the environment, or forcing open markets for exports? When the Global Environmental Facility (set up by the World Bank and UNDP to implement the Framework Convention on Climate Change and Agenda 21) drafted an Operational Directive for Transport, they assembled a team of global experts to advise them on what the GEF should focus on to reduce global greenhouse gas emissions. This team of experts recommended a host of measures, including support for bus rapid transit system promotion, non-motorized transport promotion, and maybe some alternative fuel vehicle promotion. When the draft recommendation came out, however, its focus was exclusively on the promotion of hydrogen fuel cell public transit vehicles in Asia. This document was clasified at the time, but it was leaked to the Sustainable Transport Action Network for Asia and the Pacific, the UN NGO Transport Caucus, and ITDP, and we then circulated it far and wide for comment. We were told, by senior officials in the German Government, that the change had resulted from a last minute intervention by Daimler Chrysler through their 'special liaison to the World Bank. We called a meeting with the GEF Council and had the Operational Directive changed, to include support for Non-Motorized vehicles, though the focus on alternative fuel vehicles remains.

At US AID, the cycle rickshaw improvement project was funded, after nearly a two year delay, due to strong support of two individual program officers within US AID with sufficient seniority to have the project funded, due to the fact that despite grand promises to do something in Agra all the other projects fell through, thanks to strong support from US EPA, and over the vociferous objections of the US AID Mission Director, who strongly felt that the project supported 'exploitation.'

2. Background on the Indian Cycle Rickshaw Improvement Project

The Indian Cycle Rickshaw Improvement Project sent two human powered vehicle engineers (Matteo Martignoni and Karl Miller) from North America to work in Agra and Delhi with two Indian mechanical engineers, recent graduates from IIT-Delhi (G. Shyam and S. Prabhu) to work directly with the existing cycle rickshaw assemblers and manufacturers to develop several prototypes for improved cycle rickshaws. The team was asked to develop designs which were no more than 25% more expensive than current designs, which weighed much less, which had multiple gears, and which improved the comfort for the passenger and the ergonomics for the operator. The project was to be based in Agra, home of the Taj Mahal, and the area around the

Taj Mahal was targeted, as the original project was developed with an eye to reducing emissions damaging the monument.

The original cycle rickshaw operating in Agra weighed 70-75kg, had a single gear, and a rather uncomfortable seat with no back rest. The original design used a beefed-up but otherwise standard bicycle frame for the front-end, to which was bolted an angle-iron chassis. A wooden seat was then bolted onto two strips of spring steel which was then bolted onto the chassis. Over the years, the spring-steel was replaced with cheaper mild-steel, which lost any benefit of shock absorbtion.

At the end of Phase II, two designs were developed. One design, known as the 'retrofit', retained the standard beefed-up front end of the bicycle, and replaced the angle-iron chassis, steel supports, and wooden seat with a box-tube chassis and pipe-tube chair with a woven nylon seat. The woven seat design reduced weight and provided shock absorbtion. This simple innovation reduced the weight of the vehicle to 64kg. A two-speed gear system was also developed. Together, these two innovations produced a vehicle that reduced the strain on the operator by roughly 25% to 30%.

The second vehicle, the 'integral frame' vehicle, replaced the standard front-end of a bicycle and angle iron chassis with an integral frame. This innovation brought the weight down to around 50-54kg. A three speed gear system is also currently being developed with current manufacturers. As this integral frame vehicle is much superior to the traditional vehicle, and actually costs less to produce, further efforts on the 'retrofit' were abandoned at the end of Phase II.

By the end of Phase II, roughly 90 integral and retrofit vehicles had been commercially manufactured and sold without any subsidies to local cycle rickshaw operators in Agra for roughly $110.00, roughly $10 - $15 more expensive than the existing cycle rickshaw. Local manufacturers insisted that we sell the vehicle at more than the vehicle cost to produce, even though the costs are actually less than the cost of the traditional vehicle, as they wanted to sell the vehicle as a 'luxury' to recoup their expenses in going into a new line of business.

The project is currently in its third phase. At the end of Phase III, which should be by September 30 of 2000, over 500 of the new vehicles will have been commercially manufactured and sold in Agra, and over 200 in Delhi. Roughly 2 per day are being manufactured and sold with no involvement of the project staff, indicating that there is a market for these vehicles even were there no international project team involved at this point. With a fleet of roughly 100 vehicles already operating in Agra, we then interviewed the passengers of these vehicles, most of which are clustered in the tourist area near the Taj Mahal.

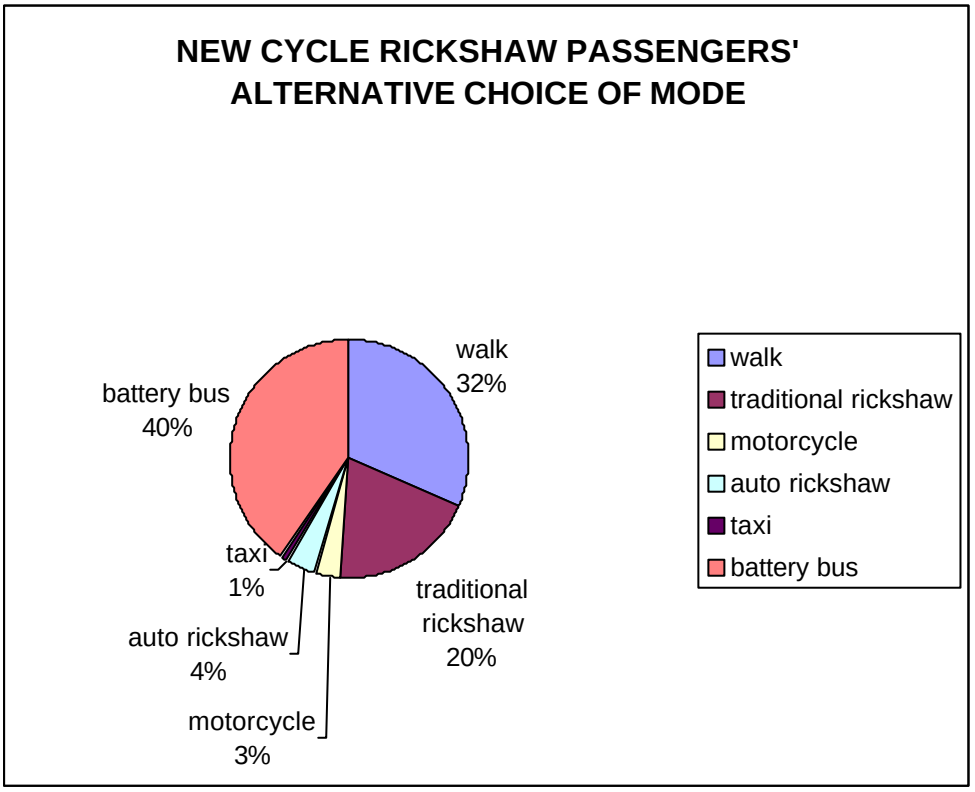
3. Measuring the Environmental Impacts of Technological Improvements in Human Powered Vehicle Technology.

The GEF and some other environmental funding agencies have guidelines regarding project funding eligibility. These guidelines are based on the tonnage of CO_2 emissions reductions that can be achieved per dollar of grant funds. In fact, such an analysis is not always performed,

except in such projects such as the conversion of coal-fired power stations where the costs of emissions reductions are rather straight forward to calculate. Nonetheless, it is important for those of us promoting the modernization of human powered vehicle technologies or bicycle infrastructure projects to develop methodologies for quantifying these emissions impacts as well.

In the India Cycle Rickshaw Improvement Project, we did not need to perform this analysis as a condition of funding. Nonetheless, this analysis was performed as part of the project in order to indicate the viability of such projects to other funding agencies. The metholology is as follows.

The project team carried out the following surveys. First, we interviewed the passengers in the new cycle rickshaws and asked them, if they did not take the new style cycle rickshaw, what sort of vehicle would they have chosen?



The results of this survey yielded the above results, which showed that 48% were attracted away from motorized modes. The battery bus is only used in the Taj Trapezium area, where motor vehicles are ostensibly banned, but in fact continue to operate though in a reduced way. As such, the battery bus became the next most popular mode choice. While the battery bus does not generate pollution locally, and hence protects the Taj Mahal, it nonetheless costs a significant amount of money in government subsidies, and the generation of electric power elsewhere generates considerable pollution. While we do not have accurate estimates of the actual subsidies to these vehicles, we can estimate this from other battery-powered bus prices. The level of these can then be compared to the costs spent on the cycle rickshaw improvement project. Generally, the cost of an electric bus is over 35% more than the cost of a standard bus,

and given the lack of spare parts in India these costs are likely to be higher. If a standard bus costs roughly $400,000, and an electric bus $540,000, this is a subsidy of roughly $140,000, assuming the passengers would be willing to pay the full cost of supporting the trip in a standard bus, including maintenance. If each bus carries roughly 55 passengers, and can make ten round trips per day, then 550 trips per day, or roughly 190,000 trips per year could be accommodated per year through this bus. As there are roughly 3 million visitors to the Taj each year, this requires 16 buses. At a subsidy of $140,000 per bus, accommodating all of these trips with electric buses will cost roughly $2.240 million.

As our surveys indicate that 40% of these trips could be willingly diverted to modern cycle rickshaw, the project should save 40% of these costs, or roughly $900,000. As our economic and financial feasibility studies indicate that the costs of the new cycle rickshaws will be cost competitive with the old cycle rickshaws, the only subsidies involved in the project were the project's costs, or $300,000, most of which went to technological innovation, promotion, and some initial subsidies to manufacturers, and end-users to mitigate against the risks associated with adopting a new technology.

Furthermore, we know that 8% of trips were shifted from motorized modes for trips to the Taj Mahal; an impressive figure given that these modes are actually banned in the Taj Mahal area where the survey was conducted. If only 8% of the 3 million trips to the Taj are made each year by two-stroke motorcycles or tricycles, this would be 240,000 trips. As the average trip distance is 5km there and back, this would reduce the total number of kilometers traveled around the Taj Mahal by 1.2 million kilometers per year. We know from the Urb-Air studies in Bombay (World Bank, 1997), that diverting these trips to non-motorized cycle rickshaws should reduce CO2 emissions by 174.75 grams per kilometer, or 209.7 tons of CO2 per year. If the benefits only last while the project is in effect (and they may in fact last into perpetuity), and project costs are $100,000 per year, this is $476 per ton of CO2 emissions reduced.

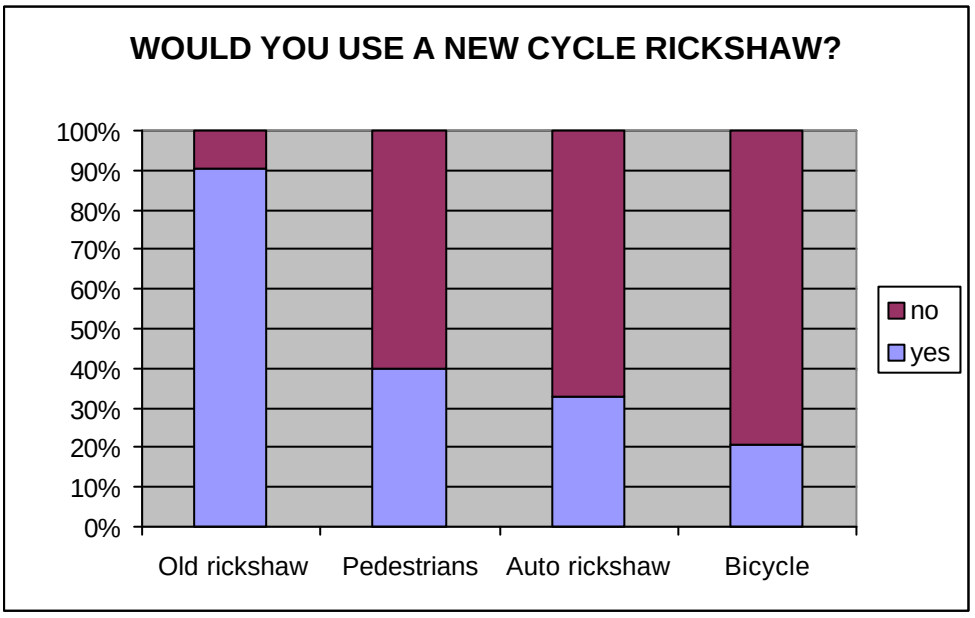
Comparing this to the relative costs and benefits of the electric bus is difficult in terms of CO2 emissions reductions, since the electricity has to be generated, and in India most of the electricity is generated in coal-fired power plants which also generate significant levels of CO2 emissions. Given the numerous unknowns, it is probably safe to assume that the likely impact of a battery bus on CO2 emission reduction is negligible.

In terms of particulate emissions, according to the Urb-Air Studies, we know that motorcycles and motorcycle rickshaws generate roughly 0.5 grams TSP per kilometer and 1.4 grams of NOx per kilometer. This yields a reduction of 600 tons of TSP per year, and a reduction of 120 tons of NOx per year. This is $166 per ton of TSP reduction, and $833 per ton of NOx reduction.

The benefits of the reduction in TSP and NOx from the battery-powered bus are more significant. A bus in India generates on average 2 grams of TSP per kilometer, or .036 grams per passenger kilometer. The same bus generates 13 grams of NOx per kilometer, or .23 grams per passenger kilometer. As one bus can handle some 950,000 passenger kilometers per year, switching each bus to a battery bus will reduce TSP by 34.2 tons and NOx emissions by 218 tons. If the battery bus costs $140,000 more than an ordinary bus, then the cost of reducing TSP is $4,093 and $458 per ton for NOx.

Thus, the costs of modernizing human powered cycle rickshaws per ton of CO2 emissions and per ton of TSP emissions compares favorably with subsidizing electric buses, the only other attempted solution in the Taj area. The electric bus is a preferred solution for minimizing NOx, as motorized cycle rickshaws do not generate that much NOx but generate a very high level of TSP.

It is still not clear the degree to which the new cycle rickshaw technology will be adopted in the non-touristed parts of the city as well, but initial indications are favorable. We asked current users of motorcycle rickshaws, bicycles, pedestrians, and traditional cycle rickshaws, if they would have been willing to make their trip using the new cycle rickshaw. These passengers were interviewed all over Agra, and were not concentrated in the Taj region where motor vehicles were banned, and hence give a bit clearer indication of the willingness of passengers to switch to alternative modes.



In this survey, some 33% of auto-rickshaw passengers said that they would be willing to use a superior human powered rickshaw if one were available and cost competitive. Some 90% of the passengers of the traditional cycle rickshaws expressed a willingness to switch. While motorcycle rickshaws probably represent no more than 10% of total trips in Agra, they nonetheless represent a disproportionate share (36%) of TSP emissions and NOx emissions (13%). No data was collected from bus passengers, but the bus fares are sufficiently low that it is unlikely that many would switch to the new cycle rickshaws.

Without a traffic demand model of the city of Agra and recent household survey data, it will be impossible to get very accurate estimates of the project's impact on emissions. It is also difficult to predict at this point the degree to which the new technology will be disseminated to other parts of the city, and the degree to which this new technology will be able to attract trips away from motorized modes. Ideally, one would need to know the total trips by each mode, the average trip distance, and the number of motorized trips that have been attracted to non-motorized trips as the

result of the introduction of the new technology. We can estimate from the above survey results that the new cycle rickshaws create the possibility of switching roughly 30% of auto-rickshaw trips to non-motorized rickshaw trips. A very rough estimate, based on averages from other cities, is that auto rickshaws represent 10% of total trips, and the average trip distance is 5 km (a reasonable estimate given the city size), and there are 200,000 trips per day by motorcycle rickshaw in Agra. If 30% of these trips were converted to non-motorized rickshaw as a result of the project, 300,000 km of motorized trips by highly polluting three wheelers could be reduced per day. This would be a reduction of 52,425 tons of CO2 emissions reduced per year, 150 tons of TSP, and 30 tons of NOx emissions per year.

Currently, the levels of particulate matter in the air in Agra and Delhi are roughly 100 times the WHO-recommended standard, though according to the WHO, no level of particulate is actually 'safe.' A large number of people in Agra are suffering from chronic upper respiratory illnesses as a result. Project team members also began to suffer from respiratory illnesses during the course of the project. There also continues to be lead in motor vehicle fuel, and carbon monoxide and ground level ozone levels are also well above WHO recommended standards. These are all generated in large measure by motor vehicle exhaust.

As one of the primary obstacles to tightening emissions restrictions around the Taj Mahal has been the lack of a cost effective alternative for helping tourists reach the monument, the introduction of the new cycle rickshaws has also helped to build political resolve to tighten restrictions on motorized traffic in the area.

In fact, one auto rickshaw operator sold his vehicle to buy one of our new vehicles (lower overheads, greater income), and one auto rickshaw manufacturer is exploring the possibility of manufacturing these new vehicles in Luknow, and has purchased two prototypes. The auto-rickshaw industry knows that it is under considerable political threat due to the environmental emissions that the vehicles generate.

The pride that the new vehicles give to their operators should also not be under-estimated. Many cycle rickshaw operators are aware that their profession is of low social status. However, the new vehicles have restored a sense of pride to the non-motorized operator profession. Many have already modified their vehicles with stereo systems, luggage compartments, and other amenities.

4. Does the Project Promote Exploitation, or Reduce It?

The US AID Mission Director was quite ashamed of the project, which she felt promoted 'exploitation.' When President Bill Clinton visited the Taj Mahal in the spring of 2000, he was presented with a host of electric and CNG vehicles that had been developed with US AID funds to improve the air around the Taj Mahal and elsewhere in India. To my knowledge, none of these prototypes has been successfully commercialized with the exception of the electric Bajaj (motorized cycle rickshaw) that is selling in Kathmandu where the traditional Bajaj was banned. Conspicuous by their absence, however, were our improved non-motorized designs. If the Mission Director of US AID didn't like the idea, it was hardly likely to appeal to Senator Jesse Helms, Chairman of the Senate Foreign Affairs Committee. US EPA had been subjected to an

embarassing audit for providing a $20,000 grant to ZAP bicycles for their electric bicycle promotion in China, which became a political football in the US Congress. The last thing any of us wanted was the Senior Senator from North Carolina yelling about US tax dollars being spent promoting cycle rickshaws. It wasn't clear that the average man in North Carolina would understand.

Nonetheless, in order to save our project, we documented the impact that the project was having on project participants. We surveyed the owners of the new vehicles, and calculated the impact that the purchase of the new vehicle had on their income. Perhaps in part because of the novelty of the new vehicles, but also because the new vehicles are more comfortable, owners found that their incomes increased on average by over 50%.

The average income of a cycle rickshaw 'wallah' in the Taj Ganj area of Agra is Rp. 110 per day, which is under $3.00 per day. The income for cycle rickshaw wallahs in Agra as a whole ranges from Rp. 60– 95 per day ($1.50 - $2), or near the internationally-recognized poverty line ($1) as measured by the World Bank. As such, the beneficiaries of this project can all be considered 'poor'.

According to our interviews, the other jobs available to this generally unskilled, often recent migrant population tend to be in day labor jobs at small workshops and factories, day labor construction, and day labor agricultural work. These jobs tend to pay around Rp.50 per ($1.18) day. Our interviews indicated that there were benefits and costs of operating a cycle rickshaw relative to these other options. The pay is moderately better. Secondly, the working conditions, in the daylight and getting reasonably ergonomic exercise, are healthier than the alternatives of working in unsafe, dark factories where they are exposed to significant occupational health and safety hazards. Furthermore, many of the wallahs said they liked the freedom associated with being a cycle rickshaw driver, as they did not have to be under the direct supervision of a boss and could go and come wherever they liked, and rest whenever they liked, unlike day laborers. Nonetheless, they felt there is something of a social stigma attached to operating a cycle rickshaw.

According to Dr. Amartya Sen, recent winner of the Nobel Prize in economics, interventions aimed at alleviating poverty can only succeed if they directly increase the capacity of the poor to earn income.

Our analysis, based on an independent interview with 33 cycle rickshaw wallahs using our new vehicles, their income increased by more than 50%, or to between Rp.150 to Rp.200 per day. As the cost of renting the new vehicles is roughly the same, at around Rp.15-25 per day, the introduction of this superior technology directly increased the income of the poor by more than 50%. Income increased because they were able to attract more passengers each day, and because each passenger was willing to pay more, primarily due to the superior comfort.

Were cycle rickshaws in the area banned all together, this population of poor people would be forced to seek employment in the other employment available to them, the wages for which tend to be lower than for cycle rickshaw operation As such, banning the vehicles would directly reduce the earning capacity of the poor.

There is little chance that this population would ever be able to afford to rent and operate an auto-rickshaw, the rental costs of which is roughly Rp. 75-80 per day. The total income for those slightly higher income individuals who rent auto rickshaws on a daily basis is only marginally higher, and because the rental costs and vehicle operating costs are higher, the financial risks are also greater. Adding a non-polluting electric motor to the auto rickshaw, while important, would only further increase the daily rental cost beyond the reach of the current cycle rickshaw wallah.

Secondly, the improved technology reduces the workload faced by the operator by one third, to a level of effort well below the average workload for other types of employment available to this low-income population. The new vehicles are of a weight and similar to the cycle rickshaws currently operating in 40 cities in the United States, including New York, San Francisco, Denver, Boulder, Savannah, Miami, Amsterdam, Prague, and Krakow. The cycle rickshaw operators in Agra are paid far less, but otherwise are no more exploited than their counterparts in the West.

Health studies done in Bangladesh on a standard cycle rickshaw indicate that the level of stress on the cycle rickshaw wallah operating with two passengers in level conditions without wind is somewhat less than the average level of stress from most other forms of manual labor available, including materials for construction and agricultural work, the two most common alternative forms of employment. In these normal conditions, and assuming that the wallah's are consuming sufficient calories, the level of exercise is healthy. Because the vehicle is of poor ergonomic design, however, the wallah's tend to experience problems of hips, lower back, and shoulders. (Gallagher, 1992)

If the conditions are windy, the roads are bad, the weight being hauled rise above 130 kg, or there are steep hills, or the wallah's are not eating sufficiently, the level of strain on the human body can become as bad as other forms of manual labor.

In Agra, the roads are in satisfactory condition, there is rarely any wind, but there are some minor hills. The introduction of the gearing system in our new vehicle reduces the strain on the human body by 17%. The reduction of the weight of our new vehicles from roughly 80 kg (traditional vehicle) to 55 kg, hauling a two passenger load of 130 kg, will reduce the strain on the operator by another 13%. They also have reduced friction with superior bearings, tires, and rear-axle alignment. In total, this is roughly a one third reduction in the level of effort (and hence the caloric consumption). In our tests, these improvements more than compensate for the modest hills in Agra, making the strain consistently less than that from other forms of labor available to this population.

5. Conclusion

The modernization of cycle rickshaw technology in India has already proven to be a more cost effective way of reducing CO2 and TSP emissions than projects promoting electric and other alternative fuel vehicles. If the technology is successfully commercialized, then the emissions reduction impacts per dollar of investment could be extremely low indeed. It is of course

conceivable that the entire cycle rickshaw fleet in India might begin a process of sustained technological innovation throughout India. The beneficiaries of these projects are also among the lowest income populations in the world, which contrasts markedly with the beneficiaries of alternative fuel vehicle promotion projects, where the beneficiaries in the long run are likely to be multinational corporations.

Nonetheless, it is possible to quantify the emissions reduction benefits of this type of project, and it is possible to convince open-minded funding agencies that modernizing human powered vehicle technologies is a more cost effective method of reducing greenhouse gas and other emissions than alternative fuel vehicle promotion projects.

As such projects do not directly benefit any multi-national corporations, however, it is difficult for them to find political support among development institutions all too often influenced by corporate lobbyists. For this reason, it is critical that such projects find political support among the increasingly vocal environmental and bicycle advocacy community.

References:

- Gallagher, D. 1992. The Rickshaws of Bangladesh. (Dhaka, Bangladesh: University Press Ltd)
- World Bank, 1997. Urban Air Quality Management Strategy in Asia: Greater Mumbai Report (Washington D.C.: World Bank Technical Paper No. 381)