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CO_2 Emissions: A Campus Comparison

Abstract Global warming, little cash inflow, and over-crowded parking lots are three problems affecting Murray State University students that could be helped by a campus-sponsored bus line. I conducted two surveys to gather data to calculate the current financial costs as well as levels of fuel consumption and CO_2 emissions. These surveys also gave me data on the proportion of students that are in favor of a bus line. With this data, along with some assumptions about the potential bus line, I was able to calculate the money, fuel and CO_2 emissions saved by the bus line. The carbon dioxide emitted by students who said they would ride a bus is more than eight times that which would be emitted with a bus. Further research is needed to obtain more accurate figures of the amounts saved with a bus line. We should work towards educating the Murray State University community of the benefits a bus line would provide.

Introduction

Driving requires the use of a fuel that, when burned emits a major greenhouse gas and contributor to global warming: carbon dioxide. Global warming is the gradual warming of the planet over time resulting from the trapping of greenhouse gases in the earth's atmosphere. Carbon dioxide accounts for 80% of the contribution to global warming, leaving only 20% of the contribution to other greenhouse gases (Lashof and Ahuja, 1990). Even short trips, like the ones made by students who live in Murray when they drive to campus, contribute to the amount of CO_2 in the atmosphere. Would the emissions from a bus be greatly less than the total emissions by individual drivers who live within 4 miles of campus?

Also, since fossil fuels are being consumed at a rate greater than they can be replenished by natural processes, the costs for product such as gasoline and diesel will continually increase as their rarity increases. Therefore, money spent to fuel these trips to campus adds up financially, too. Would the fuel costs of a bus line be less than the summation of fuel costs by individual drivers?

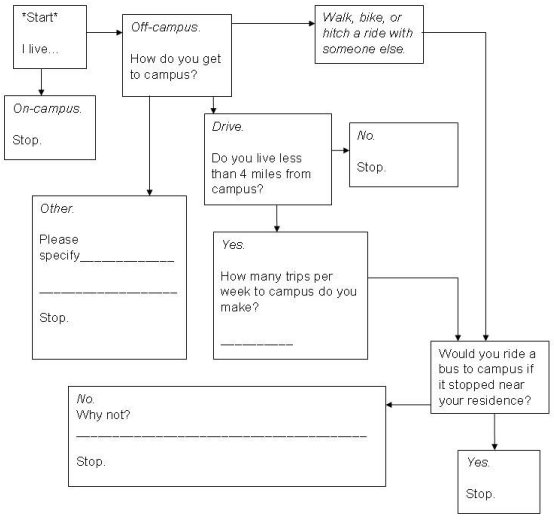
Finally, over-crowded parking lots are a problem at Murray State University. Would a bus line reduce the number of vehicles coming in and out of parking los on a daily basis?

These three questions are important when examining the benefits of a bus line, and weighing them against the potential costs.

Methods

I conducted two on-campus surveys, one of students and another of the vehicles in commuter parking lots, to gather data and gauge interest for a campus-sponsored bus line. To do the student data survey, after a few disappointing attempts on campus, I stood in commuter parking lots where I could reach my target demographic (student commuters) more efficiently. I stood in strategic areas where I had observed high amounts of student traffic between parking lots and campus buildings. Students were asked to fill out a survey for a service-learning project by filling in blanks while also marking their paths (see Figure 1). In the vehicle survey, vehicles

Figure 1. Student Survey



were counted and placed into one of two categories: passenger cars (cars, station wagons) or light trucks (trucks, jeeps, SUVs, minivans). This information was used to perform more accurate calculations determining the current expenditures, consumption rates, and emissions of students.

Results

The results of the student survey are shown in Table 1, and the results of the vehicle survey are shown in Table 2. Because Fall 2006 data is not yet available, proportions were calculated from data obtained from a Murray State University Fall 2005 graduate and undergraduate headcount (Fact Book). I took the total headcount (10,274) and subtracted the occupancy of the dorms (3,206) to get an estimated number of students living off-campus (7,068). From the number of students living off-campus, I was able to estimate actual student numbers that correspond to the answers given. This estimate was dependable on the assumption that enough students were surveyed such that their answers are representative of the lifestyles and opinions of the population of Murray State students living off-campus.

Table 2 shows that almost seventy percent of students drive passenger cars, while a little over thirty percent drive vehicles known as light trucks. This information was crucial in obtaining a more accurate profile of the consumption and emissions before and after the implementation of a bus line.

Since passenger cars, light trucks and buses have different fuel mileages and fuel types, I needed miles per gallon of fuel according to vehicle type and CO_2 emissions according to fuel type. The Environmental Protection Agency (EPA) says that passenger cars typically get 21.5 miles per gallon, while the average light truck gets 17.2, and that carbon dioxide emitted per gallon of gasoline burned is 19.4 lbs and 22.2 lbs for diesel. I assumed students drove gasoline-powered vehicles and diesel is burned in buses. I also took current gasoline and diesel prices from the American Automobile Association's Daily Fuel Gauge Report on November 26, 2006.

From my survey results and the EPA numbers on miles per gallon and carbon dioxide emissions, I calculated the gallons of fuel, pounds of CO_2 emitted, and financial costs of the average student commuter living in Murray (Table 3). Many of the calculations done hinge

Table 1: Student Survey Results.

Total	**116**	
on-campus	17	
off-campus	99	
-walk/bike/hitch a ride	5	
-drive	94	
more than 4 miles	39	30.2%
less than 4 miles	55	69.8%
ave. trips per week	9.6	
bus? Yes	19	35.3%
bus? No	36	64.7%
Why not?		
Necessity	4	8.3%
preference/convenience	27	75%
too close	5	16.7%

Table 2: Vehicle Survey Results

Passenger Cars	712	67.7%
Light Trucks	339	32.3%
Total Surveyed	1051	

Table 3. The Average Student Commuter that lives 2 miles from MSU Campus.

	Trips to Campus	Fuel Consumed	Fuel Costs	**CO_2 Emitted**	CO_2 from all commuters living in Murray (3,967)
Daily	1.9	0.4 gal	$.85	**7.5 lb**	29,704.9 lb
Weekly	9.6	1.9 gal	$4.26	**37.4 lb**	148,524.5 lb
Semester	151.7	30.5 gal	$67.33	**591.6 lb**	2,346,797.8 lb
Yearly	303.4	61 gal	$134.66	**1,183.2 lb**	4,693,623.4 lb

on the average trips (9.6/week) to class calculated from the student survey.

From the student survey, 35.3% of students living within 4 miles of Murray said they would ride a bus if it stopped near their house. If this proportion is true of all students that drive to campus and live within 4 miles of Murray, the 35.5% represents 1,367 students. Therefore, Table 4 shows the affects of students (1,367) that drive to campus even though they would rather ride a bus.

For Table 5 and Table 6, assumptions were made with the attempt to make the scenario of a bus line for Murray State University as realistic as possible. Many of the assumptions are typical of other university campus bus lines that were researched (University of California, Los Angeles and Columbia University).

If a bus line was implemented at Murray State, it would presumably run 5 days a week from 8:00 AM to 5:00 PM, Monday through Friday and make a five-mile loop around residential areas and back to campus. After searching for fuel economy for buses, I went with an average of what I found, which was five miles per gallon.

Table 5 shows the conditions to be expected if a bus line was implemented and 1,367 (the proportion of students that said they would ride a bus) students rode. This Table is based on the minimum number of bus trips to campus (53) that would carry 1,367 students 1.9 trips a day. Table 6 shows savings that resulted from 1,367 students riding a bus to campus instead of driving.

Table 4. 1,367 students driving gas-powered vehicles to campus.

	Trips to Campus	Fuel Consumed	Fuel Costs (gasoline @ 2.208/gal)	**CO_2 Emitted (19.4 lbs/gal gasoline)**
Daily	2,624.6	527.7 gal	$1,165.08	**10,236.6 lb**
Weekly	13,123.2	2,638.3 gal	$5,825.39	**51,183.2 lb**
Semester	207,346.6	41,685.3 gal	$92,041.14	**808,694.8 lb**
Yearly	414,693.1	83,370.6 gal	$184,082.27	**1,617,389.5 lb**

Table 5. 1,367 students riding a bus.

	Trips to Campus	Fuel Consumed	Fuel Costs (diesel @2.558/gal)	**CO_2 Emitted (22.2 lbs/gal diesel)**
Daily	53	53 gal	$135.574	**1,176.6 lbs**
Weekly	265	265 gal	$677.87	**5,883 lbs**
Semester	4,187	4,187 gal	$10,710.346	**92,951.4 lbs**
Yearly	8,374	8,374 gal	$21,420.692	**185,902.8 lbs**

Table 6. Savings of 1,367 students riding a bus instead of driving individually.

	Gallons of Fuel Saved	Money Saved on Fuel	**CO_2 Not Emitted**	Less # Vehicles in & out of Parking Lots
Daily	474.7	$1,029.51	**9,060.0 lb**	2,624.6
Weekly	2,373.3	$5,147.52	**45,300.2 lb**	13,123.2
Semester	37,498.3	$81,330.79	**715,743.4 lb**	207,346.6
Yearly	74,996.6	$162,661.58	**1,431,486.7 lb**	414,693.1

Discussion

My results show that a bus line would greatly reduce the amounts of fuel consumed, money spent on fuel, carbon dioxide emissions and parking lot traffic at Murray State University. These benefits are substantial: one-eighth of the carbon dioxide currently being emitted, would be emitted with a bus line. Also, there were many benefits not taken into account in the calculations, such as the costs of building parking lots, both financially and environmentally. However, there are many ways to substantiate this study in the future.

The base for my data, the commuter survey could have been improved in many ways. First, only 116 students were surveyed. With a campus population of approximately 10,300, and a commuter population of about 7,000, the proportion of students surveyed could very well be misrepresentative of the student body. Also, an unexpectedly high number of students living within 4 miles of campus said they would not ride a bus if it stopped near their residences (64.7%). When asked why they would not ride, the reason with the highest percent was preference/convenience. This leads me to believe that there may have been misconceptions about how a campus bus would operate. The percentage that said they would ride a bus also could have been increased if Murray State faculty and staff had been included in the survey.

There were also some things to note about the data tabulated. The miles per gallon figures obtained from the EPA and were from the year 1990. Since newer vehicles typically get better gas mileage, the figures I used may be lower than the average miles per gallon of vehicles on the roads today. Next, to simplify my calculations, I assumed all students drove gasoline-powered vehicles and all buses to be used would run on diesel. Also, the actual fuel economy for students driving back and forth to campus is probably lower than the combined vehicle averages because of the cold-engine factor and the stop-and-go driving of Murray roadways. Finally, implementing a bus line would require money and energy not taken into account. Besides the cost of fuel, buses would have to be purchased (approximately $190,000), drivers hired, bus pass system implemented, and many other energetic expenditures made. Parking lot construction and maintenance costs would be another aspect to consider when weighing all costs and benefits of a bus system at Murray State University.

More things to consider when analyzing my data would be that even students that said they would ride a bus may not ride it every time they some to campus, and gas and diesel prices are dynamic, although in the long-run they are likely only to increase. It would also be impossible to utilize every single space on the bus every trip, due to class schedules and the subsequent high-traffic times and low-traffic times. This factor would decrease a bus line's efficiency.

Further surveys and calculations need to be performed to get a more accurate idea of the size and interest level of the target demographic. Information should be provided to students portraying the way a campus bus line would operate and gain support from potential bus riders by providing statistics on the benefits to them and the planet. Communication with campus leaders is also essential, since they will be essential to implementation.

My results show that a bus line would drastically reduce the amounts of fuel consumed, money spent on fuel, carbon dioxide emissions and parking lot traffic. These are advantages that would benefit Murray State students, the Murray State University community and the rest of the world.

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