Bicycle Friendly Inter-campus Transportation: A case study of Bogazici University

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Abstract

In many developed countries, due to direct benefits of cycling to society, governments and municipalities use infrastructure investments, marketing programs and policy measures to increase the share of cycling in total trips Purposes of this study are to analyze inter-campus trips, determine share of different modes and discuss different infrastructure investments and strategies to increase mode share of bicycle and decrease the excessively high demand for shuttle busses. In order to that, all students' course schedules and dining hall smart card logs are analyzed and a face to face survey study with randomly selected 691 students was conducted to gather data of revealed preferences of transportation modes and stated preferences of cycling in case of possible infrastructure investments. Results of the mode share analysis are 75.5% walking, 1.7% bicycle, 18.7% shuttle bus and 4.1% motor vehicle for all inter campus trips. For trips originated from South Campus mode shares are 65.7% walking, 1.3% bicycle, 29.8% shuttle bus and 3.2% motor vehicle. Results show that, to deal with queues in the shuttle bus stops, the first and simplest thing to do is increasing number of shuttles will not work as intended because of the speed limit in campuses and capacity of traffic connecting campuses. However, stated preference study show that pro bicycling investments will decrease the demand to shuttle busses and increase the bicycle mode share significantly.

Keywords: Sustainable transportation, campus planning, bicycle

1 Introduction

There is an extensive literature about quantitative outcomes of pro-cycling programs and investments. However, these studies are generally about certain city's investments. Because of the subjective and demographic factors that affect cycling demand, accurate estimation of quantitative outcome of pro-cycling programs and investments are impossible by using these studies. In addition to that a university's population is different from a city's population with less variance in age, education level, and income. This relatively homogeneous population may react differently to popular cycling investments. Another source of uncertainty in predicting outcome of an improvement is ambiguity of the direction of causality between cycling demand and bicycle infrastructure investments.

Goldsmith (1992) identified factors affecting bicycle demand and divided into two main group as subjective and objective factors. Distance traffic safety, convenience, cost, value of time, value of exercise, physical condition, family circumstances, habits, attitudes and values and peer group acceptance is subjective factors. Climate, topography, presence of bicycle facilities and traffic conditions, access and linkage and transportation alternatives are objective

factors. Among these factors Daley and Rissel (2011) stated that perceived safety is a significant barrier to keep people away from cycling. There are programs in many cities for educating both cyclists and motorists about cyclists' legal rights. However, Pucher et al. (2010) claimed that there is no statistical evidence to prove these programs' positive quantitative effects on cyclists' safety but these educational programs increase people's self-confidence for cycling. Jacobsen (2003) introduced "safety in numbers" phenomena to explain factors affecting cyclists' safety. Jacobsen (2003) showed that as the cycling level increases injury rate of cyclists' decreases. According to Elvik (2009) and Jacobsen (2003), increase in number of cyclists' leads to increased visibility of cyclists which is an important factor for cycling safety.

Availability of a bicycle in a household is an important and direct factor that affects cycling choices (Cervero et al. 2009). Risk of theft, cost of a bicycle, maintenance and lack of safe parking areas affect bicycle ownership. In order to increase bicycle access, giveaway, loaner and service programs and bicycle sharing systems are used extensively. Researches show that these programs increase overall trip share of cycling effectively. Beside cities, universities in USA also adopt bicycle sharing systems to increase modal share of bicycle. Main problem in bicycle sharing systems is distribution of bicycles among stations. In order to improve distribution, Velib (Bicycle sharing system in Paris) bicycle sharing system rewards cyclists that use uphill stations with 15 minute extra credit (DeMaio 2009).

Daley and Rissel (2010) stated that public image of cycling and cyclist can impede penetration of cycling into different layers of society. They conducted a focus group research to identify public image of cycling and cyclists and effects of these images on cycling choices. According to results, respondents define cycling as clean, green, healthy, fun, dangerous and serious business. However, cyclists have negative image. Respondents see cyclists as risk takers, law breakers and radical green activists. Due to these negative images associated with cycling and cyclists researchers suggest that promotional campaigns for cycling must be prepared to make bicycle more mainstream.

2 Information About Bogazici University

Bogazici University one of the oldest (founded in 1863) educational instructions in Turkey. The university has 6 campuses located in Istanbul. South, North, Hisar and Ucaksavar campuses are located close to each other in Hisarustu district of Istanbul. Sarıtepe Campus is located in northern part of Istanbul, coast of Black Sea and Kandilli campus is located in Asia side of Istanbul. Educational and recreational center of the university is South, North, Hisar and Ucaksavar campuses. Universities facilities are scattered among this 4 campuses. For instance, library is located in North campus, Student associations are in South campus, and gym is in Hisar campus. Even some departments have classrooms or laboratories in different campuses. Because of this decentralized structure of the university, many students make trips between campuses during the day. Primary transportation modes that used for these trips are walking and shuttle buses. As seen in Table 1, distances are favorable for cycling. However hilly topography of the area that university located discourages people to cycle between or within campuses. Trips originated in South Campus suffer most from this topographic disincentive because of the 350m long ramp with 9.6% average grade (14.5% max. grade) located in South Campus. Students have a tendency to prefer to use shuttle busses for their trips from South Campus. This result in long queues in shuttle bus stop in South Campus.

Table 1. Distances between campuses

		Destination			
		South Campus	North Campus	Hisar Campus	Ucaksavar Campus
Origin	South Campus		873m	1268m	1340m
	North Campus	873m		892m	601m
	Hisar Campus	1268m	892m		1240m
	Ucaksavar Campus	1340m	601m	1240m	

3 Data Collection

3.1 Students' Course Schedules

For this study, Bogazici University Registrar's Office provided data of all students' course schedules and dining hall smart card logs. This data analyzed to determine origin, destination and time of trips between 33 locations in main campuses. To fill the vacant hours between courses in schedules. Some assumptions had been made. These are:

- Students spent their time between courses in library, study halls, cafes in campuses or cafes in outside of the campuses.
- Every student has a probability to go library regardless of their origin campus.
- If a student do not prefer to go to library, she/he prefer the nearest cafe or study hall to spend her/his time.
- If all cafes and study halls are full in the origin campus, she/he goes to cafes in outside of campus

3.2 Campus Transportation Questionnaire

A face to face questionnaire study with randomly selected 691 students was conducted to gather data of revealed preferences of transportation modes and stated preferences of cycling in case of possible infrastructure investments. In survey study, following items are investigated:

- Bicycle ownership
- Car ownership
- Share of cycling in trips between campuses
- Modal split of trips between campuses
- Bicycle ridership in case of bicycle sharing system investments are made in university
- Bicycle ridership, bicycle ownership in case of bicycle lift investments are made in university
- Relationships between items above and gender, income, location of residency, weather conditions

Results of stated preference questions were evaluated with a certain level of skepticism. Main purpose of this questions is to observe public attitude and enthusiasm toward cycling rather than estimating quantitative outcomes of certain investment options.

3.3 Counting of shuttle passengers and queue length at the south campus shuttle stop

Shuttle buses work continuously between South and North campuses during day. Since this service is free of charge students favor using shuttle bus than walking from south campus. There is no system available to collect passenger data of shuttle busses. Because of that, manual collection of data was carried out. A period of one week with no special event or weather event was selected for data collection. During this week, from 9:00 to 18:00 following data were collected:

- Departure time of each shuttle bus that departed from South Campus
- Arrival time of each shuttle bus that arrives to South Campus
- Number of passengers in each shuttle bus departed from South Campus
- Number of people in the queue at the moment of departure of each shuttle bus

4 Results

Analysis of course schedules and smart card logs showed that average number of students come to one of the main campuses each day is 7798. Average population of campuses during day listed in Table 2.

Table 2. Average populations of campuses during day

	South Campus	North Campus	Hisar Campus	Ucaksavar Campus
7:00-8:00	4	39	0	0
8:00-9:00	50	255	0	0
9:00-10:00	819	1840	216	185
10:00-11:00	1247	2829	457	7
11:00-12:00	1479	3337	536	346
12:00-13:00	1597	3403	478	241
13:00-14:00	1573	3211	316	40
14:00-15:00	1460	2928	357	60
15:00-16:00	1150	2126	394	3
16:00-17:00	924	1482	266	9

Origin and destination campuses of trips is found from trips between 33 locations in university. In Table 3, origins and destinations of trips for one day is listed. The term "outside" refers to all locations that are outside of campuses (home, cafes). The number of home originated or destined trips included in the table.

Table 3. Average number of trips in a day

		Destination				
		South Campus	North Campus	Hısar Campus	Ucaksavar Campus	Outside
Origin	South Campus	1888	1521	148	97	2416
	North Campus	1456	6153	330	201	5343
	Hısar Campus	194	310	7	5	777
	Ucaksavar Campus	200	355	9	0	196
	Outside	2329	5104	799	457	0

From Table 2 and Table 3, it can be seen that South and North Campuses are most crowded campuses and majority of inter-campus traffic is between these campuses. Analysis showed that, there are average 6652 (outside trips that are not home originated or destined counted as intercampus trips) trips per day between campuses. 27.7% of inter-campus trips are originated from South Campus. Table 4 shows average number of trips originated from South Campus during day.

**Table 4.** Average number of trip originated from South Campus

	South Campus	North Campus	Hısar Campus	Ucaksavar Campus	Outside
7:00-8:00	0	0	0	0	0
8:00-9:00	3	1	0	0	0
9:00-10:00	34	12	1	1	1
10:00-11:00	70	47	11	0	7
11:00-12:00	320	295	17	51	87
12:00-13:00	340	231	14	34	93
13:00-14:00	544	415	22	5	319
14:00-15:00	332	277	33	3	240
15:00-16:00	192	188	47	1	439
16:00-17:00	52	54	3	2	306

According to survey results, share of bicycle and motor vehicle owners among respondents are 12.7% and 11.3% respectively. 4.2% of respondents use motor vehicles for inter-campus trips. For bicycle usage, 2.3% of respondents use bicycle in hot weathers, 1.3% use bicycle in cold weathers, 0.79% use in rain and 0.4% use in snow. After questions about ownership or current preferences of transportation between campuses, questions about future bicycle usage preferences in case of different infrastructure investments are asked to respondents. Asked investments are bicycle sharing system, bicycle sharing system with bicycles with pedal assistance and bicycle lift (also known as Cyclocable™) in South Campus. Respondents made their considerations for each investment independently and for different routes and weather conditions. Table 5 summarizes percent of stated future bicycle usage in case of each investments independently.

Table 5. Stated preferences of bicycle usage for different infrastructure investments

	Hot weather	Warm weather	Cold weather	Rain	Snow
Results of bicycle sharing system investments					
South Campus originated trips	20.12%	24.17%	16.06%	6.51%	3.91%
South Campus destined trips	60.64%	68.45%	30.97%	16.79%	6.08%
Trips between North, Hisar and Ucaksavar	44.86%	51.81%	25.04%	14.76%	5.21%
Results of bicycle sharing systems with bicycles with pedal assistance					
South Campus originated trips	69.32%	69.90%	48.34%	28.80%	19.68%
South Campus destined trips	68.16%	73.37%	41.68%	23.30%	13.02%
Trips between North, Hisar and Ucaksavar	53.84%	56.58%	35.17%	20.69%	11.87%
Results of bicycle lift					
South Campus originated trips	68.16%	69.32%	46.45%	30.68%	16.35%

Results of the passenger and people on the queue counting are summarized in Figure 1. Queue lengths were measured on South Campus shuttle bus stop.
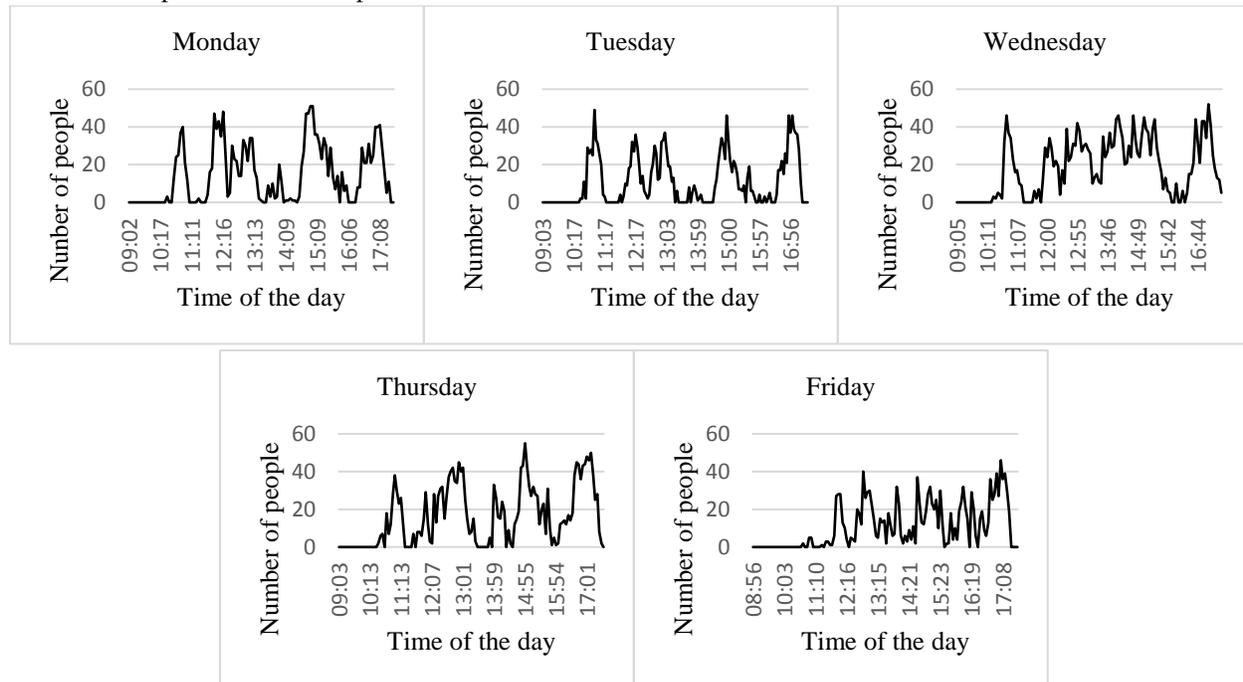
Figure 1. Number of people on shuttle bus queue during the day (Monday to Friday).

Shuttle busses do not have a fixed schedule. They operate according to a maximum waiting time of 10 minutes. If shuttle bus reaches its capacity before 10 minute, it departs. Data shows that average frequency of shuttle busses is 3.82 minute and currently shuttle busses work at 96.9% of their daily capacity.

Results from analysis of course schedule, smart card logs and counting combined and modal split of inter-campus trips are determined. Due to major share in inter-campus trips and the ramp located in the campus, modal split of trips originated from South Campus separately determined. Modal share of the mods available on campuses can be seen on Table 6.

Table 6. Modal split for inter-campus trips

All Inter-Campus Trips			
Walking	Bicycle	Shuttle Bus	Motor Vehicle
75.5%	1.7%	18.7%	4.1%
Trips Originated from South Campus			
Walking	Bicycle	Shuttle Bus	Motor Vehicle
65.7%	1.3%	29.8%	3.2%

5 Discussions and Conclusions

Universities are generally the major trip attractor and generator in the area which the university campuses resides. Because of that, dominant transportation modes of trips between campuses and to campuses have an effect on the neighborhood via visibilities of the modes. Thus, increasing share of the sustainable transportation in inter-campus transportation will increase the visibility of the sustainable modes in the neighborhood. In this study, since the distances are favorable and university campuses relatively secure from theft, bicycle is selected to promote for trips between campuses.

The results indicate that many students make intercampus trips during day (average 0.85 trip per student). Majority of these trips are caused by the fact that the locations of consecutive lessons may be in different campuses. Since break time between consecutive course hours is 10 minute, it is not possible walk inter-campus distances in time with a comfortable pace. Because of that, as seen in the figures 1-5 (peaks in figures), students prefer to use shuttle busses between consecutive courses. However, large demand in short time interval causes long queues in shuttle bus stops. In order to deal with queues, the first and simplest thing to do is increasing number of shuttles. Because of the speed limit in campuses and capacity of traffic connecting campuses, increasing number of shuttles will not work as intended. In addition to that, increasing number of shuttle busses contradicts with environmental goals of Bogazici University. As a result, to deal with queues on shuttle busses, shuttle demand must be decreased. Since inter-campus distances are too long for a 10 minute walk, walking cannot be promoted as an alternative to shuttle bus. Bicycle is the only alternative to shuttle busses. However, as mentioned earlier, topography and infrastructure is not suitable for bicycle usage. In the light of the data and literature about pro-cycling improvements, possible improvements are evaluated.

In many cities and universities bike lanes are the fundamental bicycle infrastructure. There is many studies that indicates positive relationship between level of cycling and availability of bike lanes. Unfortunately, construction of bike lanes that separated from traffic is not possible in Bogazici University due to average with of main roads in campuses is 5 meter. Instead of separated bicycle lanes, shared bicycle lanes can be constructed to campuses. Increase in cycling level is not expected from shared bicycle lanes. However, it will improve cyclists' safety.

Bicycle sharing systems are adopted by many cities and universities to increase their cycling levels. Different business models and different service providers are available for bike sharing systems. Since shuttle busses in Bogazici University is free of charge, bike sharing system must be also free of charge in order to increase cycling levels. As seen in the survey results, bike sharing system can increase cycling levels except trips originated from South Campus. Almost certain that students will use bicycle for South Campus destined trips but not for South Campus originated

trips. This will create operational difficulties like distribution of bikes among stations during day. In order to encourage students to use bicycle sharing system for South Campus originated trips, incentive programs can be used. Considering that bicycle sharing system will be free to use, this incentive cannot be financial. Incentive in form of free meals in dining hall or free Gym subscription to most frequent user in that route will be effective. In order to create a bicycle sharing system that effective in South Campus, a bicycle sharing system with bicycles that have pedal assistance system can be used. There are two types of pedal assistance in market. One of them is Pedelec™. Pedelec™ constantly assist cyclist when cyclist is pedaling. The other one is Copenhagen Wheel™. Copenhagen Wheel assists only when cyclist needs assistance like going uphill. As seen in Table 5, both system can be useful in South Campus originated trips.

Bicycle lift is a conveyor system that lifts cyclists with a retractable foot rests. Since foot rests is automatically retracted into system and system has the same level with road, there is no need for separate bicycle lane to construct this system. Result of the survey clearly shows that there will be an increase in cycling levels, if this system is constructed in South Campus.

Current parking facilities in Bogazici University are not secure and protected from weather. Secure, sheltered parking facilities can increase mode share of cycling.

In order to increase effectiveness of the infrastructure improvements listed above, proper marketing and education campaigns and bicycle related events must be organized. Marketing campaigns and events have an important role in increasing first time bicycle riders. As Daley and Rissel(2010) suggest that, this interventions must be aimed to make bicycle a mainstream activity. Education programs must be targeted to both riders and non-riders. This will decrease the conflicts in traffic and increase perceived safety.

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