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TeMA Journal of
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CYCLABILITY IN LAHORE, PAKISTAN:

LOOKING INTO POTENTIAL FOR GREENER URBAN TRAVELING

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ABSTRACT

Measuring perceived or objective cyclability or bikeability has drawn less attention compared to walkability, particularly in developing countries like those in South Asia and the Middle East. This paper presents the results of a survey about cyclability in Lahore, Pakistan, focusing on human perceptions rather than the built environment. The overall sample included a total of 379 respondents from three socio-economic classes: those from lower socio-economic backgrounds accessing traditional/older bazaars, respondents from the middle socio-economic class accessing uptown bazaars, and respondents of higher socio-economic status accessing pedestrian shopping malls. The exploratory data collection was conducted in spring 2018 in Lahore by means of a short standard questionnaire with 19 questions, resulting in 17 categorical/dummy variables, two open-ended variables, and two continuous variables targeting socio-economics, bike trip characteristics, biking barriers, and preferred travel specifications. The results showed that the middle socio-economic group was more inclined, flexible, and willing to bike compared to the lower and higher socio-economic-groups. The lower socio-economic group used the bicycle more frequently than the middle socio-economic group. Around half of the middle socio-economic group commutes via bike compared to the lower socio-economic group. There was little to no representation of 55-64 and 65+ age groups in the data. The descriptive findings of this survey indicate some preliminary signs of differences of decisions and perceptions about biking compared to high-income and European countries. These differences need to be tested in future statistical analyses.

KEYWORDS:
Urban Transportation Planning; Sustainable Mobility; Active Transport; Cyclability; Pakistan

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巴基斯坦拉合尔的循环稳定性
探索绿色城市旅游的潜力

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摘要

与步行条件相比，衡量可感知的或客观的可循环性或自行车可骑性引起的关注较少，特别是在南亚和中东等发展中国家。本文介绍了在巴基斯坦拉合尔进行的一项关于可循环性的调查结果，强调的是人类感知，而不是建筑环境。普查包括来自三个社会经济阶层的379名受访者：来自社会经济背景底层的传统/较老的集市、来自社会经济中级阶层的受访者住宅区市场，以及社会经济地位上流的步行购物中心。2018年春季，在拉合尔通过一份包含19个问题的简短标准问卷进行探索性数据采集，得出17个分类/虚拟变量、两个开放变量和两个针对社会经济、骑车旅游、自行车障碍和首选旅行规范的连续变量。结果表明，与低、高社会经济群体相比，中层社会经济群体更倾向、更灵活、更愿意骑车。底层社会经济群体比中层社会经济群体更频繁地使用自行车。与底层社会经济群体相比，大约一半的中层社会经济群体骑自行车上下班。在数据中，55-64岁和65岁以上年龄组几乎没有骑车习惯。这项调查的描述性调查结果表明，与高收入国家和欧洲国家相比，关于骑自行车的决定和感知有一些初步的差异。这些差异需要在未来的统计分析中加以检验。

关键词:
城市交通规划，可持续流动，活跃交通方式，循环性，巴基斯坦

1 INTRODUCTION

This paper provides primary data derived from a mobility survey conducted in Lahore, Pakistan in 2018 and discusses the potentials and barriers of policy-making to promote biking in the Pakistani context. The findings might also be applicable for similar neighboring geographical and cultural contexts like the Indian subcontinent and the Middle East and North Africa (MENA) region. The necessity of conducing such cycling surveys is driven by the lack of reliable disaggregate data in Pakistan and its neighboring regions.

Urban cycling can curb the ill effects of motorized transport in urban areas with respect to congestion, parking spaces, amenity, air pollution and fatal accidents (Hickman & Banister, 2014). Therefore, there is a need to increase via urban planning the number of urban bicycle-users commuting short distances. Choice of transport mode has direct relation with household income as the literature findings suggest that high income group is more flexible in choosing the transport mode for commuting while the low income group has limited options (Replogle, 1992). Previous research has shown that the bicycle, along with cars and public transport modes, plays a significant role in mobility and livelihood for people especially the poor (Anand et al., 2006; Pinto & Sufineyestani, 2018). Pakistani cities are growing at a rapid pace. Lahore itself, the second biggest city in Pakistan, already has a population of 11.13 million (Government of Pakistan, 2017). While the population of Pakistan is 207.8 million with growth rate of 2.4% (Government of Pakistan, 2017), the share of population living in urban settings has increased from 32.5% to 36.4%. This growth puts pressure on infrastructure services, especially roads. Thus, it is important to conduct research on options that can reduce congestion on roads i.e. making Lahore (now considered a megacity) more cyclable to alleviate issues of pollution, congestion, parking, and high travel costs. There is no compiled data available in Pakistan on cycling trips, income level, age, and other factors that hinder bicycling as a mode of transport. Japan International Cooperation Agency (2011) stated that the bicycle, rickshaw, and horse carriage could play an important role in making urban transport a more convenient and affordable option in Pakistan. However, facilities and infrastructure for cyclists (being a sustainable and more affordable travel mode) are either nonexistent or inadequate. As a result, those who choose to use the bicycle regardless of this dearth of infrastructure end up being the victims of 50% of all road accidents (ibid). While the proportion of non-motorized daily trips including bicycles had remained relatively high in the past, it is now declining at a significant rate. In Lahore, this decreasing trend of bicycle trips can be attributed to the shift toward motorized vehicles and increased public transport usage in the absence of adequate cycling infrastructure. JICA study in 2011 stated that the estimated proportion of a person's daily trips using motorcycle/ bicycle was 18.8%, which suggests even a lower proportion of the trips being made explicitly by bicycles (Tab. 1).

Mode		Trips (,000)	Proportion	Proportion Excluding Walk
Public Transport		3,409	19.3%	35.4%
Private Vehicle	Cars	2,894	16.4%	30.1%
	Motorcycle/ Bicycles	3,314	18.8%	34.5%
Mechanized Total (Excluding Walk)		9,617	54.5%	100.0%
Walk		8,050	45.5%	-
Total		17,667	100.0%	

Tab. 1 Proportion of daily person's Trips in Lahore (JICA, 2011)

The 2011 JICA survey showed a significant decrease in use of bicycle. The major reason behind the decreasing trend of bicycling in Lahore is because of poor physical road infrastructure. The last few decades have also seen the development of several new housing communities that did not incorporate bicycles paths into their

design. This mode is completely ignored in traffic junction design, forcing cyclists to dangerously mix in with motorized traffic and leading to low bicycle-usage. Thus, this research was conducted to collect primary data for the further analysis of the potential and constraints of cycling and to promote the integration of safe non-motorized transport modes into Pakistani urban planning.

This research is designed to address gaps in knowledge about the potential of cycling in Pakistani cities. The survey designed to answer the research gaps by investigating the effects of income, education, gender, travel distance, and bicycle ownership on cycling as a mode of transport. The survey results provide an overview of the potential of cycling in urban Pakistan. The questions sought to identify constraints like extreme weather, culture, gender, infrastructure for cycling, and dependence on family members for transport. Lastly, the survey also revealed users' mode choice depending on decisive factors like time, distance, and nature of trip. This contribution is limited to the descriptive statistics found during the data collection. In order to have enough space and capacity to present the details of the findings, this paper does not include any statistical hypothesis or modeling. The future works will use refer to this manuscript for the purpose of presenting modeling results. The survey and its findings provide numeric data for subsequent co-relational studies using dependent, independent, and extraneous variables. Statistical techniques like correlation and regression can be applied to this dataset. This study will also act as a reference unit for other urban areas in Pakistan with similar characteristics. The methodology and questions were designed to parallel the designs used in existing literature and to collect data in un-biased manner that represented all income groups.

2 CYCLABILITY

Cyclability usually refers to the ability to use the bicycle as a transport mode using spatial structures and streets, e.g. cyclability of a street (e.g. Guthrie et al., 2001) or a city (Muñoz et al., 2016). This study discusses urban cyclability but examines people's other travel choices and their individual and household conditions in addition to physical/spatial characteristics. The main reason is to improve the limited understanding of planners and decision-makers in Pakistan or similar contexts about people's perceptions of biking as a transport mode. Before it is possible to improve cyclability using objective interventions like developing biking infrastructure, it is necessary to have an evidence-based image of the factors that are associated with biking in the first place. The existing literature about cyclability shows that this term encompasses and is defined by a wide range of phenomena: modal split in order to choose policies, observed and estimated bicycle demand, bicycle levels of service, number of accidents, and physical and environmental benefits from biking (Berloco & Colonna, 2012). Jones and Novo de Azevedo (2013) observed that a "favourable climate, flat topography, fairly compact urban form and highly connected (gridded) street network appear to provide the fundamentals of a 'cyclable' city" but other cultural or human-related issues can support or weaken cyclability of a city or area. Parkin (2009) observes not only physical characteristics like road width, traffic flow and speed, average number of heavy vehicles and buses, gradient, bumpiness, lateral conflict, and aesthetics, but also human-related factors like overall feelings of safety, effort, and pleasure. Cyclability studies have a status like the general studies on the advantages and sustainability of biking. Researchers take selected (not all) aspects and limit their studies only to some perpectives and viewpoints. For instance, Pirlone and Candia (2015) take socio-economic (social and economic sustainability) and environmental terms (environmental sustainability) for analyzing the sustainability of cycling. Examples of international efforts to improve cyclability can be seen in several high-income countries that invest in their biking infrastructures as a pull factor to reduce personal car use. In Spain, (Muñoz et al., 2016) collected data about cycling-related indicators of residents in the mid-sized city of Vitoria-Gasteiz by conducted an ad-hoc telephone mobility survey of 736 employees and students in 2012 and suggested some recommendations to transition the city to a more bike-friendly one. Their suggestions including "marketing campaigns to encourage non-commuting cycling trips, bicycle measures to target social groups as opposed to individuals, bicycle-specific programs such as "Bike-to-work Days", and cycling courses."

Data collected from interviews with 343 people in a district of Milan, Italy shows that improving the city's bike lane network could lead in a 34.4% increase in cycling in the district (Rebecchi et al., 2016). In Denmark, Nielsen et al. (2013) examined cyclability using information collected from the annual Danish National Travel survey. They used the data of 2009/2010 and 2010/2011 for a total of 39222 respondents – 9128 of whom cycled an average of 7.7 kms on the survey day – and concluded that there is a high probability of cycling for short distances. Another large Danish bikeability study was conducted from 2006 to 2014 on 59000 respondents living or working in cities with more than 9000 inhabitants. It observed several biking variables like trip stages, number of trips, journeys and the travel were associated with the socio-economic and demographic characteristics (Christiansen, 2012; Christiansen & Haunstrup, 2012; Nielsen & Skov-Petersen, 2018). Studies about cycling and cyclability have rarely been conducted in neighboring countries/regions with approximate similarities to the geographical and cultural situation of Pakistani cities. In India, bicycle ownership and trip data is available in census and many researchers have used this secondary data.

These studies have been conducted on the relationships between cycling and various environmental aspects, socio-economic status, and physical factors. Srivastavaa et al. (2017) established a relation between bicycle use and its environmental effects and concluded that using bikes could save significant amount of greenhouse gases. This research also concluded that low-income households use bicycles while middle- and upper-income households used motorized vehicles. Another study conducted by Majumdar and Mitra (2015) examined behavior of cycle users with respect to travel time and physical factors. Primary data was collected with a questionnaire survey in this study. In the Middle East and North Africa (MENA) region, research on cyclability mostly deals with topics of sustainable transport, urban road infrastructure, and efficient mobility. There is not enough work available on the opportunities and constraints of cycling and socio-economic factors.

Only a few studies have been done in some countries in the region: an empirical and analytical study to promote cycling among different age groups in Turkey (Tandogan & Ergun, 2013), and an urban cyclability assessment model in Doha, Qatar (Ferwati et al., 2017). Other works done on the neighboring region of the MENA include cycling as a part of mobility patterns as a whole and does not present the status of cycling and cyclability separately (Masoumi, 2013; Soltanzadeh & Masoumi, 2014). A review of the past studies on the similar topic reveals that the topic has mainly been explored through quantitative methods. Although there are indeed studies that investigate the various factors related to people's behaviors and perceptions toward cyclability through qualitative methods, they are fewer in number. There are also some studies who employed mixed-method techniques for data collection. Some of the studies specifically targeted cyclists, while others targeted all travelers using any travel mode or the area's residents. Of all the data collection methods employed in the studies, interviews via traveler-/commuter-intercept surveys were the most common method. Other methods consisted of web- or phone-based surveys, field observations, in-depth face-to-face resident interviews, expert interviews, and focus group discussions. Low response rates were often the main limitation for collecting data through web- and phone-based interviews: response rates generally ranged 20-60%. Response rates for traveler-intercept surveys were higher, with only one study reporting a rate of 19%.

Many of these studies used a variety of locations to perform the data collection. Some of them focused on particular districts in a city or the town/city as a whole, while others conducted surveys at key locations of trip routes e.g. commercial areas, cordon points, and (occasionally) residential areas. Response ratio (the sample coverage of overall city population in terms of percentage) ranged as low as 0.03% to a high of around 0.3%. Tab. 2 summarizes the results of some of the past studies on the same topic.

3 METHODOLOGY

This study explores cyclability on the Indian subcontinent using Lahore, Pakistan as a representative example. The term cyclability in this study refers to spatial issues like different socio-economic status of different urban districts as well as the individual and household characteristics and urban travel behaviors.

Study	Sample Size	Response Rate	Case-study areas	Response Ratio	Data collection method
Arora, 2013	574 bicycle users (109-124 at each location) and 82 cycle rickshaw pullers	Not available	All locations where National Highways intersect Delhi city border (05 in number)	0.01 (cyclists) and 0.02 (cycle rickshaw)	Video recordings of two-way traffic flows at various hours of the day and Personal interviews
Chatterjee et al., 2013	Qualitative sampling: 144 (12 in each Cycling City and Town)	Not available	12 Cycling City and Town in England	0.20	In-depth face-to-face interviews
Christiansen & Skougaard, 2015	2-Stage Stratified sampling (208 Strata): 16,465 persons	58.4%: 1,938 web and 7,666 telephone interviews	Danish residents belonging from 13 geographical groups	Not available	Web (self-administered) and telephone interviews in a year
Clifton et al., 2012	Random sampling: 1884 customers (Long surveys: 697 and short surveys: 1187)	19% (long survey) and 52 % (short survey	78 retail establishments in the Portland Metropolitan Area	Not available	Customers intercept survey (via handheld computer tablets) and Field observations of built environment in 2011
Gössling, 2013	Qualitative sampling	Not available	Copenhagen	Not available	Expert interviews
Jones & Novo de Azevedo, 2013	20 (2010) and 12 (2011) representatives, 12 participants of mass bicycle ride and 15 cycle commuters	Not available	Pelotas, Brazil	Not available	Focus group discussion, Field observations and random Interviews in 2010 & 2011
Majumdar & Mitra, 2015	50 potential respondents for expert interviews and Simple random sampling for travel survey: 575 responses	24.0% (12) for e-mailed survey	17 locations of substantial trip generation in Kharagpur, India	0.20	Expert interviews (AHP Questionnaire) sent out through emails and Travel intercept survey
Muñoz et al., 2016	736 employees and students	Not available	Vitoria-Gasteiz, Spain	0.30	Telephone survey in 2012
Nielsen & Skov-Petersen, 2018	9604 residents: The sample of Danish National Travel Survey	58.4%: 1,938 web and 7,666 telephone interviews	Danish residents belonging from 13 geographical groups	Not available	Secondary data of Danish National Travel Survey
Rebecchi et al., 2016	Random sampling of residents: 343 citizens	Not available	District 7, Milan	0.20	Web survey and Direct interviews

Tab. 2 Methodological considerations of similar past studies

This study was designed with the objective of creating a small but reliable dataset to link biking behavior with individual and household characteristics, travel behavior, and spatial factors. In Indian subcontinent especially in Pakistan, there is no reliable data available on bicycling. Therefore, descriptive statistics is yet a good

contribution in this manuscript. The detailed statistical hypothesis or modelling will be presented in future work due to space limitation while referring to this manuscript.

3.1 CASE-STUDY AREAS

For the cyclability survey, Lahore is selected as it is the country's second biggest city and its population has increased at a high rate in recent years. Lahore's urban boundaries increased from 220 km in 1995 to 336 sq. km in 2005 and 665 sq. km in 2015 (Ibrahim & Riaz, 2018). The city's population grew by 3% from 5.20 million in 1998 to 11.13 million in 2017. This rapid growth of population translates into increased trip demand and has led to a shortage of available and effective transport. Fig. 1 shows Lahore's growth over the last two decades. In those two decades, the city grew southward in accordance with its master plan. This growth divided the city into areas populated by various socio-economic groups. The newly build residential sector housed middle- to high-income groups while the older developed areas housed mostly middle- and low-income groups. In the old parts of city, travel distances for activities like work, education, shopping, and leisure are generally shorter than in other parts of the city because land is used in a more mixed fashion. While on the other hand, segregation of land uses in the newly build residential areas increased the average length of trips and urban planning became car-based. Moreover, the policy of the last government regime was to promote signal-free corridors to facilitate the car users. The data shows Pakistan has experienced a massive increase (268%) in vehicle registration in the ten years between 2005 and 2015 (Gallup Pakistan, 2016). Bicycles are not included as there is no registration required for them. While it is thought that rapid transit systems in developed countries assist cities in their wealth creation by reducing car dependence, they are an expensive mode of travel in emerging countries (Newman & Kenworthy, 1999).

Two of the selected case sites in Lahore – Baghbanpura and Pakistani Bazar – are older sections of the city and have a mixed land-use urban texture. The internal road networks are largely composed of narrow and congested streets. Due to congestion, motor vehicle speed is reduced and it is safe to cycle in these areas. Baghbanpura and Pakistani Bazar are home to mostly low- to middle-income residents. Car ownership rates are lower in these areas than other parts of the city, but motorized vehicles like motorbikes and cars are still relatively common. Other selected sites – Liberty, Emporium Mall, and Packages Mall – can be considered high-income areas. Public transport routes are sufficiently developed that they can be effectively used by residents to access these shopping areas. Furthermore, all planning is oriented toward car-owners, such as large parking places and cheap parking prices. In these areas, bicycle-use is quite rare (mainly by servants in homes) as even students must commute with motorized vehicles because of long travel distances. Bicycle-use was completely ignored in road design and no parking is available for cyclists in these areas. The lack of infrastructure for cycling and the high average vehicle speed creates a dangerous environment for bike-users. The location of surveyed areas pointed out in Fig. 2.

3.2 DATA AND SAMPLE

The sample included 379 respondents spanning three socio-economic classes that correlated with their access to facilities to meet their needs. Respondents with lower incomes largely had access to traditional areas and older bazaars, while middle-income respondents accessed uptown bazaars and high-income respondents accessed pedestrian shopping malls. These bazaars and case-study markets are illustrated in Fig. 2.

The survey instrument was based on 21 questions focusing on spatial, individual and household characteristics, bike trip specifications, general mode choice, and causalities of bike-use. Tab. 3 summarizes the questionnaire including the variables and their types. Since most of the desired information was qualitative in nature, they were transformed into categorical and dummy variables suitable for discrete choice modeling. The questionnaire was kept as brief as possible so that the interviews could be completed quickly. The questionnaires were filled out during face-to-face interviews with residents living in various parts of the city.

The sample size provides only an exploratory look into residents' socio-economics, travel behavior, and cycling preferences; thus, no representativeness ratio or index is calculated for the survey. Tab. 4 summarizes the total number of respondents and valid responses for each question. In that table, "N/A" refers to either "No Response" or was applied when the question was not applicable to the respondent. This study's findings are presented in the form of frequencies and percentages for categorical and binary data as well as descriptive statistics for the two continuous variables. The two continuous variables were tested for normality via two methods: Kolmogorov-Smirnov and Shapiro-Wilk, where P-values of less than 0.05 indicate non-normality.

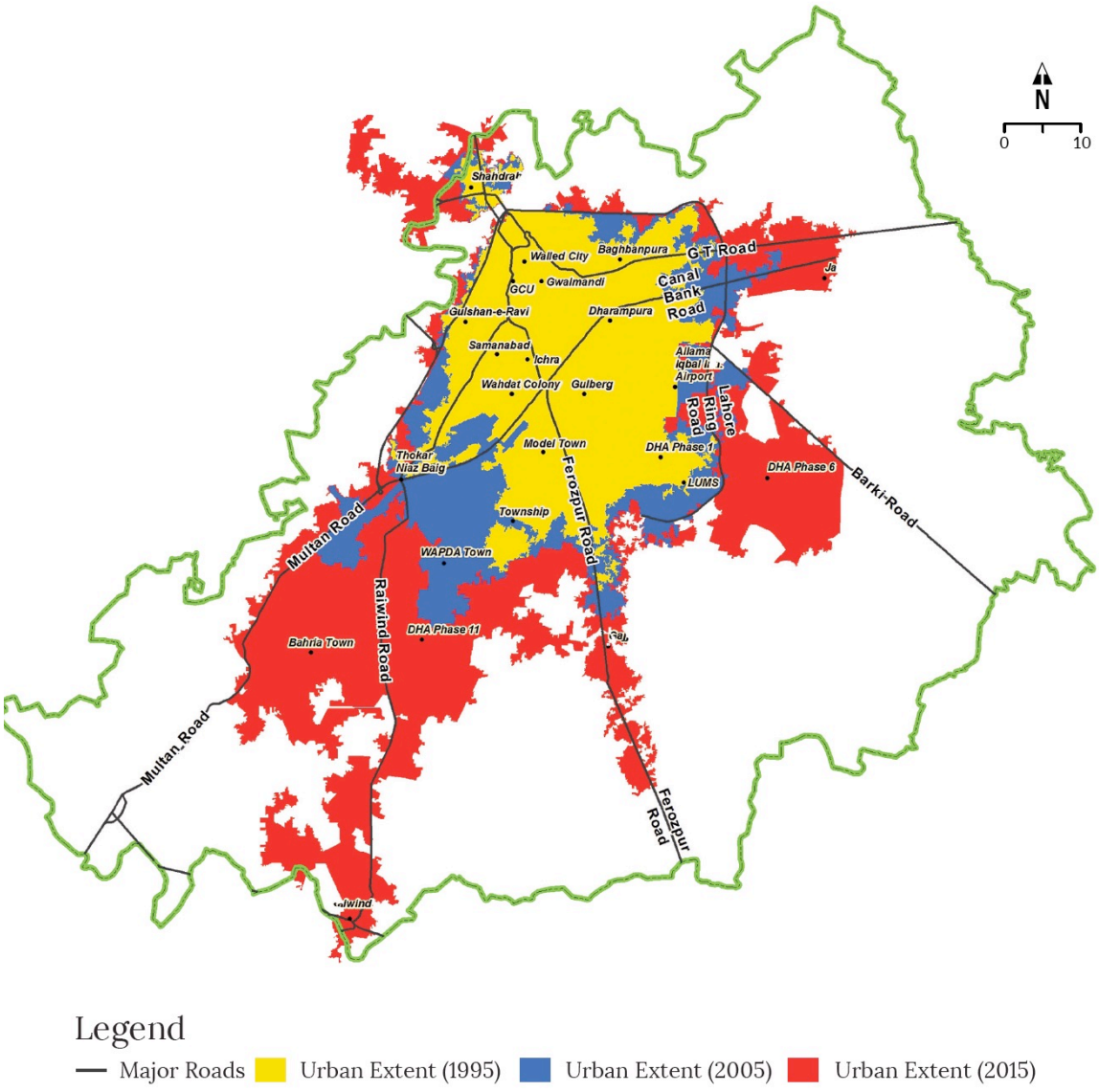


Fig. 1 Urban extent of Lahore (1995 to 2015).
Source: Ibrahim and Riaz, 2018

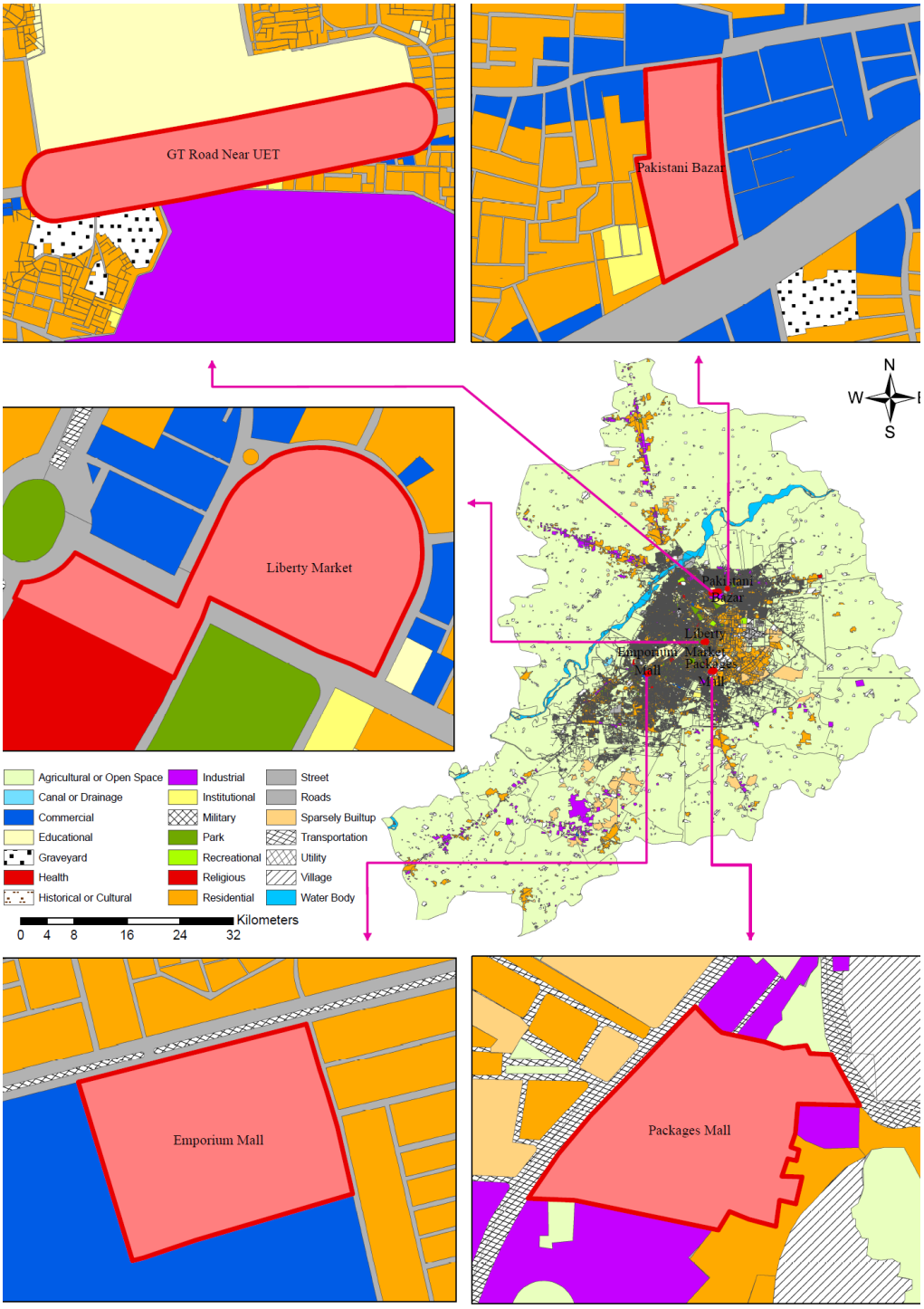


Fig. 2 Location of case study areas in Lahore City. Source (Authors, 2018)

Variable	Variable Type	Categories
Location	Categorical	Lower-Socio-Economics, Medium-Socio-Economics, and Higher Socio-Economics
Gender	Categorical	Male, Female, and Transgender
Age	Categorical	15-24; 25-54; 55-64; and >65
Income	Categorical	0-15,000; 15,000-50,000; 50,000 - 100,000; and >100,000

Education	Categorical	Under Matric, Matriculation, Under-Graduate, Graduate, and Post-Graduation
Know how to ride bicycle	Binary	Yes or No
If no why not?	Open-ended	-
Use for commuting	Binary	Yes or No
Cycling frequency	Categorical	Daily, Weekly, Monthly, Occasionally, and Need-Based
No. Of cycle user in house	Continuous	-
No. Of cycle owned in house	Continuous	-
Hindrance in bicycle use	Categorical	Health and Fitness, Weather and Environmental Condition, Culture, Gender, Family Dependency For Travelling, and Non-Availability Of Facilities I.E. Bicycle Lane
Purpose of majority trips	Categorical	Recreation, Educational, Work, Health, Fitness, and Wellbeing
Preferred mode of choice	Categorical	Walk, Cycle, Motorbike, Car, Public And Mass Transit, and Paratransit
Use cycle in addition or split of other mode	Binary	Yes or No
If not use cycle then reason	Open-ended	-
Preferred mode of choice irrespective of time	Categorical	Walk, Cycle, Motorbike, Car, Public And Mass Transit, and Paratransit
Preferred distance to travel using cycle	Categorical	0.25 Km, up to 5 Km, 5-10 Km, 10-15 Km, and More Than 15 Km
Preferred time to travel using cycle	Categorical	Under 15 Min, 15-30 Min, up to An Hour, and More Than 1 Hour
Preferred trip to travel using cycle	Categorical	Recreational, Educational, Shopping, Work, and Health-Fitness-Wellbeing
Aspect driving using cycle	Categorical	Affordability, Reliability, and Accessibility

Tab. 3 The survey instrument for quantification cyclability in Lahore, Pakistan

Category		Location	Gender	Age	Income	Education	Know how to ride bicycle
N	Valid	379	379	377	374	376	376
	N/A	0	0	2	5	3	3
Category		Use for commuting	Cycling Frequency	Hindrance in Bicycle use	Purpose of Majority Trips	Preferred mode of choice	Use Cycle in addition or split of other mode
N	Valid	341	176	364	372	374	353
	N/A	38	203	15	7	5	26
Category		Preferred mode of choice irrespective of time		Preferred Distance to travel using cycle	Preferred Time to travel using cycle	Preferred Trip to travel using cycle	Aspect driving using cycle

N	Valid	365	361	353	354	369
	N/A	14	18	26	25	10

Tab. 4 The sample size for each question

4 FINDINGS

Tab. 5 summarizes the non-continuous (categorical) findings of the overall sample by their frequencies and percentage shares. A large majority of the sample belonged to the lower socio-economic group (about 69%), while only 5% of the sample belonged to the middle socio-economic group. Due to cultural difficulties in interviewing, 71% of the respondents were male. Most respondents were in the age group of 25-54 years (66%). More than half of the respondents had an average monthly income of 15000 Pakistani Rupees (105€) to 50000 (351€)[1]. Between 24% and 28% of the sample had high school matriculation (graduation), or university degrees including under-graduate and graduate

The most popular modes of transportation in the sample were motorbike and car, each making up 33% of the responses, followed by bike at 11%. Nearly all of the respondents know how to ride a bike (97%), but less than one-third of respondents actually use it to commute. About 16% of the sample cycles daily and 14% cycles occasionally. The largest obstacles to biking are cultural issues (26%) and gender (24%) followed by other barriers related to the environment and infrastructure. Affordability, reliability, and accessibility are almost equally important for the respondent for the purpose of biking.

Another part of the findings is related to respondents' preferences regarding biking. Slightly more two-thirds of the all respondents reported that they prefer biking only short distances, i.e. up to 5 km. More than half (64%) prefer to bike less than 15 minutes, and 22% prefer biking up to 30 minutes. The travel purposes preferred for biking are recreation (21%), work (26%), and health, fitness, wellbeing (22%). The results are also graphically presented in Fig. 3.

Category		n	%	Category		n	%	Category		n	%
Location	Lower socio-economics	260	68.6	Know how to ride bicycle	yes	368	97.1	Education	under matric (less than a high school degree)	48	12.7
	Medium socio-economics	20	5.3		no	8	2.1		Matriculation (graduation)	92	24.3
	Higher socio-economics	99	26.1		N. A.	3	0.8		Under-graduate	105	27.7
Gender	Male	268	70.7	use for commuting	yes	116	30.6		Graduate	106	28.0
	Female	109	28.8		no	225	59.4		Post-graduation	25	6.6
	Transgender	2	0.5		N. A.	38	10.0		N. A.	3	0.8
Age	15-24	125	33.0	Cycling Frequency	Daily	62	16.4	Preferred Distance to travel using cycle	>1	19	5.0
	25-54	250	66		Weekly	27	7.1		0.25 Km	127	33.5
	>65	2	0.5		Monthly	11	2.9		up to 5 Km	131	34.6
	N. A.	2	0.5		Occasionally	52	13.7		5-10 Km	55	14.5

[1] Pakistani Rupees were converted to Euro based on the rate of 0.007€ for each Rupee (as of July 6, 2018).

Income	0-15000	82	21.6		Need Based	24	6.3	Preferred Time to travel using cycle	10-15 Km	29	7.7
	15000-50000	198	52.2		N. A.	203	53.6		N. A.	18	4.7
	50,000 - 100,000	78	20.6		Health and Fitness	48	12.7		under 15 min	242	63.9
	>100,000	16	4.2		Weather and Environmental Condition	55	14.5		15-30 Min	83	21.9
	N. A.	5	1.3	Hindrances	Culture	98	25.9		Up to an hour	28	7.4
Preferred mode of choice irrespective of time	Walk	41	10.8		Gender	91	24.0		N. A.	26	6.9
	Cycle	42	11.1		Non-availability of facilities	72	19.0	Preferred Trip to travel using cycle	Recreation	78	20.6
	Motorbike	124	32.7		N. A.	15	4.0		Education	71	18.7
	Car	123	32.5	Aspect driving using cycle	Affordability	123	32.5		Shopping	24	6.3
	Public / Mass Transit	31	8.2		Reliability	131	34.6		Work	99	26.1
	Paratransit	4	1.1		Accessibility	114	30.1		Health, Fitness, Wellbeing	82	21.6
	N. A.	14	3.7		N. A.	10	2.6		N. A.	25	6.6

Tab. 5 Categorical findings of the overall sample

It is also noteworthy to know how the results breakdown for different socio-economic statuses in the city. The overall share of male respondents was 71%. The dominant age group of 25-54 years ranged from 66% to 68% of respondents in the three socio-economic areas. A large portion of the sample in the lower- and middle-economic groups makes less than 15000 Rupees (105€) or 15000-50000 Rupees (105€ - 351€) per month, while less than half of respondents in the higher socio-economic group have a monthly income of 50000-100000 Rupees (351€ - 701€). There are more people with undergraduate (36%), graduate (36%), and postgraduate (10%) degrees in the case districts designated as higher socio-economic areas.

There is no large difference in biking skill levels in the three areas, but over half of respondents from middle socio-economic areas use bike to commute. The pattern of cycling frequency in middle socio-economic areas is slightly different from the other two areas. On average, people from these areas cycle occasionally (53%) based on needs (29%). The most-cited cycling barriers in the three socio-economic areas are culture (32%), gender (45%), and gender (26%) respectively. At 55.3%, 68.4%, and 64.8%, fitness, health, and wellbeing are the main reasons for biking in the three urban types. The preferred transport mode in the first group of areas is motorbike (45%), while in the second and the third groups of areas motorbike/car (25% and 25%) and car (60%) are the most popular choices. In the three socio-economic areas, 64%, 74%, and 75% use bike combined with other modes. The most preferred modes irrespective of time are motorbike and car in the first and second type of areas (combined: 69% and 60%), while car and walking are the most popular ones in the third type (combined: 69%). It is interesting that in higher socio-economic areas, 18% of people prefer to walk, compared to 9% and 5% in the other two urban types. Similarly, the tendency to bike in this area is 5% more than the other two. People in the middle socio-economic case sites have a stronger tendency to bike longer distances and for work (73%). Their most-cited biking-related issue is affordability (80%). Respondents from lower socio-economic areas prefer biking shorter distances. Accessibility is an issue for all three classes: one-fourth to one-third of the respondents from each type of area cited this problem. Fig. 4 presents the breakdown of the categorical findings for the three socio-economic areas.

There are two continuous variables: number of bicycle users per household and number of bicycles per household. Tab. 6 shows the descriptive statistics of these two variables for the whole sample. The number of bike users per household ranges from 0 to 5 with an average of 1.51, while bike ownership ranges from 0 to 4 with an average of 1.16. The distribution of these two variables was estimated by Kolmogorov-Smirnov and Shapiro-Wilk normality tests. The results show that the distributions are non-normal ($P<0.001$ as seen in Tab. 7). Although the number of bikes per household is lower in low socio-economic areas, the number of bike users is clearly higher in this urban type compared to the other two areas (Fig. 5).

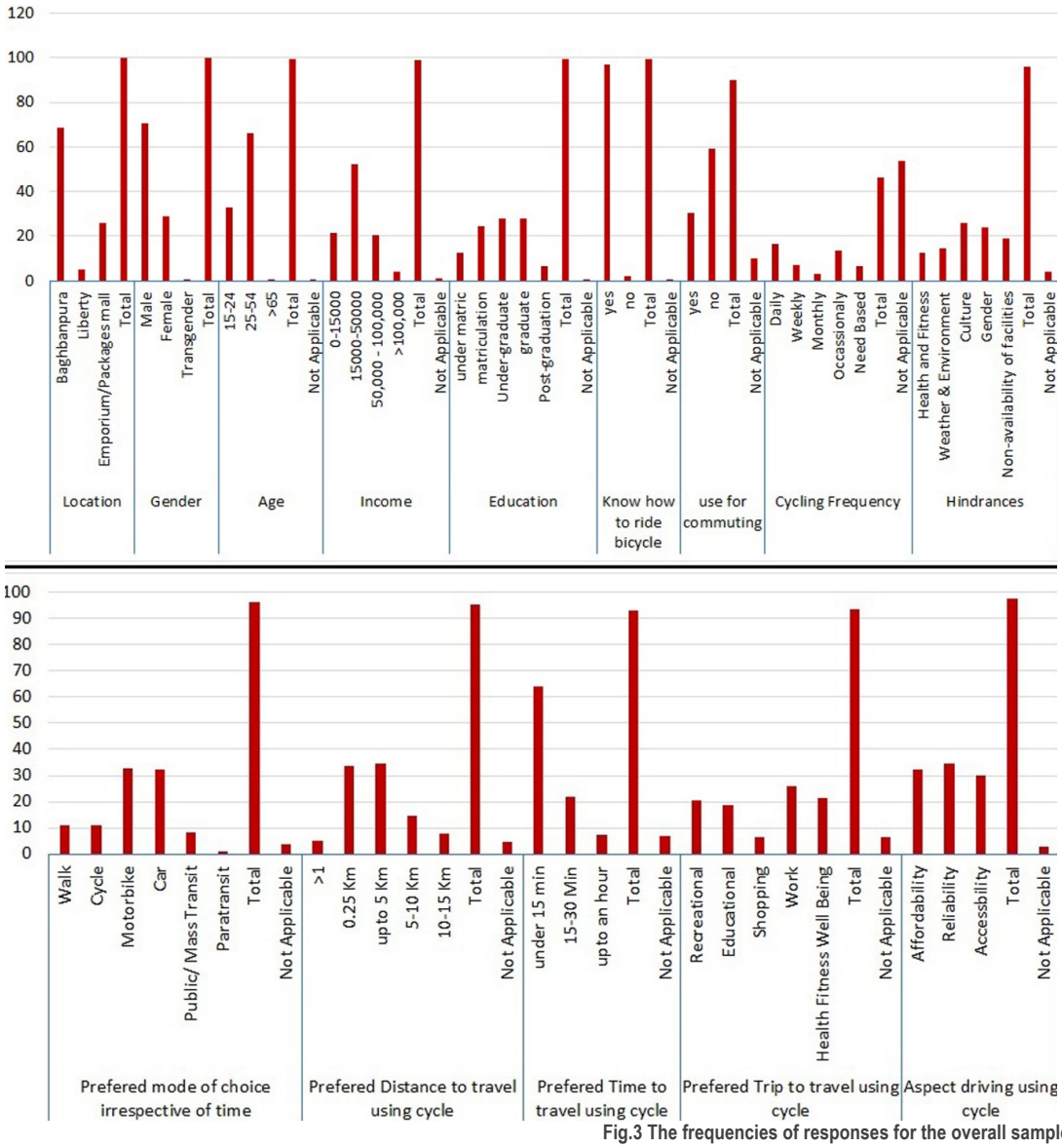
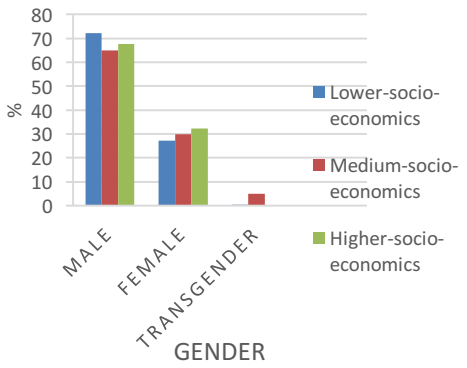
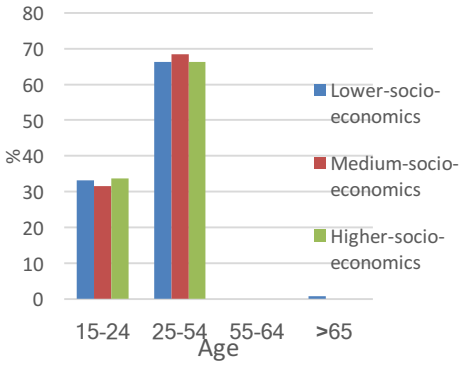
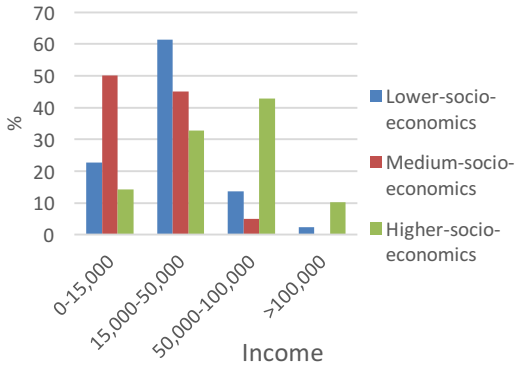
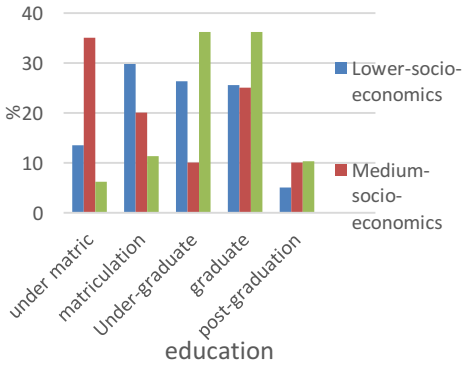


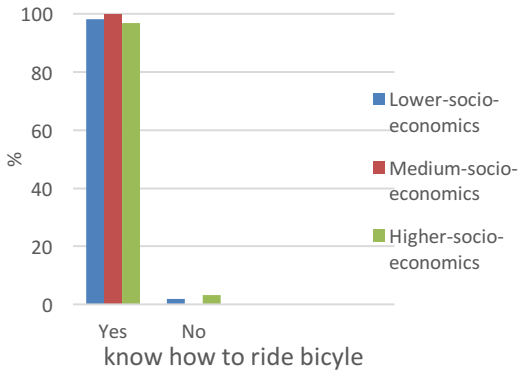
Fig.3 The frequencies of responses for the overall sample

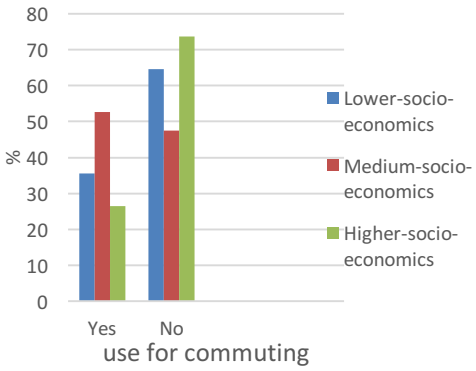

80
70
60
50
40
30
20
10
0
%
MALE
FEMALE
TRANSGENDER
GENDER
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics

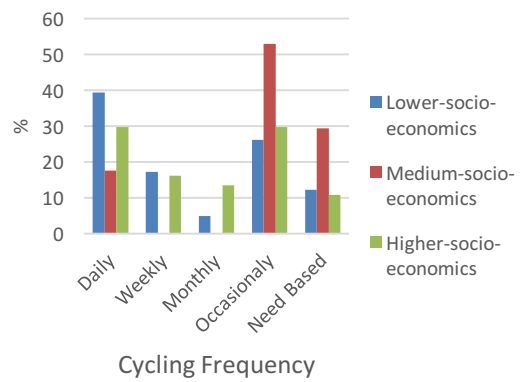

80
70
60
50
40
30
20
10
0
%
15-24
25-54
55-64
>65
Age
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics

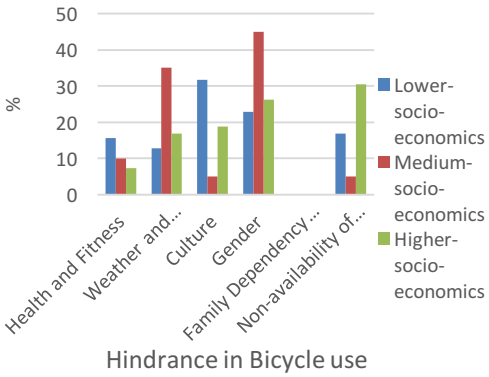

70
60
50
40
30
20
10
0
%
0-15,000
15,000-50,000
50,000-100,000
>100,000
Income
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics

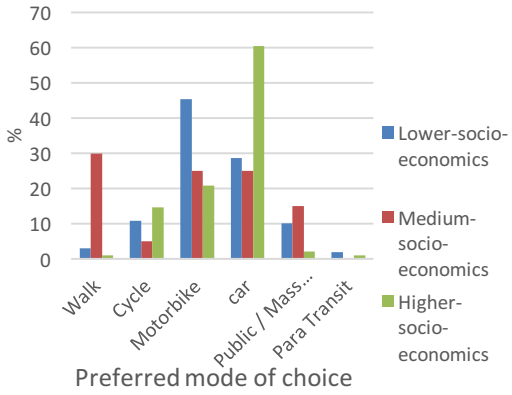

40
30
20
10
0
%
under matric
matriculation
Under-graduate
graduate
post-graduation
education
Lower-socio-economics
Medium-socio-economics


100
80
60
40
20
0
%
Yes
No
know how to ride bicyle
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics

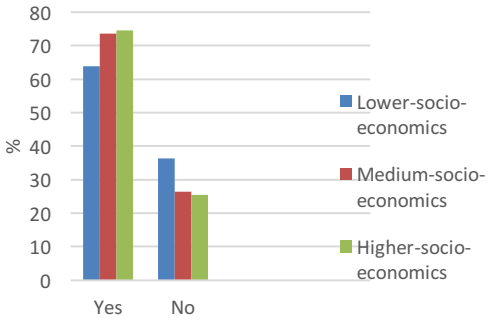

80
70
60
50
40
30
20
10
0
%
Yes
No
use for commuting
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics


60
50
40
30
20
10
0
%
Daily
Weekly
Monthly
Occasionaly
Need Based
Cycling Frequency
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics

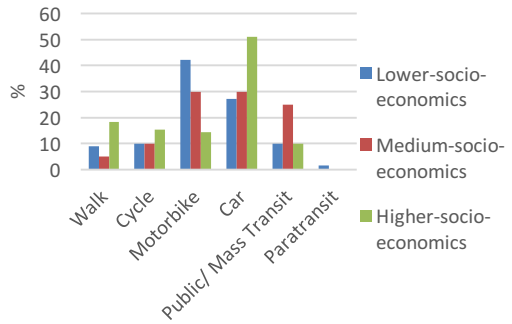

50
40
30
20
10
0
%
Health and Fitness
Weather and...
Culture
Gender
Family Dependency...
Non-availability of...
Hindrance in Bicycle use
Lower-socio-economics
Medium-socio-economics
Higher-socio-economics



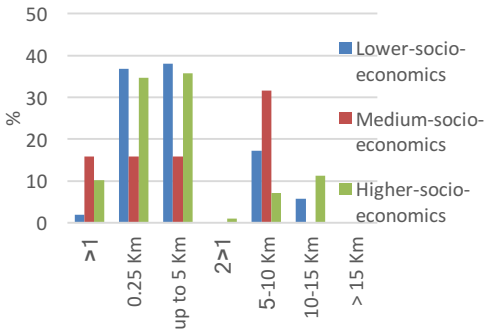
Preferred mode of choice



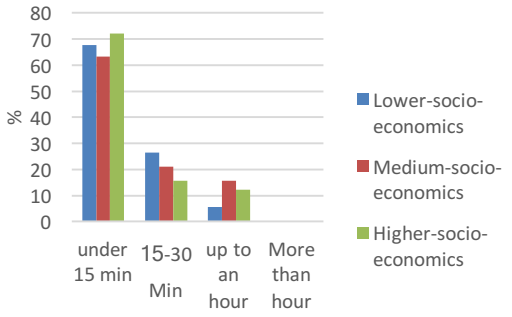
Use Cycle in addition or split of other mode



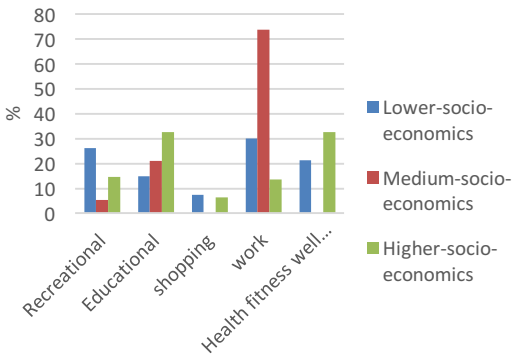
Preferred mode choice irrespective of time



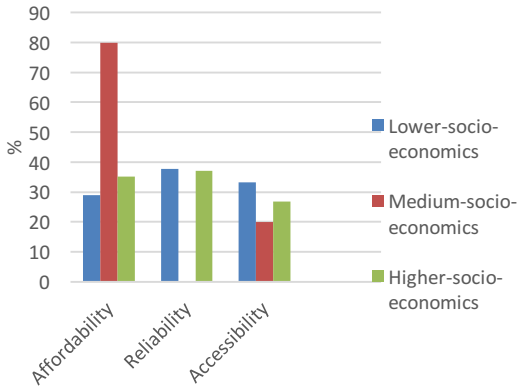
Preferred Time to travel using cycle



Preferred Time to travel using cycle



Preferred bike trip purpose



Aspect driving using cycle

Fig. 4 Breakdown of the categorical findings for the three socio-economic areas

Variable	N	Minimum	Maximum	Mean	Std. Deviation	Variance
No of Cycle user in House5	181	0	5	1,51	1,214	1,474
No of Cycle owned in house	168	0	4	1,16	0,814	0,663

Tab. 6 Descriptive statistics of continuous variables

Variable	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	P-value	Statistic	Df	P-value
No of Cycle users in House	0,241	163	<0.001	0,889	163	<0.001
No of Cycle owned in house	0,319	163	<0.001	0,806	163	<0.001

Tab. 7 Normality test results for number of cycle users and owners per household

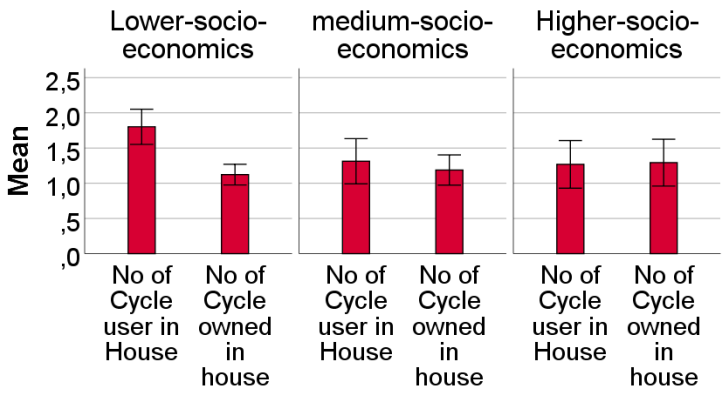


Fig. 5 Mean household bike ownership and use for three different socio-economic statuses of different districts

5 DISCUSSION

From the results above, this section discusses the standing of this research in comparison with global cycling practices. It is one of the first studies in Pakistan to explicitly include transgender residents in the survey sample, but the small number of transgender respondents makes it impossible to derive specific conclusions or recommendations based on their responses. The results showed that the middle socio-economic group was more inclined, flexible, and willing to cycle compared to lower and higher socio-economic-groups. Respondents from the lower socio-economic group frequently used bicycles compared to the middle socio-economic group. This might indicate a need-based cycling pattern and an obvious effect of socio-economic conditions of people on cycling. Bicycling is not that popular in Pakistan as in some of the other cities of Asian countries such as Singapore, Tokyo etc. who have recently developed their interest for cycling through the introduction of bike-friendly policies (Smethurst, 2015; Zhang et al., 2015).

According to the 1998 census (Government of Pakistan, 1998), around half the population of Pakistan is comprised of females and the other half is males. The results showed that culture and gender were the main

hindrances that people of Lahore faced to bicycle, may be because it is perceived that the bicycle's emergence is a product of Western culture (Smethurst, 2015), which is generally not freely welcomed in parts of Lahore, even though Lahore is the second biggest and modernized city of Pakistan. It is interesting to note that respondents from lower socio-economic case sites cited culture-based hindrances more frequently, while respondents from middle socio-economic areas cited gender- and weather-based hindrances more frequently. Also, in low-cycling countries, cycling is not evenly distributed across all ages and genders (Aldred et al., 2016); the same pattern is observed in Lahore too. In Pakistan, there exists a significant geographical effect on the choice of mode of mobility as the residents of richer areas rely on automobiles (e.g. cars) and not on bicycles (or walking), slightly more than those of poor areas (Adeel, 2018). The results showed that higher socio-economic groups indicated that the lack of infrastructure is one of the causes to discourage cycling. Weather-related hindrances are another difficulty that the same respondents pointed out. The study also showed that highly educated respondents did not prefer cycling any more than less-educated respondents. This study gives evidence that a uniform cycling policy for all genders, age groups, and cultures through the provision of necessary infrastructure might not rectify barriers to cycling in Lahore.

A study from Belgium (Vandenbulcke et al., 2011) shows that commuting by bike in one neighborhood promotes commuting by bike in nearby neighborhoods. The results in this study showed that around half of the middle socio-economic group commutes by bike. This indicates an opportunity that introducing culture of commuting through bicycle in some of the neighborhoods of Lahore may impact other neighborhoods and can promote a cycling culture. This study showed that middle-socio-economic group was more active in commuting via biking compared to other two socio-economic groups. Therefore, if cycling is promoted in middle-income socio-economic groups, it may impact the same way (as discussed above) to encourage cycling in other two socio-economic groups as well.

Regardless of trip type, none of the groups significantly showed their preference towards cycling as a travel mode, indicating that cycling is not encouraged enough so far by both users and policy-makers. The reflections can be observed through non-availability of cycling infrastructure, lack of policy, plans, and practices (e.g. bicycle-sharing, bicycle and riding facilities through other mass-transit travel modes), non-integration with other travel modes (e.g. bus-transit). Other hindrances such as hot weather and socio-cultural barriers also need to be addressed to promote cycling. Countries that are most similar in circumstances to Pakistan (e.g. China) have already adopted bike-friendly policies and long-term urban transportation plans that integrate cycling as a travel mode (Zhang et al., 2015). Even in countries like America and Canada that are heavily dependent on motorized vehicles, infrastructure is designed to accommodate bikes and planners are now pushing for more bicycle-use and less car-use (El-Assi et al., 2017; Wray, 2015). This is done by implementing bike-friendly policies and redesigning infrastructure even through the existing land-use is not very conducive to cycling (El-Assi et al., 2017). Studies show that one important factor that dooms bicycling policies is a lack of willingness to cycle (Strömberg & Karlsson, 2016) whereas in this study results showed that considerable percentage of respondents were willing to use bicycle in addition to or in-split with other modes of travel. However, a responsive cycling policy to take care of their willingness (and needs) is missing which needs to be addressed through bicycle-friendly policies.

Time, distance, and purpose of trips are the important factors that influence mode choice and much published literature is available on this topic. The results of this study showed that, even if there is no time constraint, people of lower socio-economic group were less likely to prefer bicycle to commute to their work as showed by other studies too (Ji et al., 2017). It is found that they, along with higher socio-economic group would like to travel via motorbike and car. However, respondents from middle socio-economic areas opted for public transport in addition to motorbike and car. This shows that there are some other factors involved in mode choice e.g. distance and time constraints. Furthermore, respondents from lower and higher socio-economic groups preferred to travel by bicycle up to 5 km while middle socio-economic respondents showed more willingness to travel by bike up to 10 km. This is a very important figure to consider when planning urban

transport systems for all modes of travel. In addition, the results also showed that, for shorter trips (especially under 15 minutes), respondents from all three socio-economic groups preferred to use the bicycle. Another influencing factor could be type of trip. This study showed that a significant percentage of respondents from middle socio-economic groups preferred to travel via bicycle to their work place because of the nature of trip e.g. studies show that work-stress (i.e. to reach to work place on time, type of work where repeated trips are to be made etc.) is one of the leading factors to choose travel mode to commute to work (Blanc & Figliozzi, 2016). The same group was also found to be more concerned about affordability.

The overall results show that there is a lot of potential to promote cycling practices in Pakistan among all socio-economic groups. There is need to introduce plans and policies to promote cycling in combination with other modes of transport like bike-sharing practices as in Denmark (Kaplan et al., 2015). Also, rather than solely relying on socio-economic parameters of cycling, other aspects necessary to be considered are improvement in the overall wellbeing, environment, health and urban-transportation related issues (Xiao-jiang, 2011). Some developing countries have already taken such initiatives by including cycling as a sustainable mode of travel into their policies, and recommendations to follow suit have been given in some of the literature available on Pakistan (Naeem et al., 2016). However, there is a need to take additional and more concrete steps in Pakistan, starting with the acknowledgment of biking as a viable and important mode of travel.

There is a general lack of academic studies and published research on bicycling in Pakistan, which makes it difficult to understand the perceptions and preferences of bike-users. This study has taken a leading step to address that issue by producing meaningful data on cyclability in Lahore. The study found that cycling and its benefits have previously been neglected by urban and transportation planners and policy-makers at local, regional, and national levels. It is clear from the results that people know how to ride the bike, there are active bike users, and people are willing to use the bicycle but are simply not encouraged to do so. There is a lack of planned strategies. There are social norms, weather conditions, gender- and culture-related hindrances with rectifiable effects that are not being challenged or addressed. There are many cost-effective solutions available that have been adopted by other low-income countries to integrate bicycle with other cost-effective and efficient mass transit modes (rail and bus) that can contribute to sustainable development of the country. However, such solutions have not been yet get due attention of the policy makers in Pakistan. The solution to this problem needs further in-depth understanding of the issues, a strong political will, initial capital, long-term planning, sustainable urban strategies, and inclusion of all stakeholders and modes of travel.

In terms of collected data, there was lower representation of respondents in the middle socio-economic group compared to the other two groups. Also, there was very little or no representation of the 55-64 and 65+ age groups in the data. Lahore itself is a metropolitan area with mixed land-use and mixed socio-economic distribution, so a larger sample with more defined socio-economic conditions/groups in relation with various land-uses can add further knowledge to the research question addressed in this study.

6 CONCLUSION

To conclude, this study has explored many aspects of bicycling in Pakistan (Lahore as a case study) with respect to three socio-economic groups. The overall reflection is that the bicycle is a desirable yet neglected mode of travel. It is a popular mode of travel (or/and have user) in all the three socio-economic groups that are analysed in this study which is very encouraging for the urban transport policy-makers. However, policy-makers have not embraced the bicycle as a critical opportunity to make environmentally sustainable and economically prudent policy solutions. There is a need to make bicycling more a viable and efficient mode of transport for all age groups, socio-economic classes, educational groups, cultures, and genders. The need for increased provision of bicycling infrastructure is highlighted, which would help to overcome some of the hindrances identified in this study. It will also encourage people to cycle longer distances, for longer time spans, and for multipurpose trips. The willingness of the users to bike to work can be thus further stretched

to the other trip purposes too by implementing policies that encourage bicycling. In short, Pakistan can address future concerns in energy, economics, health and other sectors by including the bicycle as a mode of travel alongside other modes. There is a need to study Pakistani bicycling preferences in conjunction with different land uses e.g. commercial, residential, educational etc. in greater depth. This research can be further extended to collect large-scale data from other cities in Pakistan i.e. lower and higher income cities. This study presented the perspective of the cycle users, a similar study can be conducted by including the perspective of policy-makers to understand the opportunities, challenges, and potential of promoting bicycling in Pakistan.

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IMAGE SOURCES

Cover photo: Syed Farhan Ahmed (Final-year student of the Department of city and Regional Planning, University of Engineering and Technology Lahore, Pakistan. Location: GT Road, Lahore. Date: 27 Dec. 2018).

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