TeMA

Journal of Land Use, Mobility and Environment

The climatic, social, economic and health phenomena that have increasingly affected our cities in recent years require the identification and implementation of adaptation actions to improve the resilience of urban systems. The three issues of the 16th volume will collect articles concerning the challenges that the complexity of the phenomena in progress imposes on cities through the adoption of mitigation measures and the commitment to transforming cities into resilient and competitive urban systems.

TeMA is the Journal of Land Use, Mobility and Environment and offers papers with a unified approach to planning, mobility and environmental sustainability. With ANVUR resolution of April 2020, TeMA journal and the articles published from 2016 are included in the A category of scientific journals. From 2015, the articles published on TeMA are included in the Core Collection of Web of Science. It is included in Sparc Europe Seal of Open Access Journals, and the Directory of Open Access Journals.

THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

Vol.16 n.1 April 2023

print ISSN 1970-9889 e-ISSN 1970-9870
University of Naples Federico II

TeMA Journal of
Land Use, Mobility and Environment

THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

1 (2023)

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realized by CAB - Center for Libraries at “Federico II” University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | on line ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples
web: www.tema.unina.it
e-mail: redazione.tema@unina.it

The cover image shows the building of Kharkiv National University of Civil Engineering and Architecture, destroyed as a result of a missile and bomb attack. March 2022 (Source: STRINGER/Reuters/Forum. https://www.pism.pl/publications/sweden-on-the-russian-aggression-against-ukraine)

TeMA. Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of transport, land use and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.
With ANVUR resolution of April 2020, TeMA Journal and the articles published from 2016 are included in A category of scientific journals. From 2015, the articles published on TeMA are included in the Core Collection of Web of Science. TeMA Journal has also received the *Sparc Europe Seal* for Open Access Journals released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe) and the *Directory of Open Access Journals* (DOAJ). TeMA is published under a Creative Commons Attribution 4.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

EDITOR IN-CHIEF

Rocco Papa, University of Naples Federico II, Italy

EDITORIAL ADVISORY BOARD

Mir Ali, University of Illinois, USA
Luca Bertolini, University of Amsterdam, Netherlands
Luuk Boelens, Ghent University, Belgium
Dino Borri, Politecnico di Bari, Italy
Enrique Calderon, Technical University of Madrid, Spain
Roberto Camagni, Politecnico di Milano, Italy
Pierluigi Coppola, Politecnico di Milano, Italy
Derrick De Kerckhove, University of Toronto, Canada
Mark Deakin, Edinburgh Napier University, Scotland
Carmela Gargiulo, University of Naples Federico II, Italy
Aharon Kellerman, University of Haifa, Israel
Nicos Komninos, Aristotle University of Thessaloniki, Greece
David Matthew Levinson, University of Minnesota, USA
Paolo Malanima, Magna Græcia University of Catanzaro, Italy
Agostino Nuzzolo, Tor Vergata University of Rome, Italy
Rocco Papa, University of Naples Federico II, Italy
Serge Salat, Urban Morphology and Complex Systems Institute, France
Mattheos Santamouris, National Kapodistrian University of Athens, Greece
Ali Soltani, Shiraz University, Iran

ASSOCIATE EDITORS

Rosaria Battarra, National Research Council, Institute of Mediterranean studies, Italy
Gerardo Carpentieri, University of Naples Federico II, Italy
Luigi dell'Olio, University of Cantabria, Spain
Isidoro Fasolino, University of Salerno,Italy
Romano Fistola, University of Naples Federico II, Italy
Stefano Franco, Politecnico di Bari, Italy
Thomas Hartmann, Utrecht University, Netherlands
Markus Hesse, University of Luxemburg, Luxemburg
Seda Kundak, Technical University of Istanbul, Turkey
Rosa Anna La Rocca, University of Naples Federico II, Italy
Houshmand Ebrahimpour Masoumi, Technical University of Berlin, Germany
Giuseppe Mazzeo, National Research Council, Institute of Mediterranean studies, Italy
Nicola Morelli, Aalborg University, Denmark
Enrica Papa, University of Westminster, United Kingdom
Dorina Pojani, University of Queensland, Australia
Floriana Zucaro, University of Naples Federico II, Italy

EDITORIAL STAFF

Gennaro Angiello, Systemica, Bruxelles, Belgium
Annunziata D'Amico, Ph.D. student at University of Naples Federico II, Italy
Federica Gaglione, Ph.D. at University of Sannio, Italy
Carmen Guida, Ph.D. at University of Naples Federico II, Italy
Nicola Guida, Ph.D. student at University of Naples Federico II, Italy
Sabrina Sgambati, Ph.D. student at University of Naples Federico II, Italy

TeMA Journal of Land Use, Mobility and Environment

THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

1 (2023)

Contents

REVIEW NOTES

TeMA Journal of Land Use, Mobility and Environment

TeMA 1 (2023) 105-120
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6093/1970-9870/9353
Received 2nd August 2022, Accepted 13th April 2022, Available online 30th April 2023

Licensed under the Creative Commons Attribution – Non Commercial License 4.0
www.tema.unina.it

Public perceptions of barriers to walk in urban areas of Lahore, Pakistan

Muhammad Ahsan [a], Nabeel Shakeel [b*], Farrukh Baig [c]

[a] Department of City and Regional Planning
Yildiz Technical University, Istanbul, Turkey
e-mail: ahsansaeedi04@gmail.com
ORCID: https://orcid.org/0000-0002-6114-5161

[b] Department of Geography, School of Earth and Environment, University of Canterbury, Christchurch, New Zealand
e-mail: nabeel.shakeel@pg.canterbury.ac.nz
ORCID: https://orcid.org/0000-0002-8576-0361
* Corresponding author

[c] School of Traffic and Transportation Engineering
Central South University, Changsha 410075, China
e-mail: farrukhbaig0304@hotmail.com
ORCID: https://orcid.org/0000-0002-5500-1989

Abstract
The development strategies in urban areas of the less developed world have predominantly focused on motorized-oriented planning, which influences the travel habits of individuals. However, there has been little research on walking as a mode of transport in Pakistani cities. In order to bridge this gap, this study examines the public's perception of barriers to walking in Lahore, Pakistan. Surveys were conducted online using structured questionnaires. To investigate pedestrians' perceptions of walking constraints, a valid sample of 277 responses was analyzed using a weighted factor and regression analysis. Findings show that pedestrians' dissatisfaction with existing infrastructure is due to the ignorance of walking as a travel mode in transport plans, policies, and strategies executed by government organizations. The integration of walking as a travel mode has been highly neglected by transport policymakers. Further, significant walking constraints have been elaborated that need to be resolved to enhance walking in urban areas.

Keywords
Walking; Pedestrian perceptions; Accessibility; Walking constraints, Lahore.

How to cite item in APA format
Ahsan, M., Shakeel, N. & Baig, F. (2023). Public perceptions of barriers to walk in urban areas of Lahore, Pakistan. *Tema. Journal of Land Use, Mobility and Environment*, *16* (1), 105-120.
http://dx.doi.org/10.6093/1970-9870/9353

1. Introduction

The environmental impact, efficiency, and overall feasibility of walking and driving are frequently compared in transportation planning research. Walking is one of the most fundamental active travel modes, yet it remains a relatively understudied aspect of transport research in developing countries. Where existing research considered public transport and cycling as travel modes for analysis, see, e.g. Aslam et al. (2018); Anwer et al. (2021); and Al-Rashid et al. (2021), walking as a travel mode has been given less attention. Walking is vital in transport research because it provides an opportunity to promote healthy and active lifestyles, reduce congestion, and improve accessibility. Cars, on the other hand, are major contributor to various environmental problems, including carbon emissions and air and noise pollution (De Nazelle et al.,2017; Mazzeo et al., 2019). Therefore, studying walking as a travel mode and its integration into the planning and designing of infrastructure helps to improve the design of cities, and make them more accessible, sustainable, and livable (Cecchini & Talu, 2011).

The extent to which walking is readily available as a safe, connected, accessible, and pleasant mode of transportation is an integral enabler of sustainable development (Bharucha, 2017; Gaglione et al., 2019).

There are several factors that make walking a convenient and comfortable mode of transportation, including density, diversity, safety, and connectivity (Southworth, 2005). Briefly explaining these factors, the more dense a neighborhood is, for example, the more destinations are within walking distance, and the streets are easier to navigate. Similarly, a diverse neighborhood is one with a variety of land uses, and because there are more things to do along the way, the built environment becomes more interesting and appealing for walking. Safety, in the same way, plays an essential role in making walking a pleasurable mode of travel by making streets more pedestrian-friendly (Lourenço & Rahaman, 2010). Traffic calming measures, speed limits, and pedestrian crossings help reduce the risk of accidents and make walking more enjoyable. Finally, connectivity makes different neighborhoods more connected and accessible on foot, which makes pedestrians' lives easier and less intimidating. In short features like density, diversity, safety, and connectivity are essential for making walking a comfortable and convenient mode of transport.

Looking at these features in the relevant literature, the study by Arvidsson et al. (2012) listed density, land-use patterns, and street connectivity as three major features of neighborhood walkability. The other studies, e.g. Balsas (2019); Bharucha (2017); Jun & Hur (2015); Bahari et al. (2014); Makki et al. (2012); and Southworth (2005), focused on such factors as built environment, safety, and the comfort level of pedestrians, destination connections with people and social environments, adjacent visual aesthetics, and connected infrastructure. Moreover, Clark et al. (2010) and Saelens et al. (2003) concluded that highly dense population areas and housing accumulation with efficient connectivity encourage walking more than less dense areas. The results further showed that the factors that encourage walking are high land use density, safety, connected infrastructure, and the aesthetics of the surroundings. Furthermore, Bahari et al. (2014) and Fonseca et al. (2022) elaborated on the influence of the built environment on walkability by considering features, including land use density and diversity, accessibility, street connectivity, safety, and security. In short, past studies indicated the importance of walking as a travel mode in association with the several features that need to be considered for transport policies to shift people towards active transportation.

There is no doubt that transport researchers from Pakistan have contributed to transport literature in several ways; however, literature on perceptions of walking constraints is still limited. Exiting studies, e.g. Aziz et al. (2018), examined the suitability of the integrated public transport system in Lahore and declared the system unharmonized. The study by Al-Rashid et al. (2022) modeled psychological barriers among older people in choosing public transport as a travel mode.

The study by Aslam et al. (2018) and Tariq & Shakeel (2021) explored the potential of cycling in Lahore as a travel mode and talked about its integration into the transportation network; however, the examination of walking as a travel mode and related components remains scarce. Therefore, this study aims to assess the

potential constraints of walking based on public perspectives in Lahore, Pakistan. For this purpose, this study has taken into consideration several built environments, safety features, and physical infrastructure-related features to analyze public perceptions of barriers to walking. The study's findings will help promote the integration of walking with motorized transport systems in Pakistan.

2. Case Study

The city of Lahore was selected as a case study area to evaluate the public perceptions, potential, and constraints of walking. Lahore is the second largest city in Pakistan and the provincial capital of Punjab province with a population of 11.13 million (PBS, 2017; Aslam et al.,2018). The city of Lahore has been developed as one of the most congested cities in Pakistan.

The urban population of the city of Lahore has grown by 3% from 5.20 million in 1998 to 11.13 million in 2017. Whereas, in the 20th century, Lahore was grown 25 times from 1901 to 1998 (Ahsan, 2019). The Spatial boundary of Lahore has expanded two times in the past two decades, from 220 km in 1995 to 336 sq. km in 2005 and 665 sq. km in 2015 (Ibrahim & Riaz, 2018). These development patterns in Lahore are augmented the car-based dependence of residents for commuting (Hameed and Anjum, 2013), resultantly in declining walking practices. In just one decade (from 2005 to 2015), a 268% increase in vehicle registration has steadily worsened the traffic congestion in Lahore (Gallup Pakistan, 2016). The project report on the urban transport master plan of Lahore conducted under the Punjab Transport Department showed that the walking modal share in the city was only 10% (JICA, 2012). Therefore, these empirical facts indicate the utmost need to study the decline of walking among individuals in the urban area of Lahore, making it the best case study for this research.

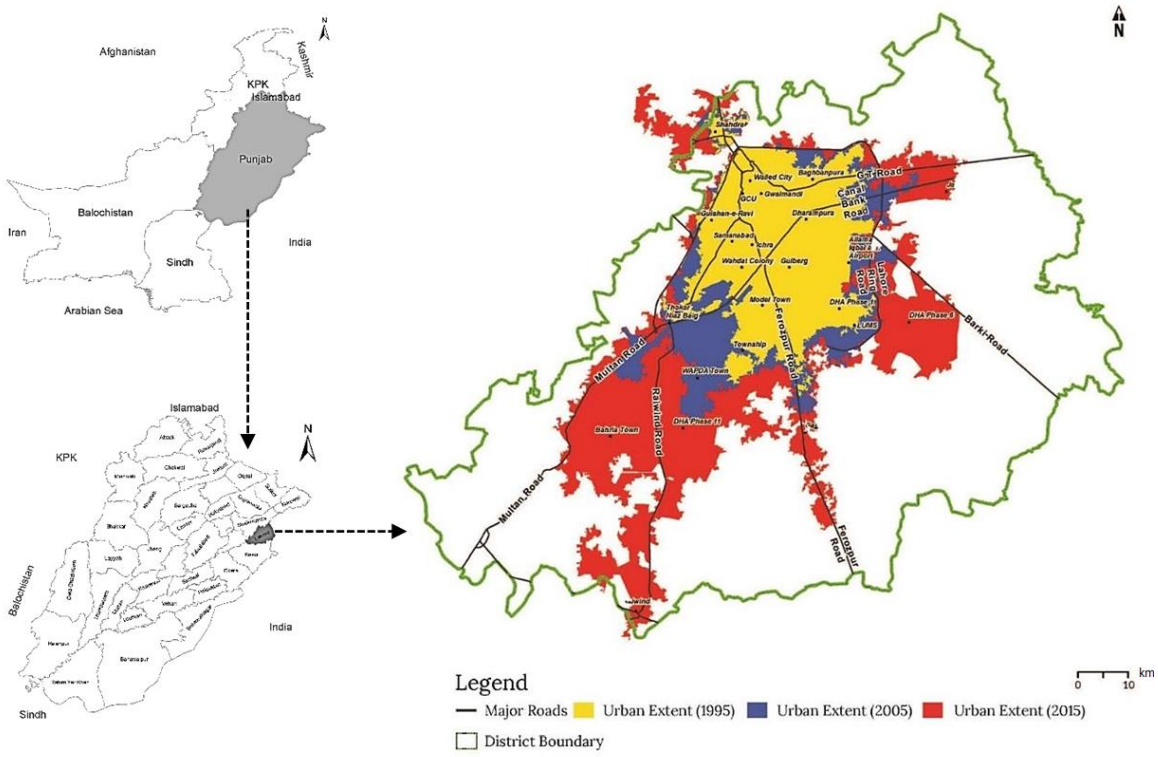

Fig 1. Spatial Extension of Lahore, Source: Ibrahim and Riaz, 2018

3. Methodology

3.1 Sample calculation and methodological considerations

The sample size for data collection was calculated with the help of Kohran's formula (Ahsan, 2019; Shakeel & Jahanzaib, 2019) as written in Eq. 1.

$$n = N/\ (1 + Ne\text{^}2\ ) \quad (1)$$

Where *n* is the sample size, *N* is the population of the city, and *e* is the marginal error rate of the sample. The sample size determined with this formula is 277, calculated by using the total population of 11.13 million with a marginal error of 5%. To collect the data, a structured questionnaire survey was conducted by using online social media platforms, i.e., Facebook, Twitter, and LinkedIn. The questionnaire was designed by using Google Forms and spread among the individuals living in different neighborhoods. The usage of these social media platforms for data collection is in line with past studies, including Zhang & Mu (2020); Liao et al. (2022); and Pak and Verbeke (2013). On these social media platforms, massive attention was paid to applying certain filters with the help of which the targeted population of Lahore was reached. This online survey in Lahore was administered and conducted during the months of January and February 2022 with an observed average response time of 7 to 10 minutes. Moreover, it was asked to share the coordinates by the respondent while filling out the questionnaire, which is spatially illustrated in Fig.2. This innovative method to collect the individual's response also helped to gain diversified data, gathered from all socio-economic classes, age and gender groups. Furthermore, before conducting the surveys, several studies related to the public perceptions of pedestrian's walking constraints were analyzed in terms of sample size, data collection method, and analysis techniques, as shown in Tab.1.

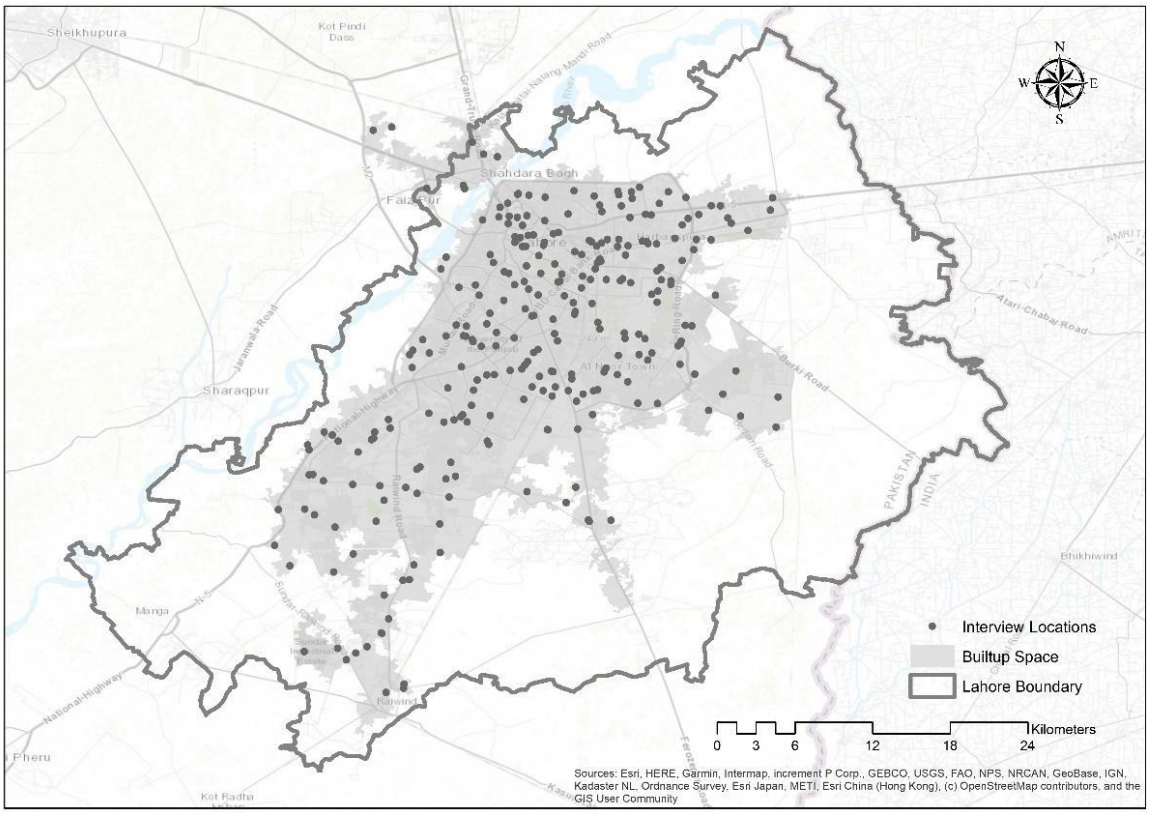

Fig.2 Spatial distribution of interview locations in Lahore

Study	Sample Size	Case Study Area	Data Collection Method	Data Analysis Technique
Bharucha (2017)	100 people from middle and lower income class	5 different districts of Mumbai city, India	Pedestrian interviews through structured questionnaire	Not specified
Bahari et al. (2014)	60 respondents	Jalan Tuanku Abdul Rahman and Central Market in Kuala Lumpur city	On street questionnaire survey	Simplified weighted factor analysis
Strohmeier (2016)	68 persons of old age	City of Vienna	Personal interviews with the help of questionnaire	Comparative analysis against several checklists
Clark et al. (2010)	17 participants were selected with the help of snow ball sampling technique	City of Edmonton	Semi- structured interviews	Interview recordings were transcribed verbatim then converted to meaning units
Grant et al. (2010)	53 participants with mean age of 75 years	Four Neighborhoods in Ottawa, Canada	Focus groups and individual interviews	A constant-comparative method was used while recordings were transcribed verbatim
Lockett et al. (2005)	13 people in photovoice session while 22 seniors participated in focused group session	Ottawa, Canada	Photovoice (a qualitative data collection method) was used followed by focus group sessions	Not specified
Ovstedal and Ryeng (2002)	1092 participants were interviewed	Six European countries: Belgium, Finland, France, Italy, Norway and Switzerland	On-street interview based on questionnaire was conducted at 22 different sites	Collected data was analyzed through correlation and regression analysis

Tab.1 Methodological consideration of similar past studies

3.2 Explanatory Variables

Tab.2 summarizes the variables along with their data types. Section 1 of the questionnaire included the characteristics of respondents, such as gender, age, and income, to assess socio-economic status, profession, and education level.

Section 2 indicated walking characteristics such as frequencies and purposes of using the walk as a travel mode, preferred traveling distance and consumed times while walking, provision of other facilities concerned with pedestrians, and their preferred mode of choice for daily travel.

Section 3 highlighted pedestrians' perception to evaluate their satisfaction level related to sidewalk conditions, street furniture, safety issues, aesthetics, and amenities.

Section 4 of the questionnaire emphasized the constraints and challenges of declining walking habits.

Variable	Variable Type	Categories
Personal Information		
Gender	Binary	Male, Female
Age	Categorical	Less than 20 years, 20–40 years, More than 40 years
Income	Categorical	None; <15,000 PKR; 15,001-50,000 PKR; 50,001 - 100,000 PKR; >100,000 PKR
Profession	Categorical	Student, Government Employee, Semi-Govt./ Private Employee, Private Business
Education	Categorical	Under Matric, Matriculation, Under-Graduate, Graduate, Post-Graduation
Walking Characteristics		
Do you walk?	Binary	Yes or No
If no, why not?	Open-ended	
Frequency of walking	Categorical	Daily, Once or twice a week, Occasionally
Purpose of walking	Categorical	Shopping, Leisure, Work, School, Access to public transportation, Health, Other (_____)
Prefer to walk rather motorized transport	Binary	Yes or No
Preferred mode of travel, other than walking	Categorical	Public Transport (Metro Bus/ train, Public Bus, Rickshaws etc.) Private Transport (Car, Motorbike, Bicycle etc.)
Travelled distance through walking	Categorical	<250 meters, 250 to 500 meters, 500 meters to 1 km, More than 1 km
Preferred Time Consumption for Walking	Categorical	<=10 min, 10 – 20 min, 20 – 30 min, > 30 min
Walking time without physical disconnectivity of walkways	Categorical	<=10 min, 10 – 20 min, 20 – 30 min, > 30 min
Footpaths free from encroachment	Binary	Yes or No
If no, reasons of encroachment	Categorical	Occupied by; hawkers, shopkeepers, utility infrastructure, parking, housekeepers, Other (___)
Availability of Zebra Crossing on intersections	Categorical	Availability of zebra crossing on; each, majority, and few intersections
Public Perception on Walking		
Shown in Tab.9	Likert scale	Highly Satisfied, Satisfied, Neutral, Dissatisfied, Highly dissatisfied
Walking Constraints		
Shown in Fig.5	Likert scale	1-Minor effects, 2- Sufficient effects, 3- Critical effects, 4-Prompt effects, 5- Devastating effects

Tab.2 Survey instrument for quantifying walking in Lahore

3.3 Analysis Techniques

Collected data were analyzed with quantitative methods and presented in the form of frequencies and percentages of binary and categorical statistics. Pedestrian satisfaction from several walking indicators was analyzed with simplified weighted factor analysis, converting the semantic values to numerical scale (Bahari et al. (2014); Kelly et al. (2011). The conversion of semantic to numerical values is shown in Tab.4. The weighted value of indicators is calculated by multiplying the weighting factor (converted numerical values) by the number of respondents, while the average weighted factor is calculated by dividing the weighted factor with the number of respondents (e.g. see Tab.3). The positive weighted factor indicates the satisfaction of pedestrians from the provided facility while negative values indicate dissatisfaction.

Scale of agreement	Weighing factors	No. of respondents	Weighted score
Highly Satisfied	2	5	10
Satisfied	1	6	6
Neutral	0	5	0
Dissatisfied	-1	8	-8
Highly dissatisfied	-2	7	-14
Total	-	31	-6

Tab.3 Weighted factor analysis and calculation example for satisfaction level determination

Scale of agreement	Numerical factor	Qualitative elucidation
Highly Satisfied	2	Highly satisfied with the walking conditions, and no further improvements are required.
Satisfied	1	Satisfied with the walking conditions but little modifications/improvements are required.
Neutral	0	Neither satisfied nor dissatisfied with walking conditions, while enough upgrading actions are necessary to be taken to make it satisfactory.
Dissatisfied	-1	Dissatisfied from walking conditions whereas plenty modifications/improvements are mandatory to be done to make the walking conditions sufficient and adequate.
Highly dissatisfied	-2	Extremely dissatisfied while walking conditions, either not existed or in worst conditions that needs proper renovation.

Tab.4 Converting semantic to numerical scale with qualitative elucidation

For walking constraints, regression analysis was used to determine the relationship between walking as a travel modes and other explanatory variables. This analysis also required numerical scale data which has been elaborated qualitatively based on the effecting scale, as shown in Tab.5.

Numerical factor	Qualitative elucidation
5	Has a devastating effect and extreme role in reducing walking habits, therefore must be resolved on highest priority.
4	Promptly effecting walking habits and is necessary to be solved abruptly.
3	Critically effecting the practices of walking habits and need to address on earliest.
2	Sufficiently effects the walking habits practices and the problems need to be address based long-term plans.
1	Have minor effects on walking habits and could be overcome while resolving the particular issues.

Tab.5 Qualitative elucidation with numerical factors of walking constraints

4. Results and Discussion

The survey sample was enriched with the male population, while a sufficient proportion of the other gender has also given their valuable input. Most of the respondents belong to the age category of 20 to 40 years. Determination of income level was mandatory to understand the socio-economic level of the interviewee, which demonstrates 28% population were unemployed or student having no income status, while 34% of people had income less than 50,000 being considered as a poor or lower-middle-income group (Ahsan, 2019; Arif et al., 2022). These people can not afford luxury cars but are still primarily dependent on motorized vehicles for mobility due to the presence of various walking constraints (Gargiulo et al., 2018).

With respect to Gender			**With Respect to Age**			**With Respect to Education**		
Type	Freq.	%	Categories	Freq.	%	Category	Freq.	%
Male	173	62%	Less than 20 years	45	16%	Under-Graduate or less	79	29%
Female	104	38%	20 - 40 years	166	60%	Graduate	125	45%
			More than 40 years	66	24%	Post-Graduation	73	26%
With Respect to Profession			**With Respect to Income**					
Categories	Freq.	%	Category	Freq.	%			
Student / unemployed	113	41%	None	77	28%			
Government Employee	48	17%	<15,000 PKR	24	9%			
Semi-Govt./ Private Employee	95	34%	15,001-50,000 PKR	70	25%			
Private Business	21	8%	50,001 - 100,000 PKR	75	27%			
			>100,000 PKR	31	11%			
Total No. of Respondents								**277**

Tab.6 Respondents' Characteristics

Indicators	**Classification**	**Descriptive Statistics**	
		Mean	**Std. Dev**
Walking habit	1= Yes 0=No	0.6101	0.4886
Frequency of Walking as a mode of transport	3= Daily 2= Once or twice a week 1= Occasionally	1.4657	1.2083
Intentions to Prefer Walking rather than Motorized Vehicles	1= Yes 0=No	0.4116	0.4930
Footpaths Free from Encroachments	1= Yes 0=No	0.2094	0.4076
Availability of Zebra Crossing lines on Intersections	1= Few 2= Major 3= All	1.3899	0.5770

Tab.7 Walking Characteristics

The results of exploratory analysis showed that the majority population have the habit of walking with mean values of 0.61. The population of developed and developing countries could have been surprised that how can someone answer whether they perform walking in yes or no. While conducting the surveys, this question was further elaborated to the interviewee to answer it based on their habits of walking as a mode of choice for travel. Moreover, keeping in view the climatical conditions, the case of Lahore is completely converse to the developed world because the population living in this city has to suffer from high temperature (Abbas et al., 2018) and the worst AQI (Pervaiz et al., 2019) in the different time span of the year. Besides this, the shortage of accessibility of public transport in different parts of Lahore forces the population to be dependent on motorized vehicles, thus minimizing the walking practices. The following questions were asked to those respondents who expressed earlier that they have a habit of walking. 31% of the population keeps the habit of walking daily while the majority population performs on a weekly basis or occasionally, having a mean value of 1.46. These results illustrate that a significant portion of people performs walking just on a need basis rather

than using it as a mode of travel. It demonstrates that walking constraints do not encourage people to walk as a mode of transportation, making them highly dependent on motorized vehicles. The population with walking habits is mainly concerned with health as a primitive indicator of walking purposes. Following health, work, and leisure are the prominent determinants of walking, as shown in Fig.3. The segment of the population reported not having regular walking habits was asked about the consequent reasons with open-ended questions where the lack of infrastructure for pedestrians, unsafe and unfriendly environment for walking, and encroached walkways in the city of Lahore was highlighted.

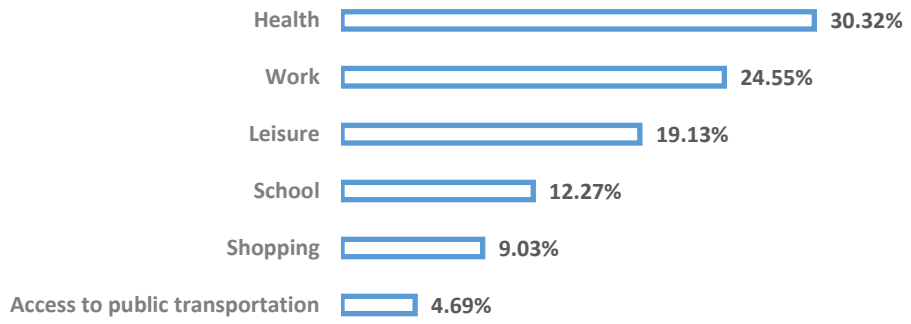

Fig.3 Purpose of Walking

Respondents were also asked whether they prefer walking as a mode of travel for accessing their desired destination or motorized vehicles. 59% of respondents refused walking as a preferred mode of choice for accessing multiple destinations with a mean value of 0.41. It's important to understand that the choice between walking and using motorized vehicles depends on a variety of factors, including distance, time, budget, personal preferences, and more. However, the predominant reasons behind preferring motorized vehicles to walk could be speed and efficiency, which allow people to cover greater distances in much less time, or the feeling of convenience as a mode of transportation.

Distance traveled			**Preferred Walking Time**			**Walking time without physical disturbance**		
Categories	No	%	**Categories**	No	%	**Categories**	No	%
<250 meters	57	21%	**<=10 min**	26	9%	**<=10 min**	108	38%
250 to 500 meters	55	20%	**10 - 20 min**	76	27%	**10 - 20 min**	46	29%
500 meters to 1 km	79	29%	**20 - 30 min**	84	30%	**20 - 30 min**	63	22%
More than 1 km	86	31%	**> 30 min**	91	33%	**> 30 min**	60	12%
Total No. of Respondents								**277**

Tab.8 Distance and Time Consumption Characteristics of Walking in Lahore

Travelled distance and time consumption characteristics of walking in Lahore are shown in Tab.8. Data demonstrates that almost 69% of people walk less than 1 Km while around 31% walk more than that. A significant number of people have intentions to walk for more than 20 minutes, but the physical disturbance and disconnectivity of walkways act as constraints reducing walking. 38% of the population faced physical disturbance within just 10 minutes, while 67% confronted it in less than 20 minutes of walking. This physical disturbance is examined as encroachment parameters and the non-availability of zebra crossing lines at intersections, as explained in perspectival. Non-availability of zebra crossing lines at an imperative road crossing section and intersections could be considered as discontinuity of pedestrian routes, which is often a major barrier to walking. The provision of zebra crossing lines could only be observed on a few major roads

or at some parts of planned communities, while most road sections and intersections are deprived of this facility, having a mean value of 1.39 (see Tab.7), leading pedestrians to unsafe environments. Another prominent parameter of physical nuisance is encroachment, i.e., only 21% of people observed footpaths free from encroachment, while 79% of the population confronts physical nuisance on walkways while walking (mean value of 0.20). Walkways and footpaths are mainly occupied by shopkeepers and vendors, using the walking infrastructure for profit-making on a personal basis, causing nuisances for the public at large. Besides this, permanent encroachment by households as stairs steps, and ramps, parking of private vehicles along the roadside, and installation of utility services on footpaths also act as a physical nuisance for pedestrians (shown in Fig.4).

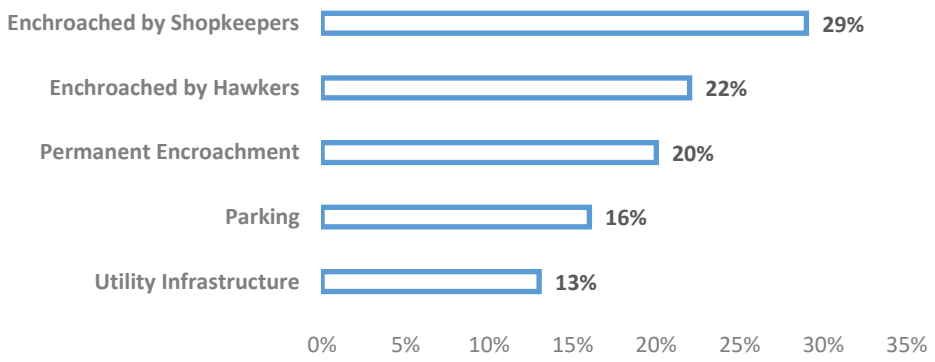

Fig.4 Reasons of Footpath Encroachment

4.1 Public Perception Determination

The public perception is evaluated by using average weighted factor analysis (as shown in Tab.9). The average weighted factor indicates the level of satisfaction or dissatisfaction as public perception, while negative or positive signs demonstrate the direction of perception. The value scale of the average weighted factor varies from 0 to 1, which indicates the least to the high level of satisfaction or dissatisfaction with public perception, where a positive sign illuminates public perception as satisfactory while negative signs as unsatisfactory.

Indicators	Weighted Factor	Average Weighted Factor
Infrastructural measures for Elders and Disabled	-302	-1.090
Environmental Qualities	-247	-0.892
Social Safety Concerns (Females)	-172	-0.621
Non-Existence of Encroachment on Footpaths	-139	-0.502
Driving Behaviour Concerns	-126	-0.455
Provision of Aesthetic and Amenities	-119	-0.429
Footpath Infrastructure Quality	-102	-0.368
Physical Connectivity/ Coherence of Walkways	-96	-0.347
Safety from Threat to Accidents	-83	-0.299
Walkways Cleanliness	-71	-0.256
Behaviour of Transport Officials	-42	-0.152

Tab.9 Average Weighted Factor Analysis Determining Pedestrian's Perception

It was observed that none of the indicators has a satisfactory public perception, which demonstrates the worst level of provided services and facilities for walking and non-consideration of walking parameters in urban policies and strategies. The highly criticized indicator is egregious convenience for elders and the disabled. It might be true that the problems and challenges associated with elders and disabled people have been considered in policymaking but not been implemented in their true spirit in real developmental projects, leading to diverse consequences. Following this, the most affecting indicator affecting walking is the air quality on the road. Other than this, safety concerns, particularly for females, are also an important concern. The existing literature on women's mobility in Lahore also declared the social environment unsafe and dangerous, e.g. the studies of (Malik et al., 2020; Jabeen et al., 2017) led to a barrier to inclusive mobility. Following these, the physical nuisance on pathways as encroached by shopkeepers or hawkers and uncontrolled parking is the most disparaged factor.

The adequate pedestrian planning highlighted in previous studies is just the provision of narrow footpaths in some parts of Lahore (Imran & Low, 2003), which are either encroached or poorly maintained, that reduced their operational capacity. Footpaths need to be free from encroachment and well maintained, infusing enthusiasm for walking in public (Haseeb et al., 2018; Tahir et al., 2015). Other factors, such as the provision of aesthetics and amenities along the walkways, are not even provided, but the heap of solid waste and garbage along footpaths are not properly removed and maintained. Bad smell from solid waste and garbage lying alongside roads and walkways establishes the unhappiest condition for walkers.

The findings highlight that the inhabitants of Lahore are dissatisfied with the walking infrastructure and its physical connectivity. On some major roads, walkways are available, but the connecting roads are deprived of this facility. Those who have the habit of walking face these problematic conditions. The unavailability of walkways increases the probability of pedestrians getting involved in crashes with other vehicles increased as they walk alongside the road.

To sum up, walking conditions were examined as dissatisfied due to the unavailability of infrastructure, social safety concerns, encroachment on footpaths, inadequate provision of aesthetics and amenities, insufficient physical connectivity/ coherence of walkways, and lack of management regarding cleanliness. Therefore, to encourage the public's walking practice, these indicators must be considered in plans and policymaking, while the collaboration of all stakeholders, predominantly the city walkers, must be considered.

4.2 Walking Constraints

Regression analysis also depicts an influential significance level of constraints as a barrier to declining walking practices. The analysis results (see Fig.5) reflect encroached footpaths, ignorance of pedestrian safety regarding accidents, excessive crime rate, and egregious weather conditions as extremely significant walking constraints. Besides encroached footpaths, pedestrian accidents because of safety ignorance by traffic movement are crucial walking constraints. Ignorance of pedestrian safety as a walking constraint refers to a lack of awareness or understanding of safe walking practices and pedestrian-friendly infrastructure. It can lead to a range of issues, including pedestrian accidents, pedestrian-vehicle conflicts, and a general lack of comfort and convenience for those who walk. Pedestrians' vulnerability on roads due to poor driving skills, incompatible pedestrian facilities, and inadequate driving education caused almost 26% of pedestrian accidents due to haphazard traffic management in Lahore (Minhas et al., 2016). Furthermore, as a walking constraint, "ignorance of pedestrian safety" can impede the creation of walkable communities. If people are unaware of the importance of pedestrian safety, they may not advocate for pedestrian-friendly infrastructure and amenities, such as well-lit sidewalks, pedestrian crossings, and pedestrian-friendly street designs.

Excessive crime in urban areas of Pakistan has a decisive impact on walking. A higher crime rate affects social dimensions of society, consequently reducing walking, while safer communities with efficient measures boost walking practices (Rad et al., 2014).

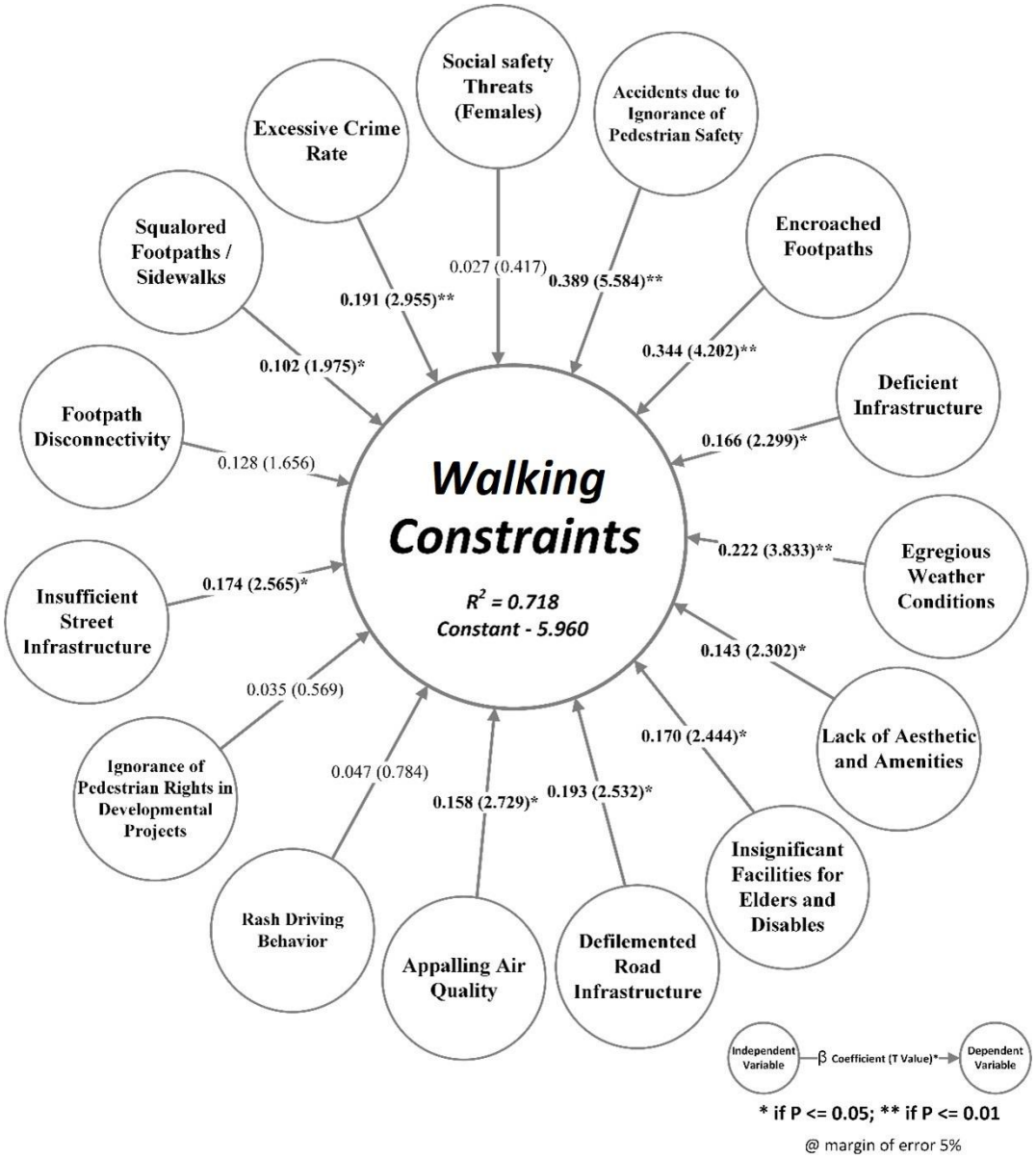

Fig.5 Walking Constraints and their Influential Significance

Egregious weather conditions in urban areas also influence walking. The built extent of Lahore lacks sufficient tact green spaces in it. Lesser provision of green spaces coupled with heavy traffic mobility has pessimistic effects on urban heat islands, which enhance the temperature in summer, causing a reduction in walking (Gray et al., 2012). Lahore suffers from high temperatures due to urban heat island effects caused by modifications in land cover, increased air pollution, lack of canopy, concrete infrastructure, and inadequate green spaces.

This study also indicates the significant effects of deficient walking infrastructure, squalor footpaths/sidewalks, insufficient street infrastructure, insignificant facilities for elders and disabled, absent road infrastructure, and lack of aesthetics and amenities on walking. Though few planned communities in Lahore have provided walking infrastructure for pedestrianization, plenty of areas are either deprived of these infrastructures, i.e., non-availability of footpaths, pedestrians' bridges, and Zebra crossing facilities, or possess poor maintenance characteristics. Street infrastructure, including streetlights for proper visibility at night, benches, and dustbins, either vanished from the streets or are insufficiently accessible. Other than this, walking is a key challenge for elders and the disabled. Insufficient time to cross the road or intersection, poor quality pavements, lack of curb ramps, the nonexistence of steps for visual impairments to find a way, etc., deprived special persons of

accessing opportunities through walking (Lo, 2010). Moreover, the lack of aesthetics and amenities has unpropitious influences on pedestrians' walking.

The crucial walking obstacles are social safety threats, particularly for females, physical disconnectivity on walkways, ignorance of pedestrian rights in developmental projects, and rash driving behavior of vehicular users. Apart from their decisive influence on pedestrians' walking, these indicators have insignificant impacts in the case of Lahore. All these walking constraints need to be resolved through long-term pragmatic plans with efficient stakeholder inclusion. Regardless of the analysed data for public perception and walking constraints determination in the settings of Lahore, further community-based in-depth understanding of respective issues is mandatory to form sustainable urban strategies leading to an inclusive mode of travel.

5. Conclusion

This study is conducted to analyze the impacts of indicators to assess public perceptions of constraints of walking in the city of Lahore. To conduct this study, a comprehensive set of data is collected from diversified socio-economic, age, and gender groups. The result of this study highlights that a minimal proportion of the population prefers walking as a mode of travel for everyday mobility. The utmost finding of this study shows extreme dissatisfaction of inhabitants with the provided urban infrastructure for walking, which was aggrandized by their poor maintenance. It is observed that none of the walking indicators have satisfactory public perception based on their beneficiary characteristics, thereby discouraging people from walking. Highly dissatisfying walking variables include the non-consideration of elders and disabled people in urban transport plans, bad environmental qualities surrounding walkways, poor infrastructural qualities, and social safety concerns. Moreover, this study has also enlightened us on the various walking constraints that act as a barrier for walkers in the built space of Lahore city. The constraints indicators that significantly impact walking are excessive crime rates, ignorance of pedestrian safety by vehicular traffic, egregious climatic conditions, and encroached footpaths for personal or profit-making business purposes. The number of other indicators, such as insufficient street infrastructure, degraded road infrastructure, a lack of aesthetics and amenities, and rash driving, also have their impacts on reducing walking practices. These elaborated walking constraints need to be resolved to make walking an efficient and viable transport mode for all age groups, genders, and socioeconomic classes.

This study is limited to people's perceptions about barriers to walking, in which factors related to infrastructure, weather, and safety have been analyzed. However, some important factors are out of the scope and this study and thus open for future research. For example, this study does not incorporate contextual factors, e.g. religion, culture, and social interaction to understand perceived barriers to walking. Similarly, how a specific group, e.g. gender or age, perceives walking can be an important avenue for future research. Other than this, the data used for analysis was collected from the city of Lahore and web-based, whereas, future studies can suggest to included cross cities comparisons to extend the current research. Finally, these findings arise from an online questionnaire. When using these tools, less educated, tech-savvy, and old people are more difficult to target, and therefore, their opinions could be underrepresented and should be included in future research.

Acknowledgement

The authors are thankful to anonymous reviewers and the Editor, Floriana Zucaro, for the valuable comments that helped to improve this research article.

References

Abbas, S., Shirazi, S. A., & Qureshi, S. (2018). SWOT analysis for socio-ecological landscape variation as a precursor to the management of the mountainous Kanshi watershed, Salt Range of Pakistan. *International Journal of Sustainable Development & World Ecology, 25*(4), 351-361.

Ahsan, M. (2019). Making Unaffordable to Affordable: Looking into Affordable Housing Issues and Its Remedies. *Architecture and Urban Planning, 15* (1), 22-29. https://doi.org/10.2478/aup-2019-0003

Al-Rashid, M. A., Goh, H. C., Harumain, Y. A. S., Ali, Z., Campisi, T. & Mahmood, T. (2021). Psychosocial barriers of public transport use and social exclusion among older adults: Empirical evidence from Lahore, Pakistan. *International journal of environmental research and public health, 18* (1), 185. https://doi.org/10.3390/ijerph18010185

Al-Rashid, M. A., Nadeem, M., Campisi, T., Shamsul Harumain, Y. A., & Goh, H. C. (2022). How Do Psychosocial Barriers Shape Public Transport Use? A Mixed-Method Study among Older Adults in Pakistan. *Sustainability, 14* (19), 12471. https://doi.org/10.3390/su141912471

Anwer, I., Masoumi, H., Aslam, A. B., & Asim, M. (2021). Logit and probit models explaining perceived cycling motives, barriers, and biking trip generation in Lahore, Pakistan. *TeMA Journal of Land Use, Mobility and Environment, 14* (3), 433-455. https://doi.org/10.6093/1970-9870/8113

Arif, M. M., Ahsan, M., Devisch, O., & Schoonjans, Y. (2022). Integrated Approach to Explore Multidimensional Urban Morphology of Informal Settlements: The Case Studies of Lahore, Pakistan. *Sustainability, 14*(13), 7788.

Arvidsson, D., Kawakami, N., et al. (2012). Physical activity and concordance between objective and perceived walkability, *Med Sci Sports Exerc, 44* (2). https://doi.org/ 10.1249/MSS.0b013e31822a9289

Aslam, S. A. B., Masoumi, H. E., et al. (2018). Cyclability in Lahore, Pakistan: Looking into Potential for Greener Urban Traveling. *TeMA Journal of Land Use, Mobility and Environment, 11* (3), 323-343. https://doi.org/10.6092/1970-9870/5806

Aziz, A., Nawaz, M. S., et al. (2018). Examining suitability of the integrated public transport system: A case study of Lahore. *Transportation Research Part A: Policy and Practice, 117,* 13-25. https://doi.org/10.1016/j.tra.2018.08.003

Bahari, N. I., Arshad, A. K., et al. (2014). Assessing pedestrians' perspective on the walkability of pedestrian environment under mixed-use development. In InCIEC 2013, pp. 355-367. Springer, Singapore. https://doi.org/10.1007/978-981-4585-02-6_31

Balsas, C. J. L. (2019). Walkable Cities: Revitalization, Vibrancy, and Sustainable Consumption. SUNY Press.

Bharucha, J. (2017). An investigation into the walkability problem in Indian cities. *Safer Communities ,16* (2), pp. 77-86. https://doi.org/10.1108/SC-02-2017-0010

Cecchini A., & Talu V. (2011). Walking (and cycling) to change the city. *TeMA - Journal of Land Use, Mobility and Environment, 4* (4), 99-108. https://doi.org/10.6092/1970-9870/605

Clark, M. I., Berry, T. R., et al. (2010). Key stakeholder perspectives on the development of walkable neighbourhoods. *Health & Place 16* (1), 43-50. https://doi.org/10.1016/j.healthplace.2009.08.001

De Nazelle, A., Bode, O., & Orjuela, J. P. (2017). Comparison of air pollution exposures in active vs. passive travel modes in European cities: A quantitative review. *Environment international, 99,* 151-160. https://doi.org/10.1016/j.envint.2016.12.023

Fonseca, F., Ribeiro, P. J., Conticelli, E., Jabbari, M., Papageorgiou, G., Tondelli, S., & Ramos, R. A. (2022). Built environment attributes and their influence on walkability. *International Journal of Sustainable Transportation, 16* (7), 660-679. https://doi.org/10.1080/15568318.2021.1914793

Gaglione, F., Gargiulo, C., & Zucaro, F. (2019). Elders' quality of life. A method to optimize pedestrian accessibility to urban services. *TeMA-Journal of Land Use, Mobility and Environment, 12* (3), 295-312. https://doi.org/10.6092/1970-9870/6272

Gargiulo, C., Zucaro, F., & Gaglione, F. (2018). A set of variables for the elderly accessibility in urban areas. *TeMA-Journal of Land Use, Mobility and Environment*, 53-66. https://doi.org/10.6092/1970-9870/5738

Grant, T. L., Edwards, N., et al. (2010). Neighborhood walkability: older people's perspectives from four neighborhoods in Ottawa, Canada. *Journal of aging and physical activity, 18* (3), 293-312. https://doi.org/10.1123/japa.18.3.293

Gray, J. A., Zimmerman, J. L., et al. (2012). Built environment instruments for walkability, bikeability, and recreation: Disability and universal design relevant?. *Disability and health journal, 5* (2), 87-101. https://doi.org/10.1016/j.dhjo.2011.12.002

Hameed, R., & Anjum, G. A. (2016). Improving the Environmental performance of bus-based public Transport system in Lahore-Pakistan. *Pakistan Journal of Engineering and Applied Sciences*.

Haseeb, A., Saleemi, A., et al. (2018). Spatial analysis for the identification of high-risk locations of road accidents with pedestrian fatalities in lahore. *Pakistan Journal of Science, 70* (4), 317. Retrieved from: https://www.proquest.com/scholarly-journals/spatial-analysis-identification-high-risk/docview/2348771590/se-

Ibrahim, M., and Riaz, S. (2018). Lahore growth-Past and future. Retrieved from: http://urbanunit.gov.pk/Upload/Photos/Urban%20Gazette%20Issue%202018.pdf (accessed at 27.04.2020).

Imran, M. & Low, N. (2003). Impact of global institutions on urban transport in Pakistan cities. In Proc. 39th ISoCaRP Congress.

Jabeen, T., Sunbal, M., et al. (2017). Relationship between Women Mobility and Sexual Harassment: Empirical Study of Metropolitan City of Lahore. *Pakistan Journal of Criminology, 9* (4), 90. Retrieved from: https://www.proquest.com/scholarly-journals/relationship-between-women-mobility-sexual/docview/2164962204/se-2

JICA. (2012). "The project for Lahore urban transport master plan "in the Islamic republic of Pakistan." Transport Department, Government of Punjab 2. Retrtieved from: https://www.urbanunit.gov.pk/Upload/Photos/103.pdf (accessed at 30.04.2020).

Jun, H. J., & Hur, M. (2015). The relationship between walkability and neighborhood social environment: The importance of physical and perceived walkability. *Applied Geography, 62*, 115-124. https://doi.org/10.1016/j.apgeog.2015.04.014

Kelly, C. E., Tight, M. R., et al. (2011). A comparison of three methods for assessing the walkability of the pedestrian environment. *Journal of Transport Geography, 19* (6), 1500-1508. https://doi.org/10.1016/j.jtrangeo.2010.08.001

Liao, B., van den Berg, P. E., van Wesemael, P. J., & Arentze, T. A. (2022). Individuals' perception of walkability: Results of a conjoint experiment using videos of virtual environments. *Cities, 125*, 103650. https://doi.org/10.1016/j.cities.2022.103650

Lo, C. (2010). What are the Main Problems Individuals with Mobility Issues Encounter Daily in the Kingston Galloway Orton Park Neighbourhood?.

Lourenço, J., & Rahaman, K. R. (2010). Pedestrian Planning in City Centers: a Study of Guimarães and Braga. *TeMA -Journal of Land Use, Mobility and Environment, 3* (1), 37–46. https://doi.org/10.6092/1970-9870/134

Lockett, D., Willis, A., et al. (2005). Through seniors' eyes: an exploratory qualitative study to identify environmental barriers to and facilitators of walking. *Canadian Journal of Nursing Research Archive, 37* (3).

Makki, S., Surat, M., et al. (2012). The importance of design characteristics in walking from student's perspective: a case study in Universiti Kebangsaan Malaysia. *Journal of Building Performance, 3* (1).

Malik, B. Z., Rehman, Z., et al. (2020). Women's mobility via bus rapid transit: Experiential patterns and challenges in Lahore. *Journal of Transport & Health, 17*, 100834.

Mazzeo, G., Zucaro, F., & Morosini, R. (2019). Green is the colour. Standards, equipment and public spaces as paradigm for the Italian sustainable city. *TeMA Journal of Land Use, Mobility and Environment, 12* (1), 31-52. https://doi.org/10.6092/1970-9870/5836

Minhas, M. K., Rehman, Z. U., et al. (2016). A study of factors influencing accidents on Lahore Islamabad motorway (m-2). *Pakistan Journal of Science, 68* (1), 63.

Newman, P., and Kenworthy, J. (1999). Sustainability and cities: overcoming automobile dependence. *Island press*.

Ovstedal, L., and Ryeng, E. (2002). Understanding pedestrian comfort in European cities: How to improve walking conditions. *In European Transport Conference, Cambridge, UK* (6).

Pak, B. & Verbeke, J. (2013). Walkability as a Performance Indicator for Urban Spaces. *Crowdsourcing and Sensing, 1*, 423-432. Retrieved from: https://www.researchgate.net/publication/279925396_Walkability_as_a_Performance_Indicator_for_Urban_Spaces_Strategies_and_Tools_for_the_Social_Construction_of_Experiences

Pervaiz, S., Javid, K., Khan, F. Z., Talib, B., Siddiqui, R., Ranjha, M. M., & Akram, M. A. N. (2019). Spatial analysis of vegetation cover in urban green space under new government agenda of clean and green Pakistan to tackle climate change. *Journal of Ecological Engineering, 20*(4).

Rad, V. B., Najafpour, H., et al. (2014). The Systematic Review on Safety in Urban Neighborhoods. *Life Science Journal, 11* (10).

Saelens, B. E., Sallis, J. F., et al. (2003). Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. *Annals of behavioral medicine, 25* (2), 80-91. https://doi.org/10.1207/s15324796abm2502_03

Shakeel, N., & Jahanzaib, M. (2019). Influence of land use, socio-demographic and travel attributes on travel behaviour in City of Lahore. *Architecture and Urban Planning, 15* (1), 67-74. https://doi.org/10.2478/aup-2019-0009

Southworth, M. (2005). Designing the wa. lkable city. *Journal of urban planning and development, 131* (4), 246-257. https://doi.org/10.1061/(ASCE)0733-9488(2005)131:4(246)

Strohmeier, F. (2016). Barriers and their influence on the mobility behavior of elder pedestrians in urban areas: challenges and best practice for walkability in the city of Vienna. *Transportation research procedia, 14*, 1134-1143. https://doi.org/10.1016/j.trpro.2016.05.184

Tahir, M. N., Haworth, N., et al. et al. (2015). Observations of road safety behaviours and practices of motorcycle rickshaw drivers in Lahore, Pakistan. In Proceedings of the 2015 Australasian Road Safety Conference, Australian College of Road Safety (ACRS).

Tariq, F., & Shakeel, N. (2021). Modeling and Predicting Commuters' Travel Mode Choice in Lahore. Global Social Sciences Reviews VI(III), 106-118. https://doi.org/10.31703/gssr.2021(VI-III).12

Zhang, X. & Mu, L. (2020). Incorporating Online Survey and Social Media Data into a GIS Analysis for Measuring Walkability. In: Lu, Y., Delmelle, E. (eds) Geospatial Technologies for Urban Health. Global Perspectives on Health Geography. Springer, Cham. https://doi.org/10.1007/978-3-030-19573-1_8

Author's profile

Muhammad Ahsan

He is currently pursuing his master's degree in the Department of City and Regional Planning, Yildiz Technical University, Istanbul as Turkey Burslari Scholarship holder. He has recently completed his Erasmus+ Traineeship program in Katholieke Universiteit (KU) Leuven, Belgium in the faculty of Architecture. The author has completed his bachelor's degree in City and Regional Planning from University of Engineering and Technology (UET), Lahore and endowed with two gold medals based on excellent educational performance. Mr. Ahsan's research interests are related to affordable housing, urban regeneration of informal housing, urban transportation and walkability, and integration of spatial and statistical tools in urban planning.

Nabeel Shakeel

He is currently pursuing his PhD in Geography from the School of Earth and Enviornment, University of Canterbury, New Zealand. He is a forward-thinking transport planner and human geographer with specializations in the areas of travel behavior analysis, transport equity and accessibility, and spatial data analytics. The underlying goal of his research is to develop approaches for designing equitable and accessible transport services and analyze them with behavioral perspectives. He received his becholar's degree in Urban Planning and Master degree in Transportation Planning.

Farrukh Baig

He received the M.S. degree in transportation planning and management from the Dalian University of Technology, Dalian, Liaoning, China, in 2017. He is currently pursuing a Ph.D. degree in traffic engineering at Central South University, Changsha, Hunan, China. He has been an Associate Member of the American Society of Civil Engineering since 2020. He serves various International journals as a reviewer and has attended multiple international conferences. His research interests include automated vehicles, smart cities, road safety, transportation planning, transport policy, and urban management.