

TeMA

Journal of
Land Use, Mobility and Environment

The characteristics of urban travel behaviors and the attitudes of passengers in the Middle East and North Africa (MENA) is less-studied. There is a considerable knowledge gap about the circumstances of how people think and decide about their short-term, medium-term, and long-term mobility for commute and non-commute travels.

TeMA Journal of Land Use, Mobility and Environment offers papers with a unified approach to planning and mobility. TeMA has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).

Special Issue 1.2018

URBAN TRAVEL BEHAVIOR IN THE MIDDLE EAST AND NORTH AFRICA

ISSN 1970-9889
University of Naples Federico II

TeMA

Journal of
Land Use, Mobility and Environment

Special Issue 1.2018

URBAN TRAVEL BEHAVIOR IN THE MIDDLE EAST AND NORTH AFRICA

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

Cover Image by Houshmand E. Masoumi of landscape in Teheran

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.

The Italian *National Agency for the Evaluation of Universities and Research Institutes* (ANVUR) classified TeMA as scientific journal in the Area 08. TeMA 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 3.0 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, Polytechnic University of Bari, Italy
Enrique Calderon, Polytechnic University of Madrid, Spain
Roberto Camagni, Polytechnic University of Milan, Italy
Derrick De Kerckhove, University of Toronto, Canada
Mark Deakin, Edinburgh Napier University, Scotland
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 Studies on Mediterranean Societies, Italy
Luigi dell'Olio, University of Cantabria, Spain
Romano Fistola, University of Sannio, Italy
Carmela Gargiulo, University of Naples Federico II, 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 Studies on Mediterranean Societies, 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, PhD at University of Naples Federico II, Italy
Gerardo Carpentieri, PhD at University of Naples Federico II, Italy
Stefano Franco, PhD student at Luiss University Rome, Italy
Rosa Morosini, PhD student at University of Naples Federico II, Italy
Marco Raimondo, Engineer, University of Sannio, Italy
Maria Rosa Tremitera, PhD student at University of Naples Federico II, Italy
Andrea Tulisi, PhD at Second University of Naples, Italy

Special Issue 1.2018

URBAN TRAVEL BEHAVIOR IN THE MIDDLE EAST AND NORTH AFRICA

Contents

- 3** **Editorial Preface**
H. E. Masoumi
- 7** **Understanding the needs of Mena public transport customers: culture of service and gender responsive recommendations**
A. Delatte, T. Baouni, R. Belwal, L. Daou, D. Gourram, R. Imam, M. S. Zitoun, A. Smadi
- 31** **Urban Travel behavior determinants in Saudi Arabia**
G. Tesoriere, M. F. Errigo
- 47** **Modeling and forecasting car ownership based on socio-economic and demographic indicators in Turkey**
H. Ceylan, O. Baskan, C. Ozan
- 67** **Analysis of the main service quality dimensions affecting satisfaction the metropolitan rail public transit users in Algiers**
T. Baouni, R. DE Ona, B. Merad, L. Tahraoui, J. L. Machado – Leon, J. De Ona
- 83** **Travel Behaviour across urban and rural areas of Pakistan**
M. Adeel
- 95** **The development of a walkability audit. Based on Iranian cities pedestrian environment**
A.Soltani, M. Hossein Pour, M. Sholeh, P. Zare

EDITORIAL PREFACE

Special Issue 1.2018

Urban Travel Behavior in the Middle East and North Africa

Dr. Ing. Houshmand E. Masoumi,
Technische Universität Berlin, Center for Technology and Society, Berlin, Germany
E-mail: masoumi@ztg.tu-berlin.de

This Special Issue the TeMA Journal of Land Use, Mobility and Environment focuses on an already researched subject of urban travel behavior and decisions in the less-studied geographical context of the Middle East and North Africa (MENA). There is a large knowledge gap concerning the circumstances of urban mobility decision-making within the socio-cultural context of the MENA region and the differences in people's preferences and approaches toward transport compared to other regions of the world. A relatively large body of literature has been produced about the topic in the international context during the past three decades, but the literature is limited to primarily high-income countries. As a result, the sub-topics being discussed today have become quite narrow in focus. However, most of the countries located in the MENA region are in need of more general studies clarifying the main human-related aspects of urban mobility in order to provide local urban transportation planning norms and thereby achieve more sustainable transport modes. This lack of knowledge is the reason behind the publication of this special issue. In this issue, the geographical borders of the MENA region issue encompass the widely accepted area of Iran in the east to Morocco in the west. Turkey has not been included in some MENA definitions previously, and Pakistan has been excluded in most of them. Nevertheless, due to strong socio-cultural and religious relations, they have been included in this issue.

So far, a limited number of studies have addressed urban travel behavior and people's mobility preferences and decisions in conjunction with the socio-economics, land use, and human activities in the region. There have been studies undertaken in Egypt (El-Bany et al., 2014; El-Dorghamy & Mosa, 2016), Jordan (Hamed & Olaywah, 2000; Shbeeb & Awad, 2013), Iran (Ahmadi Azari et al., 2012; Babakan et al., 2018; Etminani-Ghasrodashti & Ardeshtiri, 2015, 2016; Hatamzadeh et al., 2017b, 2017a; Masoumi, 2013, 2014, 2015; Mehdizadeh et al., 2016, 2017; Rezasoltani et al., 2015; Shahangian et al., 2012; Soltani, 2017; Soltani & Shams, 2017; Soltanzadeh & Masoumi, 2014), Lebanon (Chalak et al. 2016; Danaf et al., 2014), Saudi Arabia (Al-Atawi, 2016; Al-Atawi & Saleh, 2014; Alotaibi, 2017), United Arab Emirates (Abulibdeh, 2017), Turkey (Gokasar & Gunay, 2017; Ozbil et al., 2016), and Pakistan (Gul et al., 2018). Nevertheless, the amount of studies, their subject coverage, and research quality are not entirely satisfying. Moreover, due to the limited number of studies on each sub-topic, little to no consistency or decisive results have been generated. Overall, this research output still does not seem sufficient for policy-making on national or local levels. Thus, more in-depth studies using primary and/or secondary data are needed.

As noted in the above paragraph, most of the published results have been generated since 2012 onwards, indicating the novelty and recentness of the studies and indirectly implying the need for more studies covering a wider range of sub-topics. In the meantime, the precision, accuracy, and comprehensiveness of the studies are still far from satisfactory.

In response to the above needs, this issue is aligned with the following research topics:

- Interconnections of people's urban transport preferences and needs with urban growth and housing;
- Relations between urban travel behavior and socio-economics, demographics, and culture;
- Modeling and forecasting of future urban mobility trends and needs;
- Human perceptions about urban transportation;
- Walkability and urban land use on the micro scale.

The issue starts with a paper from Delatte et al. describing passengers' needs regarding public transportation in Casablanca, Algiers, Amman, Beirut, and Muscat. This study has a good geographical coverage, including cities from the westernmost reaches of the region through to the east in Oman. The current status of public transit use in the five cities is presented in the manuscript by means of data collected from 984 respondents and 49 women in focus groups. A paper on Saudi Arabia by Errigo and Tesoriere on urban travel behavior determinants in the cities of Riyadh (the capital), Dammam, and Buraydah highlights the connection between travel behavior, the national economy, and social issues, and suggests that the Saudi urban development strategy change urban form in order to reduce car dependency. Similarly, Ceylan et al. focus on socio-economic and demographic determinants and indicators of car ownership in Turkey. According to their forecasting based on scenarios related to Gross Domestic Production and gasoline price, they predict that the car ownership rate in Turkey will be between 230 and 325 vehicles per one thousand inhabitants depending on economic achievements, global oil prices, and national taxation policies. Despite this projected growth, the figure will still be smaller than the major European Union countries. In a paper representing North Africa, Baouni et al. use the results of the Customer Satisfaction Survey of Algiers (2014) to investigate the socio-economic variables and urban travel patterns behind customer satisfaction with the city's new collective transit systems like the new tramway and underground heavy rail system. Adeel examines the variation between urban and rural mobility characteristics such as travel length/time, trip frequency, etc. targeting individual and household socio-economic variables. The paper's analysis of the 2007 Pakistani national survey data finds that the built and social/cultural environments are important in determining travel mode choices, especially for women. Finally, Soltani et al. attempt to produce a walkability audit tool based on environmental measures of walking behaviors in a neighborhood of Shiraz, Iran. They found 50 environmental measures to be reliable and meaningful factors when included in the audit tool.

The papers of this issue investigate travel behaviors in cities from Morocco, Algeria, Jordan, Lebanon, Oman, Iran, Turkey, Saudi Arabia, and Pakistan. The authors are based in Algeria, Jordan, Lebanon, Iran, Turkey, Saudi Arabia, Spain, Oman, Italy, Australia, and the UK. The referees of this issue are researchers and experts located in Iran, Italy, Malaysia, Australia, France, and the UK.

REFERENCES

- Abulibdeh, A. (2017). Implementing congestion pricing policies in a MENA Region City: Analysis of the impact on travel behaviour and equity. *Cities*. Advance online publication. doi:<https://doi.org/10.1016/j.cities.2017.12.003>
- Ahmadi Azari, K., Arintono, S., & Hamid, H. (2012). Effects of parking and cordon charge policies on tourist's modal shift in central business district of Mashhad city, Iran. *Current Issues in Tourism*, 15(5), 489–496. doi:<https://doi.org/10.1080/13683500.2011.634495>
- Al-Atawi, A. (2016). Sustainable travel modes in Saudi Arabia: Is there a potential for formal car-sharing scheme? *World Journal of Science, Technology and Sustainable Development*, 13(1), 46–55. doi:<https://doi.org/10.1108/WJSTSD-10-2015-0052>
- Al-Atawi, A., & Saleh, W. (2014). Travel behaviour in Saudi Arabia and the role of social factors. *Transport*, 29(3), 269–277. doi:<https://doi.org/10.3846/16484142.2014.913199>
- Alotaibi, O. M. (2017). Potential Demand for Public Transport in Riyadh City, Saudi Arabia. Cardiff University.
- Babakan, A. S., Alimohammadi, A., & Taleai, M. (2018). An agent-based evaluation of impacts of transport developments on the modal shift in Tehran, Iran. *arXiv preprint arXiv:1803.04934*. Advance online publication. doi:<https://doi.org/10.1080/19439342.2014.994656>

- Chalak, A., Al-Naghi, H., Irani, A., & Abou-Zeid, M. (2016). Commuters' behavior towards upgraded bus services in Greater Beirut: Implications for greenhouse gas emissions, social welfare and transport policy. *Transportation Research Part A: Policy and Practice*, 88, 265–285. doi:https://doi.org/10.1016/j.tra.2016.04.001
- Danaf, M., Abou-Zeid, M., & Kaysi, I. (2014). Modeling travel choices of students at a private, urban university: Insights and policy implications. *Case Studies on Transport Policy*, 2(3), 142–152. doi:https://doi.org/10.1016/j.cstp.2014.08.006
- El-Bany, M. E.-S., Shahin, M. M., Hashim, I. H., & Serag, M. S. (2014). Policy sensitive mode choice analysis of Port-Said City, Egypt. *Alexandria Engineering Journal*, 53(4), 891–901. doi:https://doi.org/10.1016/j.aej.2014.09.006
- El-Dorghamy, A., & Mosa, A. I. (2016). Exploring children's travel to school in upgraded informal settlements: A qualitative case study of Ezbet El-Haggana. *Transportation Research Procedia*, 14, 1277–1286. doi:https://doi.org/10.1016/j.trpro.2016.05.200
- Etminani-Ghasrodashti, R., & Ardeshiri, M. (2015). Modeling travel behavior by the structural relationships between lifestyle, built environment and non-working trips. *Transportation Research Part A: Policy and Practice*, 78, 506–518.
- Etminani-Ghasrodashti, R., & Ardeshiri, M. (2016). The impacts of built environment on home-based work and non-work trips: An empirical study from Iran. *Transportation Research Part A: Policy and Practice*, 85, 196–207. doi:https://doi.org/10.1016/j.tra.2016.01.013
- Gokasar, I., & Gunay, G. (2017). Mode choice behavior modeling of ground access to airports: A case study in Istanbul, Turkey. *Journal of Air Transport Management*, 59, 1–7. doi:https://doi.org/10.1016/j.jairtraman.2016.11.003
- Gul, Y., Sultan, Z., Moeinaddini, M., & Ahmed Jokhio, G. (2018). Measuring the differences of neighbourhood environment and physical activity in gated and non-gated neighbourhoods in Karachi, Pakistan. *Journal of Urban Design*, 1–20.
- Hamed, M. M., & Olaywah, H. H. (2000). Travel-related decisions by bus, servis taxi, and private car commuters in the city of Amman, Jordan. *Cities*, 17(1), 63–71. doi:https://doi.org/10.1016/S0264-2751(99)00052-9
- Hatamzadeh, Y., Habibian, M., & Khodaii, A. (2017a). Walking behavior across genders in school trips, a case study of Rasht, Iran. *Journal of Transport & Health*, 5, 42–54. doi:https://doi.org/10.1016/j.jth.2016.08.011
- Hatamzadeh, Y., Habibian, M., & Khodaii, A. (2017b). Walking and jobs: A comparative analysis to explore factors influencing flexible and fixed schedule workers, a case study of Rasht, Iran. *Sustainable cities and society*, 31, 74–82.
- Masoumi, H. E. (2014). A theoretical approach to capabilities of the traditional urban form in promoting sustainable transportation. *Theoretical and Empirical Researches in Urban Management*, 9(1), 44–60.
- Masoumi, H. E. (2015). *Transformation of Urban Form and the Effects on Travel Behavior in Iran*.
- Masoumi, H. E. (2013). Modeling Travel Behavior Impacts of Micro-Scale Land Use and Socio-Economic Factor. *Tema. Journal of Land Use, Mobility and Environment*, 6(2), 235–250. doi:https://doi.org/10.6092/1970-9870/1484
- Mehdizadeh, M., Mamdoohi, A., & Nordfjaern, T. (2017). Walking time to school, children's active school travel and their related factors. *Journal of Transport & Health*, 6, 313–326. doi:https://doi.org/10.1016/j.jth.2017.01.012
- Mehdizadeh, M., Nordfjaern, T., & Mamdoohi, A. (2016). The role of socio-economic, built environment and psychological factors in parental mode choice for their children in an Iranian setting. *Transportation*, 1–21. doi:https://doi.org/10.1007/s11116-016-9737-z
- Ozbil, A., Argin, G., & Yesiltepe, D. (2016). Pedestrian route choice by elementary school students: The role of street network configuration and pedestrian quality attributes in walking to school. *International Journal of Design Creativity and Innovation*, 4(2), 67–84. doi:https://doi.org/10.1080/21650349.2015.1123120
- Rezasoltani, M., Behzadfar, M., & Said, I. (2015). A Model Development for Children's Walking in Neighborhood. *Procedia-Social and Behavioral Sciences*, 201, 30–38. doi:https://doi.org/10.1016/j.sbspro.2015.08.116
- Shahangian, R., Kermanshah, M., & Mokhtarian, P. (2012). Gender Differences in Response to Policies Targeting Commute to Automobile-Restricted Central Business District: Stated Preference Study of Mode Choice in Tehran, Iran. *Transportation Research Record: Journal of the Transportation Research Board*. (2320), 80–89. doi:https://doi.org/10.3141/2320-10
- Shbeeb, L., & Awad, W. (2013). Walkability of School Surroundings and its Impact on Pedestrian Behaviour. *Tema. Journal of Land Use, Mobility and Environment*, 6(2), 171–188. doi:https://doi.org/10.6092/1970-9870/1608
- Soltani, A. (2017). Social and urban form determinants of vehicle ownership; evidence from a developing country. *Transportation Research Part A: Policy and Practice*, 96, 90–100. doi:https://doi.org/10.1016/j.tra.2016.12.010

Soltani, A., & Shams, A. (2017). Analyzing the influence of neighborhood development pattern on modal choice. *Journal of Advanced Transportation*, 2017. doi: <https://doi.org/10.1155/2017/4060348>

Soltanzadeh, H., & Masoumi, H. E. (2014). The Determinants of Transportation Mode Choice in the Middle Eastern Cities: The Kerman Case, Iran. *Tema. Journal of Land Use, Mobility and Environment*, 7(2), 199–222. doi:<https://doi.org/10.6092/1970-9870/2518>

TeMA Urban Travel Behavior in the Middle East and North Africa
SPECIAL ISSUE 1.2018 | 7-30
print ISSN 1970-9889, e- ISSN 1970-9870
doi: <http://dx.doi.org/10.6092/1970-9870/5458>

review paper received 31 January 2018, accepted 30 April 2018

Licensed under the Creative Commons Attribution
Non Commercial License 3.0
www.tema.unina.it

Delatte, A., Baouni, T., Belwal, R., Daou, L., Imam, R., Zitoun, M.S., Smadi, A. (2018). Understanding the needs of MENA public transport customers: Culture of service and gender-responsive recommendations. *Tema. Journal of Land Use, Mobility and Environment*, 7-30
doi:<http://dx.doi.org/10.6092/1970-9870/5458>



UNDERSTANDING THE NEEDS OF MENA PUBLIC TRANSPORT CUSTOMERS:

CULTURE OF SERVICE AND GENDER-RESPONSIVE RECOMMENDATIONS

ALINE DELATTE^a, TAHAR BAOUNI^b, RAKESH BELWAL^c, LINDOS DAOU^d,
DOUNIA GOURRAM^e, RANA IMAM^f, MADANI SAFAR ZITOUN^g, AYMAN
SMADI^h

^a Research Manager, UITP MENA Centre for Transport Excellence,
e-mail: aline.delatte@uitp.org; ^b Professor, Ecole Polytechnique d'Architecture et
d'Urbanisme (EPAU) d'Alger, Laboratoire Ville, Urbanisme et Développement
Durable, e-mail: tbaouni@yahoo.fr;

^c Associate Professor, Faculty of Business, Sohar University, e-mail:
rbelwal@soharuni.edu.om;

^d Holy Spirit University of Kaslik, USEK Business School, Lebanon, e-mail:
lindosdaou@usek.edu.lb;

^e Head of UITP Maghreb Office, e-mail: dounia.gourram@uitp.org;

^f Associate Professor of Civil Engineering, The University of Jordan, e-mail:
r.imam@ju.edu.jo;

^g Professor, Departement of sociology, University of Algiers 2, e-mail:
safamad@yahoo.fr; ^h Director, UITP MENA Centre for Transport Excellence, e-
mail: ayman.smadi@uitp.org

ABSTRACT

Fast population growth, urban sprawl and the raise in households' motorization observed in all major cities of the Middle-East and North-Africa (MENA) region, are constantly challenging public transport providers who seek to handle efficiently the continuously rising travel demand. Most of the MENA cities suffer from traffic congestion that not only impacts the quality of life of MENA citizens, but also their access to job opportunities, health services, and social and political participation. Alongside the development of public transport network, it is crucial to encourage urban dwellers to reduce their dependence on personal cars, use public transport, and develop soft mobility skills. Therefore, operators and service providers need to define customer-centric strategy and build a culture of service excellence in line with their customers' expectations. In cooperation with academic partners, the UITP MENA Centre for Transport Excellence launched the User-Oriented Public Transport research project with the aim to understand the perceptions of female and male users and non-users about public transport services in five MENA cities: Algiers, Amman, Beirut, Casablanca and Muscat. The methodological framework was built around the five dimensions of the user's needs pyramid: safety, security, ease-to-use, comfort and experience. Based on the quantitative analysis of data collected from 984 respondents and the qualitative analysis of 49 women's testimonies collected during the focus groups, recommendations were made to encourage culture of service and gender mainstreaming in public transport development in the region.

KEYWORDS:

Public Transport; Urban mobility; Gender Mainstreaming; Customer service

1 INTRODUCTION

Since the 1950s, the MENA region has gone through drastic demographic and socio-economic changes. Whilst the population growth and urbanization rate in the MENA region are the fastest worldwide, unemployment is critically high, especially among youth and women who respectively represent a quarter and a half of the overall 420 million regional population (UN DESA, 2014; UN DESA, 2017; ILO, 2013). Cities are where most pressing challenges are concentrated: unsustainable resources, energy consumption, carbon emissions, pollution, and health hazards (Barresi & Pultrone, 2013). The lack of integrated urban and transport development strategies in most MENA cities has led to an uncontrolled - and often informal - urban sprawl of polycentric cities lacking sufficient connectivity. At the same time, the rapid motorization of households has exacerbated the already congested urban areas affecting dramatically the quality of life in terms of air quality, commuting time and distance, safety, space occupancy and accessibility (El-Geneidy et al., 2013).

Transport is the backbone of urban development. It is an enabler for job accessibility, health services and the social and political participation (Farrington, 2007; Rode et al., 2017). Together with the efforts made to develop sustainable transport infrastructure, it is crucial to encourage urban mobility behavioral changes, and support urban dwellers to shift from car use and ownership to public transport use and soft mobility behaviors (Gakenheimer, 1999; Banister, 2008; Rojas-Rueda et al., 2012; Furlan & Faggion, 2015). However, the poor image of public transport in MENA cities and the strong social status assigned to the private cars aggravate the situation: public transport is perceived as the mode for 'poor people', while 'car ownership and use' becomes a symbol of status for the current generation, especially among the medium and high economic sections of the society (El-Geneidy et al., 2013). For the so called 'captive public transport riders', safety, security, reliability, affordability are crucial factors affecting their daily life and access to socio-economic opportunities and services (Thynell, 2014). To counteract with this negative image of public transport, operators and service providers need to define customer-centric strategy and build a culture of service excellence (Union International des Transports Publics [UITP], 2018). The onus lies in providing attractive public transport services, which compete with the flexibility and comfort of the private car, provide current users a positive experience, and encourage new female and male customers from different age groups, socio-economic status to use public transport as the prominent mode.

This paper presents the key-findings of the research project on perceptions of users and non-users in five MENA cities – Algiers, Amman, Beirut, Casablanca and Muscat – conducted in 2017 by the UITP MENA academic network. The aims of the project are to identify the key factors which will improve public transport services, from users' perspectives, and to highlight women's expectations for a more gender-responsive public transport offers in MENA cities. The first part of the article discusses the state of the art in term of customer-centric strategies in the region, as well as the current data availability on mobility habits in the region, with a specific focus on women's mobility and personal security. The second part of the paper presents briefly the current transport governance and public transport development in each of the project's cities. The research scope, methodology and theoretical framework are developed in the third part of this paper. Finally, the key-findings and recommendations are presented.

2 BACKGROUND

2.1 UNDERSTANDING MENA PUBLIC TRANSPORT USERS' NEEDS

During the last decade, public transport has witnessed a shift in its image from a public authority managing urban infrastructure to a quality service provider to the urban dwellers. Public transport is not an industry anymore, rather it is more of a service now. Just like any other service in the market, the quality of the public transport service is what defines its market share. Public Transport sector in its new role, therefore,

needs to reinvent itself to retain and attract customers on all occasions and routes (Nelson et al., 2010; Lai & Chen, 2011; Felleson & Friman, 2008). In the MENA region, transport authorities are striving to make public transport more attractive by building a culture of service excellence. This requires the development of a customer-centric strategy and the provision of high quality services all along the customer's trip, from origin to the destination in terms of safety, reliability, information, staff support, cleanliness, safe and secure built environment, etc. To provide the right service at the right time and right location, it is crucial to understand current and potential future customers, know their needs, habits and preferences according to their socio-economic profile and life phases (UITP, 2018). The Dubai Roads and Transport Authority (RTA) is one of the leading authority in the MENA region in terms of customer-centric strategy. Since 2016, RTA has been emphasizing 'Happiness Strategy' as one of the eight strategic objectives in the RTA vision for 2030. To measure the corresponding achievement happiness indicators are regularly measured based on customers' feedback collected through satisfaction surveys and monthly Customer Council. In Tehran, satisfactions surveys are regularly being conducted by the bus and metro operator to monitor and adjust the services. In Egypt, the Cairo Governorate in 2015 introduced satisfaction surveys to improve bus operation in the areas of public transport service delivery (Environmental and Social Management Framework [ESMF], 2015). The Casa Transport SA – the transport authority for the Greater Casablanca agglomeration – planned establishing a Mobility Observatory to gather and collect data to optimize the monitoring of transport development in the urban area. These are only few of the good examples initiated by MENA authorities to meet informed decisions based on travel analysis and match customers' expectations. However, the frequency and quality of data collected is uneven due to the diverse development advancements and political stabilities. Often, surveys are partial or obsolete, and do not reflect the reality of the fast growing travel demand and mobility needs. Even if data are available, their access remains limited which prevent academia and researchers to conduct comprehensive and comparative analysis on travel preferences, habits and modal choices in the MENA region (Delatte, 2016; CoMun, 2014; El-Geneidy et al., 2013). Due to the limited data availability and accessibility, little is known about mobility patterns in the MENA region, and even less on women's travel behaviors since data are rarely gender disaggregated (World Bank, 2011a). However, it is internationally recognized that gender influences modal choice and travel habits as much as age, professional status, and other socio-economic factors, if not more. The traditional share of household responsibilities leads women and men to undertake different travel patterns. Women are more likely to make travel chains, with a larger range of purposes than men are. Additionally to the common daily work trips women undertake most of the trips related to children-care, health-care and household-care (CIVITAS, 2014; Deike, 2013; World Bank, 2011b; FIA Foundation, 2016; Duchène, 2011; ITF, 2018). Several surveys conducted in the MENA region on women's mobility confirm that women and men have different experiences in public transport, different challenges during their journeys, different modal choice (EBRD, 2016; LSE, 2015; Elias & Shiftan, 2014; Tillous & Gillot, 2014; Montagne, 2014; World, Bank 2011a). All surveys agree that security concerns are the main constraints in women's mobility. In Egyptian rail system, security concern is the reason for not using trains to commute to work by 69% of surveyed women (EBRD, 2016). It is confirmed by another survey in which 86.5% of Egyptian women respondents affirm not feeling safe or secure on public transport (UN Women, 2013). Cairo was recently ranked as the "most dangerous" megacity for women (Thomson-Reuters Foundation, 2017). In Morocco, 63% of women living in urban areas have experienced some form of violence in public spaces, including on public transport (Haut Commissariat au Plan, 2012). In Tunisia, a survey of public transport users revealed that 89% of women had suffered harassment (CREDIF, 2016). In Beirut, harassment is a daily concern for women using minivans and most of the incidents go unreported due to the lack of judicial system to report such incidents (Nasr, 2017). The secretary of the Jordanian National Commission for Women (JNCW) estimates that 80% of women face harassment (The Nation, 2014).

The feeling of insecurity impacts women's modal choices and public transport ridership: In Jordan, some women report changing their travel patterns, especially modal choice, to reduce harassment risk while traveling by public transport (Truluck, 2015). In Egypt, women prefer using informal minibuses in which all passengers are seating rather than the public standard buses in which harassment is more likely to occur (LSE, 2015). Security concerns, complex time management due to their diverse responsibilities and the lack of gender-responsive transport infrastructure do not only affect women's daily activities (Duchène, 2011) but also their opportunity to access higher revenue, career growth and professional development. Safe transport is essential for women's economic inclusion (World Bank, 2011a; EBRD, 2016). It is especially true for women living in suburban areas. In Morocco 80% of surveyed women affirmed that the lack of transport provision limits their autonomy in 2010 (CoMun, 2014). In Jordan, 40% of women reported having to turn down employment opportunities because of a lack of access to a viable means of transport (Jordan Times, 2017). Women unemployment in the MENA region is the highest rate worldwide with 18% unemployed women compared to an average of 8% in OECD countries (Organisation for Economic Cooperation and Development [OECD], 2014). During the last years, MENA governments are given more attention to women's unemployment. In line with the agenda of international organizations which see gender-equity as a social objective as well as an economic growth opportunity (World Economic Forum [WEF], 2018; McKinsey & Company, 2015). Alongside infrastructure development, understand the needs of women and provide gender-responsive services in the MENA region – taking into account the local cultural and social norms (Duchène, 2011) – are urgent needs. Few and isolated measures have been already undertaken by authorities, public transport operators and NGOs in MENA cities. However, most of the measures are punctual, isolated and do not belong to an integrated comprehensive strategy, which directly reduce their efficiency (Delatte & Smith, 2018).

2.2 PUBLIC TRANSPORT DEVELOPMENT IN THE FIVE CITIES OF THE PROJECT

To contribute to fill the knowledge gap on mobility preferences in the MENA region, the research project seeks to conduct a comparative analysis of public transport perceptions in five MENA cities: Algiers, Amman, Beirut, Casablanca and Muscat. Each of the five cities is at a different stage in terms of governance structure and public transport development. The following chapters provide a short city-specific contextualization. Main urban and transport characteristics are summarized in Fig. 1.

Algiers Wilaya

With 3.47 million inhabitants in 2016, the urban agglomeration of Algiers is developed around a hypercentre, surrounded by the pericentral zone, the peripheral crown and the industrial poles. Algiers city centre hosts 35% of the 800,000 jobs of the wilaya on only 2% of the agglomeration (Baouni, 2015). However, the ongoing urban sprawl in Algiers leads to an extension of the urban transport perimeter well beyond the administrative metropolitan area which challenges the organization of urban transport in the city of Algiers. Several modes of public transport are available in Algiers: private and public buses, cable-cars, suburban train, metro and tram. While most of these modes are operating for several decades already, the transport authorities AOTU-A became officially operational in 2016. The AOTU-A is playing the role of the main and unique decision-maker for the transport development of the agglomeration. However, legitimacy of this relatively new entity still need to be established, with stakeholders' commitment to cooperate. In Algiers, 6.5 million trips are made daily, mostly for work and education purposes. The forecasts of the preparatory studies for the transport plan of the Master Plan for Urban Planning and Development (PDAU) foresee 7.5 million daily trips in 2020 (Parque expo, 2015). Reports from previous household surveys and research show

that walking remains the dominant mode in the practice of travel in Algiers: it represents more than 50% of total displacements in 2010. In terms of motorised trips, public transport is the mostly used mode for daily trips with a share of 65% of the modal split (Bureau d'Etudes des Transports Urbains d'Alger [BETUR], 2004, Baouni et al., 2013).

Greater Amman

In Amman, the rapid growth of the city – with an estimated population of over 4.18 million inhabitants (Department of Statistics [DOS], 2016) – and unplanned urban sprawl have resulted in reduced accessibility, increased traffic jams, and weakened the insufficient public transport system. It is worth mentioning also the undesirable negative environmental (both noise and pollution) and safety impacts associated with increased vehicular traffic. This is reflected in the high percentage of licensed vehicles in Amman; making up 79% of the total vehicles of Jordan, with a total of 963,211 vehicles in 2012 (Salameh & Imam, 2014). Since 2009, the Transportation and Traffic Management Department within the Greater Amman Municipality (GAM) is responsible for all aspects of transport and traffic management within Greater Amman.

Public buses are operated under its authority. Additionally, coasters (minibuses) owned by private operators and shared-taxis are operating in Greater Amman. The current system is fragmented, unplanned, unreliable, and not appropriate to users' mobility needs: lack of information about routes, frequency and schedule of services. Minibus and shared-taxi services operate without designated stops; they are simply hailed at any point along their routes. However, political efforts have led to undertaking the construction of the Amman Bus Rapid Transit (BRT) project which is expected to be operational in 2020. In 2016, GAM estimated public transport share to be 14% of all daily trips in the urban agglomeration (UITP MENA Centre for Transport Excellence [UITP MENA CTE], 2017). Currently, the system is largely used by captive riders. A 2009 estimate indicated that around 65% of public transport users in Amman do not own a car and have no other alternative besides public transport (GAM, 2009).

Greater Beirut

While the Greater Beirut Area (GBA) – with 2.23 million residents – is the area to be considered in terms of urban transport, there is currently no single entity responsible for the transport and urban development of the metropolitan area. The lack of integrated and efficient governance and the political instabilities faced for the last several decades are real barriers for the transport and urban development of the metropolitan area. This lead to an almost inexistent formal public transport in Greater Beirut. Informal minivans and shared-taxi are the most widely used mass transit in the agglomeration, and considered as the current public transport for the context of this paper. Traffic congestion is one of the most serious urban development problems in Beirut (Rishani, 2011; Ayoub, 2014; Massena, 2016).

The Ministry of Environment estimated the cost of urban congestion to eight percent of Lebanon's GDP. Additionally, the current average fleet age is older than 10 years. This leads to critical air pollution issues in Greater Beirut. Transportation expenses represent a significant 15% of households' expenditures (World Bank, 2017). According to the Council for Development and Reconstruction [CDR] (2013), modal shares of motorized trips in 2009 for Greater Beirut are divided as follow: 80% private cars, 18% taxis (shared taxi rides) and 2% public transport. In an attempt to tackle transport issues, the Comprehensive Public Transport Program for Greater Beirut Area was endorsed by the Government of Lebanon (GOL), and recognized as one of the country's economic priority projects. The Program consists of the development of a BRT and feeder bus network, expected to be developed in three phases (North, South and East components) (CDR, 2017).

Greater Casablanca

Greater Casablanca, with a population of 5.12 million inhabitants (2015 census) is the largest urban area in Morocco, the strongest economic pole in Morocco. In the Greater Casablanca Development Plan (2015-2020) it is envisioned to raise the metropole to the level of a connected and inclusive international Financial Hub. Optimizing the current urban mobility is one of the axis of the plan, with the construction of 80 km of dedicated lanes public transport, Casablanca Transport SA represents the public authority for transport development in Greater Casablanca. It is one of the leading governance in the MENA region. Two main public transport stakeholders are operating in Casablanca: Casatramway (RATP DEV) since 2012 and M'dina bus (a private companies cluster) operating the bus network since 2004. While the recently implemented tram system comply with the current norms in terms of accessibility for all, the bus fleet in Casablanca is old and in poor condition. Shared-taxis are also a widely used mode of transport in the urban agglomeration, and remains the only alternative for non-motorized households living in the suburbans area, where public transport is not available (CoMun, 2014). During the last decade, economic growth leads to household motorization raise. At the same public transport rideship dropped (UITP MENA CTE, 2016a). However, motorization rate is still relatively low in Casablanca (244 cars per thousand inhabitants in 2015). In 2012, walking was the most dominant mode of transport in Casablanca with more than half of daily trips made by walking, public transport share was estimated to 13% of all daily trips (UITP, 2015). The opening of the tram system in 2012 has probably impacted positively the overall share of public transport.

Muscat

Muscat – capital and largest city of the Sultanate of Oman with 1.47 million inhabitants – is following a horizontal low density urban development which leads to a continuous urban sprawl of the metropole (Belqacem, 2010). However, Muscat has the highest population density of 400 inhabitants per square km in comparison to other governorates of Oman (National Center for Statistical Information [NCSI], 2017). Witnessing a remarkable growth in the last four decades in almost all areas, the Sultanate of Oman has shown a deep concern towards the development of public transport to ease out the traffic congestion and to address the safety concerns (Belwal, 2013).

Public transport services in Oman are currently in an expansion phase. The very first public transport services started operating as intercity service in 1972 with the establishment of Oman National Transport Company (ONTC), which was rebranded in 2016 as Mwasalat (Belwal, 2017). The currently expanding network is planned to provide bus stop at maximum distance of 800 m to 70% of the population by 2025 (Bus Transport Master Plan, 2016).

| | Algiers (Wilaya) | Greater Amman | Greater Beirut | Greater Casablanca | Muscat |
|---|--|--|--|---|----------------------------|
| Population (mn) | 3,47 (2016) | 4,18 (2016) | 2,23 (2015) | 5,12 (2015) | 1,47 (2015) |
| Density (inh./km ²) | 4580 | 2458 | 9680 | 2644 | 400 |
| Motorization (cars/1000 inh.) | 287 (2014) | 263 (2016) | 269 (2015) | 244 (2015) | 551 (2015)* |
| Mass transit | Suburban train: 121 km Metro: 13.5 km Tram: 23.2 km Cable-Car: 5 lines Bus fleet: 250 public buses; 4000 private buses | Bus fleet: 471 public buses; 11,151 private buses; 202 coasters (private minibuses) | Bus fleet: 5000 legal mini-buses; 15,000 illegal minibuses (all private) | Suburban train: 32 km Tram: 31 km Bus fleet: 866 public buses | Bus fleet: 39 public buses |

source: UITP MENA CTE 2017, *2016

Fig.1 Main urban and transport characteristics of the five MENA cities, (Delatte, 2012)

The Ministry of Transport and Communications aims to achieve 25% public transport modal split by the year 2040, as stated in the Public Transport Master Plan 2015-2040. However, motorization rate in Muscat is one of the highest worldwide with 551 cars per thousand inhabitants. The high car dependency and the traditionally embedded social status of the car in Oman imposes the most formidable challenges to behavioral changes. Additionally, the extreme hot weather during almost nine months in a year imply the implementation of attractive infrastructure (AC shelters, corridors, vehicles) which represents financial burden for public transport developers (Belwal & Belwal, 2010; Belwal, 2017).

3 METHODOLOGY AND RESEARCH SCOPE

In cooperation with the regional academic partners, the MENA Centre for Transport Excellence launched the User-Oriented Public Transport research project with the aim at understanding the perceptions of female and male users and non-users on public transport services in the MENA region. Common methodology for data collection and analysis were developed to highlight comparative results in five MENA cities: Algiers, Amman, Beirut, Casablanca and Muscat.

Based on an investigation of empirical researches done by MENA academic and research centers on public transport (Chalak et al., 2015; Center for the Study of the Built Environment [CBSE], 2015; Baouni et al., 2014; Imam, 2014; Shaaban & Khalil, 2013; Belwal & Belwal, 2010; Koushki et al., 2003), the main active scholars sharing common research interests on social science and urban mobility empirical research were identified and contacted. Time and resource availability to implement the research project were the main criteria for the establishment of the consortium. This cooperative project with six academic partners launched the activities of the UITP MENA academic network.

3.1 OBJECTIVES AND THEORETICAL FRAMEWORK

The first objective of this research was to assess users and non-users' perceptions on public transport services along the five public transport dimensions – safety, security, ease-to-use, comfort and experience – through the quantitative analysis of data collected using questionnaires in the five cities. The second objective was to identify the barriers encountered by women to access public transport and to understand their expectations for safer and more secure public transport services by qualitatively analyzing the data collecting through focus groups organized in the five cities. The analytical framework used in this study was based on the concept of the hierarchical pyramid of human needs model, developed in the 50s by psychologist Maslow (as cited in Van Hagen, 2015, p. 8). The Maslow's hierarchy of needs became a reference in the behavioural research and has been recently adapted to travel behavioural studies, such as by Van Hagen (2015) in his research work on rail interchanges optimization. In line with the current mobility challenges in the MENA region, security (surveillance camera, security staff to protect users from robbery, harassment, etc.) and safety (crossing facilities, sidewalks, etc.) have been identified as the two primordial basic needs to ensure users' satisfaction. Additionally, the journey by public transport should be easy, i.e., convenient and with little hassle (integrated ticketing system, real-time information delivery, journey planners, etc.). Also the traveller expects a comfort at the station and on-board (shelters, seats, air quality, etc.) while travelling. Finally, the need of a pleasant experience must be fulfilled (friendly staff, additional services such as Wi-Fi, shopping facilities, etc.) (See Fig. 2) The questionnaire and focus groups script were developed around the five dimensions of the UOPT pyramid.

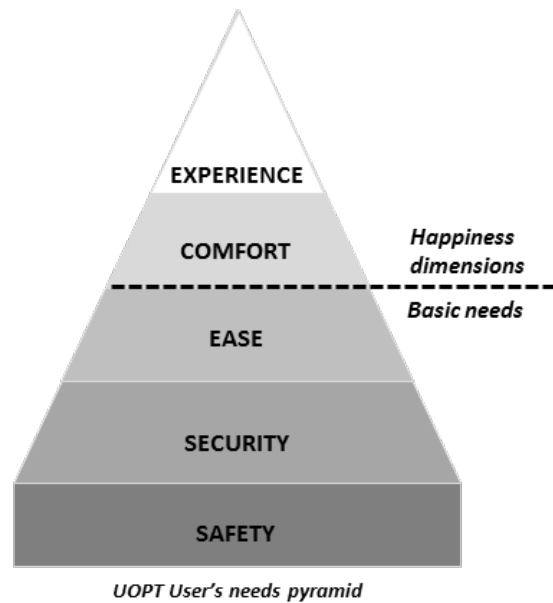


Fig. 2 UOPT user's needs pyramid, (Delatte, 2016)

3.2 DATA COLLECTION AND METHODOLOGY

The nature of this research was partly exploratory and partly descriptive. The research followed a mixed-method approach of analysis where the comparison-based description was given a due emphasis in the methodology to ensure the production of comparative results and highlight regional differences and similarities taking into account local cultures and values. The same methodology was therefore applied in each of the five cities. Questionnaires were administered to the respondents in March 2017 six cities using stratified sampling approach with the objective to reach equal number of females and males having diverse mobility habits. More than 50 students were involved for collecting data and conducting focus group interviews at locations such as public transport hubs, on-board public transport vehicles, malls, parking, and taxi stations. The questionnaire contained 50 multiple choice questions and was structured along four main categories: (1) Socio-economic characteristics of the respondents, (2) mobility habits, (3) mobility tools and (4) perceptions on public transport services following the five dimensions of the user's need pyramid. The dataset is composed of 984 valid responses (from 511 women and 473 men). After cleaning and preparation of the data, the respondents were categorized according to their mobility habits in four segments: (1) female and (2) male users - using mass transit at least once a week; and the (3) female and (4) male non-users – using mass transit less than once a week.

| Description of the samples | | Gender in % | | PT use in % | | Age in % | | | | | HH status in % (multichoice possible) | | | Occupation in % (multichoice possible) | | |
|----------------------------|-----|-------------|-----|-------------|-----------|----------|-------|-------|-------|-----|--|---------|---------------|---|-------------|----------|
| | | Women | Men | Users | Non-users | 16- | 16-25 | 26-45 | 46-59 | 60+ | Single | Married | with children | working | not working | students |
| n= | | | | | | | | | | | | | | | | |
| Algiers | 220 | 49 | 51 | 94 | 6 | 6 | 44 | 24 | 15 | 10 | 61 | 38 | 15 | 39 | 19 | 46 |
| Amman | 166 | 61 | 39 | 52 | 48 | 1 | 77 | 13 | 9 | 0 | 83 | 17 | 7 | 35 | 11 | 61 |
| Beirut | 67 | 60 | 40 | 18 | 82 | 1 | 60 | 34 | 4 | 0 | 79 | 21 | 6 | 64 | 6 | 48 |
| Casablanca | 318 | 52 | 48 | 77 | 23 | 0 | 53 | 29 | 13 | 4 | 64 | 35 | 16 | 50 | 13 | 41 |
| Muscat | 213 | 46 | 54 | 37 | 63 | 0 | 51 | 40 | 8 | 1 | 62 | 38 | 19 | 48 | 20 | 38 |

Fig. 3 Profiles of sample respondents, (Delatte, 2016)

Two-thirds of the respondents are regular public transport users. For Casablanca and Algiers, these four segments were divided in two: respondents giving their perception on bus services or on rail services. A descriptive analysis was conducted to identified similarities and differences on perceptions among the diverse segments and between each city. The profiles of the sample respondents are presented in Fig.3, and the size of the segments in the five cities are given in Fig.4.

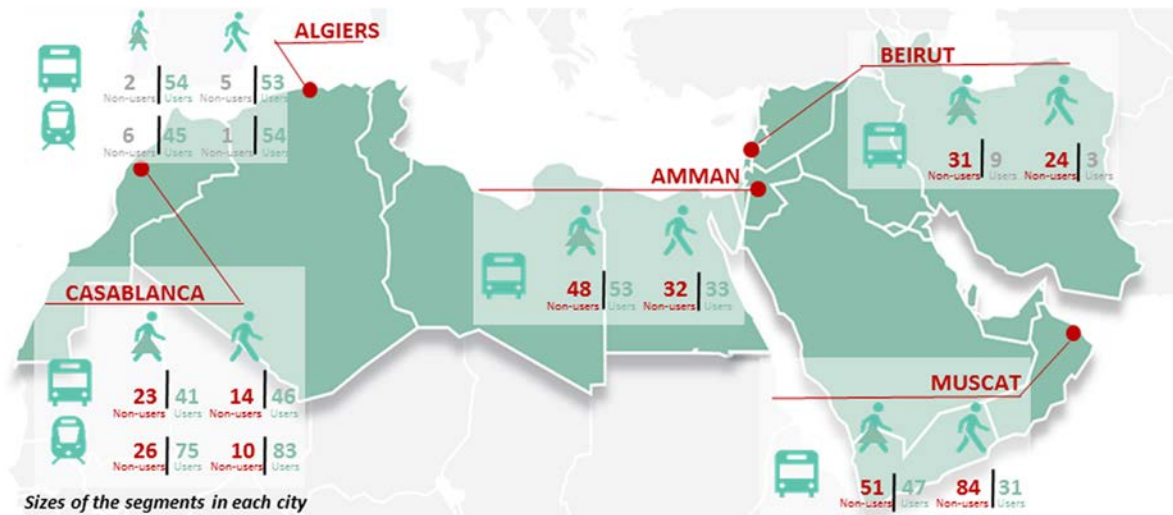


Fig. 4 Sizes of the segments for the data analysis by city, (Delatte, 2016)

The focus groups were conducted in November 2017 with a targeted group size of 8 to 12 women in each of the five cities. The groups included a mix of regular public transport users as well as non-users, with diverse socio-economic characteristic (age, marital status, employment, mobility habits). The two main objectives of the discussion were to identify the barriers and triggers to use public transport and to find solutions to improve public transport services from women's perspectives. 49 women participated in the focus groups across the five cities.



Fig. 5 Focus groups with women in Algiers (left) and in Beirut (right), November 2017.

The results of the discussion were qualitatively analyzed (descriptive narrative), barriers encountered by women in using public transport were sorted using the five dimensions of the user's need pyramid and suggested measures for improvements were categorized under urban design/environmental, innovation and operational, community involvement, capacity building and policy.

4 KEY-FINDINGS AND DISCUSSIONS

Through the quantitative and qualitative analysis of the data collected, the key findings were summarized and clustered in three main action areas: (1) establishing a culture of public transport services, (2)

encouraging sustainable mobility behavior, especially by youth, (3) developing safe and secure environment for women and gender-responsive services.

4.1 ESTABLISHING A CULTURE OF PUBLIC TRANSPORT SERVICES

Infrastructure, design and marketing

Prior focusing on the culture of services, it is primordial to provide the basic infrastructures such as well-maintained shelters with sufficient seats at stations with heating and AC system – especially in cities with extreme weather –, well-maintained vehicles with operational door-system, stop-request buttons. Additionally, an integrated and electronic ticketing system is part of the overall ease-to-use dimension of the public transport provision. The most significant finding is that none of all system assessed is providing enough shelters and seats in waiting areas, according to respondents' perceptions.

Among all system analyzed, the bus system in Muscat and the tram system in Casablanca have the best ranking related to image/design of the services and delivery of information: more than two-third of the respondents likes the image and design of the tram in Casablanca; similar results for the bus in Muscat; three-quarter and two-third of the respondents respectively for Casablanca tram system and Muscat bus system know where to find information. For the public transport systems of in other cities, design and information availability are negatively perceived (see Fig.6).

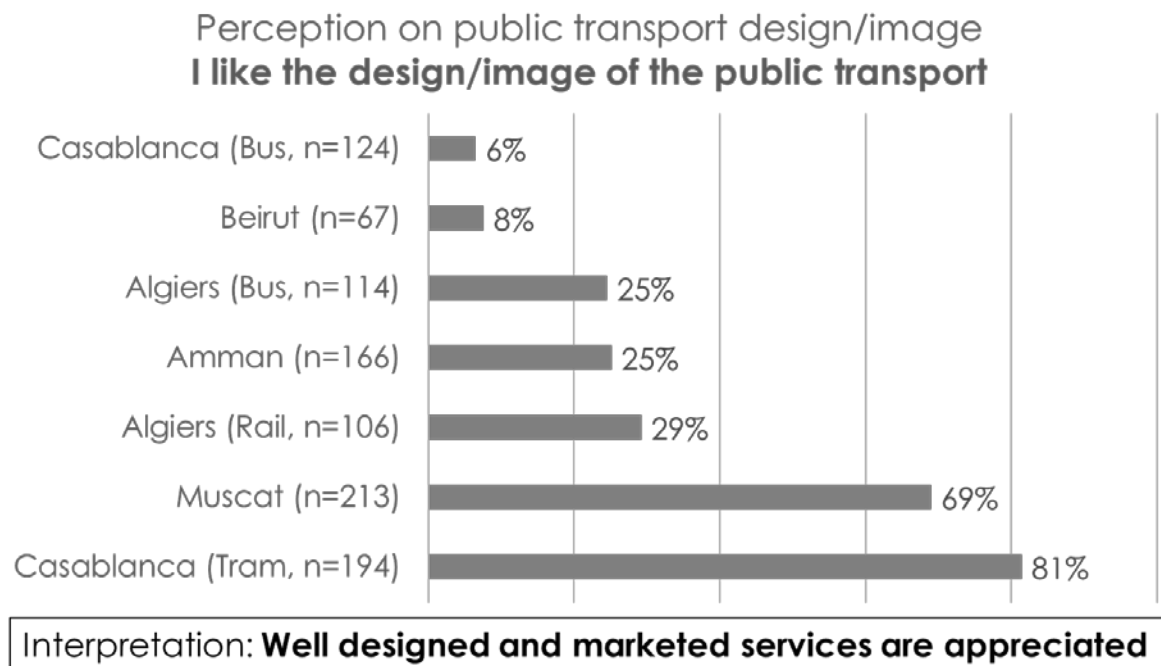


Fig. 6 Share of the all respondents having a positive perception on public transport design, by cities, (Delatte, 2016)

The positive perceptions in for the Casablanca Tram and Muscat bus system can be attributed to the successful rebranding strategy launched by Mwasalat in 2016 with the overall aim at improving its image and attract customers on the bus network in Muscat (Belwal, 2016). Additionally, to customers' recognition, Casa Tramway received in 2017 the quality management system certification ISO 9001 (version 2015) which is an international recognition of the successful customer-centric strategy implemented by the operator. Adding key-indicators performance complying with international quality service standard in tender specifications contributes to encourage operators to excel in customers' service, and ensure a transparent results evaluation and monitoring.

Trained and professional staff

Three adjectives were used in the questions related to public transport staff: driving behavior (safety), helpfulness in case of incidents (security), and friendliness (experience). In all five cities, driving behavior have been massively negatively assessed and considered as unsafe by users and non-users. Concerning friendliness and helpfulness in case of incidents, it seems that these two qualities go hand in hand from a user's perception: most of respondents who perceived public transport staff as helpful do also qualified them as friendly. It can be concluded that friendliness of staff could easily contributes to raise the security feeling of customers (see Fig.7).



Fig. 7 Share of the all respondents having a positive perception on public transport staff, by cities, (Delatte, 2016)

In Casablanca, tram staff is having a more positive image than bus users. It is worth noting that 200 police staff are present on the tram network. In Algiers, the discussion with women shows the metro and tram system is perceived as safe and secure, and police and security staff are present and drivers seem to be trustful in case of incidents. It is not the perception shared in the bus system, in any of the five cities. Women do not count on bus drivers to help in case of incidents and believe that drivers do not have legal power to intervene and protect their passengers. Some women do even feel uncomfortable or harassed by bus and taxi drivers. *"Bus drivers are really unbearable"* (participant in Beirut). Two main recommendations emerge from the assessment of public transport drivers and staff behavior: (1) enforce safety driving rules and (2) raise selection and training level for public transport employees. Road fatalities rates in MENA countries belong to the highest one worldwide (WHO, 2015). Authorities and operators have to strengthen safe driving behavior trainings for bus and taxi drivers: stopping at designated areas, giving priority to pedestrians at crossing facilities, careful and prudent driving behaviors. Additionally, rules and enforcement should be established to educate other private cars to respect pedestrians and bus priorities on the road, and at the stations. The "Drive between the lines" campaign conducted in 2016 in Tehran, is an example

among others on the way to raise drivers' awareness on safety issues. Developing more strict process to select and train public transport drivers were suggested during the focus groups. With the aim at professionalizing the service and raising drivers' awareness on their responsibilities to ensure safety, security and comfort of the customers. Additionally, the low presence of female public transport staff were raised during the focus groups. Encourage female drivers will contribute to women's confidence to use public transport: *"If there will be more women drivers, I will use public transport daily."* (Participant in Muscat) However, these recommendations should be embedded in an overall customer service strategy giving staff a key role and responsibilities, along with professional recognition: *"Only a satisfied employee can make a satisfied customer"* (UITP, 2018).



Fig. 8 Maintenance center Casa Transport ©sife.elamine.hd-147

4.2 ENCOURAGING SUSTAINABLE MOBILITY BEHAVIOR

Mobility education

In Amman and in Muscat, the three main reasons for using public transport are related to the non-ability to use private car: no car, no license and public transport is the less expensive mode of transport. Two-third of the respondents in Amman and half of the respondents in Muscat are under 25 years old. It can be assumed that they are captive public transport users, with financial constraints and would probably purchase a car as soon as they will afford. Especially since social status of the car seems to be high among non-users in Amman and Muscat respondents, regardless of their gender, with respectively a third and a quarter of the non-users affirming that "they like their car" (see Fig.9). The results of the focus groups confirmed the current dependency to the private car mainly due the low frequency and low coverage of public transport which makes car use more flexible (even if traffic and parking issues have been mentioned as barriers for car use).

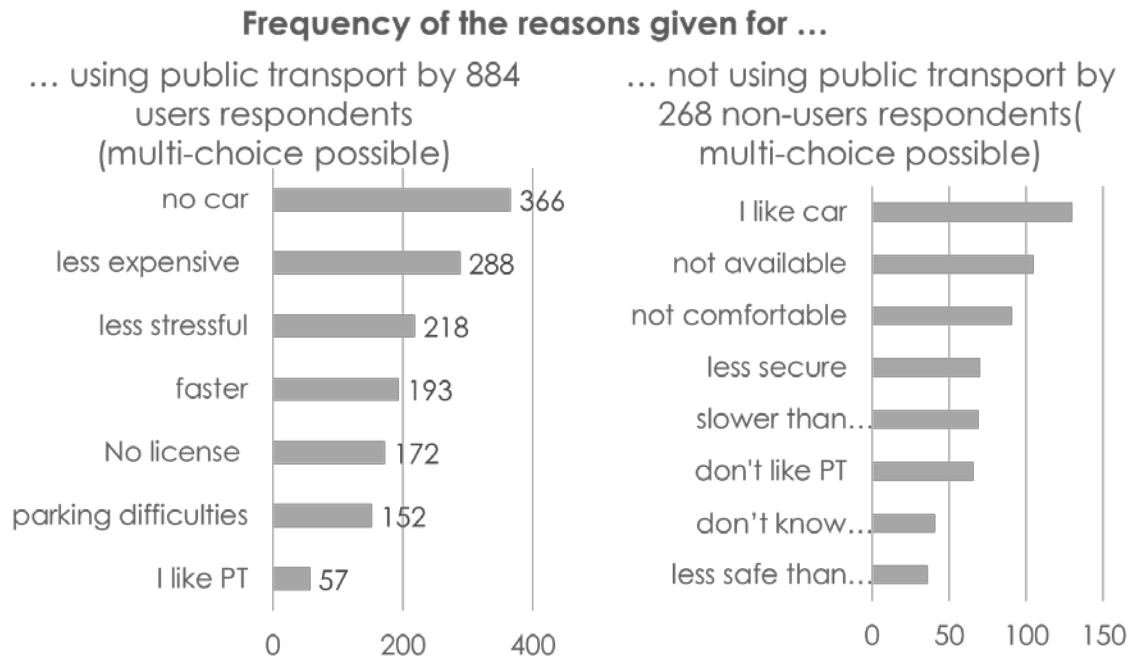


Fig. 9 Frequency of the reasons given for using or not using public transport, (Delatte, 2016)

Women feel more secure in the private car. Freedom and flexibility are related to car use, indeed women in Algiers mentioned that they can stay outside longer at the evening when they are travelling by car. *"Since I have my own car, I feel free, independent and comfortable in my commuting. I don't have time limit anymore"* (Participant in Algiers).

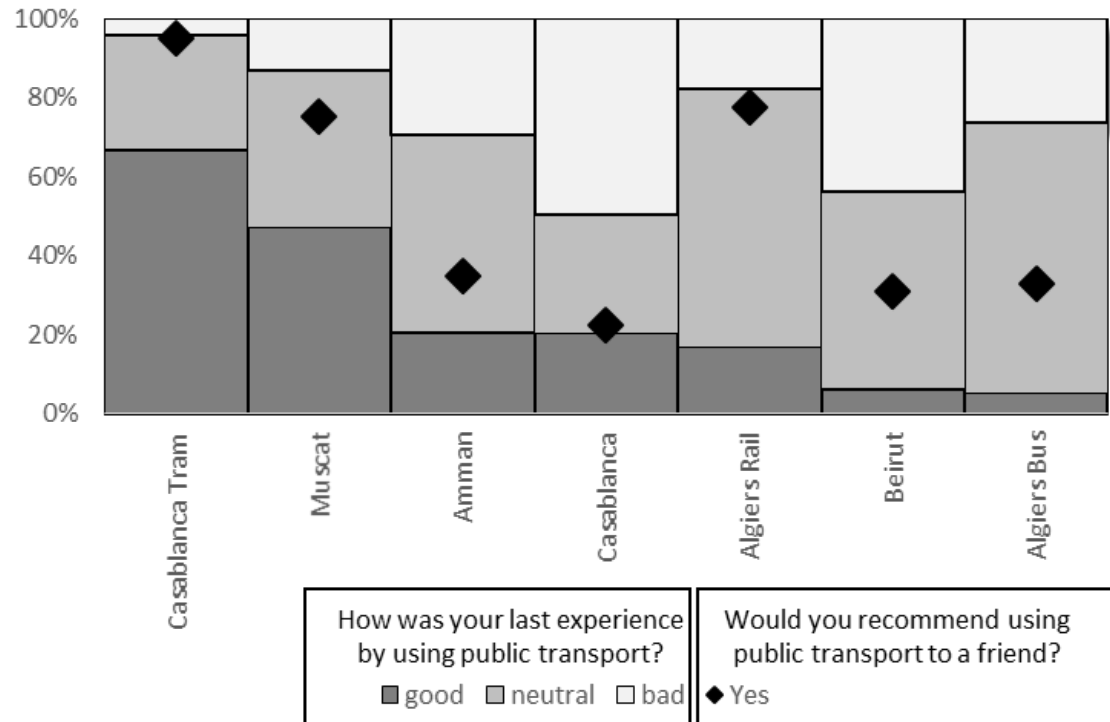
However, in Muscat, the preference to use the car is not only related to mobility habits, it is also related to cultural and social norms. A participant in Muscat do not use public transport because of her family and social surrounding, *"it is a shame for women to use taxi or bus."* (Participant in Muscat). Another participant expresses the lack of privacy in public buses as the main reason to avoid it: *"I will never user the bus, especially the urban buses in Muscat because the windows are not tinted: everyone could see me."* (Participant in Muscat). Similar statements were heard in Amman: *"Public transport makes me feel uncomfortable as I would feel that I am losing my personal space; so I prefer using my own car."* (Participant in Amman). Disrespectful behaviors are a critical factor in women's modal choice *"Some men do not respect women in public transport [...] I wish I would have my own car, so I never use public transport anymore."* (Participant in Amman).

Preventing harassments against women are developed later in this paper. Knowing that a quarter of the total MENA population is under 25 in 2017 (UN DESA, 2017), it appears crucial to raise youth awareness and encourage them to adopt sustainable mobility behaviors, and develop common understanding on individual contribution to reduce own urban footprint for the benefits of the whole urban population.

Happy customers are the best ambassadors

Despite the overall negative image of public transport in the five cities, especially the bus system, the share of users with positive assessments of the services is higher than the share of among non-users. This highlights the predefined negative image public transport that respondents have, without even having experimented it, for some of them.

As Fig. 7 shows, there is a direct correlation between the positive and neutral experience of using public transport and the readiness to recommend it to a friend. Happy public transport users are the best ambassadors of the system.



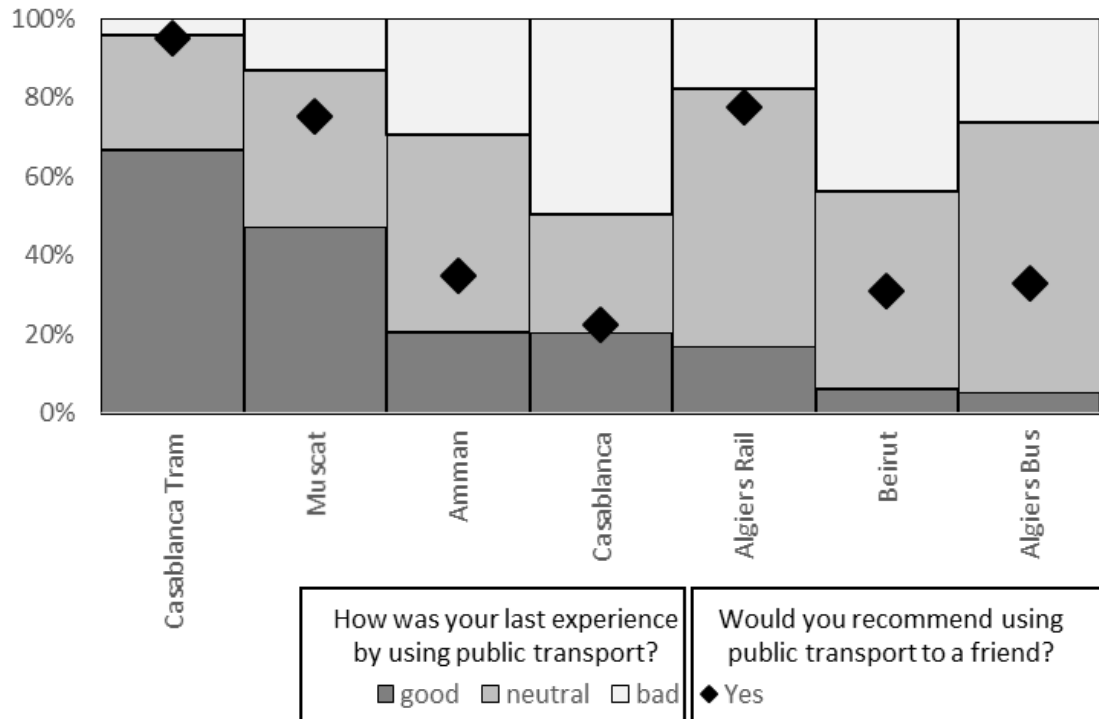
Interpretation: **Happy customers are the best ambassador**

Fig. 10 Correlation between positive experience and readiness to recommend public transport use to a friend, (Delatte, 2016)

In Casablanca, the most selected reasons for using public transport are the advantages public it is giving compared to the private car: less expensive, faster and less stressful than the car. This finding is really positive, since it is showing that public transport users are not captives but do a real modal choice by travelling with PT rather than private car. Additionally, almost all respondents in the five cities affirmed being annoyed by other passengers' behaviors. It is therefore crucial to build a culture of travelling collectively in respect of other passengers is a key factor to improve the overall customer experience. In Casablanca, M'Dina Bus cooperated with the non-governmental organization AFAK promoting civic behavior in Morocco, to develop an audio guide to learn how to behave on board: "civisme au bord du bus" (<http://mdinabus.ma/AFAK/>).

4.3 DEVELOPING GENDER-RESPONSIVE SERVICES

One of the most significant gender-specific results of the analysis is the difference in perception on personal security by using public transport: Women are more concerned by security issues than men are. Among all 131 female non-users respondents of the questionnaire, 41% cited "Public Transport is less secure than car or taxis" as the reason for not using public transport. It is the second most often selected reasons among women after "I like to use my own car" (47%). On the other hand, security concerns were mentioned by only 12% of the 137 male non-users (see Fig. 8). These findings clearly illustrate the gender gap in perceptions to security in public transport. Personal security was at the core of the discussion in Amman, Beirut and Casablanca: verbal harassment, physical harassment, or robbery. *"I'm afraid of using PT because I feel it is a dangerous way to move around because there is a lot of robbery and physical harassment going on."* (Participant in Amman).



Interpretation: **Happy customers are the best ambassador**

Reasons for not using public transport among non-users

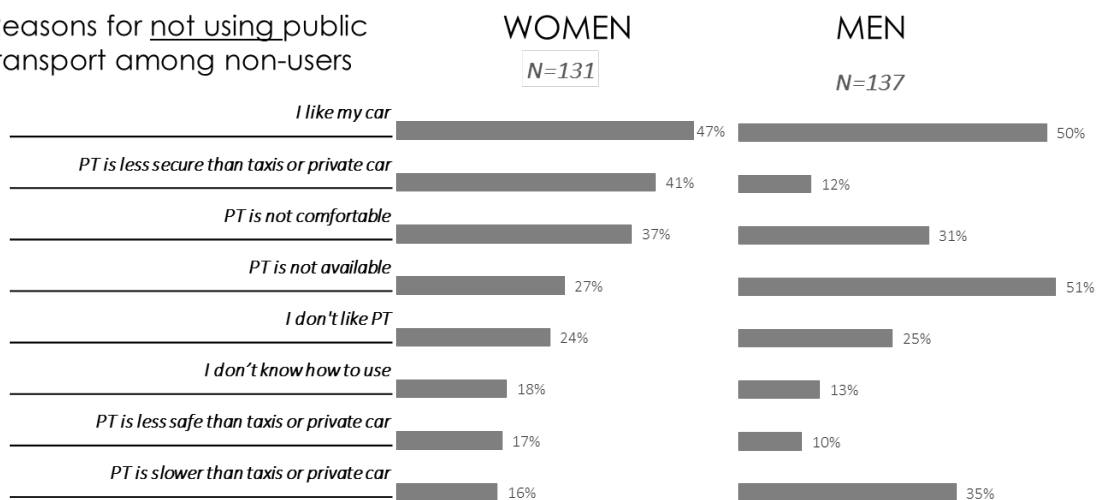


Fig. 11 Reasons for not using public transport among non-users, by gender, (Delatte, 2016)

While personal security is the main difficulty women faced in public transport, several other barriers have been identified during the discussion such as the low coverage, no fixed schedule, lack of bus stops, information, and short operating hours that do not match women's need in terms of daily mobility. These barriers generate constraints in women's daily activities and affect their overall quality of life and ability to contribute to economic and social development. The negative impact on women's health have been also discussed in all cities: lack of shelters to protect them from extreme weather, bad conditions of buses which expose them to rain and wind, lack of toilets is especially problematic for long commute. Several factors lead to a permanent stress: risk of accidents on the way to/from the station women and on-board due to unsafe

drivers' behaviors, harassments on the street and on-board. The lack of security is the most impacting factor on distress of women which lead to fear of travelling at night, psychological distress of women who were victims of harassment or heart about other women's experiences. Women use to dress differently by travelling with public transport. Finally, physical tiredness by having to walk long due to the low coverage and lack of bus stops (see Fig.11).

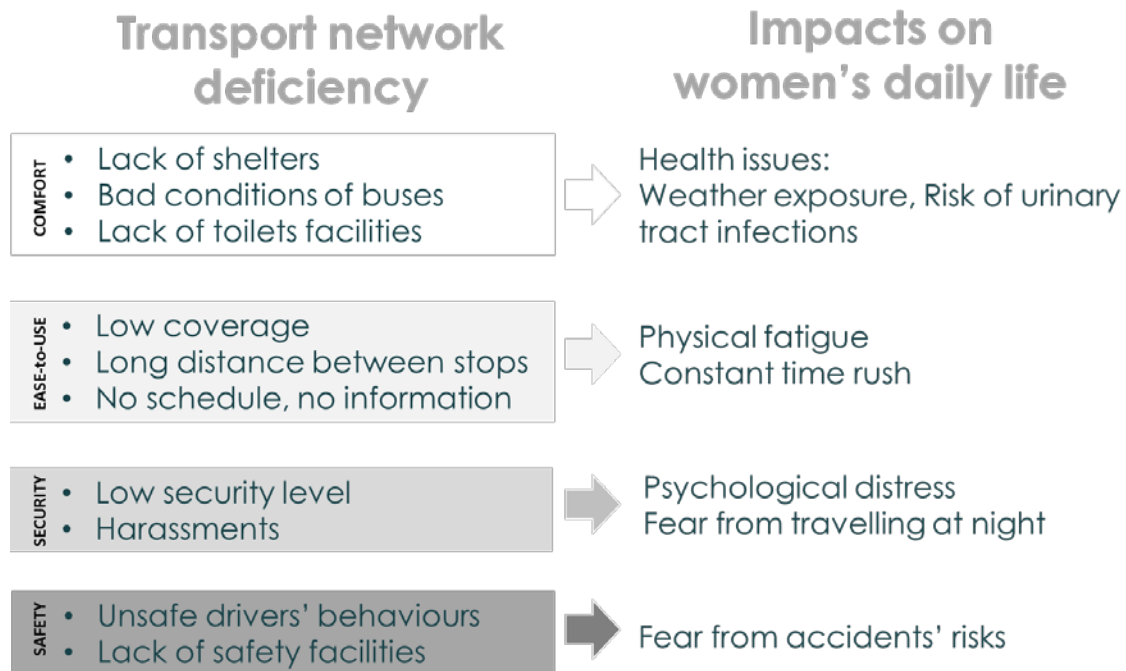


Fig. 12 Impacts of transport services deficiency on women's daily life, results of the focus groups, (Delatte, 2016)

Safe and secure walking environment

Walking environment have been widely discussed during the focus groups. Due to the long distances between two stations, women are either depending on other relatives to pick them up, or have to take a taxi (which may be hardly affordable) to reach their final destination. When women do walk they are exposed to safety risk: inexistent sidewalk, or poor conditions (broken, narrow). It is a real hassle for mother with trolley, or women with packages. Additionally to the conditions of the paths, lighting is often missing on the last miles of their trip which makes the walk unsecure, due to some dark areas and streets to be crossed at early morning or late evening hours. *"Regarding the lack of light on the street, yes, sometimes I'm scared when I walk to the bus stop early morning"* (Participant in Algiers). Developing a safe walking environment to and from the stations is a necessity to make public transport attractive: short distance between bus stops, with urban furniture, safe crossing facilities, large sidewalks, and light street. It will contribute to provide a safer and more secure environment for captives' public transport users and walkers, and encourage other women to practice walking and adopt and healthier life style.

Longer operation hours

Among all respondents, more than 80% have to wait for the next departure for at least five minutes. In some cases, it can extend to one hour, since drivers wait until the vehicles capacity is reached before departing, which is regularly the case in Algiers, Amman and Beirut, according to participants. The short operational hours of public transport limit the time public transport captives have to complete their daily duties. They have to plan the activities according to public transport schedules which are often unreliable.

"My daily commute is a nightmare. I live only 4 km away from my work, but I spent more than 3 hours in buses" (Participant in Algiers).

In Casablanca, Algiers and Amman, women express the stress generated by the complex travel organization and the long time they spent outside the house to achieve their daily duties. Current public transport operation hours are not appropriate: starting too late on the morning and stopping too early at the evening. Women express the will to participate to cultural and social events (such as theater, concerts, etc.) and have though to renounce to it due to the lack of services at the evening. Additionally, one participant had to renounce to promising job opportunities due to the lack of accessibilities. Extending public transport operation hours at early morning and late evening for women will help women to complete their diverse activities, avoid daily stress and rush to reach the first or the last bus. Women will have also more opportunities to access social life and as one participant emphasizes it will contribute to the virtuous circle of presence of women in public space: *"By having more women participating to social life in public place at the evening, social norms will change and gender diversity in public space (and public transport) will be better accepted"* (Participant in Algiers). Additionally, longer operational hours will also enable women to travel longer distances and accept better job opportunities, with higher potential of professional development.

Women – only carriages: a city – specific decision

As it was mentioned earlier in the article, the lack of privacy is a barrier for women to use public transport. Disrespectful behaviour of other passengers, and more dramatically harassment against women leads to the development of solutions in which women's physical integrity are preserved, such as women-only carriage. Women participating to the focus groups expressed divergent positions regarding women-only areas. For example, in Muscat women request more privacy when using public transport and suggest the use of separate areas in buses, tinted glass or curtains. However, in Casablanca and Algiers, women warn against the negative long-term impact that deploying women-only sections could have on social inclusiveness. In Amman, there is a generational debate: young women expressed opposition to women-only sections, while older women liked the reassurance that their daughters and granddaughters are travelling in a safe and secure area. In Beirut, women-only taxis and buses are perceived as appropriate solution at late evening and night. Urban mobility is experiencing a paradigm shift and requires innovation that addresses challenges specific to the region, conscious of our local cultures and values (Zureiqat, 2014; LSE, 2015). It is important to develop services in line with the local specificities and social norms. Involving women at each stage of process of gender-responsive development will contribute to reach the most appropriate solutions locally and ensure customers' acceptance.

Reporting system and legal understanding

The lack of reliable reporting process and legislation to prevent harassment and protect the victims add to the difficult to eradicate fear of using public transport. It is a worldwide issue (FIA Foundation, 2016). However, it has mentioned only in two of the focus groups, in Casablanca and Amman.

"Once clear harassment reporting procedure and sanctions will be applied, there are clear complaint procedures and sanctions applied, harassers will have fear and not the women. And we will feel safe" (participant in Casablanca). *"There is no way to report a harassment case while preserving the dignity and confidentiality of the complaint."* (22 year old, PT user in Amman).

In all five countries, reporting harassment is an unclear and very complex process. Harassment remains a taboo subject. In Lebanon, there is no national legislation against harassment, the Lebanese penal code does not state any explicit criminalization of sexual harassment (Nasr 2017). The legislative gap is comparable in Jordan, according to the, Jordanian law does not protect women efficiently against harassment (Jordanian National Commission for Women). However, in Algeria a law criminalizing violence against women, including harassment in public space, has been adopted recently, in March 2015, and a

national strategy against sexual harassment has been deployed in 2016. Non-governmental organizations are very active in MENA cities to raise awareness on harassment issues. In Beirut, Harasstracker provides a social space for victims and bystanders to report incidents, with the application mapping the location and details of harassment cases posted by victims. Similarly, in Algeria, the 'J'Existe' campaign on Facebook offers women a channel to denounce harassment. Public authorities and operators are also key actors by developing strategies to reduce harassment in public transport. For example, in Morocco, the 'Marrakesh: Safe and Friendly City for All' program was implemented in order to foster a no-tolerance attitude to harassment. As part of this initiative, the local bus operator ALSA trained its drivers to counter the problem and it broadcasted videos raising awareness of sexual harassment on board buses. Similar visual campaigns have emerged on buses in Tunis under a partnership between urban operator TRANSTU and CREDIF, a public organization under the Tunisian Ministry for Women, Family and Children (CODATU, 2017). Entitled '#Mayerkebch' (meaning: 'the harasser does not ride with us'), this initiative encourages women to speak out against harassment in an effort to tackle the problem in local transport. Authorities, operators and NGOs need to develop reporting process and raise public transport customers' awareness on the forms of harassment, the impacts on women and to provide an efficient system for women to report incidents. Several measures were mentioned during the focus groups as suggestions to be implemented in the five cities. These diverse measures need to be implemented in a comprehensive matter, covering the five following dimensions: operational aspects, urban environment, community awareness, policy and legal aspects and capacity building (see Fig. 12)

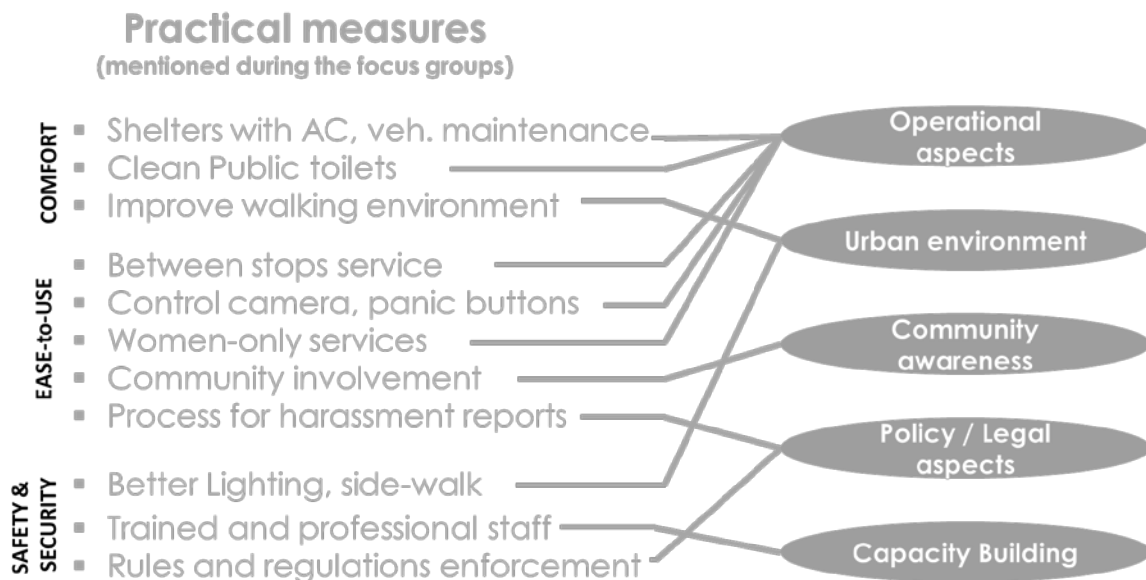


Fig. 13 Gender-responsive measures mentioned during the focus groups, sorting along five dimensions, (Delatte, 2016)

5. CONCLUSIONS

Demographic and socio-economic changes are and will continue challenging urban and transport development in MENA cities. Nowadays, the MENA region counts 28 cities with over one million inhabitants; more than three-quarters of the overall population is living in cities; and urbanization is predicted to continue growing in the coming decades, with a doubling of the urban population in MENA region between 2015 and 2050 to reach an estimated mark of 440 million (UN DESA, 2014). There is an urgent need to address the major congestion issues and achieve the transition towards sustainable transport development. Investments in infrastructure are a necessity to keep pace with growing mobility demand. At the same time, encouraging

travel behavioral changes towards green modes of transport, including public transport is one of the most challenging and essential mission of authorities and mobility providers.

The outcomes of the User-Oriented Public Transport project contribute to fill the knowledge gap on public transport perceptions in MENA cities through primary data analysis among female and male regular customers and car users, in two Maghreb cities (Algiers and Casablanca), two Mashreq cities (Amman and Beirut) and one GGC city (Muscat).

Recommendations have been formulated to address policy-makers, decision-makers, planners and operators along three main action areas:

- Developing a culture of public transport use by giving priority to the human interaction between the customers and the public transport employees. Public transport customers are first of all pedestrians. It is crucial to give them priority, to ensure a safe environment to reach the public transport network through safe and secure urban surrounding. Drivers, controllers and public transport staff at the stations, are the human face of public transport services. Respectful and friendly interactions contribute to improve the overall image of public transport;
- Encouraging youth to adopt sustainable mobility behaviors. Youth are the future public transport customers, as well the future decision-makers and planners. Mobility education at school and at university level will contribute to raise awareness. Making urban dwellers accountable for the quality of their urban environment in terms of air quality, space availability will lead to a rational shift from the private car to public transport use;
- Ensuring safe and secure public transport environment is a societal concern as well as a prerequisite to fill the current worldwide gender gap. Several dimensions have to be taken into account to develop a safe and secure environment for women: from urban design elements to regulations and legal enforcements through capacity building and women's employment in the public transport sector. Indeed, women need to feel safe and secure all along their journey with an appropriate street lighting along the way to the next stations, lively waiting areas in which they feel comfortable, friendly drivers and public transport staff they trust. Therefore, it is crucial to involve women at all levels of public transport development from planning to decision-making through implementation to better match women's needs. Transport is not gender neutral (World Bank, 2011b). It is now widely recognized and several international commitments have been taken to strengthen gender equity and diverse initiatives are promoting women's employment in transport field, as well as encouraging gender-responsive urban transport solutions (International Transport Workers' Federation, World Bank Transport, FIA Foundation, UITP, UN Women).

Additionally, research efforts should be pursued in the MENA region to understand travel behaviors and influential factors of modal choice with gender consideration. The lack of disaggregated gender data is not only a MENA issue, it is a worldwide concern (FIA Foundation, 2016; Duchène, 2011). It is crucial to generate evidence on gender concerns to support decision-makers to meet informed decisions for the benefits of all. Finally, cooperative research projects on MENA region level are crucial to stimulate knowledge transfer, to share best regional experiences, and learn from regional similarities and differences. Furthermore, strengthening cooperation between public authorities, civil society, private sectors and researchers will contribute to an optimization of resources through better synergy and complementarity, and ensure the implementation of informed decisions.

REFERENCES

Ayoub, J. (2014). *Beirut, the Concrete Jungle of the Middle East*. Available at: <https://www.al-monitor.com/pulse/originals/2014/09/beirut-lebanon-urban-infrastructure-inefficiency.html>

- Banister, D. (2008). The Sustainable Mobility Paradigm. *Transport policy*, 15(2), 73-80.
- Baouni, T. (2015). *Impacts des nouveaux TCSP sur la mobilité des usagers à Alger*. International Conference CODATU, February, Istanbul.
- Baouni, T., Bakour, M., & Berchache, R. (2013). Les effets de la multi modalité sur la mobilité des usagers. *Insaniyat*, No. °62, Editions CRASC.
- Barresi, A., & Pultrone, G. (2013). European Strategies for Smarter Cities. *Tema. Journal of Land Use, Mobility and Environment*, 6(1), 61-72, doi:<http://dx.doi.org/10.6092/1970-9870/1455>
- Belqacem, M. (2010). Urban Sprawl and City Vulnerability: Where Does Muscat Stand? In Indian Ocean Tropical Cyclones and Climate Change (233-243). *Springer*, Dordrecht.
- Belwal, R. (2013). People's Perception of Public Transport Services in Oman. *Jurnal Teknologi*, 65(3), 9-16.
- Belwal, R. (2016) Rebranding ONTC to Mwasalat. *In MENA CTE Journal*, 20-22.
- Belwal, R. (2017). Public Transportation in Oman: A Strategic Analysis. *Advances in Transportation Studies*, 42(3).
- Belwal, R., & Belwal, S. (2010). Public Transportation Services in Oman: A Study of Public Perceptions. *Journal of Public Transportation*, 13(4), 1.
- Bureau d'Etudes des Transports Urbains d'Alger [BETUR] (2004). *Enquêtes ménages sur les déplacements à Alger, Rapport*.
- Center for the Study of the Built Environment [CBSE] (2015). *Using Public Transportation in Amman*. Available at: <http://www.csbe.org/publications-and-resources/using-public-transportation-in-amman/>
- Chalak, A., Al-Naghi, H., Irani, A. and Abou-Zeid, M. (2015). Commuters' Behavior towards Upgraded Bus Services in Greater Beirut: Implications for Greenhouse Gas Emissions. *Social Welfare and Transport Policy*
- CIVITAS (2014). *Gender Equality and Mobility: Mind the Gap! Policy Note*. Available at: <http://civitas.eu/content/civitas-policy-note-gender-equality-and-mobility-mind-gap>
- CODATU (2017). *Mobilite urbaine et genre en Tunisie: Quelle place pour la femme dans le transport en 2017?* Available at: <http://www.codatu.org/actualites/mobilite-urbaine-et-genre-en-tunisie-quelle-place-pour-la-femme-dans-le-transport-en-2017/>
- CoMun (2014). *Reseau Marocain de Transport Public - Etat des lieux synthetique du transport public dans les villes membres du REMA-TP*. Available at <http://www.co-mun.net/maroc/les-reseaux-thematiques/rema-tp-transport-public/etat-des-lieux-et-benchmarking>
- Council for Development and Reconstruction [CDR] (2013). *Urban Transport Development Project. Project Brief*. Available at: <http://projects.worldbank.org/P034038/urban-transport-development-project?lang=en>
- Council for Development and Reconstruction [CDR] (2017). *Environmental and Social Impact Assessment (ESIA) for the Bus Rapid Transit System between Tabarja and Beirut and Feeders Buses Services*. Available at: <http://documents.worldbank.org/curated/en/811741508852056569/pdf/SFG3709-EA-P160224-Box405306B-PUBLIC-Disclosed-10-24-2017.pdf>
- CREDIF (2016). *La violence fondée sur le genre dans l'espace public en Tunisie*. Available at: <http://www.credif.org.tn/>
- Deike, P. (2013). *Gender and Sustainable Urban Mobility*. Available at: <https://unhabitat.org/wp-content/uploads/2013/06/GRHS.2013.Thematic.Gender.pdf>
- Delatte, A. (2016). Household Travel Surveys: Who Uses Public Transport in MENA? *In MENA CTE Journal*, 23-26.
- Delatte, A., & Smith, K. (2018). Driving the MENA region Forward: Securing public transport for women. *In Public Transport International [PTI] Magazine, January 2018 Issue*, 9-11. Available at: <https://view.joomag.com/pti-magazine-1-2018-teaser/0036872001516706127?short>
- Department of Statistics [DOS] (2016). *Jordan statistical yearbook*.
- Duchène, C. (2011). *Gender and Transport. Discussion Paper No. 2011-11*. International Transport Forum [ITF]: Leipzig.

- EBRD (2016). *Safe transport for all - Issues and operational lessons from the Egyptian National Railways*. Available at: <http://www.ebrd.com/gender-tools-publications.html>
- El-Geneidy, A., Diab, E., Jacques, C., & Mathez, A. (2013). *Sustainable Urban Mobility in the Middle East and North Africa*. Available at: <http://www.unhabitat.org/grhs/2013>
- Elias, E., & Shiftan, Y. (2014). *Gender differences in travel behavior in the Arab World: Comparison of case studies from Jordan and Israel*. In WIIT "Bridging the Gap", 5th International Conference, Paris.
- Environmental and Social Management Framework [ESMF] (2015). *Greater Cairo Urban Transport Infrastructure Development Project*. Available at: <http://www.cairo.gov.eg>
- Farrington, J. H. (2007). The New Narrative of Accessibility: its Potential Contribution to Discourses in (Transport) Geography. *Journal of Transport Geography*, 15(5), 319-330.
- Fellessen, M., & Friman, M. (2008). Perceived satisfaction with public transport service in nine European cities. *In Journal of the Transportation Research Forum (Vol. 47, No. 3)*.
- FIA Foundation (2016). *Safe and Sound. International Research on Women's personal safety on public transport. Research Series Fair Mobility*. Available at: <https://www.fiafoundation.org/connect/publications/safe-and-sound>
- Furlan, R., & Faggion, L. (2015). The Development of Vital Precincts in Doha: Urban Regeneration and Socio-Cultural Factors. *American Journal of Environmental Engineering*, 5(4), 120-129.
- Gakenheimer, R. (1999). *Urban Mobility in the Developing World. Transportation Research Part A: Policy and Practice*, 33(7-8), 671-689.
- Greater Amman Municipality [GAM] (2009). *Transport and Mobility Master Plan. Amman, Jordan*.
- Haut Commissariat au Plan (2012) *Enquête nationale sur la prévalence de la violence à l'égard des femmes au Maroc 2009*. Available at: <https://www.hcp.ma/>
- Imam, R. (2014). Measuring Public Transport Satisfaction from User Surveys. *International Journal of Business and Management*, 9(6), pp.106-114.
- International Labour Organization [ILO] (2013). *Global Employment Trends 2013: Recovering from a Second Jobs Dip. International Labour Ofce. Geneva: ILO*.
- International Transport Forum [ITF] (2018). *Understanding Urban Travel Behaviour by Gender for Efficient and Equitable Transport Policies. Discussion Paper 2018.01*.
- Jordan Times (2017). *Amman Citizens Face Daily Transportation Hustle*. Available at: <http://www.jordantimes.com/news/local/amman-citizens-face-daily-transportation-hustle>
- Koushki, P.A., Al-Saleh, O.I., & Al-Lumaia, M. (2003). On Mangement's awareness of transit passenger needs. *Transport Policy* 10 (2003), 17-26. Elsevier Science Ltd.
- Lai, W. T., & Chen, C. F. (2011). Behavioral intentions of public transit passengers—The roles of service quality, perceived value, satisfaction and involvement. *Transport Policy*, 18(2), 318-325.
- LSE (2015). *Gender, Transport and the Egyptian Economy. LSE Institute of Public Affairs: London*.
- Massena, F. (2016). *Bus Map Project to untangle Beirut's bewildering transit routes*. Available at: https://www.al-monitor.com/pulse/originals/2016/07/lebanon-traffic-map-bus-public-transportation.html#disqus_thread
- McKinsey & Company (2015). *The power of Parity: How advancing women's equality can add \$12 trillion to global growth*. Available at: www.mckinsey.com/mgi
- Montagne, C. (2014). Voices of expatriate and bus user women in Abu Dhabi (UAE). *Constraints and detour strategies*. In WIIT "Bridging the Gap", 5th International Conference, Paris.
- Nasr, N. (2017). *Fighting sexual harassment in Lebanon: where are we now and how far have we come? KIP Project on Gender and Sexuality*.

- National Center for Statistical Information [NCSI] (2017). *Statistical Year Book, National Centre for Statistical Information, Sultanate of Oman*. Available at: https://www.ncsi.gov.om/Elibrary/LibraryContentDoc/bar_Statistical%20Year%20Book%202017_c2111831-e13a-4075-bf7b-c4b5516e1028.pdf
- Nelson, J. D., Wright, S., Masson, B., Ambrosino, G., & Naniopoulos, A. (2010). Recent developments in flexible transport services. *Research in Transportation Economics*, 29(1), 243-248.
- Organisation for Economic Cooperation and Development [OECD] (2014). *Women in public life: Gender, law and policy in the Middle East and North Africa*. Available at: www.oecd-ilibrary.org
- Parque Expo (2015). *Plan Directeur d'Aménagement et d'Urbanisme de la wilaya d'Alger*.
- Redman, L., Friman, M., Gärling, T., & Hartig, T. (2013). Quality attributes of public transport that attract car users: A research review. *Transport Policy*, 25, 119-127.
- Rishani, S. (2011). *Get me out of this traffic jam*. Available at: <https://www.mashallahnews.com/get-me-out-of-this-traffic-jam/>
- Rode, P., Floater, G., Thomopoulos, N., Docherty, J., Schwinger, P., Mahendra, A., & Fang, W. (2017). Accessibility in cities: transport and urban form. In *Disrupting Mobility* (239-273). Springer, Cham.
- Rojas-Rueda, D., De Nazelle, A., Teixidó, O., & Nieuwenhuisen, M. J. (2012). Replacing car trips by increasing bike and public transport in the greater Barcelona metropolitan area: a health impact assessment study. *Environment international*, 49, 100-109.
- Salameh, B. & Imam, R. (2014). Developing Roadway Traffic Noise Prediction Models for the City of Amman. *Journal of American Science*, 12(2s), 23-30.
- Shaaban, K. and Khalil, R.F. (2013). Investigating the Customer Satisfaction of the Bus Service in Qatar. *Elsevier Procedia - Social Behavioral Sciences* 104 (2013), 865-874.
- The Nation (2014). *As Jordanian Women Leave the Home, Sexual Harassment Reaches Unprecedented Levels*. Available at: <https://www.thenation.com/article/jordanian-women-leave-home-sexual-harassment-reaches-unprecedented-levels/>
- Thomson-Reuters Foundation (2017). *The world's most dangerous megacities for women*. Available at: <http://poll2017.trust.org/>
- Thynell, M. (2014). *Gender sensitive-policies in the area of urban transport; between research and international institutions*. in WiIT 2014 – 5th international conference.
- Tillous, M., & Gillot, G. (2014). *Women only cars in the Cairo metro: A response to what problem?* In WiIT "Bridging the Gap". 5th International Conference, Paris.
- Truluck, E. (2015). *Understanding Street Harassment in Jordan: A Comparative Analysis of Syrian Refugees' and Jordanian Citizens' Experiences of Street Harassment in Jordanian Host Communities*. Independent Study Project (ISP) Collection. Paper 2056.
- UITP MENA Centre for Transport Excellence [UITP MENA CTE] (2016). *MENA Transport Report 2016*. UITP MENA CTE: Dubai.
- UITP MENA Centre for Transport Excellence [UITP MENA CTE] (2017). *MENA Transport Report 2017*. UITP MENA CTE: Dubai.
- UITP MENA CTE (2016a). *Mobility in Cities Database – Lessons learned from the cities of the MENA region*. Dubai
- UN Women (2013). *Study on Ways and Methods to Eliminate Sexual Harassment in Egypt*.
- Union International des Transports Publics [UITP] (2015). *Mobility in Cities Database*. Available at: <http://www.uitp.org/MCD>
- Union International des Transports Publics [UITP] (2018). *Building a culture of service excellence to develop a public transport business, Action Points*. UITP: Brussels.

United Nations, Department of Economic and Social Affairs, Population Division [UN DESA] (2014). *World Urbanization Prospects: The 2014 Revision*. CD-ROM Edition.

United Nations, Department of Economic and Social Affairs, Population Division [UN DESA] (2017). *World Population Prospects: The 2017 Revision*. DVD Edition.

Van Hagen, M. (2015). *Effect of Station Improvement Measures on Customer Satisfaction*. In: Journal of Traffic and Transportation Engineering, vol. 3, 7-18 doi:<http://dx.doi.org/10.17265/2328-2142/2015.01.002>

World Bank (2011a). *Making Transport Work for Women and Men: Challenges and Opportunities in the Middle East and North Africa*. Available at: <https://openknowledge.worldbank.org/handle/10986/17648>

World Bank (2011b). *Gender and Mobility in the developing countries*. Available at: <https://openknowledge.worldbank.org/handle/10986/9111>

World Bank (2017). *Project Information and Integrated Safeguards Data Sheet*. Available at: <http://documents.worldbank.org/curated/en/docsearch/projects/P160224>

World Economic Forum [WEF] (2018). *This is why women must play a greater role in the global economy*. Available at: <https://www.weforum.org/agenda/2018/01/this-is-why-women-must-play-a-greater-role-in-the-global-economy/>

World Health Organization [WHO] (2015). *Global status report on road safety 2015*. WHO: Geneva.

Zureiqat, H. (2014). *Tackling Transport and Mobility Challenges in the Middle East: Why a Local Approach is Key*. Available at: <http://www.newcitiesfoundation.org/tackling-transport-mobility-challenges-middle-east-local-approach-key/>

IMAGE SOURCES

Cover: Tram in Algiers, source: Prof. Baouni

Fig. 1 Main urban and transport characteristics of the five MENA cities, A. Delatte

Fig. 2 UOPT User's needs pyramid, A. Delatte

Fig. 3 Profiles of sample respondents, A. Delatte

Fig. 4 Sizes of the segments for the data analysis by city, A. Delatte

Fig. 5 Focus groups with women in Algiers (left) and in Beirut (Right), November 2017. Source: Prof. Safar-Zitoun, Dr. Lindos Daou

Fig. 6 Share of the all respondents having a positive perception on public transport design, by cities, A. Delatte

Fig. 7 Share of the all respondents having a positive perception on public transport Staff, by cities, A. Delatte

Fig. 8 Centre Maintenance Casa Transport ©Sife.Elamine.HD-147

Fig. 9 Frequency of the reasons given for using or not using public transport, A. Delatte

Fig. 10 Correlation between positive experience and readiness to recommend public transport use to a friend, A. Delatte

Fig. 11 Reasons for not using public transport among non-users, by gender, A. Delatte

Fig. 12 Impacts of transport services deficiency on women's daily life, results of the focus groups, A. Delatte

Fig. 13 Gender-responsive measures mentioned during the focus groups, sorting along five dimensions, A. Delatte

AUTHOR'S PROFILE

Aline Delatte, Eng. and M.Sc., senior Research Manager at UITP MENA Centre for Transport Excellence. Since 2015, Ms. Delatte is conducting social research on urban mobility at UITP MENA CTE, Dubai. Her current research interests are customer-centric strategies and gender-responsive measures in public transport development. She established the research partnership, the methodology and conducted the data analysis of the User-Oriented Public Transport project, presented in this article. Ten years ago, Ms. Delatte started her career in the urban development field as a civil engineer (ESTP, Paris). In 2012 she successfully graduated from the Urban Management Programme of the Technical University of Berlin and started her career as an urban transport researcher in Germany (TU Berlin, DLR). Aline Delatte is active on LinkedIn and Twitter.

Tahar Baouni, PhD, is Professor and Research Director at the Ecole Polytechnique d'Architecture et d'Urbanisme (EPAU), Algiers. He has been the director of the research laboratory Ville, Urbanisme et Développement Durable of EPAU and a member of the Scientific Council of EPAU since 2006, and was a member of the EPAU administrative council from 2009 to 2012. He was also chair on the scientific council of Institut Supérieur de Formation Ferroviaire (ISFF), Algiers

from 2005 to 2009. Baouni is also an associated professor in the department of Geography and Spatial Planning at Bab Ezouar in Algiers. He is a consultant to offices and agencies of urbanism and transport and has been responsible for numerous research projects in these fields.

Dr. Rakesh Belwal is an Associate Professor in Business at Sohar University of Oman. He has a rich experience of tertiary-level teaching at different institutions. Further to teaching, he has imparted training programs to government, public, and private sector officials in India, Ethiopia, UAE, and Oman. Dr. Rakesh has strong record of accomplishment of publications in leading journals, and has participated in several conferences. He has served the academic panels of different universities and has won a number of prestigious research grants. He also serves the University of Queensland Business School, Australia as an Adjunct Associate Professor.

Lindos Daou, holder of a PhD in Marketing from USEK, is an Assistant Professor lecturing in Marketing and Management at USEK Business School. Besides teaching, Dr. Daou is also a researcher and member of the CIRAME research center at the School and part of the scientific committee of Research and Business Link Review (RBL). He also occupies the position of Head of the Management Department. In the scope of conducting research and studies for BEPS, he has initiated several studies involving the Arab Business Schools. His areas of research in Marketing include university branding, student satisfaction, social media and advertising. He was also selected by the Institute of International Education (IIE) and US State Department to participate in the Fulbright Scholarship program for Junior Faculty Development program for Lebanon at the University of Illinois, USA.

Dounia Gourram is holder of a Master degree in urban development, transport and mobility, from the Institut d'Aménagement et d'Urbanisme de Lille (IAUL), Dounia Gourram is head of the UITP Maghreb Office.

Dr. Rana Imam is an Associate Professor of Transportation Engineering at the University of Jordan. Dr. Imam is a broad-minded transport expert with extensive working and research experience in the transport sector, in both Europe and Asia. She holds both Bachelor's and Master's degrees in Civil and Environmental Engineering from the American University of Beirut (Lebanon), and a PhD in Transportation Engineering from University College London (UK). She is experienced in many public transport aspects, from system planning, operations, and infrastructure design to sustainable vehicle technologies, energy consumption, and emission calculations for different transport modes.

Safar Zitoun Madani is Professor of Urban Sociology in the Department of Sociology at Algiers 2 University. He is the head of LASADET Laboratory (Laboratory of Socio-Anthropological Analysis of Territories Development). His research and publications focus on the analysis of urbanization, urban and housing policies, the evaluation of protection and social action policies in Algeria and the Arab world and on urban mobility. He is the author of several books including the study "Urban mobility in the agglomeration of Algiers. Evolutions and Prospects, (with Tabti-Talamali A.) Blue Plan and World Bank, Sophia-Antipolis, 2009, p. 107.

Dr. Ayman Smadi is the director of the UITP MENA Office and Centre for Transport Excellence, in Dubai. Before joining UITP, Dr. Smadi, was the Executive Director of Transport and Traffic Management at the Greater Amman Municipality (GAM). Dr. Smadi holds a Ph.D. in Transportation Engineering from Iowa State University (USA); an M.S. in Civil Engineering – Transportation Systems from the University of Oklahoma (USA); and a B.S. in Civil Engineering from Jordan. He was selected in 2008 as a Fulbright Scholar.

TeMA Urban Travel Behavior in the Middle East and North Africa
SPECIAL ISSUE 1.2018 | 31-46
print ISSN 1970-9889, e- ISSN 1970-9870
doi: <http://dx.doi.org/10.6092/1970-9870/5449>

review paper received 29 January 2018, accepted 13 April 2018

Licensed under the Creative Commons Attribution
Non Commercial License 3.0
www.tema.unina.it

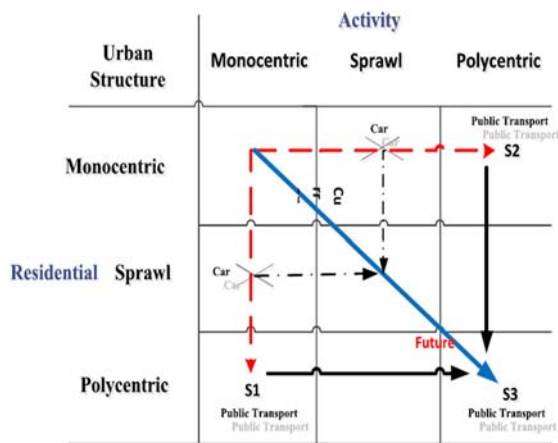
Tesoriere, G. & Errigo, M. F. (2018). Urban travel behavior determinants in Saudi Arabia. *Tema Journal of Land Use, Mobility and Environment*. 31-46.
doi: <http://dx.doi.org/10.6092/1970-9870/5449>

URBAN TRAVEL BEHAVIOR DETERMINANTS IN SAUDI ARABIA

GIUSEPPE TESORIERE^a, MAURIZIO FRANCESCO ERRIGO^b

^a School of Economics, University of Enna "Kore", Cittadella Universitaria, 94100, Enna, Italy
e-mail: giuseppetesoriere@unikore.it
URL: www.unikore.it

^b Faculty of Engineering and Architecture, University of Enna Kore, Cittadella Universitaria, 94100, Enna, Italy
e-mail: maurizio.errigo@unikore.it
URL: www.unikore.it



ABSTRACT

The manuscript investigate the travel behavior in three Saudi cities: Riyadh, Dammam and Buraydah. The whole transport system, accessibility and different mobility are related to urban strategies, urban patterns and to urban plans that, at different level, manage the country defining aims and strategies for the development and management of the territory. Travel behavior inside these three important and different cities is influenced by the whole urban structure, by economy reason and by urban and political strategies. Not less important are social factors that has to be studied and has to inspire every urban action. Make more diversified, dynamic and modern economy seems to be the priority of national agenda of Kingdom of Saudi Arabia. As happened in the past, exogenous factors are addressing a rapid transformation of the public policy, in which urban mobility is one main paradigm. In this framework, a part of paper focused on the main determinants of urban travel behavior and the blueprint agenda of government to make more transit oriented the cities. Although the urban travel behavior is complex phenomena in Saudi Arabia, of which the main effect is related to massive car dependency of people for mobility, some clarifications would suggest the approach to analyse current factors are impacting on national choices and introduce ideas to make urban policy part of a bigger project.

KEYWORDS:

Mobility; Car dependency; Travel behavior; Governance; Urban Policy

1 INTRODUCTION

In the last years, the fast growth in population, urbanization, economy and motorization, has caused a fast growth of traffic congestion in Saudi Arabia with a deep and urgent need to elaborate and implement some urban transport strategy able to give a strong effort and to balance the urban development preserving country from congestion and pollution. By 2030, the population of Riyadh, the capital and the largest city in the country, is expected to increase from 5.4 million to 8 million. Five Saudi cities have over a million people each and a number of medium size cities are expanding rapidly. To achieve these issues, the central government has recently approved public transport plans in some main cities such as Riyadh, Makkah, Madinah, Jeddah and Dammam.

This fast urbanization has promoted some deep change in urban structure with the shift from compact monocentric city to a city characterized by urban sprawl with the evident effect of generation of traffic congestion, longer trip distances, and traffic accidents. Allied to the growth in economic activity and population has been an increase in mobility. This has generated high levels of car ownership and car use.

In Saudi Arabia the fertility rate has decreased from 4 in 2000 to 2.6 in 2013; the Saudi population has grown from 15.6 million in 2000 to 20,7 million in 2013 and non-Saudi population has grown from 5,3 million in 200 to 10,1 million in 2013 (almost twice). More than half of the Saudi population is concentrated within a Western-Eastern corridor comprising the 5 metropolises: Riyadh, Jeddah, Mecca, Medina and Damman. Riyadh has 6.369.710 inhabitants, Dammam has 1.064.000 inhabitants while Buraydah has 559.723 inhabitants (World Urbanization Prospect, 2014).

The Kingdom of Saudi Arabia is a monarchy ruled by King Salman bin Abdulaziz Al Saud, who is both head of state and head of government and Riyadh is the capital city of the Kingdom.

In the 1970s Saudi Arabia developed a very important economic growth due to the country's oil reserves; one of the first impact of this was an increase of the urban area of the cities; Riyadh, in particular, was characterized by a fast population growth that caused the need of a new policy for housing that changed the urban form and the inhabitants' mobility.

Relating to this changes, Saudi cities have adapted their form to the new needs and they became more similar to american patterns of urban transportation than those of Europe, because a lot of cities have decentralised residential districts and fabrics, assuming the configuration of a whole formed by a lot of suburban parts that have caused the complete predominance of private car in the whole urban system.

Private mode is predominantly used in Riyadh, Dammam and in all Saudi arabia cities. Most of Arabian cities don't have a public transport system but the most links between the different parts of the city are developed using private car. The Kingdom of Saudi Arabia (KSA) had no more than 22.805 cars in 1971. This number reached 2.052.934 cars in 1996 (Ministry of Interior (MOI), 1996), in 2008 there were 6.800.000 cars (Gat website, 2008). According to the latest statistics in 2016, the number has reached over than 12 million cars (Gat website, 2016), with almost 80.000 km of paved roads; by 2030 it is expected that there will be 26 million of cars. Cars in Saudi Arabia are very common because their operating costs are very low and, overall, fuel prices are very low; private cars are affordable to many people on a lower income, and this largely compensates for the lack of an effective public transport system (Al-Fouzan, 2011).

Riyadh has become a car-oriented city since the 1950s and the economic boom compounded this in the 1970s. Riyadh has witnessed tremendous growth in automobile dependence in the last few decades; between 1968 and 1996 the total number of cars in use increased from 26.880 to an estimated 670.300. The average vehicle ownership per household also increased nearly two and a half times during the same period (Al-Dubikhi, 2007). Riyadh can be seen as a classic example of an urban environment designed solely around an infrastructure based on the automobile. Riyadh is a car-based city. The phrase that "many people

have built their way of life around their cars" is absolutely true in Riyadh; High car dependence is in large part determined by the climatic conditions, by low price of gasoline and by cultural and religious beliefs (Aldalbahi & Walker, 2015); Low gas prices, non-fuel tax, high vehicle ownership, low registration fees, and weak land use are other reasons that cause car dependency. High car dependency also causes traffic congestion, air pollution, road accidents and fatalities, and public health decline.

Saudi Arabia had encouraged road transport in the past as had it maintained one of the lowest petrol prices in the world, at \$ 0.13 per liter. In 2018, this price was raised to about \$ 0.54 per liter; the total length of road is 221,372 km while the road density is about 11 km of road per km of land area.

Due to increasing car ownership, traffic congestion is becoming a serious problem and introducing public transport is being considered by the planning authority as a way of reducing traffic congestion and meeting the future travel requirements of the city.

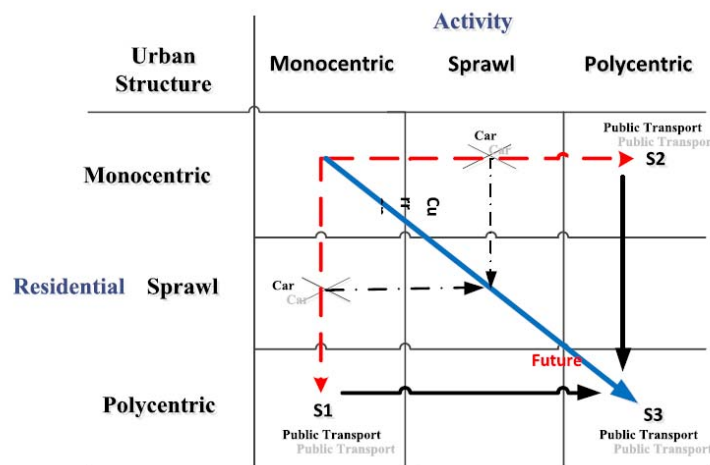


Fig. 1 Urban structure and population distribution scenarios process (Alqhatani, et al., 2014)

At present, Riyadh has no tram and train service but it has been designed to be used in the upcoming years. A defining feature is that women in Saudi Arabia are not permitted to drive (but maybe some change will be realized within 2018) and therefore rely on male relatives, expatriate male private drivers and taxis, resulting in large numbers of trips per Saudi household. In Saudi culture, females and males are always segregated on urban buses and are usually transported separately on group transportation services. Because of this tradition, females expect a door-to-door service which public transport, generally, is ill-equipped to provide. Trips made by males aged 16 and over are higher than females in a similar age category.

2 BACKGROUND: SAUDI ARABIA ECONOMIC OVERVIEW

Since 70s Saudi Arabia experienced a rapid economic transformation, becoming one of the fastest growing oil economies in the Middle East, where a third of the OPEC total barrels and thus nearly 10m barrels a day is produced by the Kingdom (The Economist, 2014).

This event has been impacting on the transformation of cities in Saudi, led by government expenditures, which recorded an increase from US\$1.6 billion in 1970 to US\$158.9 billion in 2010 (Alshahrani, 2014).

As a consequence, hence, Saudi Arabia's macroeconomic stability is massively polarised around oil sector contribution, accounting for 25.1 percent in 2016 (excluding import duties) at current price to GDP versus 27.2 percent in the previous year (Saudi Arabian Monetary Agency).

In this instance, data on GDP at constant prices indicates that the economy grew by 1.7 percent to SAR 2,589.6 billion in 2016 compared to 4.1 percent in 2015, in which oil sector GDP increased by 3.8 percent, while the non-oil sector GDP rose by 0.2 percent (Saudi Arabian Monetary Agency).

Whereas, the growth rate of the non-oil private sector GDP was 0.1 percent, rising to SAR 1,000.3 billion, and the non-oil government sector grew by 0.6 percent to SAR 428.4 billion (Saudi Arabian Monetary Agency). In this scenario, despite the oil sector (at current prices) recorded a decline of 8.9 percent in 2016 compared to a decline of 44.9 percent in the prior year, a political debate is still opened on the feasibility of oil economy to tackle challenges and needs of a country affected by increasing population might reach 31.457 million in 2030 (UNHabitat), and where urban population growth tripled from 9.32 million in 1980 to 29.8 million in 2014 (UNHabitat). These trends might influence development program and public expenditure of the Kingdom for such key sectors like education, health, housing, transportation, and telecommunication services. However, as confirmed by 10th Development Plan, the budgeted public investment of 2.4 trillion Riyal is still oriented to finance development projects of the major sectors, including human resources, social and health, and infrastructure (Oxford business group). The 10th Development Plan allocates 372 billion Riyals for spending on infrastructure, which is about 76% more than what was allocated in the 9th Plan as part of a set of interventions planned to increase the contributions of key sectors to GDP, like financial, tourism, and transport. In this scenario, as happened in the past, exogenous factors seemed to recall again urgent review of national agenda and its approach to address negative externalities of massive dependency from oil sector, requiring blueprint ideas abled to play catalyst role for a development of the Kingdom (Future Saudi City Program).

3 DISCUSSION: URBAN PATTERNS RELATED TO MOBILITY

Often the city are characterized by endless peripheries, by poor provision of public space, by low residential densities and by not so clear urban form. Urban form is not simple to define, because, often, is characterized by fragmentation, by the presence of urban-rural transition areas, by the predomination of patterns dominated by infrastructures.

The urban growth is different and various, examining the different contexts in which is organized Saudi Arabia. In many cases the administrative urban boundaries are larger than the built up settlements and comprises rural parts with low densities but, in some case, boundaries are smaller than urban agglomerations.

Saudi cities resemble American patterns of urban development and transportation more closely than those in Western Europe; the difference between urban, suburban and rural area is done using the density; urban is considered an area with more than 50% built up density; suburban has a density between 10% and 50%; rural settlements have a density smaller than 10% (Al-Mosaind, 2001). Saudi Arabia has a special situation that makes the community high car dependency.

| City | Non Built up Areas | Built up Areas |
|----------|--------------------|----------------|
| Dammam | 49% | 51% |
| Riyadh | 34% | 66% |
| Buraydah | 40% | 60% |

Tab. 1 Urban Patterns (UN-Habitat, 2015)

The Saudi Arabian culture influences the people to have more cars. The people have different cars for different uses. Many of the Saudi Families have special drivers, which require the use of more than one car. The average vehicle ownership in Saudi Arabia is 349 vehicles per 1,000 people. This high rate is the result of community dependency on private cars and the limited public transportation.

The urban form of Saudi cities is deeply based on the use of the car; Saudi cities are characterized by low density, single-use development, spacious houses and buildings. Urban form is dominated by infrastructures with an horizontal spreading of urban area with some level of dispersion of houses and buildings. Open

spaces and vacant land are about 46% of total land within city boundaries. Riyadh has 19% of open space and 14% of vacant land; Dammam has 31% of open space and 18% of vacant land; Buraydah has 34% of open space and 7% of vacant land. This land is localized in the middle of the cities and, in many cases, it remains empty for years because the owners have no incentive to build on them.

| City | Open Space | Vacant Land | High built up density | Medium built up density | Low built up density | Total |
|----------|------------|-------------|-----------------------|-------------------------|----------------------|-------|
| Dammam | 31% | 18% | 41% | 9% | 1% | 100% |
| Riyadh | 20% | 14% | 45% | 18% | 3% | 100% |
| Buraydah | 34% | 6% | 43% | 8% | 9% | 100% |

Tab. 2 Proportion of built up areas (UN-Habitat, 2015)

Territory could be divided in three categories: open space; non residential areas and residential areas. Open space are the unbuilt zone such as open countryside, forests, parks, water bodies; non residential are areas that are destined to non residential use but that are characterized by the presence of public-private buildings; residential areas include buildings for residential use. Residential area are heterogeneous; inside them is possible to stress the presence of four types of building typology: formal subdivision, informal subdivision, housing projects and atomistic or organic district. In nearly 50% of Saudi cities, formal subdivisions represent around 15% of the total urban areas and represent 45% of the residential areas; formal subdivision is characterized by a defined urban design in which are combined buildings, streets and sidewalks; informal subdivision is characterized by lacking evidence of urban form with the lack of paved streets, sidewalks or streetlights, form is dominated by linear route and districts are regular in side and shape. The urban form is dominated by a clear hierarchy with linearity of road network, with frequency of intersections and regularity of block sizes. The primary roads are unpaved, indicating that the area was built without the full complement of formal services. Informal subdivision represents 19% of the total urban area with a land allocated to streets of almost 28%. Housing projects comprise a large range of typologies, from towers to suburban housing; are districts built following a plan or built by a developer at the same time or in phases. Streets are linear but sometimes there is some curvilinear element.

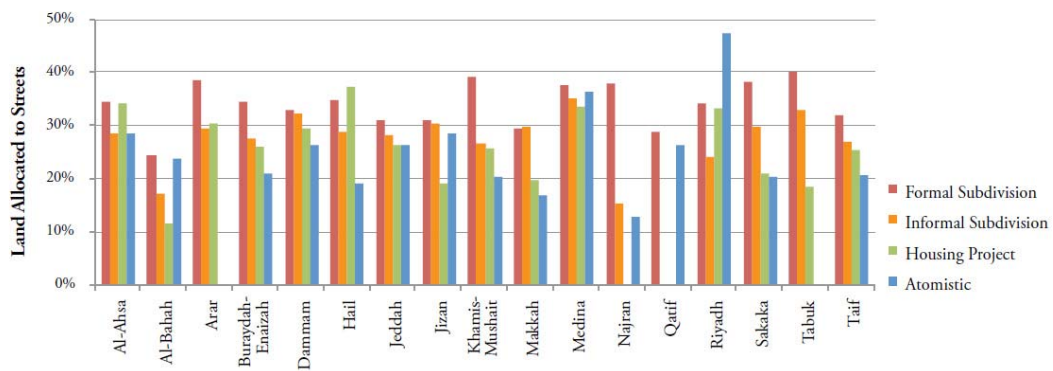
Housing projects typology represent 1,8% of total urban area; the land allocated to streets varies a lot depending on building typology; the index (around 67) belongs to moderate connectivity and it varies from 95 points in Dammam to 13 points in Al-Bahah. The urban design is focused on minimizing the land allocated to streets and minimizing the public space. The least building district is the atomistic; it has not a regular street layout, intersections are irregular and road width is characterized by extreme variety. Street connectivity index is around 48 points. Atomistic typology covers around 6% of the total urban area.

In Riyadh and Dammam this typology is not present. The expansion of cities is characterized by changes in urban form and in the city structure; in Saudi Arabia, a sit happens in nearly 50% of Saudi cities, land allocated to streets is around 40%, with streets widths of 10 meters. (UN-Habitat, 2013). The Future Saudi Arabia City Programme, focusing on 17 cities, aims to achieve a sustainable development and urbanization in the Kingdom.

Land allocated to streets, in Saudi cities, varies between 10.6% and 28.9%, with an average of 22.3%. In this statistic is comprised open space and this is the reason because this values appear so low. Excluding open space the value rise to 27.8% as average value; in Riyadh is higher than 30%, in Dammam is around 27% while in Buraydah is a bit more than 30%. The street connectivity index, as studied by UN-Habitat, is the results of three variables: the length, the width and the number of intersections; in 14 cities of 17 analyzed the index is higher than 80 points which means that connectivity is quite good. Riyadh has a connectivity index of around 81 points while Dammam has 62 points; Buraydah has 79 points (UN-Habitat, 2015).



Fig. 2 Urban configurations, Jeddah (UN-Habitat, 2016)



Tab. 3 Land allocated to streets in cities by residential typologies (UN-Habitat, 2015)

Dammam and Riyadh have the larger street in Saudi Arabia; the average width is around 18 meters in Riyadh and 17 meters in Dammam while in Buraydah the width is around 15 meters; street density, that measures the length of the street network per square kilometer, is around 15,7 km streets per km² in Dammam, 17 in Riyadh and almost 20 in Buraydah.

Intersection density is a good indicator of compactness and walkability, the UN-Habitat optimal level is estimated in 100 intersections per square kilometer; Dammam has a value of around 110 while Riyadh has a value of 135; the average value, in Saudi Arabia, is around 136.

| City | Land allocated to streets (%) | Street density (km/kmq) | Intersection density (#/kmq) | Average street width (m) |
|----------------------|-------------------------------|-------------------------|------------------------------|--------------------------|
| Dammam | 27,73% | 15,78 | 102,24 | 17,57 |
| Riyadh | 31,24% | 17,45 | 128,10 | 17,90 |
| Buraydah | 30,29% | 19,89 | 155,59 | 15,23 |
| Average Saudi Arabia | 27,85% | 18,12 | 136,28 | 15,45 |

Tab. 4 Streets' characteristic (UNHabitat, 2015)

4 DISCUSSION: PLANNING TOOLS IN SAUDI ARABIA

Regarding Planning tools and instruments to manage the country and to develop aim and achieving to enforce Saudi Arabia, the planning governance is divided in five levels: National, Regional, Sub regional, Local and Detailed levels. On National level there is the National Spatial Strategy; on Regional Level there is the Regional Development Plans; on Sub Reg. Level there are the Structure Plans that setting the future proposal for strategic land uses, distribution of activities and major road network on the governorate level; on Local Level there are the Local Plans that Adding details to the Structure Plan on the city level, and setting zoning and building regulations for different land uses, on Detailed Level there are the Action Area Plans that concerns Historic Areas, Residential Districts or City Centers. Pilot cities (Dammam, Riyadh and Buraidah) have been selected to review their local plans and test how well they achieve their objectives. The Ministry of Municipal and Rural Affairs (MoMRA) initiated the first National Spatial Strategy (NSS) in the late 70's to promote a more "balanced development" (Middleton, 2009). In 2000, the Council of Ministers approved a new version of the NSS that introduced two new instruments: development corridors and growth centers, as shown in figure 3.

In the National Spatial Strategy all stakeholders in the country, including youth, women and the private sector, will be engaged in dialogues and planning; and the Strategy will have these main aims:

- promoting a spatially balanced pattern of population distribution on national space;
- minimizing the adverse consequences of the continuous increase in the population of large cities;
- ensuring the efficient utilization of infrastructure and public services already in place;
- directing support to the overall growth of small and medium cities;
- diversifying the economic base of different regions as to fully utilize their existing resources;
- supporting selected settlements to act as growth centers capable of transmitting and coordinating development impulses toward surrounding areas;
- supporting new activities that contribute positively to the integration between rural and urban areas;
- improving the administrative structure of selected growth centers and defining accurately their service areas;
- fostering development within border cities due to their importance for national security.

The nine objectives of the NSS have given strong emphasis to economic growth despite the overall objective of achieving balanced regional development. The National Strategy has adopted two main instruments to guide the spatial development across the regions: the development corridors and the growth centers.

The NSS review is one of the key components of the Future Saudi Cities Programme (FSCP), which is a joint partnership between UN-Habitat and MoMRA. The FSCP is covering 17 cities diverse in size and functions that include all the capitals of the 13 Saudi regions. The Ministry of Transport has prepared the National Transport Strategy in cooperation with all concerned bodies in the transport sector in the Kingdom of Saudi Arabia. The strategy was discussed and reviewed by the Council of Ministers and the Shura Council. The strategy is based on a future vision to provide an integrated transport sector that includes all types of transport means to meet the Kingdom's future needs.

The strategy also focuses on safety, effectiveness, efficiency and technological development, and encourage and promote the economic development and competitiveness of the Kingdom of Saudi Arabia at an international level. It also provides a healthy and safe environment for community members.

The Saudi road network is rather developed but the railway network still needs to be improved for the sake of economic efficiency and environmental sustainability.

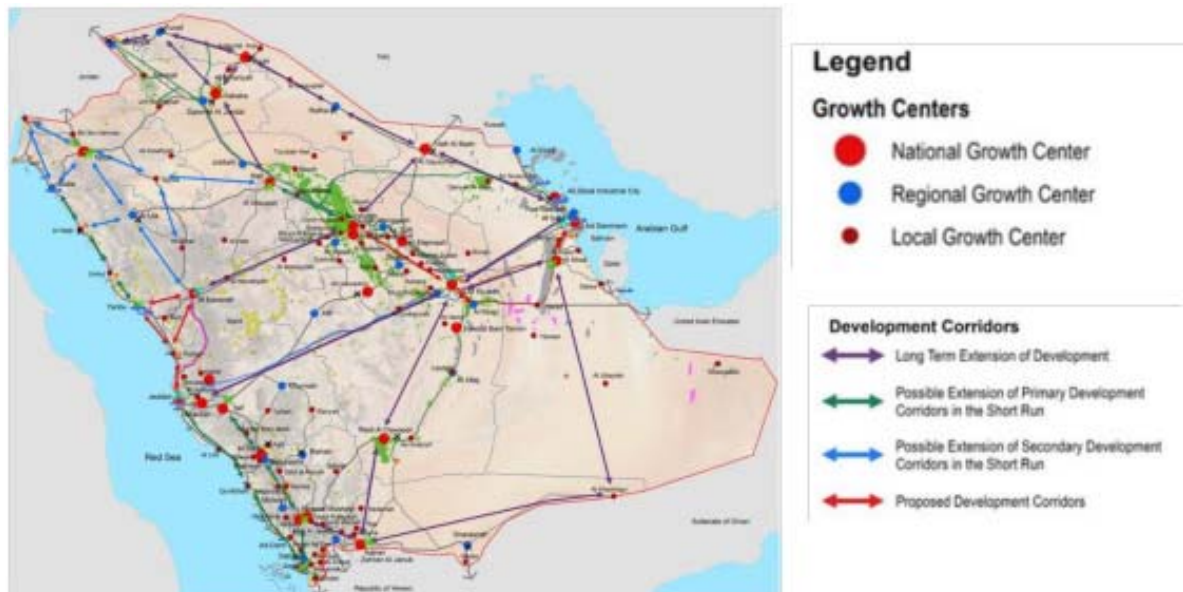


Fig. 3 National Spatial Strategy (UN-Habitat, 2016)

Project outcomes of the National strategy are: developing an activity plan for reducing carbon emissions of the transport sector, improving road safety by applying intelligent transport systems, and making NTS a sustainable sector strategy through comprehensive monitoring and review. To improve urban transportation in the major cities of the Kingdom, integrated public transport concepts are being developed that include light rail and dedicated bus transportation. The railway network is expanding and thereby creating a regional railway network to facilitate high-speed passenger trains and support multi modal transport of goods.

5 FINDINGS: URBAN TRAVEL BEHAVIOR AND IMPACTS OF PUBLIC POLICY

The car dependency is the most tangible effect of the travel behaviour in Saudi Arabia. This is the conclusion of a stream of literature focussed on investigating this phenomenon in the Kingdom (Koushki, 1987; Aljoufie, 2012; Al-Atawi, 2014; Limtanakool, 2014; Aldalbahi & Walker, 2015). In this sense, the study of Aldalbahi, Walker (2015) tried to give evidence on travel behaviour based on complex correlations among exogenous variables. To explain this thesis, the two researchers focussed on how urban mobility behaviour of people living in Riyadh is highly depended on a set of factors. To this end, the evident finding of this paper is that people are extremely depended from the car and that the car dependency is result of travel behaviour in the capital.

Following these assumptions, our study attempts to explore the variables mentioned by this literature and investigates the determinants of the travel behaviour taking into consideration recent socioeconomic transformation addressed by the government. This point is well underlined in the literature about the role of national policy in affecting mobility behaviour of people through a public expenditure (Al-Hathloul, 2002). This postulation finds evidence from study conducted in Jeddah (Aljoufie, 2012). Jeddah, as one of the largest city of the Kingdom, experienced a tremendous transportation expansion led by government from 1970-1980 (Al-Hathloul & Mughal, 1991; Daghistani, 1993). In this period the transportation infrastructure rapidly increase from 136 km to 435 km, experiencing an expansion of 69% and an annual growth of 6.9%. These findings may confirm how policy in Saudi Arabia affected the mobility system and, in general terms, the behaviour of people more oriented to choice the car as consequence of political orientation. In parallel, other studies attempt to investigate the travel

behaviour from a social point of view to give more empirical evidence of the phenomenon observed, exploring impact of social rules and lifestyle. As reported in Al-Dubikhi (2007), "religious and cultural reasons are critical factors to generate highly dependency from adult males for travel and, consequently, large number of trips to meet the needs of the female members".

This statement is validated by the study Al-Atawi, (2014) based on randomly selected sample of 1220 households interviewed in the Tabuk city.

The study confirms the importance of social factors in choosing the car as preferred transportation mode for all travel purposes. From this study, social factors like role of family head and its work position are highly correlated to car dependency. The findings may confirm part of the postulations of previous study (Koushki, 1987), which focussed on the effects of socio-economic traits such as family size, family income, employment, and car ownership utilized as the explanatory variables in transportation choice.

On the basis of a questionnaire, this paper frame the social characteristics of the travel behaviour in Saudi Arabia, which seems be affected by family head role, family size, high-income level, and number of autos owned according to the results reported. The analysis, hence, may indicate a sort of correlation among households' daily vehicle-trips, family size and car ownership.

Indeed, it remarks that high income and the factor of social prestige affected the use of public transit in the Kingdom, which is less than 1/2 of the transit ridership in the US (Koushki, 1987).

On the other side, other studies tried to combine social factors with additional exogenous factors, like the climatic conditions in the country as limitation to walk and spend time outdoor (Aldalbahi, Walker, 2015). This issue is critical in all cities of Kingdom and its effects exemplified how traditional pedestrian environment, and in general land use for outdoor public space, have been transformed to car dependent city without experiencing the transit city urban form as experienced in most Western cities (Newman & Kenworthy, 1999). This is the case of Jeddah, where the total area devoted to transportation infrastructure increased from 2.8% in 1964 to 7.3% in 2007 (Aljoufie, 2012).

The result reported in the research indicate that that road density in relation to the urban area changed from 0.005 km/ha in 1964 to 0.015 km/ha in 2007. To explain this finding, the study stressed the point related to the population growth and its impact on the number of urban trips, which recorded increase from 798,430 trips in 1980 to 6051,883 trips in 2007 (MOMRA, 1980; Municipality of Jeddah, 2004b; IBI, 2007). Favourable economic trend, then, has stimulated a growth of car market and, in general car ownership, which reported: 120 cars per thousand persons in 1980 (Al-Hathloul & Mughal, 1991) and 299 cars per thousand persons in 2006 (Municipality of Jeddah, 2006). Consequently, the number of daily trip per person increased from 0.77 trips/person in 1970, 2.29 trips/person in 2002 to 1.86 trips/person in 2007. To this end, all these factors has stimulated tremendously the daily share of car usage with an increase from 50% in 1970 to 64% in 1980 and, further, to 91.1% in 2002 and 93% in 2007 (IBI, 2007; MOMRA, 1980; Municipality of Jeddah, 2006).

This continuous growth in choosing car usage for travel is exacerbated by additional factors related to market low prices of operating costs (Aldalbahi & Walker, 2015), fuel negligible car taxation and lack of any economic disincentives to car use in general terms. In this instance, the vehicle registration charge is around 26 USD (Ministry of Interior, Kingdom of Saudi Arabia) compared to other countries, like United Kingdom or France, where it can reach 55 pounds¹, and 46.15 euros² respectively. On the basis of these findings the travel behaviour in Saudi Arabia may be summarised by a formula, which has the purpose to highlight the main determinants of the car dependency as result of this stream of literature (Koushki, 1987; Aljoufie, 2012; Al-Atawi, 2014; Aldalbahi & Walker, 2015). As dependent variable, hence, car dependency is function of five explanatory variables.

¹ www.gov.uk

² www.french-property.com

$$Y_{CD,t} = f(PETROL_t, GOV_t, SORUL_t, CLIM_t, CARMARK_t)$$

$Y_{CD,t}$ Dependant variable is a measure of car dependence

$PETROL_t$ = Petrol share to National revenue

GOV_t = Government investments

$SORUL_t$ = Social rules

$CLIM_t$ = Climate

$CARMARK_t$ = Car market

To this end, car dependence might be the result of the interaction of all these variables, which would suggest how the travel behaviour is complex phenomena. In these terms, the available data gives a measure of this car dependence in the Kingdom, expressed in the terms of car ownership rates.

In 2016 vehicle ownership rates per 1000 persons were 257 in Riyadh (General Authority for Statistics), which is relatively low in comparison with international cities. Major metropolitan cities in the US have an average of 796 cars per 1000 people (Bureau of Transportation Statistics, United States Department of Transportation), while Australia averages 740 (Australian Bureau of Statistics), and Europe 468 (Litman, Victoria Transport Policy Institute, 2011). Albeit the car ownership rate is slightly increased from 1,669,710 in 2007 to 1,791,085 in Riyadh, then, there are more cases exemplified how car dependency currently affecting the mobility system in the country. This is the case of Eastern province, the largest region of Saudi Arabia and business hub of the country, where is located Saudi Aramco, the state-owned oil producing company. In this region, the population is around 4,100,000 and ownership car rate is almost the half of the US rate. Namely, it is 389 per 1000 person (General Authority for Statistics). On the other side, data from Al-Qassim region, one of the key areas for agriculture of the Kingdom, are quite aligned with Riyadh framework. Although the people living in Al-Qassim Region are 20% of those living in Riyadh, the car ownership rate is 266 units per 1000 person compared 257 units of the capital, giving interesting evidences of transportation system in these parts of the Kingdom (General Authority for Statistics). In all three cases, then, the trend recorded by General Authority for Statistics is positive and the car ownership for individuals increased from 2007 to 2016 as confirmed by the number of auto sales a year. In fact, Saudi Arabia is currently the largest importer of vehicles and auto parts in the Gulf Cooperation Council region, accounting for about 770,000 auto sales a year (Gulf Petrochemicals and Chemicals Association). On the other side, the lack of effective transport system has contributed to generate this car city phenomenon, and consequently the shape and extension of cities, mostly affected by massive form of unbalanced density rates and underdeveloped land use, which can reach 59 person/Ha in Dammam, capital of Eastern Province, where the vacant land is 15,714 Ha, as 49% out of total area, or can reach less than 10 persons /Ha in some administrative divisions of Buraydah, Capital of Al-Qassim Region, where the vacant land is around 43% of total (UN-Habitat). To this end, critical question emerged as priority: how the government intends to tackle these challenges? To address these questions, the study mentioned (Koushki, 1987; Aljoufie, 2012; Al-Atawi, 2014; Aldalbahi & Walker, 2015) should be updated by new variables able to capture the current reform and rapid economic and social changes. To address these questions, the study mentioned (Koushki, 1987; Aljoufie, 2012; Al-Atawi, 2014; Aldalbahi & Walker, 2015) should be updated by new variables able to capture the current reform and rapid economic and social changes. In this scenario, the main agent of change might be the negative economic trend of oil economy in the least few years, which gave evidence on fragility and weakness of an economy founded on unique resource as engine of

development. The extreme volatility of oil system, exemplified by price dropping to under \$30/barrel in the first quarter of 2016, and inconstant performances opened a political debate to find alternative ways to make more resilience and robustness Saudi Arabia's economic and financial structure, fostering a structural reform of all economy (National Transformation Program).

To make more competitive, sustainable and diversified the economy, therefore, the Council of Ministers has tasked the Council of Economic and Development Affairs with establishing and monitoring the mechanisms and measures necessary for the implementation of "Saudi Arabia's Vision 2030".

The Council of Economic and Development Affairs has established an effective and integrated governance model, which translate the Vision into various implementation programs.

In order to achieve the ambitious goals of "Saudi Arabia's Vision 2030", the National Transformation Program 2020 was launched across 24 government bodies operating in strategic economic sectors.

In this framework, the national transportation system is a pillar of the new agenda, mostly oriented to improve efficiency of transportation infrastructure, increase usage of public transportation, increase percentage of private sector participation in financing and operating transportation projects focused on railway and port project (strategic objectives, 3, 4, 6, Ministry of Transportation, National Transformation Program 2020). In parallel, the national government announced mega projects to develop integrated and modern public transport systems in major cities, such as Riyadh, Mecca, Medina, Jeddah and Dammam, where new public system projects are under construction (Global Mass Transit, 2016). This is the case of the construction underway of Riyadh Light Metro, will comprise six lines, spanning 177.8 km and covering 85 stations. The investment amounted at around USD 23 billion. The new infrastructure of the capital will serve 1,500 passengers per hour per direction. But 8,000 passengers per hour per direction are forecasted in future. The construction will be completed by 2019. On the other side, Saudi Arabia's Council of Ministers authorized a new integrated public transport system comprising metro and buses in Dammam and Qatif within the Eastern Province. The Dammam-Qatif Metro project will cost around USD16 billion, which will have to two main lines, one will connect Dareen Island to Qatif and the second will connect Dammam to the international airport. These projects exemplified the government orientation and evidenced the current efforts to create the right conditions in making the economy more competitive, dynamics and modern. To integrate this investment program, a delicate reform process is involving the society and the role of women in the society, and their economic contributions to the nation's future. In this instance, the willingness is to increase female workforce participation from 22 percent to 30 percent by 2030. To achieve this goal, the government is reviewing the approach towards a change of society, started in 2013, when the King Abdullah appointed 30 women to Shura Council, the highest advisory body, and when two years later women were allowed to both vote in and run for office in municipal council elections, for the first time in the country's history. In 2017, consequently, the government announced that the women in Saudi Arabia would be allowed to drive, implementing the order by June 2018. Despite uncertain effects could be generated from 9 million potential drivers on the road (Cia's World Factbook), this new policy surely will influence vehicle demand, ride-sharing services like Uber or Careem, and even immigration patterns in the country, where low-wage immigrants often work as hired drivers. On the other side, also the car market price could be affected by these changes. Recalling the above-mentioned studies, hence, we might say that the conditions observed by the literature are mutating rapidly. New exogenous factors could replace or changes the explanatory variables used to study the car dependency and thus the travel behaviour in the Kingdom. This allows us to rethink a formula able to reflect the recent socioeconomic transformations.

On the basis on these premises, hence, a new formula could be written as follows.

$$Y_{CDi} = f(PETROL_i, GOVPT_i, WOMENDRIV_i, CLIM_i, CARMARK_i)$$

Y_{CDi} Dependant variable is a measure of car dependence

PETROL_i = Petrol share to National revenue

GOVPT_i = Government investments for public transportation

WOMENDRIV_i = Women drivers

CLIM_i = Climate

CARMARK_i = Car market

Following this evidence, few points are necessary to be explained. The petrol share to national revenue remains as independent variables, which will be one of the main public expenditure drivers in the next years. Albeit, the government has issued a number of programs, such as the National Transformation Program, the Fiscal Balance Program, and the Government Restructuring Program, and adopted a fiscal reform process, introducing VAT at 5 percent in 2018 and land taxes at 2.5 percent in 2015, an incisive structural reform will be needed to replace partially the oil system role to national revenues, embracing other taxable items like property tax. On the other side, public transportation will impact on the process oriented to change car cities in sustainable and modernised urban environments. The impact of public transportation system will be depended on both financial and social issues. In fact, women may impact on urban mobility as new car users, affecting the governmental efforts to reduce car dependency.

New market segments may open business opportunities and attract private investments, and in general automotive companies. Therefore, it presumes once again that the car dependence and consequently the transportation mode choice would be influenced by social factors as stressed by the literature.

For these reasons, "WOMENDRIV" as variables abled to affect the number of cars in the Kingdom should be considered as new determinant, and thus included into the formula. To tackle these market trends, hence, new sustainable and resilient approach in addressing physical planning will be highly recommended. In regards, the Future Saudi Cities Programme currently carried out by UN-Habitat and the Secretariat of City Planning in the Ministry of Municipal and Rural Affairs gives evidence of the efforts to "make cities inclusive, safe, resilient and sustainable" according to Sustainable Development goal 11. Future Saudi Cities Programme can have a key role in giving emphasis of the importance of urban density, mixed land use and new mobility paradigms, providing the guidelines to create the conditions in transforming cities with more sustainable patterns and recommending the Government to prioritize the interventions (Cervero, 1998; Kenworthy & Laube, 1999). Taking into consideration the massive vacant land of Saudi cities, the positive side is that there are ideal conditions to address the policy to increase the density and readjust the current use of land, impacting on transit-oriented urban forms as consequence. In terms of policy, then it would appear that physical planning strategies to reduce car dependence need to work in concert with other actions oriented to charge more for car ownership and use in cities, and vice versa as clarified by the correlations among variables included within the formula.

In this instance Singapore and Tokyo are examples of cities where the costs of car ownership and use have been set high for many years and physical planning policies have emphasised development patterns oriented to transit, walking and cycling.

6 CONCLUSIONS AND IMPLICATIONS

In summary, although a physical planning policy as variable might complete the formula proposed, the conclusion of the study gives evidence of the implications determined by the complex phenomena observed. The urban travel behaviours in Saudi Arabia is a phenomenon constantly changing as a result of different and correlated exogenous factors, which are related to political, economic, financial social sphere but also, deeply linked with urban strategies and urban management. Despite the forecasts are uncertain and often unpredictable, automobile dependence in cities is not inevitable in any case. As agreed with Kenworthy et

al. (1999), the capacity to make more transit oriented the cities is highly depended on the responsiveness of public policy in handling the correlation among variables and their impact within detailed programs or agendas. In this instance, urban policy and its instruments are not a panacea for all contexts. Rather, the effectiveness of these tools is strongly associated with the ability to make urban policy part of a bigger project as a mosaic extremely complex. In this sense, the current political will and the reform of the Kingdom would seem to be oriented in making cities part of future development, and the formula proposed would indicate the main determinants to achieve this purpose in the next future. Due to increasing car ownership, traffic congestion is becoming a serious problem and introducing public transport is being considered by the planning authority as a way of reducing traffic congestion and meeting the future travel requirements of the city. Travel behavior inside the three observed cities is influenced by the whole urban structure, by economy reason and by urban and political strategies. Not less important are social factors that has to be studied and has to inspire every urban action. The urban form of Saudi cities is deeply based on the use of the car; Saudi cities are characterized by low density, single-use development, spacious houses and buildings. Urban form is dominated by infrastructures with an horizontal spreading of urban area with some level of dispersion of houses and buildings. In Saudi Arabia there is an urgent need for investments in the infrastructure services to meet the needs of the current demand. Furthermore, the city needs many of the necessary elements that create a healthy environment, and better life quality. One of the most important elements is creating public transport system to reduce the car dependency and its negative effects (wasting time in traffic congestion, air pollution, road accidents, low use – less than 2% of trips – of public transport, oil consumption and not sustainable development...). In all Saudi Arabia there is the need to have some important strategies that will help to work on urban patterns and to change urban form making able to change travel behavior of Saudi inhabitants; something has done by UN-Habitat, for example with the Future City Programme; this could be seen as a start point to work on the complexity of Saudi cities, on their economy, environment, policy and management, focusing on promoting the ability to elaborate some vision able to reduce the car dependency and able to promote the construction of another image of the city. To achieve this is needed time, citizens' and political awareness, technical ability and a good and strong urban management. It is needed a strategic urban governance that interests and involves every urban stakeholder.

REFERENCES

- ADA. (2004/1424H). Public Transport Study For the City of Arriyadh: Pilot Project - Phase I (Executive Summary). Riyadh: Ar-Riyadh Development Authority.
- ADA (2004) Masterplan phase 2. High commission for the development of Riyadh, Arriyadh Development Authority 2004.
- Alarabiya. (2012). *The gasoline in Saudi Arabia is the cheapest among the Gulf Countries*. Retrieved January 25, 2013. Available at: <http://www.alarabiya.net/articles/2012/08/24/233891.html>
- Al-Atawi, A. & Saleh, W., (2014) "Travel behaviour in Saudi Arabia and the role of social factors", *Transport*, 29 (3): 269-277. doi: <http://dx.doi.org/10.3846/16484142.2014.913199>
- Aldalbahi, M. & Walker G., (2016), "Riyadh Transportation History and Developing Vision", *Procedia - Social and Behavioral Sciences*, Vol.1, Pag. 163-17
- Al-Dubikhi, S. A. (2007). Exploring the potential for successful public transport in Riyadh. PhD thesis, Architecture, Building and Planning, The University of Melbourne
- Al-Fouzan, S. (2011). Reducing Car-Dependence in Ar-Riyadh City through the Integration of Land-use Planning and Transport. Unpublished PhD, Department of Architecture and Building Science, Strathclyde, Glasgow, UK
- Al-Hathloul, S. (2002). Riyadh Architecture in One Hundred Years. Paper presented at the Darat al-Funun on April 21, 2002, Amman

- Al-Hathloul, S. & Mughal, M. (1991). Jeddah. *Cities*, 8 (4): 267–273.
- Aljoufie, M., et al. (2012) "Spatial-temporal analysis of urban growth and transportation in Jeddah City, Saudi Arabia", *Cities*, 31: 57–68. doi: <http://dx.doi.org/10.1016/j.cities.2012.04.008>
- Al-Mosaind, M. (2001). The Effect of Changes in Land Use Distribution on Travel Patterns in Riyadh, Saudi Arabia. Paper presented at the Conference of Planning for Cities in the 21st Century: opportunities and Challenges (WPSC), Shanghai.
- Alqhatani M., Setunge S. & Mirodpour S. "Can a polycentric structure affect travel behavior? A comparison of Melbourne, Australia and Riyadh, Saudi Arabia" in *J. Mod. Transport.* (2014) 22(3):156–166. doi: <http://dx.doi.org/10.1007/s40534-014-0054-y>.
- Australian Bureau of Statistics, vehicle ownership, available at: <http://www.abs.gov.au>.
- Bureau of Transportation Statistics, United States Department of Transportation, vehicle ownership rates, available at: <https://www.bts.gov>.
- Bahaydar m. H., "Urban sprawl and its negative effects on Jeddah", Research paper presented at Ball State University, Indiana, 2013.
- Buraidah city review report, future of Saudi cities program (2017), UNHabitat.
- Cervero, R. (1998). *The Transit Metropolis: A Global Inquiry*. Island Press, Washington, DC.
- Daghistani, A. (1993). A case study in planning implementation. Working Paper No. 32. University of Newcastle upon Tyne.
- Dammam city review report, future of Saudi cities program (2016), UNHabitat.
- French Property, available at: <https://www.french-property.com>.
- Future Saudi City Program, available at: <https://www.futuresaudicities.org>.
- General Authority for Statistics, vehicle ownership rates, available at: <https://www.stats.gov.sa/en>.
- Government of the United Kingdom, available: <http://www.Gov.uk>.
- Global Mass Transit, (2016) "Public transport in Saudi Arabia: Priority sector for government investment", available at: <https://www.globalmasstransit.net/archive.php?id=24083>.
- Gulf Petrochemicals and Chemicals Association, (2017), "Saudi's automotive ambitions grow Saudi Arabia is planning to become the region's car manufacturing hub", available at: <http://www.gpca.org.ae/news/saudis-automotive-ambitions-grow-saudi-arabia-is-planning-to-become-the-regions-car-manufacturing-hub>.
- Ibi, G. (2007). Jeddah public transportation study. Saudi Arabia: Ministry of Transportation.
- Jeddah Municipality (2004). Jeddah structure plan. Saudi Arabia: Jeddah Municipality.
- Jeddah Municipality (2006). Transportation and traffic development plan. Saudi Arabia: Jeddah Municipality.
- Jeddah Municipality (2008). Jeddah transportation urgent plan.
- Kenworthy J.R. & Laube F.B. (1999) "Patterns of automobile dependence in cities: an international overview of key physical and economic dimensions with some implications for urban policy", *Transportation Research Part, A* 33, 691–723.
- Koushki, P., A. (1987) "The effect of socio-economic development on household travel behavior in Saudi Arabia", *Socio-Economic Planning Sciences*, 2 (3): 131–136. doi: [http://dx.doi.org/10.1016/0038-0121\(88\)90014-6](http://dx.doi.org/10.1016/0038-0121(88)90014-6).
- Kingdom of Saudi Arabia, Vision 2030, available at: <http://vision2030.gov.sa/en>.
- Kingdom of Saudi Arabia, National Transformation Program 2020, available at: http://vision2030.gov.sa/sites/default/files/NTP_En.pdf.
- Limtanakool, N., Dijst, M., Schwanen, T. (2014) "The influence of socioeconomic characteristics, land use and travel time

considerations on mode choice for medium- and longer-distance trips", *Journal of Transport Geography*, 14: 327–341.

Litman, T. (2011), "The Future Isn't What It Used To Be Changing Trends And Their Implications For Transport Planning", Victoria Transport Policy Institute, available at: <http://www.vtpi.org/future.pdf>.

Masoumi H. E. (2013), Modeling the Travel Behavior Impacts of Micro-Scale Land Use and Socio-Economic Factors Smart. *TeMA Journal of Land Use, Mobility and Environment*, Vol. 2, pp 235-250. doi: <http://dx.doi.org/10.6092/1970-9870/1547>.

Middleton D. A., (2009). Growth and Expansion in Post-War Urban Design Strategies: C. A. Doxiadis and the First Strategic Plan for Riyadh Saudi Arabia (1968-1972). Georgia Institute of Technology: Doctor of Philosophy in Architecture.

Ministry of Interior, Kingdom of Saudi Arabia, available at: <https://www.moi.gov.sa/wps/portal/Home/Home>.

MOMRA (1980). Jeddah action master plans: Technical report no. 5: Transportation survey (Vol. 2). Ministry of Municipal and Rural Affairs, Riyadh, Saudi Arabia.

Moraci F. 6 Fazio C. (2013) Le città smart e le sfide della sostenibilità. *TeMA Journal of Land Use, Mobility and Environment*, Vol. 6, n. 1, pp 35-45. doi:<http://dx.doi.org/10.6092/1970-9870/1459>.

Newman, P. & Kenworthy, J. (1999). Sustainability and Cities: Overcoming Automobile Dependence. Island Press, Washington, DC.

Observatory of Economic Complexity, the MIT Media Lab, available: <http://www.atlas.media.mit.edu>.

Oxford business group, "Saudi Arabia's new development plan shows clear commitment to education and the private sector", available at: <https://oxfordbusinessgroup.com/analysis/long-game-new-development-plan-shows-clear-commitment-education-and-private-sector>.

Sami Abdullah Al-Dubikhi (2007). Exploring the Potential for Successful Public Transport in Riyadh. Melbourne: The University of Melbourne, Australia.

Saudi Arabian Monetary Authority, (2017), "53rd Annual Report", Available at: <http://www.sama.gov.sa/en-US/EconomicReports/AnnualReport/Fifty%20Third%20Annual%20Report.pdf>.

Saudi Arabia, UNHabitat, available at: <https://unhabitat.org/saudi-arabia>.

The Economist, Why the oil price is falling, available at: <https://www.economist.com/blogs/economist-explains/2014/12/economist-explains-4>.

The telegraph, (2017) "Saudi Arabia to allow women to drive in major milestone for country", available at: <http://www.telegraph.co.uk/news/2017/09/26/saudi-arabia-allow-women-drive/>.

The World Factbook, Middle East: Saudi Arabia, available at: <https://www.cia.gov/library/publications/the-world-factbook/geos/sa.html>.

UN-Habitat (2013), Streets as public spaces and drivers of urban prosperity, Nairobi.

UN-Habitat (2015), Future Saudi Cities Programme, International Experiences on National Spatial Frameworks, Nairobi.

UN-Habitat (2015) Spatial Capital of Saudi Arabian cities. Street connectivity study for the city prosperità initiative. Nairobi.

Un-Habitat (2016), Review National Spatial Strategy, Kingdom of Saudi Arabia, Nairobi.

Washington Post, (2017) "Saudi Arabia wants to revitalize its economy. Letting women drive will be part of that", available at: https://www.washingtonpost.com/news/worldviews/wp/2017/09/29/saudi-arabia-wants-to-revitalize-its-economy-women-drivers-will-be-part-of-that/?utm_term=.a52edffc209d.

IMAGE SOURCES

Fig. 1: Alqhatani, Setunge, Mirodpour, 2014.

Fig. 2, Fig. 3: UN-Habitat, 2016

AUTHOR CONTRIBUTIONS

Maurizio Francesco Errigo conceived and wrote paragraphs "Introduction", "Urban Patterns related to mobility" and "Planning Tools in Saudi Arabia". Giuseppe Tesoriere conceived and wrote paragraphs "Saudi Arabia Economic Overview" and "Urban travel behavior: determinants and impacts of public policy". Maurizio Francesco Errigo and Giuseppe Tesoriere conceived and wrote together "Conclusions and implications". The manuscript was produced through contributions of all authors; all authors have given approval to the final version of the manuscript.

AUTHOR'S PROFILE

Giuseppe Tesoriere. PhD student in Economics, Law and Business at Kore University of Enna. He holds a Master of Science in Economics at University of Palermo, and took two executive education programs in PFM in developing countries and Economic growth at Harvard Kennedy School, specialisation in Econometrics and quantitative analysis from SIdE - Italian Econometric Association and followed a course on Urban and Metropolitan areas at MIT

Maurizio Francesco Errigo. Researcher and Assistant Professor in Urbanism at Faculty of Engineering and Architecture, University of Enna Kore. PhD in Urban Planning (2007). Advanced Training Course in Design of the coastal landscape (2004) Master in Management of Local Authorities (2010). From 2007 to 2011 He is Professor at Mediterranean University of Reggio Calabria. From 2011 to 2013 Post Doc researcher at Delft University of Technology, where He is Professor at MSc in Urbanism (2012-2013).

TeMA Urban Travel Behavior in the Middle East and North Africa
SPECIAL ISSUE 1.2018 | 47-66
print ISSN 1970-9889, e- ISSN 1970-9870
doi: <http://dx.doi.org/10.6092/1970-9870/5452>

review paper received 29 January 2018, accepted 06 april 2018

Licensed under the Creative Commons Attribution
Non Commercial License 3.0
www.tema.unina.it

Ceylan, H., Baskan, O. & Ozan, C. (2018). Modeling and forecasting car ownership based on socio-economic and demographic indicators in Turkey. *Tema Journal of Land Use, Mobility and Environment*. 47-66 doi: <http://dx.doi.org/10.6092/1970-9870/5452>



MODELING AND FORECASTING CAR OWNERSHIP BASED ON SOCIO-ECONOMIC AND DEMOGRAPHIC INDICATORS IN TURKEY

HUSEYIN CEYLAN^a, OZGUR BASKAN^b, CENK OZAN^c

^a Department of Civil Engineering, Pamukkale University; e-mail: hceylan@pau.edu.tr URL: <http://www.pau.edu.tr/insaatmuhendisligi>

^bDepartment of Civil Engineering, Pamukkale University e-mail: obaskan@pau.edu.tr URL: <http://www.pau.edu.tr/insaatmuhendisligi> ^cDepartment of Civil Engineering, Adnan Menderes University e-mail: cenk.ozan@adu.edu.tr URL: <http://www.akademik.adu.edu.tr/bolum/muhendislik/insaat/>

ABSTRACT

Since car ownership is an important determinant to analyze car travel behavior especially in developing countries, this paper deals with modeling and forecasting car ownership in Turkey based on socio-economic and demographic indicators such as Gross Domestic Product (GDP) per capita, Gasoline Price (GP), car price and number of employees by using multiple nonlinear regression analysis. Although most of the studies on this subject prefer using annual data, we use monthly data for the analysis of car ownership since all explanatory variables and exchange rates used for the modeling are unstable and vary even in a short period in developing countries such as Turkey. Thus, it may be possible to reflect the effects of socio-economic and demographic indicators on car ownership more properly. During the modeling process, exponential and polynomial nonlinear regression models are set up and then tested to investigate their applicability for car ownership forecasting. Based on results of the Kolmogorov-Smirnov test, the polynomial models has been selected to forecast car ownership for the year 2035. In order to reveal the possible different trends of the independent variables in future, car ownership is forecasted along the scenarios which are related to the GDP per capita and GP. Results show that Turkey's car ownership may vary between 230 and 325 per thousand capita in 2035 depending on economic achievements, global oil prices and national taxation policies. The lowest and the highest values of the car ownership may provide insight to car producers and transport planners in Turkey. Another significant result presented in this study is that car ownership rate will be substantially lower in Turkey than that in the European Union countries despite it has an increasing trend in the past two decades.

KEYWORDS:

Car ownership; Socio-economic and demographic indicators; Multiple nonlinear regression

1 INTRODUCTION

Beginning from the second half of the 20th century, there is a substantial increase in car ownership in almost all industrialized countries, and more recently in many of the developing countries (Dargay & Gately, 1997). Thus, car ownership has received considerable attention especially for three decades because of its increasing trend over the years and also its important role in the overall planning for transportation decision-makers and car manufacturers. As known, although some additional costs arise after owning a car by a household (i.e. fixed costs, taxes, parking costs, car inspection costs, etc.), environmental and road infrastructure related problems come to exist resulting from high use of car rather than owning a car. However, it is clear that there is a non-negligible relationship between car ownership and car use. For this reason, modeling and forecasting car ownership has been one of most studied topics in the transportation field for many years regarding to importance both in land-use and transportation road network planning as well as its relationship transport related problems such as energy consumption, environmental and health effects. Thus, the objective of this study is to develop a forecasting model for car ownership and apply it to determine future trends of car ownership in Turkey for the year 2035.

Before presenting the literature review in the context of car ownership, in connection with this issue, it should be noted that Turkey applied for full membership to the European Union (EU) in 1987 (Ministry for EU Affairs, 2018). However at that time, the EU's decision about the accession of Turkey to the EU was not positive although the EU underlined Turkey's eligibility for membership. The accession of Turkey was prevented by the EU's own situation on the eve of the single market completion which prevented the consideration of further enlargement. The EU also pointed out that Turkey needs to improve its economy and make some improvements in related policies and social fields. In the context of car ownership which may be a sign for development level of a country, car ownership rate in Turkey was significantly less than those in European countries in the year of accession application to the EU made by Turkey as can be seen in Fig. 1. The figure illustrates the variation of car ownership rates of European countries per thousand capita from 1990 to 2015 based on the data provided by Eurostat (2018a). The rate of car ownership in Turkey was 29 per thousand capita in 1990 which is the smallest rate of car ownership among the European countries.

This value was nearly half of the car ownership rate of Romania which has the second lowest car ownership rate in 1990. In addition to this, other statistic shows the seriousness of the situation in terms of Turkey is that the average rate of car ownership was 290 per thousand capita in European countries at the same year. This situation can be seen in the Figure 1 such that car ownership rates were higher than the value of 300 per thousand capita in several west European countries while it was above 400 per thousand capita in many others in 1990. In the later years, increasing trend of car ownership continued in most of the European countries such that particularly Italy reached the value of 533 per thousand capita in 1995. At that time, this value was more than ten times of Turkey's car ownership of 49 per thousand capita. By the time Turkey solely reached the value of 100 passenger cars per thousand capita in 2010, the average car ownership was 448 per thousand capita in EU countries. By the year of 2015, Turkey was one of the six countries with less than 200 passenger cars per thousand capita in Europe as can be seen in Figure 1. These statistics clearly show that the modeling and forecasting car ownership in Turkey needs to be seriously taken into consideration and reasons for significantly low rates of car ownership in Turkey have to be revealed by considering effective parameters. As known, car ownership can be modeled as a function of socio-economic and demographic variables (Ben-Akiva et al., 1981; Janson, 1989). Additionally, there are two types of car ownership models such as disaggregate and aggregate. In disaggregate models, which may be called as micro analysis, the household is the basic unit for modeling car ownership whilst the aggregate model is interested in modeling car ownership on a macroscopic level within the range from a city zone to a country.

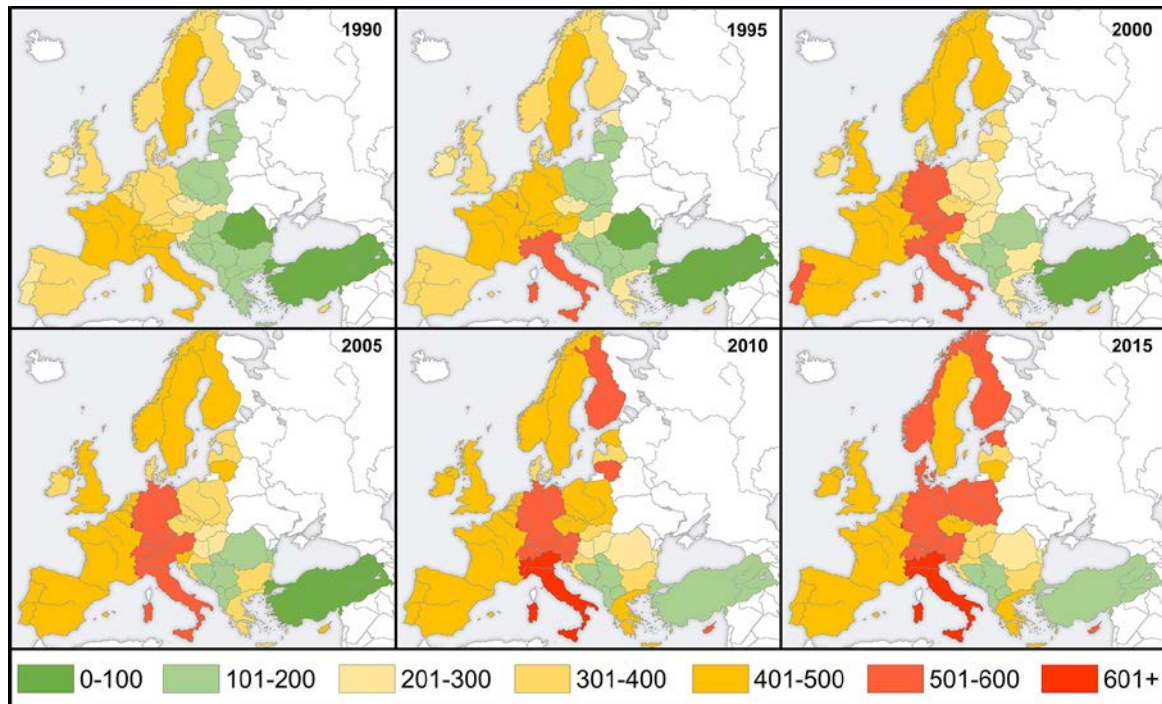


Fig. 1 Historical development of car ownership in European countries between 1990 and 2015 (per thousand capita)

In this context, one of the first studies was presented by Meurs (1993) in which car ownership level by household has been investigated using a panel data model. It has been found that owning the second car by household was more sensitive to changes in the explanatory variables of the model. Dargay & Gately (1997) forecasted the growth in car ownership until 2015 for Organization for Economic Cooperation and Development (OECD) and six Asian countries. They forecasted car ownership using Gompertz function regarding to independent variables such as income and population. They found that the increase on fuel consumption and emissions on those countries were about the same trend within studied period. Afterwards, Dargay & Gately (1999) projected car growth and total vehicle stock until 2015 for OECD countries including three Asian countries. The projections were executed based on the estimated model that explains the growth of car ownership as a function of Gross Domestic Product (GDP) per capita. In addition to these studies, the effect of income distribution was studied by Dargay (2001). It was found that the income elasticity on car ownership was significantly greater with respect to the rising income than the elasticity with respect to the falling income. From a different viewpoint, Romilly et al. (2001) addressed some quite new techniques to avoid uncertainties caused by some methods in car ownership modeling. They proposed five alternative methods by considering relationships between car ownership, income, motoring costs and bus fares. Another contribution to the literature from this study, the inclusion of bus fare variable in the model makes it more sensitive and it also allows to consider different assumptions regarding to the public transport user costs. Similarly to the study by Romilly et al., Medlock & Soligo (2002) modelled car ownership by considering related data from 28 countries. One of the most important results was that the income elasticity falls whereas countries become increasingly developed contrary to the widely held view in the literature. Similarly, Lam & Tam (2002) presented a car ownership model by using eight independent variables effecting car ownership. Results showed that the GDP per capita has positive effect on the growth of the total number of private cars and motorcycles while average first registration tax and annual passenger trips on public transport have negative effect on car ownership. Ögüt (2004) modelled car ownership in Turkey by using three different models namely Logistic, Power growth and Gompertz curves for the year 2020. Results emphasized that the future trends of car ownership for the models Power growth and Gompertz curves were quite similar to each other. Kumar & Rao (2006) conducted a stated preference experiment by using

multinomial logit model in order to determine the growth of car ownership in the context of household surveys. Their results revealed that stated preference approach may help planners who need to determine car ownership decisions of households in especially developing countries. It can be seen from the revealed literature, researchers have used several methods for modeling car ownership by looking from different perspectives so far. At this point, a fuzzy multiple-regression model was used to determine car ownership in Turkey over the period of 1970-2000 by Ögüt (2006). The major reason for applying fuzzy regression was to overcome the inter-correlation problem associated with the independent variables. Results showed that the proposed model provided an output range about the growth of car ownership in Turkey between 1970 and 2000 by applying fuzzy regression. Clark (2007) remarked that income is a significant determinant for car ownership modeling. In addition to this, it has also been emphasized in this study that the use of cross-sectional data by modeling may lead to an overall conclusion which does not reflect the variation of local circumstances. Potoglou & Susilo (2008) compared multinomial logit, ordered logit and ordered probit car ownership models by using different data sets in terms of evaluation measures. Results showed the advantage of the use of multinomial logit car ownership model in the level of household by comparison of three models. From the point of disaggregate models, one of the pioneer works in the literature has been conducted by Potoglou & Kanaroglou (2008). They examined the influence of micro level data in modeling car ownership in the context of household. The reason which differs this study from the others is that the neighborhood characteristics were included in the model by introducing several measures related to the neighborhood household. Additionally, the effect of urban structure which is another efficient parameter on household car ownership has been studied in the work by Matas et al. (2009). In their study, urban structure has been considered by means of accessibility to employment by public transport. Results showed that the most important variable affecting to the growth of car ownership is spatial variable. As another point of view, Çodur & Tortum (2009) proposed an Artificial Neural Network (ANN) approach for modeling car ownership in Turkey based on aggregate data such as GDP per capita, petrol prices, car prices, and road lengths. The proposed model has been compared with the multiple linear regression model. It has been concluded that the ANN approach outperforms the linear regression model and it is more reliable in terms of the ability of nonlinear behavior. Woldeamanuel et al. (2009) addressed that analyzing the factors affecting car ownership of household requires time-dependent behavior of family members. Thus, a panel data model has been applied to examine variation of car ownership by considering this issue. Acker & Witcox (2010) used car ownership as mediating variable in order to determine the relationship between car use and built environment by using a structural equation modeling approach which validates the proposed hypothesis. Azadeh et al. (2012) proposed a new approach combined the ANN and Fuzzy Linear Regression to forecast car ownership much more reliably in uncertain environments. Results confirmed that the proposed approach provided more reliable forecasting for car ownership by considering socio-economic and demographic variables. Chen and Zhang (2012) investigated the growth of car ownership by using city-level aggregate data under different policies implemented in megacities in China. In their study, a principal component analysis has been applied and the results indicate that the relationship between income and the growth of car ownership was very strong in China. Ritter & Vance (2013) analyzed specifically the effect of family size on car ownership in Germany. They used multinomial logit model considering other explanatory variables namely the availability of public transport, fuel prices and land use density. Results showed that the proposed model estimated increasing trend in the number of cars although the population decreased. Another study conducted in city-level by Anowar et al. (2014) examined the effect of population on car ownership rather than other exogenous variables by using ordered and multinomial logit models. According to the results, the ordered logit model clearly revealed the advantage of considering of segmentation in the population. A different type of logit models namely sequential logit model has been proposed to forecast car ownership in Turkey by Akay & Tümsel (2015). Based on disaggregated data provided by 3722 households in the year of 2013, the dominant parameter affected the probability of owning a car of household was

found as income. In another study conducted in Turkey by Yayar et al. (2015), disaggregate data has been used to model car ownership in the city-level. The model was estimated by using binary logit model. It has been found that car ownership of a household was positively affected if household head was a homeowner and had high income. Guerra (2015) looked the problem from different perspectives and investigated the relationship between car ownership and suburbanization. Results relied on mixed logit model showed that both variables are highly correlated with each other and move hand in hand. To further illustrate the concept of disaggregate data, Yagi & Managi (2016) performed an empirical study of the car cohort model with demographic determinants of car ownership in Japan. One of the significant results drawn from this study is that the elasticities of income and fuel prices on car ownership have a tendency to decrease. Shen et al. (2016) examined the factors affecting car ownership using different types of logit models. The major finding in this study is that car ownership tends to decrease when households in suburban are benefited from rail transit. Korkmaz et al. (2016) proposed artificial bee colony algorithm to forecast car ownership in Turkey for 2025 based on some variables such as population, GDP per capita, and fuel prices. They have found that the car ownership rate in Turkey will be reach to the value of 150 per thousand capita in 2025 according to considered explanatory variables. Recently, Yang et al. (2017) investigated how the growth of car ownership affects the use of urban space and environment. Using aggregated data within the years 1994 and 2012 the proposed model has been applied to 293 cities in China. Results showed that car ownership was directly related to GDP per capita, built-up area, road area, urban density and number of taxis. Transport planners frequently require information on car ownership and they utilize it for designing transportation infrastructure, determining travel behaviors, planning road safety measures etc. For example, Sinniah et al. (2014) investigated residential location preferences related to travel behavior. In the study, after it is stated that the relevant literature concentrates on the preferences in relation to physical and demographic aspects, such as land uses, car ownership, income, etc., it is suggested that social and cultural issues such as racial diversity should be taken into account for residential location preferences. For this purpose, reliability analysis and factor analysis are applied to determine that religious and culture are influential in terms of residential location preferences. In the conclusions, it is indicated that this approach adds a different perspective on travel behavior studies. Soltanzadeh and Masumi (2014) investigated the most influential determinants of modal choices in Kerman, Iran. It is indicated that accessibility to public transportation and convenience of it may convince people to shift from car driving to public transit use. In addition, it is pointed out that the four variables of gender, household size, age, and car ownership significantly affect modal choice decisions. From a different viewpoint, there is a well-known paradox between transport planners and car manufactures such that one usually tries to reduce car use while the other one tries to maximize sales figures. Nevertheless, forecasting car ownership may help car producers to manage their selling business and transport planners to plan their policies related to transportation infrastructure and safety measures. In this study, it is considered that the most important parameters affecting the growth of car ownership in Turkey are GDP per capita, Gasoline Price (GP), Car Price (CP), and Number of Employees (NE). Thus, this study deals with modeling and forecasting car ownership by using multiple nonlinear regression model based on explanatory variables under different scenarios. The paper is organized as follows. The model variables with their historical development for the observation period and multiple nonlinear regression models are given in the next section. Forecasting car ownership and related scenarios are presented in Section 3. Finally, last section is about conclusions and future directions.

2 MATERIALS AND METHODS

2.1 MODEL VARIABLES

Determining and taking into account the parameters affecting car ownership have been the topic of many researchers. Most of the existing studies relied on socioeconomic and demographic indicators such as financial data and population. In this study, car ownership in Turkey is modeled and forecasted based on GDP per capita, gasoline prices, car prices and number of employees. In this section, historical data for the model variables are presented.

Car ownership

In the early 1970's, car ownership was considered a privilege or a luxury that there were only 4 cars per thousand capita in Turkey (Öğüt, 2006). This value has reached 134 per thousand capita at the end of 2015. The historical development of car ownership in monthly basis between January 1997 and December 2015 is given in Figure 2 (TSI, 2018a).

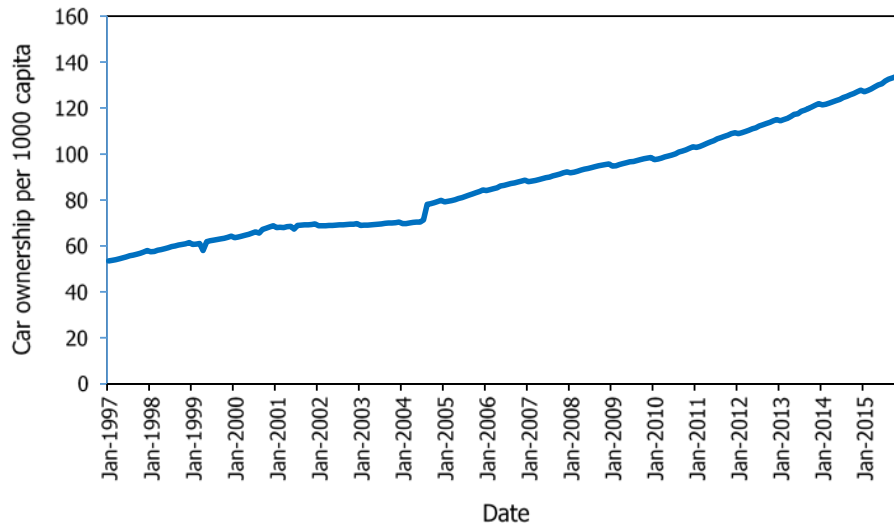


Fig. 2 Historical development of car ownership in Turkey, 1997-2015

As can be seen in Figure 2 that the tendency to increase in car ownership between 1997 and 2000 has stopped due to the 2001 Turkish economic crisis and this steady state continued until the middle of 2004. Together with the reduction in the impacts of the economic crisis, a large amount of car sales realized due to the long-suppressed car ownership demand in 2004, and the car ownership has continued to grow since then. Another reason for this sudden spike in car ownership in 2004 is that a tax incentive implemented by the central government of Turkey between August 2003 and December 2004 in order to renew the passenger car stocks by Turkish Law Number 4962. With this regulation, the average age of passenger car stock in Turkey rapidly decreased from 6.1 to 5.3 at the end of 2004, while this value has slightly decreased to the value of 4.3 in 2015 (Eurostat, 2018b). These results clearly show that this tax incentive had a direct effect on car sales and passenger car stock has continued to be renewed depending on new car sales in Turkey. However, the rate of car ownership in 2015 in Turkey is still much less than that in European countries because of several reasons related to socio-economic and demographic determinants.

GDP per capita

GDP per capita is one of the most important parameters in car ownership decision, particularly for a household owning a second car as mentioned in the previous section. Wu et al. (2014) indicated that there is an S-shaped relationship between GDP per capita and car ownership rates in their study. It means that there is a saturation point for car ownership. In this context, Rota et al. (2016) determined the saturation

level of car ownership based on the aggregated data from 59 countries including EU members as about 622 per thousand capita. As the rate of car ownership in Turkey is still substantially lower than this value, it is strongly expected that it continues to grow depending on the development of the GDP per capita. In this context, the International Monetary Fund (IMF) recognizes Turkish economy as an emerging market economy as one of the world's newly industrialized countries (IMF, 2011). Main economic sectors of Turkey are agricultural, industrial, service, construction and contracting sectors. With the 5.1 percent growth in 2017, Turkey has played an important role on short-term growth on emerging and developing European economy (IMF, 2017a). According to the IMF, Turkey has the world's 13th largest GDP by purchasing power parity and 17th largest nominal GDP (IMF, 2017b). The historical development of GDP per capita in Turkish Lira (TL) and USD exchange rate in monthly basis between January 1997 and December 2015 is given in Figure 3 (TSI, 2018b).

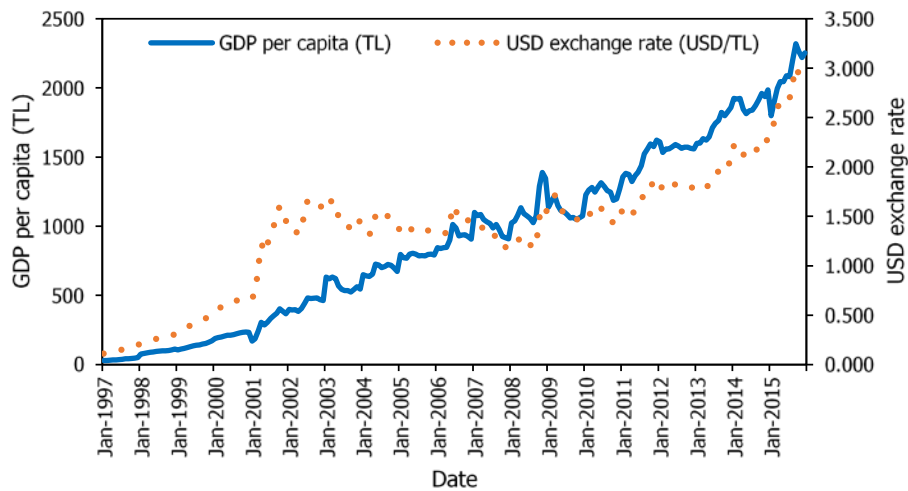


Fig. 3 Historical development of GDP per capita in Turkey, 1997-2015.

It can be seen in Figure 3 that TL has appreciated and depreciated periodically between 1997 and 2015. This fluctuation and sudden spikes in inflation rate leads to an unstable GDP per capita growth in Turkey. On the other hand, it may be clearly seen that the GDP per capita has increased in the last two decades in Turkey and will increase about %29 by 2022 (IMF, 2017b). In Figure 4, passenger vehicle stocks with respect to the GDP per capita in Purchasing Power Standards (PPS) is illustrated for the EU countries and Turkey for 2015 (Eurostat, 2018a; 2018c).

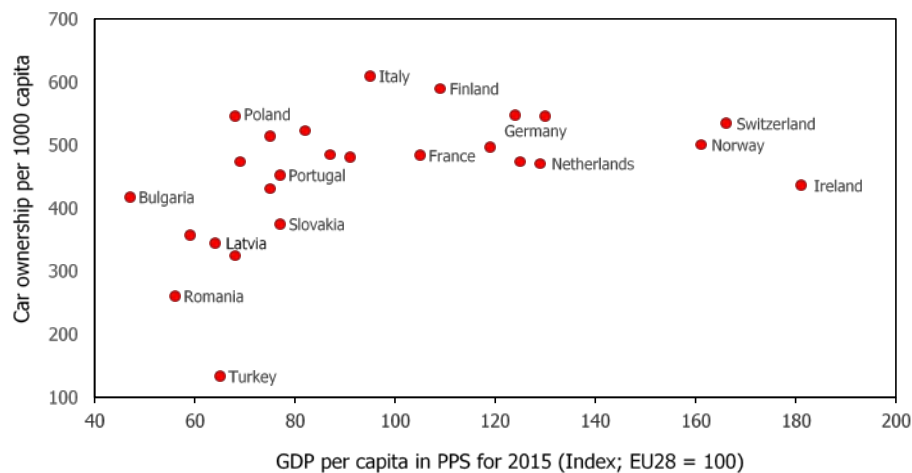


Fig. 4 Car ownership and GDP per capita in EU countries and Turkey

As can be seen in Figure 4 that car ownership value is around 500 per thousand capita in several EU countries in which GDP per capita is above 70. As for the rest, the passenger car stock varies between 250 and 400 while it is 134 for Turkey. It should be noted that the car ownership ratio in Turkey is three times lower than Latvia although similar PPS values are observed in two countries. Therefore, car ownership rate is still substantially lower in Turkey than in the European Union countries despite an increasing trend in the past decades.

Car prices

Individual car ownership in Turkey began with opening two new automobile factories, Tofaş-Fiat and Oyak-Renault in 1968 and 1969, respectively. In the following years, Ford, Honda, Hyundai and Toyota has produced automobiles in their factories in Turkey. Although the Turkish automotive industry becomes an important actor of the national economy, it serves for the production of foreign brands and countries. For instance, 0.6 million passenger cars were registered in Turkey in 2014 and about 65% of total registrations were imported from France, Germany, Italy, Korea, Japan and United States (TSI, 2018a). Therefore, car prices not only are dramatically affected by the inflation and tax rates, but also depend on USD and EURO exchange rates. While the average car price is about 1500 TL in 1997, this value exceeded 50,000 TL at the end of 2015. The historical development of average car prices and USD exchange rate in monthly basis between January 1997 and December 2015 is given in Figure 5 (TSI, 2018c).

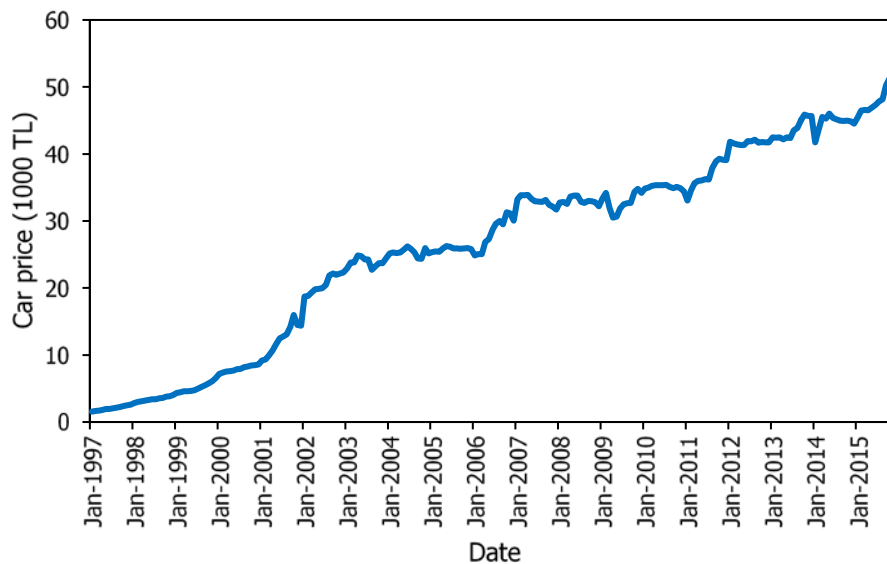


Fig. 5 Historical development of car prices in Turkey, 1997-2015

In addition to the car prices, impact of tax policies can be considered as a very strong determinant in car ownership decision in Turkey. The central government of Turkey implements a policy called "Special Consumption Tax" (SCT) in car sales means that a buyer has to pay the SCT up to 110% of the net price of the car that he wants to purchase. Furthermore, 18% value added tax is implemented on net price plus SCT at purchase. Due to this taxation system, buyers have to pay almost two times more for owning a new car in Turkey. Despite the high tax rates, the car ownership in Turkey continues to grow and it may be useful to investigate the potential impacts of car prices on car ownership.

Gasoline prices

Energy demand of Turkey rapidly grows as well as the increase of population and growing industrialization. According to the Ministry of Energy and Natural Resources (MENR), domestic crude oil resources could meet only 7.7% of demand in 2017 (MENR, 2018).

Therefore, Turkey's major imported energy source is mineral fuels including crude oil. In order to provide a trade balance between import and export, high tax policies are implemented and the consumers face very high retail prices of diesel, gasoline and LPG. The historical development of gasoline prices between January 1997 and December 2015 is given in Figure 6 (TSI, 2018c).

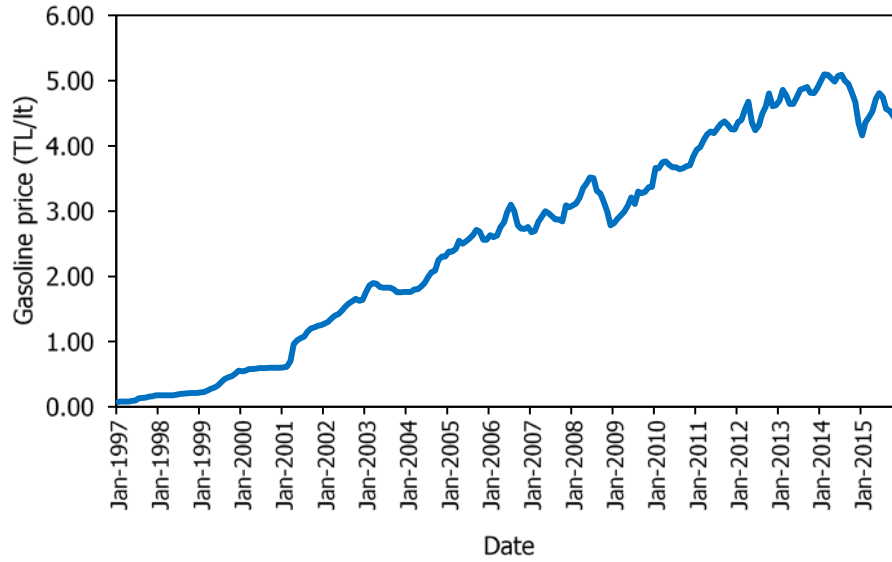


Fig. 6 Historical development of gasoline prices in Turkey, 1997-2015

As can be seen from Figure 6 that the gasoline price was about 0.08 and 4.37 TL/litre in January 1997 and December 2005, respectively. It should be noted that gasoline prices have been fluctuated quite often in Turkey. Rapid decreases on retail prices arise from decrease on global oil prices while spikes arise from increase on global oil prices and taxes. It should also be noted that this fluctuation depends on appreciation and depreciation of Turkish currency against the US dollar as well.

In the point of view of tax policies on gasoline prices, Turkey can be considered as one of the countries which has the highest gasoline prices in the world owing to high excise taxes on gasoline prices (OECD, 2016). According to the statistics by Republic of Turkey Energy Market Regulatory (EMRA, 2017), net gasoline prices in December 2017 in Istanbul was 1.77 TL/lit but its value reached to 5.57 TL/lit with excise taxes and other expenditures such as wholesale margin, income share and retail margin. Thus, this determinant should be taken into account to model and forecast car ownership in Turkey as it is one of most important determinants to decide having a car for buyers with its significantly high price when considered operating cost of a car.

Number of employees

The rate of car ownership is sensitive to the changes in the ratio of the working population to the total population over time. Especially in Europe and Japan, while the working population has changed more slowly in the last 30 years, this rate has increased more rapidly in developing countries (Pişkin, 2017). The main reasons for this may be the demand in agricultural labor force decreased in rural areas and a large amount of people migrated to the cities in which growing industrialization revealed new job opportunities. The historical development of Urban Population Rates (UPR) of EU countries and Turkey between 1960 and 2016 is given in Figure 7 (The World Bank, 2018).

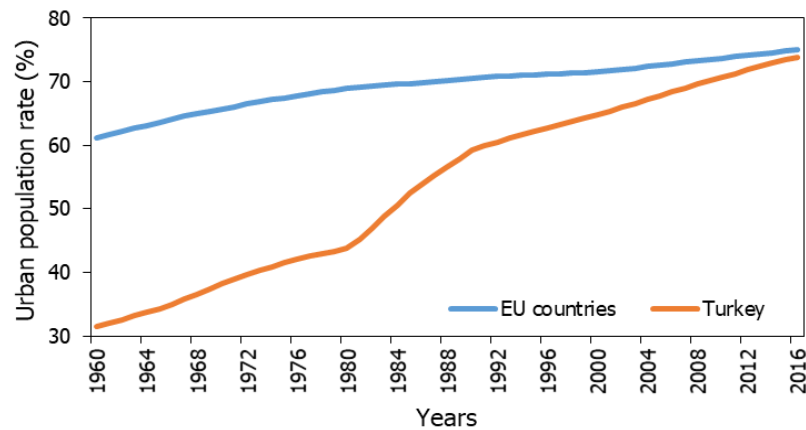


Fig. 7 Historical development of urban population rates of EU countries and Turkey, 1960-2016

It can be seen from Figure 7 that the UPRs are about 61% and 32% in 1960 for EU countries and Turkey, respectively. The UPR in Turkey increased about 134% between 1960 and 2016 while it increased only 23% in EU that most EU countries may have approached a saturation level. On the other hand, from 1960s, urbanization and industrialization developed in Turkey and growing number of people began to move to the cities and the urban population rate dramatically converged to the EU average in 2016 with the value of 74% which may be considered as a near-saturation point for Turkey. Therefore, it can be stated that the UPR in Turkey would not rise steeply in the medium and long term. However, car ownership rate is still substantially lower in Turkey than in the EU countries despite an increasing trend in the past decades. A reason for the lower car ownership rates in Turkey is that young (dependent) population ratio is relatively higher than developed countries. In order to evaluate the potential future labor force of Turkey, proportion of young population in five most populated EU countries and Turkey between 1997 and 2015 is given in Figure 8 (Eurostat, 2018d).

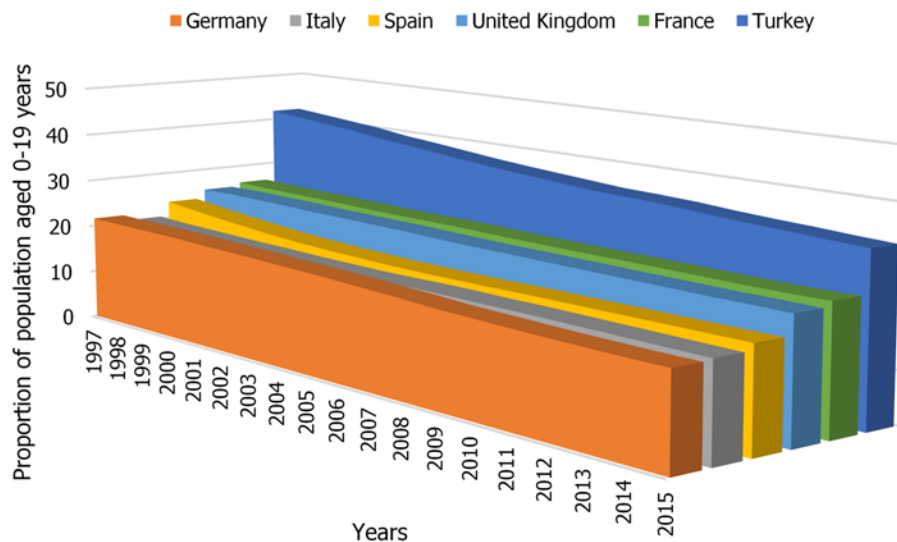


Fig. 8 Proportion of young population in five EU countries and Turkey, 1997-2015

As can be seen from Figure 8 that Turkey has higher proportion of young population than five most populated EU countries. It may be stated that the potential future labor force may lead to an increase of car ownership in Turkey. The historical development of number of employees between January 1997 and December 2015 is given in Figure 9 (TSI, 2018d). It can be seen in the figure that the number of employees

in Turkey is above 26 million in 2015 while it is about 21 million in 1997. It should be noted that the demand for seasonal wage labor in agriculture and tourism increases the number of employees between May and October every year.

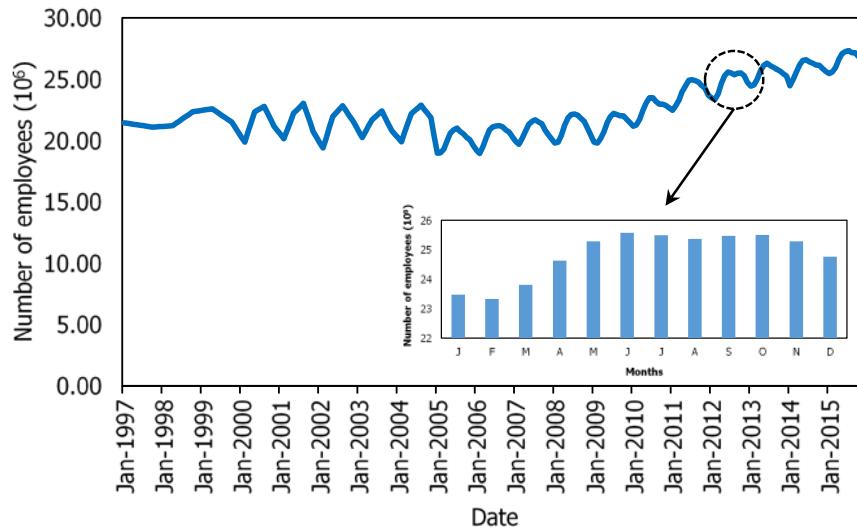


Fig. 9 Number of employees in Turkey, 1997-2015

2.2 MULTIPLE NONLINEAR REGRESSION MODELS

Before implementing the multiple regression models, the correlation coefficients given in Table 1 were calculated in order to show the relationships between explanatory variables affecting car ownership. It can be seen from the table that all determinants were correlated with car ownership and the highest correlation was demonstrated between car ownership and GDP per capita as 0.989. On the contrary, the lowest correlated determinant with car ownership was found as NE with the value of 0.744. Although the second highest correlated determinant with car ownership was GP with the value of 0.964, previous study presented by Baskan et al. (2008) demonstrated that the increase on gasoline prices may not considerably affect the rate of car ownership. In fact, historical development of gasoline prices in Turkey given in Figure 6 clearly shows the reason for this contrast. The GP has an increasing trend over the years and its value reached to 5.7 TL/lt from 0.08 TL/lt at the end of 2017¹. Thus, especially in recent years, the gasoline price has started to be effective determinant to decide buying a car for community living in Turkey due to its high increase.

| | GDP PER CAPITA | GP | NE | CP | CAR OWNERSHIP |
|----------------|-------------------|-------|-------|-------|------------------|
| GDP PER CAPITA | 1.000 | | | | |
| GP | 0.972 | 1.000 | | | |
| NE | 0.716 | 0.648 | 1.000 | | |
| CP | 0.968 | 0.978 | 0.601 | 1.000 | |
| CAR OWNERSHIP | 0.989 | 0.964 | 0.744 | 0.947 | 1.000 |

Tab. 1 Correlation coefficients of car ownership and its determinants

Nonlinear regression models play a more important role day by day since many engineering problems can be better expressed by using nonlinear models than linear. The reason is that many of explanatory variables affecting dependent variable have nonlinear relationship with each other.

¹ The data until at the end of 2015 are used for the whole analysis because of absence of data between the years 2015 and 2017 for other determinants.

There is also a nonlinear relationship between dependent and independent variables for many complex problems occurred in nature. Thus, the nonlinear model is commonly preferred option to analyze for such problems. Usually, a nonlinear model can be presented with the following equation:

$$y = f(x, \phi) + \xi \quad (1)$$

where y is the dependent variable i.e. response variable, f is the model, x is the independent variable, ϕ represents the model parameters to be estimated and ξ is the error term. It can be stated that a regression model becomes nonlinear when its parameters are nonlinear. For this, each of model parameters should be evaluated whether it is nonlinear or not. The nonlinearity of a model parameter can be decided by whether its second derivative equals to zero or not. Thus, the model can be recognized as nonlinear, linear or a mix of linear and nonlinear parameters depending on whether all parameters of a model are nonlinear or not (Archontoulis & Miguez, 2015). Choosing a suitable regression model fitting to data is always a hard task. First thing to do in this issue is to decide whether the model is linear or nonlinear. Although nonlinear models have some disadvantages, parsimony, interpretability and prediction ability are their main advantages (Bates & Watts, 2007). One of the widely used nonlinear models is in exponential form as given in the following equation:

$$Y = w_1 + w_2 \cdot e^{w_3 \cdot X_{GDP}} + w_4 \cdot e^{w_5 \cdot X_{GP}} + w_6 \cdot e^{w_7 \cdot X_{CP}} + w_8 \cdot e^{w_9 \cdot X_{NE}} \quad (2)$$

where Y is car ownership, X_{GDP} , X_{GP} , X_{CP} , and X_{NE} are explanatory i.e. independent variables, and w_i ($i=1,2,\dots,9$) is the set of coefficients. In this study, multiple nonlinear regression analyses are carried out using XLSTAT software (XLSTAT, 2018). Considering the coefficients of the regression analysis given in Table 2 the model can be represented as given in Eq. (3).

| VARIABLE | COEFFICIENT | VALUE |
|----------------|-------------|-----------|
| | w_1 | 4.50460 |
| GDP PER CAPITA | w_2 | 97.98317 |
| | w_3 | 0.00024 |
| GP | w_4 | -35.76402 |
| | w_5 | -0.11878 |
| CP | w_6 | -58.63220 |
| | w_7 | -0.12495 |
| NE | w_8 | -6.63064 |
| | w_9 | 0.01489 |

Tab. 2 Coefficients of multiple nonlinear regression model in exponential form

$$Y = 4.50 + 97.98 \cdot e^{0.00024 \cdot X_{GDP}} - 35.76 \cdot e^{-0.11878 \cdot X_{GP}} - 58.63 \cdot e^{-0.12495 \cdot X_{CP}} - 6.63 \cdot e^{0.01489 \cdot X_{NE}} \quad (3)$$

It can be concluded from the analysis that although the observed and predicted values are well fitted with high R^2 value of 0.98, a statistical test has been carried out to ensure whether the model is suitable to forecast car ownership or not. In this context, the Kolmogorov-Smirnov (KS) as goodness of fit test has been used as it is one of the mostly used statistical test to verify suitability of nonlinear regression models. The two sample KS test is used to test whether observed and predicted values of car ownership come from the same distribution. The KS statistic quantifies a distance between the empirical distribution function of two samples.

In the KS test, H_0 hypothesis is considered that two samples follow the same distribution.

On the other hand, the value of α (i.e. significance level) is the probability of making the wrong decision when the null hypothesis is true. The critical value of D obtained from the KS table at the 0.05 α level has been found as 0.096 which is less than the value of D as seen in Table 3. This means that null hypothesis is rejected and it can be concluded that the observed and predicted car ownership values come not from the same distribution.

| | VALUE |
|-------------------------|-------|
| D | 0.110 |
| p -value (two-tailed) | 0.129 |
| α | 0.05 |

Tab. 3 Results of two-sample Kolmogorov-Smirnov test (two-tailed)

Thus, the other mostly used type of nonlinear regression models namely polynomial has been used to fit the observed and predicted data. The mathematical form of the regression model is given in Eq. (4).

$$Y = w_1 + w_2 \cdot X_{GDP} + w_3 \cdot X_{GP} + w_4 \cdot X_{CP} + w_5 \cdot X_{NE} + w_6 \cdot X_{GDP}^2 + w_7 \cdot X_{GP}^2 + w_8 \cdot X_{CP}^2 + w_9 \cdot X_{NE}^2 \quad (4)$$

where Y is car ownership, X_{GDP} , X_{GP} , X_{CP} , and X_{NE} are explanatory i.e. independent variables, and w_i ($i=1,2,\dots,9$) is the set of coefficients. Coefficients of multiple nonlinear regression model in polynomial form are found as given in Table 4 by using the XLSTAT software. The polynomial regression model can be represented as given in Eq. (5).

| VARIABLE | COEFFICIENT | VALUE |
|----------------|-------------|-----------|
| | w_1 | 106.74185 |
| GDP PER CAPITA | w_2 | 0.01725 |
| | w_6 | 0.000001 |
| GP | w_3 | 17.52527 |
| | w_7 | -1.70376 |
| CP | w_4 | -1.52711 |
| | w_8 | 0.02274 |
| NE | w_5 | -4.71569 |
| | w_9 | 0.11733 |

Tab. 4 Coefficients of multiple nonlinear regression model in polynomial form

$$Y = 106.74 + 0.017 \cdot X_{GDP} + 17.52 \cdot X_{GP} - 1.53 \cdot X_{CP} - 4.72 \cdot X_{NE} + 0.000001 \cdot X_{GDP}^2 - 1.70 \cdot X_{GP}^2 + 0.023 \cdot X_{CP}^2 + 0.117 \cdot X_{NE}^2 \quad (5)$$

Car ownership has been predicted by using polynomial regression model for the observation period 1997-2015 with coefficient of determination (R^2) value of 0.99 as given in Figure 10 which visualizes the quality of the fit by comparing the predicted values to the observed values. According to the KS test result for polynomial model the computed D value of 0.083 is less than the critical value of D obtained from the KS table which is 0.096 at the 0.05 α level. This means that null hypothesis is accepted and the polynomial form of the multiple regression model can be used to forecast car ownership.

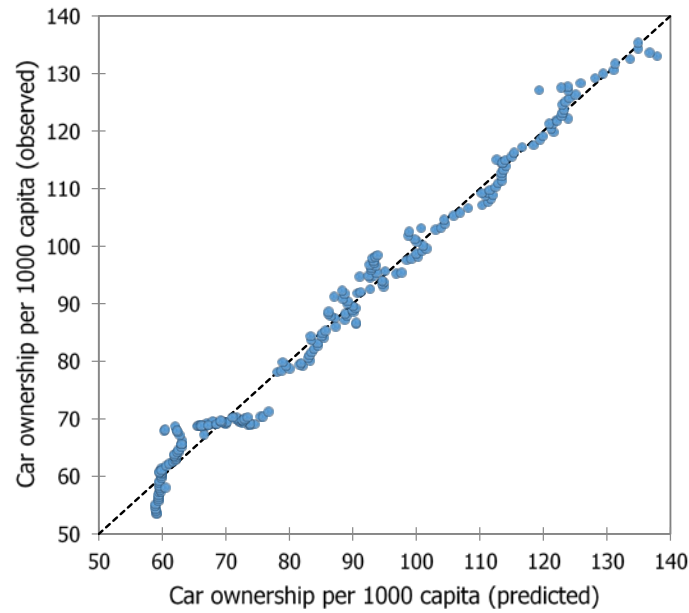


Fig. 10 Relationship between the observed and predicted values of car ownership

3 FORECASTING CAR OWNERSHIP IN TURKEY

As car ownership is most likely sensitive to the changes in the values of the parameters given in the previous section, a scenario based approach is used to explore future car ownership ratio in Turkey. In this context, future trends for all four parameters are identified based on their values observed between January 1997 and December 2015. Resulting future trend equations and their related R^2 values are given in Figure 11.

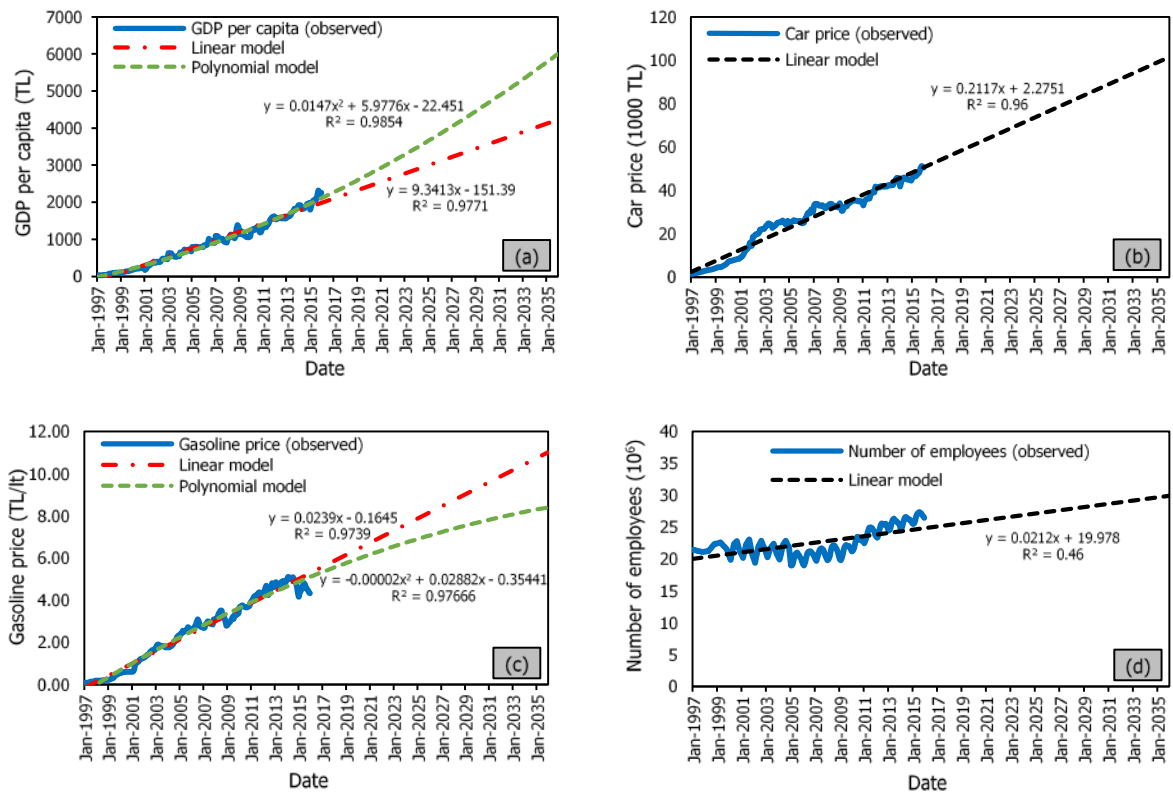


Fig.11 Future trend equations for GDP per capita, CP, GP and NE

As can be seen in Figure 11 that the projection of parameters CP and NE were conducted based on fitting linear trends which are well suited to their historical development. The NE is assumed to increase in the similar tendency with the growing population unless new employment opportunities are created or new labor market regulations are considered in Turkey. As an upper-middle-income country, Turkey is the 17th-largest economy in the world with \$10,891 GDP per capita and macroeconomic stability dramatically improves Turkey's economic performance since 2000 (World Bank, 2017). It may be assumed that Turkey may move into the high-income status in case of overcoming domestic challenges and recovering geopolitical environment. From this point of view, polynomial increase in GDP per capita represents an optimistic perspective while linear increase represents the current growth as seen in Figure 11. On the other hand, direct and indirect fuel taxation play an important role in fiscal consolidation strategy in Turkey. Additionally to the value added tax system, a special consumption tax has been applied to the fuel prices in Turkey since 2002 and total tax ratio in retail gasoline price reached up to 64% in 2015 (EMRA, 2016). Considering that Turkey faces with budget deficits, revenue from taxes on fuel will be the most decisive factor in retail gasoline price. In future, total tax rate in gasoline prices may be decreased depending on the positively changed economic indicators in Turkey. Therefore, projection of GP is executed based on two trends namely linear and polynomial which represent current growth and an optimistic perspective, respectively as illustrated in Figure 11. In order to represent the effect of different growth patterns of GDP per capita and GP on car ownership in 2035, four scenarios are generated as given in Table 5.

| GROWTH PATTERNS FOR EXPLANATORY VARIABLES | | | | |
|---|----------------|------------|--------|--------|
| SCENARIO NO | GDP PER CAPITA | GP | NE | CP |
| 1 | Polynomial | Polynomial | Linear | Linear |
| 2 | Polynomial | Linear | Linear | Linear |
| 3 | Linear | Polynomial | Linear | Linear |
| 4 | Linear | Linear | Linear | Linear |

Tab. 5 Generated scenarios for car ownership estimation

For all scenarios, Turkey's car ownership until 2035 is calculated using Eq. (5) and the results are illustrated in Figure 12.

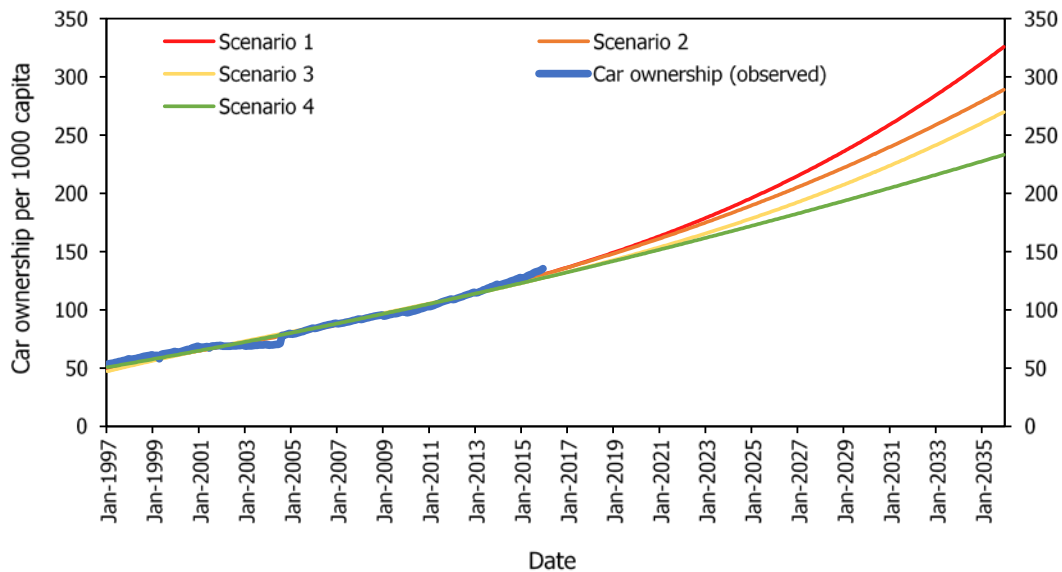


Fig. 12 Forecasted values of car ownership based on four scenarios

It can be seen in Figure 12 that Scenario 4 with a linear increase in GDP per capita and GP reveals the lowest car ownership rate about 230 passenger cars per thousand capita in Turkey for 2035. On the other hand, car ownership in Turkey may reach up to 325 per thousand capita according to Scenario 1, which represents achieving economic success of Turkey that GDP per capita increases more than current growth rate with decreasingly growing gasoline prices. It can obviously be seen that even though Scenario 1 provides the highest car ownership rate, passenger car stocks per thousand capita in Turkey for 2035 will be significantly less than the most of the EU countries have already had in 2015.

It should also be noted that the point of saturation in per capita car stocks will probably not be reached by 2035 in Turkey. This can be clearly seen from the figure where car ownership rate in Turkey continues to rise according to the all scenarios even in the year of 2035.

4 CONCLUSIONS

This study deals with modeling and forecasting car ownership based on explanatory variables such as gross domestic product per capita, gasoline prices, car prices, and number of employees which were considered the most effective parameters for households owning a car in Turkey. Multiple nonlinear regression analysis has been selected for modeling car ownership because of its ability to represent the effect of instable determinants and to provide a perfect fit to the observed data set. The data were used on a monthly basis due to some disadvantages of the use of annual data. We have utilized two set of nonlinear regression models namely polynomial and exponential. Polynomial regression model were preferred to forecast car ownership for the year of 2035 since exponential model did not meet the requirement according to the results of Kolmogorov-Smirnov test.

In order to forecast car ownership, the explanatory variables were fitted to the observed data and their future trends were determined. In order to represent the effect of different trends of explanatory variables for 2035, car ownership was forecasted along four scenarios which were related to different expected values of gross domestic product per capita and gasoline prices. It can be concluded that the lowest and highest values of car ownership may provide insight to car producers and transport planners in Turkey. Another result can be drawn from this study might be that car ownership in Turkey with the value of 325 per thousand capita will be significantly less than the average value for European countries even the best optimistic scenario was taken into consideration.

Although the present study provides useful insights for transport planners and car manufacturers in terms of future trends of car ownership in Turkey based on optimistic and pessimistic scenarios, car ownership could not be forecasted by using disaggregated data which is not collected regularly in Turkey.

In the future, car ownership must be modeled and forecasted by using disaggregated data which might be more reliable.

REFERENCES

- Acker, V. V., & Witlox, F. (2010). Car ownership as a mediating variable in car travel behaviour research using a structural equation modelling approach to identify its dual relationship. *Journal of Transport Geography*, 18(1), 65-74. doi:<http://dx.doi.org/10.1016/j.jtrangeo.2009.05.006>
- Akay, E., & Tümsel, B. (2016). An Empirical Investigation of Household Automobile Ownership: A Sequential Logit Model. *Social Sciences Research Journal*, 4(4), 35-45. Available at: <http://dentaworld.dergipark.gov.tr/ssrj/issue/22475/240409>
- Anowar, S., Yasmin, S., Eluru, N., & Miranda-Moreno, L. F. (2014). Analyzing car ownership in Quebec City: a comparison of traditional and latent class ordered and unordered models. *Transportation*, 41(5), 1013-1039. doi:<http://dx.doi.org/10.1007/s11116-014-9522-9>

- Archontoulis, S. V., & Miguez, F. E. (2015). Nonlinear Regression Models and Applications in Agricultural Research. *Agronomy Journal*, 107(2), 786-798. doi:<http://dx.doi.org/10.2134/agronj2012.0506>
- Azadeh, A., Neshat, N., Rafiee, K., & Zohrevand, A. (2012). An adaptive neural network-fuzzy linear regression approach for improved car ownership estimation and forecasting in complex and uncertain environments: the case of Iran. *Transportation Planning and Technology*, 35(2), 221-240. doi:<http://dx.doi.org/10.1080/03081060.2011.651887>
- Baskan O., Ceylan H., Haldenbilen S., & Ceylan H. (2008). Spreadsheet Modeling Approach for Estimating Car Ownership. *8th International Congress on Advances in Civil Engineering*, September 15-17, Cyprus.
- Bates, D. M., & Watts, D. G. (2007). Nonlinear regression analysis and its applications. New York: Wiley. doi:<http://dx.doi.org/10.1002/9780470316757>
- Ben-Akiva, M., Manski, C. F., & Sherman, L. (1981). A Behavioral Approach to Modelling Household Motor Vehicle Ownership and Applications to Aggregate Policy Analysis. *Environment and Planning A*, 13(4), 399-411. doi:<http://dx.doi.org/10.1068/a130399>
- Chen, X., & Zhang, H. (2012). Evaluation of Effects of Car Ownership Policies in Chinese Megacities. *Transportation Research Record: Journal of the Transportation Research Board*, 2317, 32-39. doi:<http://dx.doi.org/10.3141/2317-05>
- Clark, S. D. (2007). Estimating local car ownership models. *Journal of Transport Geography*, 15(3), 184-197. doi:<http://dx.doi.org/10.1016/j.jtrangeo.2006.02.014>
- Çodur, M. Y., & Tortum, A. (2009). Modelling car ownership in Turkey using neural networks. *Proceedings of the Institution of Civil Engineers - Transport*, 162(2), 97-106. doi:<http://dx.doi.org/10.1680/tran.2009.162.2.97>
- Dargay, J., & Gately, D. (1997). Vehicle ownership to 2015: Implications for energy use and emissions. *Energy Policy*, 25(14-15), 1121-1127. doi:[http://dx.doi.org/10.1016/s0301-4215\(97\)00104-3](http://dx.doi.org/10.1016/s0301-4215(97)00104-3)
- Dargay, J., & Gately, D. (1999). Incomes effect on car and vehicle ownership, worldwide: 1960–2015. *Transportation Research Part A: Policy and Practice*, 33(2), 101-138. doi:[http://dx.doi.org/10.1016/s0965-8564\(98\)00026-3](http://dx.doi.org/10.1016/s0965-8564(98)00026-3)
- Dargay, J. M. (2001). The effect of income on car ownership: evidence of asymmetry. *Transportation Research Part A: Policy and Practice*, 35(9), 807-821. doi:[http://dx.doi.org/10.1016/s0965-8564\(00\)00018-5](http://dx.doi.org/10.1016/s0965-8564(00)00018-5)
- Energy Market Regulatory Authority. (2016). Turkish Petroleum Market Report 2015. Retrieved December 24, 2017, available at: <http://www.emra.org.tr/TR/Dokuman/8321>
- Energy Market Regulatory Authority. (2017). Turkish Petroleum and LPG Market Report 2017. Retrieved March 6, 2018. Available at: <http://www.epdk.org.tr/TR/Dokumanlar/Petrol/YayinlarRaporlar/Fiyatlandirma>
- Eurostat-Statistical office of the European Union. (2018a). Retrieved January 02, 2018. Available at:http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_eqs_carhab&lang=en
- Eurostat-Statistical office of the European Union. (2018b). Retrieved March 06, 2018. Available at: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_eqs_carage&lang=en
- Eurostat-Statistical office of the European Union. (2018c). Retrieved January 02, 2018. Available at: <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00114&plugin=1>
- Eurostat-Statistical office of the European Union. (2018d). Retrieved January 02, 2018. Available at: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=demo_pjanind&lang=en
- Guerra, E. (2015). The geography of car ownership in Mexico City: a joint model of households' residential location and car ownership decisions. *Journal of Transport Geography*, 43, 171-180. doi:<http://dx.doi.org/10.1016/j.jtrangeo.2015.01.014>
- International Monetary Fund. (2011). World Economic Outlook April 2011, Tensions from the Two-Speed Recovery Unemployment, Commodities, and Capital Flows. Retrieved January 02, 2018. Available at: <http://www.imf.org/en/Publications/WEO/Issues/2016/12/31/Tensions-from-the-Two-Speed-Recovery-Unemployment-Commodities-and-Capital-Flows>
- International Monetary Fund. (2017a). World Economic Outlook October 2017, Seeking Sustainable Growth: Short-Term Recovery, Long-Term Challenges. Retrieved January 02, 2018. Available at: <http://www.imf.org/en/Publications/WEO/Issues/2017/09/19/world-economic-outlook-october-2017>

- International Monetary Fund. (2017b). Retrieved January 02, 2018. Available at: <http://www.imf.org/external/pubs/ft/weo/2017/02/weodata/weorept.aspx?sy=2017&ey=2022&scsm=1&ssd=1&sort=countr&ds=.&br=1&pr1.x=44&pr1.y=16&c=186&s=NGDPD%2CNGDPDPC%2CPPPGDP%2CPPPPC%2CPPPSH%2CLUR%2CLP&grp=0&a>
- Jansson, J. (1989). Car Demand Modelling and Forecasting: A New Approach. *Journal of Transport Economics and Policy*, 23(2), 125-140. Available at: <http://www.jstor.org/stable/20052878>.
- Korkmaz, E., Doğan, E., & Akgüngör, A. P. (2016). Estimation of Car Ownership in Turkey Using Artificial Bee Colony Algorithm. *3th International Conference on Traffic and Transport Engineering*, November 24-25, Belgrade, Serbia. Available at: http://ijtte.com/uploads/news_files/ICTTE%20Belgrade%202016_Proceedings.pdf.
- Kumar, M., & Rao, K. V. (2006). A Stated Preference Study for a Car Ownership Model in the Context of Developing Countries. *Transportation Planning and Technology*, 29(5), 409-425. doi:<http://dx.doi.org/10.1080/03081060600917793>
- Lam, W. H., & Tam, M. (2002). Reliability of territory-wide car ownership estimates in Hong Kong. *Journal of Transport Geography*, 10(1), 51-60. doi:[http://dx.doi.org/10.1016/S0966-6923\(01\)00038-2](http://dx.doi.org/10.1016/S0966-6923(01)00038-2)
- Matas, A., Raymond, J., & Roig, J. (2009). Car ownership and access to jobs in Spain. *Transportation Research Part A: Policy and Practice*, 43(6), 607-617. doi:<http://dx.doi.org/10.1016/j.tra.2009.04.003>
- Medlock, K. B., & Soligo, R. (2002). Car Ownership and Economic Development with Forecasts to the Year 2015. *Journal of Transport Economics and Policy*, 36(2), 163-188. Available at: <http://www.ingentaconnect.com/contentone/lse/jtep/2002/00000036/00000002/art00001>
- Meurs, H. (1993). A panel data switching regression model of mobility and car ownership. *Transportation Research Part A: Policy and Practice*, 27(6), 461-476. doi:[http://dx.doi.org/10.1016/0965-8564\(93\)90052-m](http://dx.doi.org/10.1016/0965-8564(93)90052-m)
- Ministry for EU Affairs, Republic of Turkey (2018). Retrieved January 04, 2018. Available at: https://www.ab.gov.tr/111_en.html
- Ministry of Energy and Natural Resources, Republic of Turkey - Petrol. (2018). Retrieved January 02, 2018, available at: <http://www.enerji.gov.tr/en-US/Pages/Petrol>
- Organization for Economic Cooperation and Development. (2016). Fossil Fuel Support Country Note: Turkey. Retrieved March 06, 2018, available at <http://stats.oecd.org/wbos/fileview2.aspx?IDFile=0144c270-446f-48db-88f0-4ea1542244a5>
- Öğüt, K. S. (2004). S-Curve Models to Determine the Car Ownership in Turkey. *ARI Bulletin of the Istanbul Technical University*, 54(2), 70-76. Available at: <http://web.itu.edu.tr/oguts/S-curve%20car%20ownership.pdf>
- Öğüt, K. S. (2006). Modeling Car Ownership in Turkey Using Fuzzy Regression. *Transportation Planning and Technology*, 29(3), 233-248. doi:<http://dx.doi.org/10.1080/03081060600811004>
- Pişkin, S. (2017). Automotive Sector Report. (in Turkish). Retrieved January 02, 2018, available at http://www.tskb.com.tr/i/content/3081_1_Otomotiv%20Sektor%20Raporu.pdf
- Potoglou, D., & Susilo, Y. (2008). Comparison of Vehicle-Ownership Models. *Transportation Research Record: Journal of the Transportation Research Board*, 2076, 97-105. doi:<http://dx.doi.org/10.3141/2076-11>
- Potoglou, D., & Kanaroglou, P. S. (2008). Modelling car ownership in urban areas: a case study of Hamilton, Canada. *Journal of Transport Geography*, 16(1), 42-54. doi:<http://dx.doi.org/10.1016/j.jtrangeo.2007.01.006>
- Ritter, N., & Vance, C. (2013). Do fewer people mean fewer cars? Population decline and car ownership in Germany. *Transportation Research Part A: Policy and Practice*, 50, 74-85. doi:<http://dx.doi.org/10.1016/j.tra.2013.01.035>
- Romilly, P., Song, H., & Liu, X. (2001). Car ownership and use in Britain: a comparison of the empirical results of alternative cointegration estimation methods and forecasts. *Applied Economics*, 33(14), 1803-1818. doi:<http://dx.doi.org/10.1080/00036840011021708>
- Rota, M. F., Carcedo, J. M., & Garcia, J. P. (2016). Dual approach for modelling demand saturation levels in the automobile market. The Gompertz curve: macro versus micro data. *Investigación Económica*, 75(296), 43-72. doi:<http://dx.doi.org/10.1016/j.inveco.2016.07.003>
- Shen, Q., Chen, P., & Pan, H. (2016). Factors affecting car ownership and mode choice in rail transit-supported suburbs of a large Chinese city. *Transportation Research Part A: Policy and Practice*, 94, 31-44. doi:<http://dx.doi.org/10.1016/j.tra.2016.08.027>

Soltanzadeh, H., & Masumi, H. E. (2014). The Determinants of Transportation Mode Choice In The Middle Eastern Cities: The Kerman Case, Iran. *TeMA Journal of Land Use, Mobility and Environment*, 7(2), 199-222. doi:<http://dx.doi.org/10.6092/1970-9870/2518>

Sinniah, G. K., Shahi, M. Z., Vigar, G., & Aditjandra, P. T. (2014). Residential Location Preferences. The Significance of Socio-Cultural and Religious Attributes. *TeMA Journal of Land Use, Mobility and Environment*, 7(2), 223-238. doi:<http://dx.doi.org/10.6092/1970-9870/2656>

The World Bank. (2017). An overview of the World Bank's work in Turkey. Retrieved January 02, 2018, available at:<http://pubdocs.worldbank.org/en/254861507539327826/Turkey-Snapshot-Fall2017.pdf>

The World Bank. (2018). The United Nations Population Division's World Urbanization Prospects. Retrieved March 06, 2018, available at https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?end=2016&locations=TR-EU&start=1960&view=%20chart&year_high_desc=true

Turkish Statistical Institute. (2018a). Retrieved January 02, 2018, available at <https://biruni.tuik.gov.tr/medas/?kn=89&locale=en>

Turkish Statistical Institute. (2018b). Retrieved January 02, 2018, available at http://www.turkstat.gov.tr/VeriBilgi.do?alt_id=1020

Turkish Statistical Institute. (2018c). Retrieved January 02, 2018, available at <https://biruni.tuik.gov.tr/tufedagitimapp/>

Turkish Statistical Institute. (2018d). Retrieved January 02, 2018, available at http://www.turkstat.gov.tr/PreTablo.do?alt_id=1007

Woldeamanuel, M. G., Cyganski, R., Schulz, A., & Justen, A. (2009). Variation of households' car ownership across time: application of a panel data model. *Transportation*, 36(4), 371-387. doi:<http://dx.doi.org/10.1007/s11116-009-9210-3>

Wu, T., Zhao, H., & Ou, X. (2014). Vehicle ownership analysis based on gdp per capita in China: 1963– 2050. *Sustainability*, 6(8), 4877-4899. doi:<http://dx.doi.org/10.3390/su6084877>

XLSTAT [Computer software]. (2018) Retrieved January 02, 2018, available at <https://www.xlstat.com/en/>

Yagi, M., & Managi, S. (2016). Demographic determinants of car ownership in Japan. *Transport Policy*, 50, 37-53. doi:<http://dx.doi.org/10.1016/j.tranpol.2016.05.011>

Yang, Z., Jia, P., Liu, W., & Yin, H. (2017). Car ownership and urban development in Chinese cities: A panel data analysis. *Journal of Transport Geography*, 58, 127-134. doi:<http://dx.doi.org/10.1016/j.jtrangeo.2016.11.015>

Yayar, R., Çoban, M. N., & Tekin, B. (2015). Identifying the Factors Affecting the Car Ownership: A Case Study in Urban Areas of the Province of Tokat. *Journal of Management and Economics*, 22(2), 603-617. doi:<http://dx.doi.org/10.18657/yecbu.30802>

IMAGE SOURCES

Cover: created using a drone by the authors

Fig. 1-12: created by the authors

AUTHOR'S PROFILE

Huseyin Ceylan, associate Professor in Civil Engineering Department at Pamukkale University in Denizli, Turkey. He received a doctorate degree in Transportation Division with a thesis on discrete design of urban transportation networks using meta-heuristic Harmony Search Algorithm. His research interests focus on urban transportation planning, transportation network design, urban public transportation systems and operations research. He is author of more than 40 publications.

Ozgur Baskan, associate Professor in Dept. of Civil Engineering at Pamukkale University in Turkey. He received his PhD degree in Transportation Engineering from Graduate School of Natural and Applied Sciences from the same university in 2009. In 2012, he was a visiting scholar at the Division of Transportation Engineering, Technical University of Bari, Italy. He is currently mainly interested in the fields of traffic and transportation planning, specifically road network design, traffic assignment, and nature-inspired optimization algorithms. Dr. Baskan is the author of more than 35 papers in peer-reviewed international journals and conference proceedings.

Cenk Ozan, received the B.Sc. degree in Civil Engineering, the M.Sc. and the Ph.D. degrees in transportation Engineering from Graduate School of Natural and Applied Sciences at Pamukkale University, in 1999, 2002, and 2012, respectively. He has been working as Assistant Professor in Department of Civil Engineering at Adnan Menderes University, and has been involved in several scientific and technical projects. He studies in the fields of traffic and transportation planning, specifically network design, traffic assignment, optimization, and population-based heuristic methods.

TeMA Urban Travel Behavior in the Middle East and North Africa
SPECIAL ISSUE 1.2018 | 67-82
print ISSN 1970-9889, e- ISSN 1970-9870
doi: <http://dx.doi.org/10.6092/1970-9870/5455>

review paper received 30 January 2018, accepted 29 April 2018

Licensed under the Creative Commons Attribution
Non Commercial License 3.0
www.tema.unina.it

Baouni, T., De Ona, R., Merad, B., Tahraoui, L., Machado Leon, J.L., De Ona, J. (2018). Analysis of the main service quality dimensions affecting satisfaction of the metropolitan rail public transit Users in Algiers. *Tema Journal of Land Use, Mobility and Environment* .67-82.
doi: <http://dx.doi.org/10.6092/1970-9870/5455>



ANALYSIS OF THE MAIN SERVICE QUALITY DIMENSIONS AFFECTING SATISFACTION OF THE METROPOLITAN RAIL PUBLIC TRANSIT USERS IN ALGIERS

TAHAR BAOUNI^a; ROCIO DE OÑA^b; BADRA MERAD^a; LYES TAHRAOUI^a; JOSÉ LUIS MACHADO-LEÓN^b JUAN DE OÑA^b.

^a Ecole Polytechnique d'Architecture et d'Urbanisme (EPAU) d'Alger, Laboratoire Ville, Urbanisme et Développement Durable, BP 177- 16200 Alger
e-mail: tbaouni@yahoo.fr; t.baouni@epau-alger.edu.dz; badi.merrad@live.fr; tahraouilies@gmail.com; URL: www.epau-alger.edu.dz; ^b TRYSE Research Group, University of Granada, ETSI Caminos, Canales y Puertos, c/Severo Ochoa, s/n, 18071 Granada (Spain); e-mail: jdona@ugr.es; rociadona@ugr.es & jmachadoleon@ugr.es; URL: www.ugr.es

ABSTRACT

The improvement in public transit is one of the basic and essential pillars to promote sustainable urban and metropolitan mobility everywhere. Algeria's transportation system primarily relies on private vehicle, which causes innumerable problems such as congestion, emissions, traffic accidents, social inequalities, gender inequalities, and deterioration of the environment. Given that, the Algerian Government has recently carried out some transportation projects such as the Algiers metro and tramway service to promote collective public transportation in the country. Therefore, it becomes essential to provide public administrations and technicians with relevant information and efficient analytical tools to help enhance and develop this mass transit. In this line, the first Customer Satisfaction Survey was designed and implemented in November 2014 at the three railways transit services of Algiers: the light rail, the underground heavy rail (both started into operation in 2011) and the commuter rail. Thanks to this survey instrument, users' profiles and travel patterns were found out. Moreover, an analytical framework based on a principal component analysis and an ordered probit model identified service quality dimensions and their impact on users' overall satisfaction. In addition, the effect of socio-economic variables and travel patterns on the previously identified quality dimensions was obtained through multiple linear regression models. The results presented in this paper could help Algerian transport authorities towards elaborate specific proposals to increase transit ridership.

KEYWORDS:

Public transport; Users; mobility; Service quality; Regression models; Algiers.

1 INTRODUCTION

Public transport (PT) usage is a world-wide priority of sustainable mobility policies. Over recent years, the quality of PT has become a critical factor for considering these more efficient transport modes as a suitable alternative to travelling by private car. Therefore, since the end of the 20th century, the number of studies analysing quality in this sector has grown significantly. A big amount of practices has been carried out around the world, most of them based on passengers' point of view, as it is considered the most relevant for service performance evaluation (Berry et al., 1990). It is possible to identify some differences between the quality analysis carried out in different geo-social contexts. In fact, transport users have different requirements from their service that differ between individuals, periods of time and geographical contexts. The analysis of service quality in PT started at different times in different locations around the world. According to a classification developed by the World Bank in 2014 based on the GNI per capita of the countries, high income countries (GNI per capita \geq \$12,736) began to evaluate service quality at the end of the 20th century. In the countries defined as having middle and low incomes, quality studies started to be widespread after 2010. However, these last studies are predominantly only being done by academics because the operators, managers and public administrations have yet to introduce this tool into their operating strategies. The most commonly used survey type around the world is the paper based with face to face Customer Satisfaction Survey (CSS). However, in the higher income countries (mainly in the USA and Europe) stated preferences surveys (e.g., Román et al., 2014; dell'Olio et al., 2011) and attitudinal surveys (de Oña et al., 2016; Diab et al., 2017) are also used. The more developed countries also use new technology for data collection, on-line surveys (de Oña et al., 2016), on-line surveys using QR codes (Guirao et al., 2016), face to face interviews supported by tablet or laptop (Román et al., 2014), etc.

According to the methodology used to analyse service quality, high income countries have introduced more sophisticated analysis models, predominantly discrete choice models (Diab et al., 2017; Román et al., 2014), structural equation models (de Oña et al., 2016; Park et al., 2004) and data mining algorithms (de Oña et al., 2012; Garrido et al., 2014). In medium and low-income countries simpler analysis tools are normally used based on the SERVQUAL scale (Irfan et al., 2012; Ojo et al., 2014), factorial analysis and/or regression analysis (Alpu, 2015), or simple structural equation models (Hadiuzzman et al., 2017; Irfan et al., 2012).

Therefore, the main objective of this paper is to describe and analyze the results of the first CSS of users carried out for all rail PT services in the metropolitan area of Alger (Algiers): light rail, underground heavy rail and commuter rail. This paper also aims to achieve the following secondary objectives: a) identify the existing profiles of users of the three rail public transit services; (b) identify travel patterns of rail public transit users; (c) identify the main dimensions/constructs that affect the perceptions of service quality of these rail public transit modes; (d) analyze the relationships between the service quality dimensions and the overall satisfaction; and e) analyze the effect of socio-economic variables and travel patterns on the previously identified quality dimensions. This research contributes to the literature with interesting and useful information about the quality of the rail PT services of Alger (upper middle GNI per capita country group, \$4,126–\$12,735, according to the World Bank 2014 classification). The organization of the paper is as follows. Section 2 describes the Algerians' mobility and the existing metropolitan rail public transit modes. In Section 3, we introduce the methodology applied, that is, the survey implementation and data collection procedure and the methods used for modeling the survey data: Principal Component Analysis and Ordered Probit model. The results of the analysis are reported in Section 4. Last, Section 5 summarizes the main conclusions of the paper.

2 BACKGROUND OF URBAN TRANSPORT IN ALGIERS

Algerian cities are characterized by extremely rapid urban growth with an imbalance increasingly marked between the center stagnating and peripheral areas experiencing major socio-economic changes which generate, as a consequence a demand for travel more and more growing and diverse. The agglomeration of Algiers, a perfect illustration of the problem of transport in Algeria, is characterized by a strong urban sprawl, high residential density, road and motorway network at the limit of saturation, particularly during peak hours, which results in congestion of transport networks and environmental damage reaching alarming levels. In recent decades, Alger has developed considerably and has become a major metropolis with almost 3 million inhabitants and an annual growth rate of 1.7% (DAL-Wilaya of Algiers, 2016). In addition to all this, the sharp acceleration in industrial and commercial activities has led that the urbanization has spread widely in the periphery (East, North West and South East). The huge acceleration shows that there is a clear need of transport infrastructures in order to support this development. Less than 2% of the area of the town, the center of Algiers, comprises six towns and concentrates (Berchache, 2011): 23% of the population; 33% of jobs; 15% of school and university enrolment; and 40% of motorized flow. The result of this growing spaces are for instance: grabbing the traffic and parking, difficulty in walking, the almost permanent congestion, fatigue, loss of time, noise and air pollution and other threats. Roughly speaking we can say that urban transport is increasing sharply from 3.4 million trips per day in 1990, 4.8 million trips in 2004, and 6.5 million trips in 2014 (BETUR-CNEAP, 2004; Baouni, 2015a). Knowing that the movements for mandatory reasons (work, studies) are the main source of daily mobility of the capital (70.6%), these factors, although not exhaustive, suggest an overall increase in mobility needs every day. Therefore, this suggests a worsening of traffic conditions in the central areas of the capital, which are still the major trip generators (employment, education, services) (Charton, 2010). Regarding the modal split of these movements, most of them are made through walking (56%) and only 44% using motorized modes, which may be considered as a low figure for a city with the size of Algiers, whereas the shared public transport in motorized fashion is around 65% (BETUR-CENEAP, 2004). Besides this, public transport represents about 54.0% and the remainder of trips is on foot (36.5%) or by car (9.5%) (Dessau et al, 2006). In motorized modes (Collective Transport Car + Particular), student mobility is generally higher than that of the other inhabitants, however private cars are much lower (15 to 20% instead of 31.6% for residents). The urban transport organization in Algiers' city is particularly complex. First, this complexity is partially due to the fact that the perimeter of urban transport in Algiers does not coincide with the administrative boundaries of Algiers' city. This urban transport perimeter, which remains to be defined, extends far beyond the metropolitan area and extends over the neighboring provinces of Blida, Boumerdes and Tipasa. Second, several companies provide the public transport services: ETUSA, TRANSUB, SNTF, RATP El Djazair, SETRAM and private operators. The Urban Transport Company and Suburban Algiers (ETUSA) is a public company that provides public transport to the Algiers suburbs. Its business is mainly concentrated in inner city stations that goes from the First of May, up to Audin, Martyrs Square, and to the east and the heights of Algiers. It affects up to 10 buses on the busiest lines. ETUSA daily transports some 100,000 passengers. However, the company's productivity is very low: it carries only 220 passengers per bus per day, while the international recommendations are about 800 passengers per bus per day. ETUSA also operates five cable transport systems, two elevators and an escalator (ETUSA, 2014). In terms of service quality, the company's difficulties may due to the average speed evolution, which fluctuate between 7 and 10 km/h. Similarly, the loss in traffic mileage is estimated at 30%. All these problems give an unattractive image of the network and impose huge operating costs. In addition to the ETUSA's services, 3,300 private operators have increased very significantly the facilities of public transport in the capital. They have a 3,405 vehicles fleet with 94,820 seats available, representing about 80% of the total supply of bus public transit. In July 2014, private

operators provided 68% of the total public transportation network in Algiers' city (140 lines over 216 lines). However, despite the important role of private operators in the provision of public transport services in Algiers, ETUSA maintains a monopoly in the city center. In the absence of physical and fare integration between different operators (private or public) travelers are forced to pay two or three rates, depending on the origins and destinations of their trips. In addition to regular public transport services provided by public or private operators, there are other public companies and some private agencies that provide specialized transportation services: Government provides transportation services on grounds "home-work" with 1,359 vehicles and a total capacity of 38,480 seats available, representing 7.6% of trips by public transport.

The university transportation responds to a request for transport of students from their residences to educational structures. For this purpose, 588 vehicles are available (328 on the urban network and 260 on the regional network) with a capacity of 58,800 seats that supports 10% of urban mass movement.

These two types of transport are highly subsidized, either directly in the case of university transport, where the Office National des Oeuvres Universitaires contracts with private operators, or indirectly, when a government provides free transportation services to his employees. The recent modernization of the suburban railway (2009) and the metro and tram entering in operation in 2011 should result, in the short term, of the spread the shared trips on public transport (Figure 1). Indeed, the railway suburban Algiers operates a network of 45 km of railway line consisting of two lines that share a common core (12 km) between Gare Central El Harrach and Algiers, where they are divided into two: one serving the eastern suburbs, from El Harrach Until Réghaia station, over a length of 19 km; and the other serving the West Island, from El Harrach Birtouta to the station, a distance of 14 km. The suburban railway network electrification in 2009 allowed the rail network in the suburbs of Algiers to carry a total of 28.3 million passengers in 2014 with 130 trains a day and offering a nominal capacity of 198,000 seats (Talamali, 2015). The National Rail Transport Company (SNTF) is the main rail operator (public) in Algeria, and its program for 2025 includes a number of projects in Algiers: the new link Oued Smar-Gué de Constantine; the link Birtouta New city of Sidi Abdellah / Zéralda over a length of 23 km; the construction of the Central Station Travellers; regional rail yard Dar El Beida; and, the rail service from the airport. These programs will be complemented by projects for serving the future port and the construction of the Hamma's central station. The tram and the subway's priority section start up, which became effective in 2011 allowed, besides meeting the expectations of the population in terms of mobility in terms of comfort, safety and significant speed, improve Algerians' life quality and create new urban development zones. The tram commissioning of the priority section of the subway, which became effective in 2011 will allow, besides meeting the expectations of the population in terms of mobility in terms of comfort, safety and significant speed, improve quality of life of Algiers and create new urban development zones. The subway extends from the Grande Poste to El Harrach over a length of 13.5 km with twelve stations. It entered in operation in November 2011, and it will be extended by 2016, on the one hand to Martyrs' Square (1.7 km) and, secondly, to El Ain Naadja (3.5 km). Other extensions are under study: from El Harrach Intl lines, with a length of 10 km; and Ain Naadja – Baraki, about 4 km (by 2020). At the beginning, metro was managed by RATP El Djazair, and later by the Algiers Metro Company, the public concessionaire of the metro infrastructure. The Algiers metro, which runs from 5am to 11pm every day, is not working to its full capacity and the number of passengers carried in 2014 is around 16.1 million passengers (EMA-RATP El Djazair, 2014). This low amount of people could be justified because of the line design, as the line does not cover all areas of the capital. The first line (Fusillés East to Dergana, via Bordj El Kiffan) entered into operation in 2011 and it was later extended to the southwest side (to Birmandrais from the Fusillés' station).

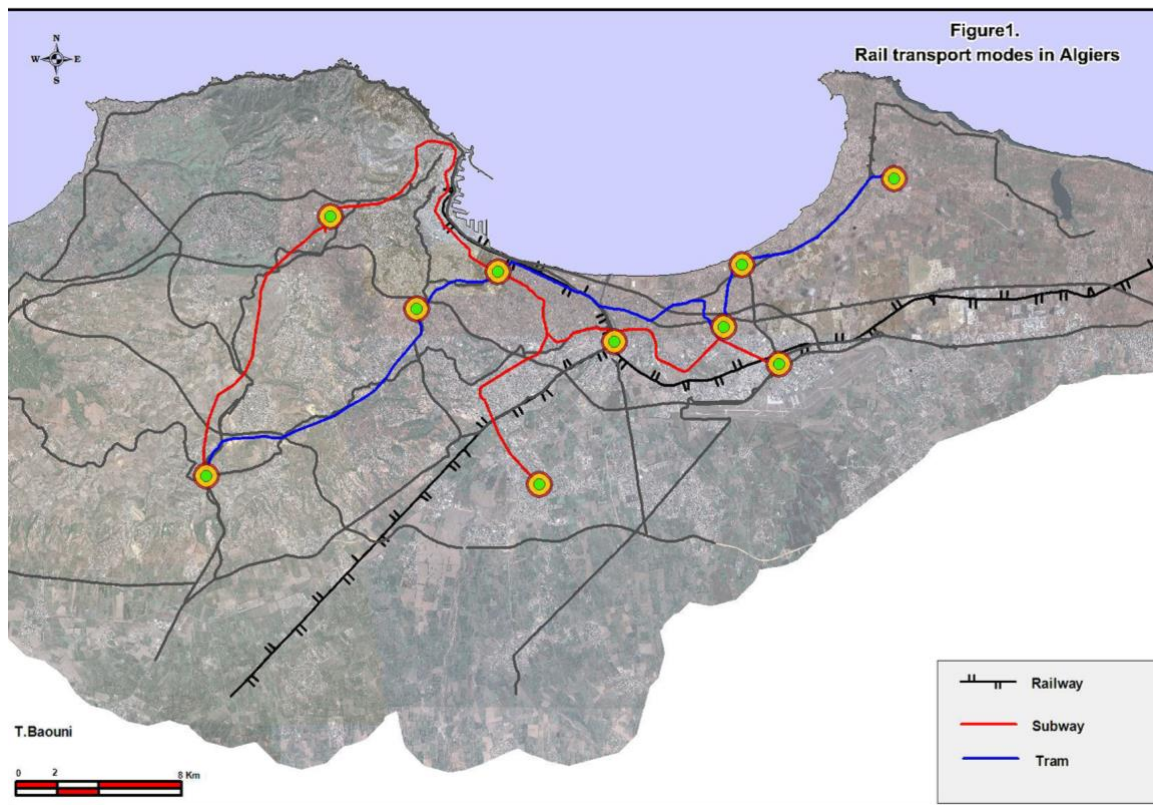


Fig. 1 Rail transport modes in Algiers

Bordj El Kiffan - Dergana has been operational since 2014. ETUSA initially assured the tramway management. Now, SETRAM (Society Algerian Tramways), a joint venture with three companies (Enterprise Metro d'Alger, RATP Développement and ETUSA), manage the tramway. According to study's forecasts, the number of customers should reach 185,000 passengers a day. However, SETRAM's statistics showed 8,821,527 passengers per year in 2014. Finally, in theory the taxi should be considered as complementary to the major public transport. However, it has substituted it, particularly in the inner city, where ETUSA is unable to meet demand on the lines for which it has exclusivity. This mode offers 42,348 available seats using 10,587 vehicles. Urban taxis carry about 6% of motorized trips (DTW, 2014). For a long time, they have addressed the weaknesses and shortcomings raised by the transit system; especially in terms of speed, comfort and safety, but they are an element that promotes traffic conditions degradation, especially in the inner city, because of their large number, the practice of twinning causing untimely stoppages on roads and lack of parking spaces on street reserved for them.

3 METHODOLOGY

3.1 SURVEY IMPLEMENTATION AND DATA COLLECTION

Based on the local context, an ad-hoc CSS was designed and implemented based on a thorough literature review of service quality measurement and evaluation (De Oña et al., 2015; De Oña & De Oña, 2014) and similar PT services in developed countries (De Oña et al., 2013). The CSS consisted on three different questionnaires adapted to each of the three railway transit services in Algiers. The data collection procedure was conducted face-to-face during three days between November 24th and November 26th, 2014, in different areas of the transportation services (different stations, in vehicles, and more). A total of 358 surveys were collected, which 347 were valid. The number of respondents was fairly evenly distributed (104, 108 and 135 respectively) across the three modes (light rail, underground heavy rail, and commuter rail).

The language chosen to conduct the data collection was French. Additionally, the interviewers were able to translate the question to Arabic in a closed form for non-French speaking respondents.

The survey instrument consisted of three parts: Part A, gathered users' perceptions about the quality of the service and their overall satisfaction; Part B collected the characteristics of the trip made by the respondent; and Part C asked the socio-demographic characteristics of the interviewed passengers. Users' perceptions were measured with an 11-point scale (0-lowest quality and 10-highest quality), while users' overall satisfaction was measured with a 5-point Likert scale (1-lowest level of satisfaction, 5-highest level of satisfaction). The number of service attributes evaluated varied between 28 and 30 depending on the questionnaire used for each PT service (i.e., metro, tramway and commuter rail); 25 of them were equal for the three transit modes. These service attributes were related to Availability of the service, Accessibility, Information, Time, Customer Service, Comfort and Safety.

3.2 METHODS

Principal Component Analysis (PCA)

PCA analyzes interrelationships among a large number of variables and explains these variables in terms of their common underlying factors (Hair et al., 2010). Additionally, this technique allows to make estimates of the factors themselves (factor scores), which then replace the original variables in the subsequent analysis (Hair et al., 2010). Several statistical criteria must be met before a correct application of this analytical technique for ensuring data consistency (Hernandez & Monzón, 2016): sample size, reliability, sampling adequacy, and Bartlett's test sphericity. Field (2009) defined as a proper sample size having at least 10–15 participants per observed variable. Cronbach's alpha is the measure of internal consistency reliability and a value from 0.7 is generally considered to represent an acceptable scale. The index used to measure the sampling adequacy is Kaiser-Meyer-Olkin (KMO) index. The KMO statistic varies between 0 and 1. Hutcheson and Sofroniou (1999) defined values between 0.5–0.7 as mediocre, values between 0.7–0.8 as good, values between 0.8–0.9 as great and values above 0.9 as superb. Finally, significant Bartlett's test indicates if the correlations among the observed variables are sufficiently large to apply a PCA. A criterion of an eigenvalue greater than or equal to 1.0 was used for factor extraction and a VARIMAX orthogonal-rotation method was used as it simplifies factor interpretation.

Order Probit (OP) Model

The OP model was originally developed by McKelvey and Zavoina (1975). In the OP model there is an observed ordinal variable Y , which is, in turn, a function of another variable Y^* that is not measured. Specifically, in the ordered model there is a continuous unmeasured latent variable Y^* , whose values determine what the observed ordinal variable Y matches. The continuous latent variable Y^* has various threshold points. The value Y_i of the observed variable depends on whether or not the value of Y^* crossed a particular threshold, as showed by the following equations (1).

$$\begin{aligned}
 Y_i &= 1 \text{ if } Y_i^* \leq \mu_1 \\
 Y_i &= 2 \text{ if } \mu_1 < Y_i^* \leq \mu_2 \\
 &(\dots) \\
 Y_i &= j \text{ if } \mu_{j-1} < Y_i^* \leq \mu_j \\
 &(\dots)
 \end{aligned} \tag{1}$$

$$Y_i = m \text{ if } Y_i^* > \mu_{m-1}$$

In the population, the continuous latent variable Y^* is equal to Eq. 2:

$$Y_i^* = \sum_{k=1}^K \beta_k X_{ki} + \epsilon_i = Z_i + \epsilon_i \quad (2)$$

where there is a random disturbance term ϵ_i normally distributed. The error term reflects the fact that the variables may not be perfectly measured, and some relevant variables may be not introduced in the equation.

By means of the OP we can estimate the expected average value of the Y_i^* (Eq. 3):

$$E(Y_i^*) = Z_i = \sum_{k=1}^K \beta_k X_{ki} \quad (3)$$

Once we have estimated β coefficients and the $(m-1)$ k cutoff terms, we can estimate the probability that Y will have a particular value. The formulas are the following (4):

$$P(Y_i = j) = \Phi(\mu_j - x_i \beta) - \Phi(\mu_{j-1} - x_i \beta) \quad (4)$$

$$P(Y_i = m) = \Phi(\mu_m - x_i \beta) - \Phi(\mu_{m-1} - x_i \beta) = 1 - \Phi(\mu_{m-1} - x_i \beta)$$

Finally, the OP model can be used to estimate the probability that the unobserved variable Y^* falls within the various threshold limits. Users' overall satisfaction is used as dependent variable of the proposed model and the service quality dimensions extracted with the PCA are introduced as independent variables.

Multiple Linear Regression Model

Multiple regression is a method used to model the linear relationship between a dependent variable and one or more independent variables. The model is estimated by least squares, which yields parameter estimates such that the sum of squares of errors is minimized. The resulting prediction equation is

$$Y_i = (b_0 + b_1 X_{i1} + b_2 X_{i2} + \dots + b_n X_{in}) + \epsilon_i \quad (5)$$

Where Y is the dependent variable, b_1 is the coefficient of the first predictor (X_1), b_2 is the coefficient of the second predictor (X_2), b_n is the coefficient of the n th predictor (X_n), and ϵ_i is the difference between the predicted and the observed value of Y for the i th observation. One regression model is calibrated for each service quality dimension extracted from the PCA, whereas the trips and socioeconomic characteristics are used as independent variables at each model. A stepwise procedure was used by adding variables in the regression model, if they made a significant contribution to the predictive power of the equation.

4 RESULTS AND DISCUSSION

The conditions and nature of mobility needs have evolved with the changing pace of life of the population and this is an important element that has affected the mobility of Algerians with the tram and metro start up. First, we want to emphasize that the results indicate that the gender distribution of respondents is roughly speaking 49.3% respectively of the male and 50.7% of female.

Table 1 shows that the gender distribution of respondents is roughly speaking 49.3% respectively of the male and 50.7% of female; and consisted of 39% of employees, 31.7% of students, 11.2% of the liberal function, 6.3 % women in the home and 10.4% belonging to categories other than those already mentioned (retired, unemployed, housewives, etc.). It is therefore quite normal that the results show a predominance

of the category of civil servants and students on the part of the socio-professional categories using the rail mode Algiers.

| Variable / Category / Specifications | Cases | % |
|--|-------|------|
| Sample Size | 347 | |
| Transportation Mode | | |
| Metro | 108 | 31.1 |
| Commuter Rail | 135 | 38.9 |
| Tramway | 104 | 30.0 |
| B1. Reason to do your trip by metro? | | |
| Comfort | 135 | 16.0 |
| Congestion | 108 | 12.8 |
| Frequency | 63 | 7.4 |
| No private vehicle | 67 | 7.9 |
| Lack of parking | 62 | 7.3 |
| Price | 66 | 7.8 |
| Safety | 79 | 9.3 |
| Speed | 201 | 23.8 |
| Another reason | 27 | 3.2 |
| Missing Values | 38 | 4.5 |
| B2. Trip purpose | | |
| Shopping | 29 | 8.4 |
| Studies | 90 | 25.9 |
| Leisure | 7 | 2.0 |
| Work | 138 | 39.8 |
| Doctor | 2 | 0.6 |
| Others | 47 | 13.5 |
| Missing Values | 34 | 9.8 |
| B3. Mode taken to get from origin to station | | |
| Bus | 106 | 27.1 |
| Walk | 168 | 43.0 |
| Metro | 11 | 2.8 |
| Motorcycle | 1 | 0.3 |
| Taxi | 32 | 8.2 |
| Commuter rail | 8 | 2.0 |
| Tramway | 14 | 3.6 |
| Private Car | 50 | 12.8 |
| Missing Values | 1 | 0.3 |
| B4. Time trip origin-station (min) | | |
| Average | 24,3 | |
| Standard Deviation | 30,6 | |
| Minimum | 1 | |
| Maximum | 240 | |
| Q1 (25%) | 8,0 | |
| Q2 (50%) | 15,0 | |
| Q3 (75%) | 30,0 | |
| Missing Values | 1 | |
| B5. Mode taken to get to destination from station | | |
| Bus | 68 | 18.3 |
| Walk | 237 | 63.7 |
| Metro | 4 | 1.1 |
| Taxi | 22 | 5.9 |

| | | |
|--|------|------|
| Tramway | 8 | 2.2 |
| Motorcycle | 1 | 0.3 |
| Commuter rail | 2 | 0.5 |
| Private Car | 23 | 6.2 |
| Missing Values | 7 | 1.9 |
| B6. Time trip station-Destination (min) | | |
| Average | 22,1 | |
| Standard Deviation | 25,7 | |
| Minimum | 1 | |
| Maximum | 180 | |
| Q1 (25%) | 8,0 | |
| Q2 (50%) | 15,0 | |
| Q3 (75%) | 25,0 | |
| Missing Values | 16 | |
| B7. Frequency of use | | |
| > 4 days/week | 165 | 47.6 |
| 3-4 days/week | 78 | 22.5 |
| 1-2 days/week | 41 | 11.8 |
| Occasionally | 61 | 17.6 |
| Missing Values | 2 | 0.6 |
| B8. Transport mode alternative to this PT service | | |
| Bus | 201 | 50.9 |
| Walk | 16 | 4.1 |
| Metro | 5 | 1.3 |
| Taxi | 79 | 20.0 |
| Commuter rail | 11 | 2.8 |
| Tramway | 10 | 2.5 |
| Private Car | 68 | 17.2 |
| Missing Values | 5 | 1.3 |
| C1. Availability of: | | |
| Driver license | 222 | 64.0 |
| Access to private vehicle | 114 | 32.9 |
| Access to motorcycle | 7 | 2.0 |
| Access to bicycle | 12 | 3.5 |
| None | 100 | 28.8 |
| C2. Level of studies completed | | |
| Without studies | 16 | 4.6 |
| Mandatory school | 61 | 17.6 |
| High School or Professional Education | 59 | 17.0 |
| Bachelor's degree or higher | 206 | 59.4 |
| Missing Values | 5 | 1.4 |
| C3. Employment Status | | |
| Employed | 137 | 39.5 |
| Unemployed | 12 | 3.5 |
| Student | 110 | 31.7 |
| Homemaker | 22 | 6.3 |
| Liberal Profession | 39 | 11.2 |
| Retired | 18 | 5.2 |
| Other | 6 | 1.7 |
| Missing Values | 3 | 0.9 |
| C4. Age (years of age) | | |

| | | |
|-------------------------------------|-----|------|
| <18 | 6 | 1.7 |
| 18-25 | 139 | 40.1 |
| 26-40 | 97 | 28.0 |
| 41-65 | 82 | 23.6 |
| >65 | 14 | 4.0 |
| Missing Values | 9 | 2.6 |
| C5. Household monthly income | | |
| < 36001DA | 63 | 18.2 |
| 36.001-54.000DA | 74 | 21.3 |
| 54.001-72.000DA | 30 | 8.6 |
| > 72.000DA | 23 | 6.6 |
| Missing Values | 157 | 45.2 |
| C6. Gender | | |
| Female | 176 | 50.7 |
| Male | 171 | 49.3 |

Tab. 1 Trip and socio-demographic characteristics

Our survey shows that the surveyed population is quite as motorized (32.9%) as reported before. This figure actually seems okay and can be explained by the evolution of individual car ownership in recent years according to what we have observed in Algerian households. In addition, it should also be noted that 64% of respondents say they have a driving license. However, the results for the two-wheel (motorcycle and bicycle) are to be handled with great care because they do not reflect what is going on and the data collected in recent years show that the two are still very low and represent only 0.2% of motorized modes (Baouni et al, 2014; BETUR-CENEAP, 2004). Furthermore, the results for the level of study seem to be quite significant because the 59.4% represents the population of employees and liberal function of the respondent sample. Finally, to complete the analysis of the results on the socio-economic profile of the sample, it is interesting to note that the field survey showed that the age of 18-25 category comes in first place with 40.1% followed by the class of 26-40 years with 28% and, finally, the age group of 41-65 years with 23.6%. These figures show that the rail modes (metro, tram and suburban railway) are relatively popular among the young. Table 1 also shows that 23% of respondents mainly use rail modes for reasons of speed, while the frequency, the ticket price, security and others are weakly significant and seem to have the same value estimated at 7%. Furthermore, the low value of around 4.5% is allocated for other reasons. As the results show, in fact, that 65.7% of trips related to mandatory reasons (39.4% and 25.9% work studies). Results clearly reflect that walking is the dominant mode (43%) for reaching stations, followed by bus (27%). Although the car is the preferred travel mode in Algiers, the survey's results show that the private car only represents 12.8% of the share market for reaching the stations. This can be explained by the lack of parking areas near the stations. The modes for reaching the final destination from the rail station follow the same patterns as from origin to the rail station. Table 1 shows that the highest values are for walking (63.7%) and buses (18.3%). Also, suburban railway and tram are poorly used in trips from origin to the station and from the station to the final destination. The average time from origin to the station is 24.3 min; while from the station to the final destination is 22.1 min. This lets us conclude that the average duration is substantially identical in both directions. Indeed, the rail modes are highly use by customers: 47.6% use them more than 4 times per week. The survey reveals that 50.9% of the people would use the bus as an alternative method in case of interruption of rail services, while taxi and private car fashion show 20% and 17.2% respectively. PCA identifies five dimensions that have a fairly significant impact on the quality of rail service in Algiers (see Table 2). These dimensions are related to the service operation, infrastructural comfort, safety and customer service, accessibility and personal comfort. The fairly extensive interpretation

of variables in each dimension gives a more or less correct picture of the overall quality of service, which translates into an average variance extracted of 0.59.

| | | PCA Factor loadings | PCA Factor scores weights |
|-------------------------------|--|---------------------|---------------------------|
| SQ1 | SERVICE OPERATION (Cronbach's Alpha: 0,87) | | |
| Q130 | Punctuality | 0.79 | 0.30 |
| Q14 | Waiting time on the platform | 0.78 | 0.28 |
| Q2 | Number of trains per day (frequency of the service) | 0.76 | 0.28 |
| Q1 | Operating hours of the service | 0.66 | 0.28 |
| Q12 | Updated, precise and reliable information in stations (price. operating hours. stops. service interruptions. etc.) | 0.55 | 0.13 |
| Q11 | Updated, precise and reliable information on vehicles (operating hours, stops, service interruptions, etc.) | 0.51 | 0.11 |
| Q4 | Regularity of the service (absence of interruptions caused by breakdown or incidents) | 0.47 | 0.13 |
| SQ2 | INFRASTRUCTURAL COMFORT (Cronbach's Alpha: 0,82) | | |
| Q18 | Lightning on vehicles | 0.78 | 0.35 |
| Q17 | Cleanliness of the vehicle | 0.77 | 0.32 |
| Q23 | Lightning in stations | 0.68 | 0.26 |
| Q20 | Temperature and ventilation system on vehicle and in stations | 0.68 | 0.30 |
| Q22 | Cleanliness of the stations | 0.64 | 0.23 |
| SQ3 | SAFETY AND CUSTOMER SERVICE (Cronbach's Alpha: 0,80) | | |
| Q253 | Sense of security against slipping, falling and accidents at vehicle doors and escalators. | 0.75 | 0.39 |
| Q25 | Sense of security against theft and aggression in stations and on vehicles | 0.66 | 0.31 |
| Q251 | Sense of security against accidents while traveling (crash/vehicle derailment) | 0.66 | 0.31 |
| Q15 | Effectiveness and speed of employees to respond, give information and deal with user's daily problems | 0.65 | 0.28 |
| Q16 | Performance of the Customer Service (offices, web site, contact by phone, deal with complaints, etc.) | 0.49 | 0.14 |
| SQ4 | ACCESSIBILITY (Cronbach's Alpha: 0,59) | | |
| Q6 | Easy access to stations and platforms from the street | 0.70 | 0.44 |
| Q3 | Proximity of stations to origin/destination | 0.69 | 0.46 |
| Q5 | Easy connection with other transportation modes such as taxis, bus, tramway, metro, commuter rail, cable car, etc. | 0.58 | 0.34 |
| Q13 | Speed of the trip | 0.39 | 0.17 |
| SQ5 | PERSONAL COMFORT (Cronbach's Alpha: 0,67) | | |
| Q24 | Seat availability in stations and on platforms | 0.69 | 0.47 |
| Q19 | Level of comfort on vehicle (enough room seating/standing up) | 0.62 | 0.38 |
| Q21 | Appropriate driving | 0.41 | 0.21 |
| Goodness-of-fit Indices | | | |
| Bartlett test ($p < 0.001$) | | 3835 | |
| Measure of Sampling Adequacy | | 0.86 | |
| Average Variance Extracted | | 0.59 | |

Tab. 2 Principal Component Analysis results

Also, it should be noted that the value of Cronbach's Alpha is quite high (between 0.59 and 0.87) for service operation dimensions, infrastructure comfort, safety and customer service and personal comfort as to the dimension accessibility speed which is considered according to the Cronbach's Alpha to be acceptable (value equal to 0.59). It was noted that the permissible limit value is in the range of 0.6-0.7 (Hair et al, 2010). Table 3 shows that the dimensions relating to "service operation", "safety and customer service" and "personal comfort" present a p-value lower than 0.05. This reflects a significant impact on the overall quality

of service. Also, Algerian rail public transport generally has a better image than the bus or private car. Satisfaction factors are the frequency, time of waiting in the docks, security, and punctuality. The latter two are the two most important elements for users regarding the service quality of public transport before the comfort, which remains an important dimension of quality of service (cleanliness, more space, etc.).

| Explanatory Variable | Coefficient | Robust Standard Error | P-value |
|---------------------------|-------------|-----------------------|---------|
| SQ1 | 0.227 | 0.042 | 0.000 |
| SQ2 | 0.115 | 0.064 | 0.075 |
| SQ3 | 0.171 | 0.042 | 0.000 |
| SQ4 | 0.093 | 0.049 | 0.057 |
| SQ5 | 0.098 | 0.044 | 0.026 |
| cut1 | 1.335 | 0.560 | 0.017 |
| Cut2 | 2.572 | 0.510 | 0.000 |
| Cut3 | 4.619 | 0.543 | 0.000 |
| Cut4 | 6.404 | 0.593 | 0.000 |
| Goodness-of-fit Indices | | | |
| Sample Size | 347 | | |
| Chi squared (p<0.001) | 135.670 | | |
| Log-likelihood function | -311.193 | | |
| McFadden Pseudo R-squared | 0.239 | | |

Tab.3 Ordered Probit Model of Customer Satisfaction with the PT services

| Model | Dimension | Explanatory Variables | Non-standardised coef. (B) | Typical error | Standardised coef. (B) | t | Sig. |
|----------|-----------|-----------------------|----------------------------|---------------|------------------------|--------|------|
| | | | B | Beta | | | |
| 1 | SQ1 | (Constant) | 8,059 | .286 | | 28.140 | .000 |
| | | B6 | -.16 | .006 | -.198 | -2.710 | .007 |
| | | B1_Prix | -.941 | .361 | -.192 | -2.609 | .010 |
| | | B8_bus | -.841 | .298 | -.206 | -2.825 | .005 |
| | | B1_Frequence | .848 | .367 | .170 | 2.310 | .022 |
| 2 | SQ2 | (Constant) | 7.703 | .272 | | 28.362 | .000 |
| | | B1_Confort | .438 | .198 | .163 | 2.216 | .028 |
| | | B1_Vitesse | .508 | .211 | .182 | 2.404 | .017 |
| | | B1_Seurite | .605 | .224 | .198 | 2.698 | .008 |
| | | B6 | -.010 | .004 | -.186 | -2.550 | .012 |
| 3 | SQ3 | C1_permiss | .371 | .201 | .134 | 1.848 | .066 |
| | | B1_Prix | -.439 | .245 | -.135 | -1.792 | .075 |
| | | (Constant) | 6.304 | .358 | | 17.585 | .000 |
| | | B1_Prix | -.835 | .382 | -.168 | -2.189 | .030 |
| | | C2_obligatoire | .702 | .402 | .132 | 1.749 | .082 |
| | | B1_Seurite | .708 | .348 | .151 | 2.034 | .044 |
| | | B6 | -.011 | .006 | -.142 | -1.914 | .057 |
| | | C4_plus40 | .654 | .342 | .144 | 1.914 | .057 |
| | | B1_Vitesse | .626 | .329 | .146 | 1.901 | .059 |
| 4 | SQ4 | (Constant) | 8.251 | .291 | | 28.394 | .000 |
| | | B3_pied | .678 | .239 | .213 | 2.833 | .005 |

| | | | | | | | |
|--------------------------------|-----|-------------------|----------------|-----------------------|-------------|--------|---------|
| | | C5_54o72DA | -.994 | .330 | -.228 | -3.014 | .003 |
| 4 | SQ4 | B8_bus | -.623 | .242 | -.193 | -2.573 | .011 |
| | | B1_Congesti on | -.576 | .246 | -.173 | -2.341 | .020 |
| | | B6 | -.009 | .005 | -.144 | -1.921 | .057 |
| | | B1_Prix | -.544 | .290 | -.140 | -1.875 | .063 |
| | | (Constant) | 6.566 | .224 | | 29.369 | .000 |
| | | C4_plus40 | .909 | .321 | .212 | 2.832 | .005 |
| 5 | SQ5 | B8_taxi | .913 | .342 | .199 | 2.672 | .008 |
| | | C5_plus72D A | -.926 | .443 | -.156 | -2.089 | .038 |
| | | B6 | -.010 | .006 | -.132 | -1.772 | .078 |
| Godness-of-fit Indices (ANOVA) | | | | | | | |
| | | | Sum of Squares | Degrees of Freedom | Mean Square | F | P-value |
| 1 | SQ1 | Regression | 101.128 | 4 | 25.282 | 7,149 | .000 |
| | | Residual | 569.394 | 161 | 3.537 | | |
| | | Total | 670.522 | 165 | | | |
| 2 | SQ2 | Regression | 50.899 | 6 | 8.483 | 5,550 | .000 |
| | | Residual | 243.042 | 159 | 1.529 | | |
| | | Total | 293.941 | 165 | | | |
| 3 | SQ3 | Regression | 100.184 | 6 | 16.697 | 4,488 | .000 |
| | | Residual | 591.513 | 159 | 3.720 | | |
| | | Total | 691.697 | 165 | | | |
| 4 | SQ4 | Regression | 69.006 | 6 | 11.501 | 5,228 | .000 |
| | | Residual | 349.762 | 159 | 2.200 | | |
| | | Total | 418.768 | 165 | | | |
| 5 | SQ5 | Regression | 71.476 | 4 | 17.869 | 5,262 | .001 |
| | | Residual | 546.762 | 161 | 3.396 | | |
| | | Total | 618.238 | 165 | | | |

Tab. 4 Multiple Linear Regression Analysis of Service Quality Dimensions and Socio-demographic Characteristics

Table 4 shows the effect of socio-economic variables and travel patterns on the main service quality dimensions: service operation (SQ1), infrastructural comfort (SQ2), safety and customer service (SQ3), accessibility (SQ4) and personal comfort (SQ5). The socio-economic variables and travel patterns that do not show a significant influence ($p\text{-value} > 0.10$) on each service quality dimension have not been included in Table 4. The trip time from the station to destination (-0.198), the ticket price (-0.192), and considering the bus as an alternative to the rail public transportation (-0.206) play a negative influence over the dimension of service operation. However, the rail transit's frequency has a positive impact (0.170) on this dimension. The trip time from the station to destination (-0.186) and the ticket price (-0.135) play a negative influence over the dimension of infrastructural comfort. However, other reasons for using the rail transit, such as comfort (0.163), speed (0.182), safety (0.198); and the availability of a driver license (0.134) have a positive impact on this dimension. In the case of safety and customer service (SQ3), also the trip time to destination (-0.142) and the ticket price (-0.168) play a negative role. However, speed (0.146) and safety (0.151), and a low level of studies (0.132) and an age over 40 years old (0.144) have a positive impact on this dimension. The trip time from the station to destination (-0.144), the ticket price (-0.140), the congestion (-0.173), considering the bus as an alternative to the rail public transportation (-0.193) and a high (54-72 kDA)

household monthly income (-0.228) play a negative influence over the dimension of accessibility. However, the possibility of accessing the station from origin walking has a positive impact on this dimension (0.213). And finally, the trip time from the station to destination (-0.132) and a very high (over 72 kDA) household monthly income (-0.156) play a negative influence over the personal comfort. However, an age over 40 years old (0.212) and considering the taxi as an alternative to the rail public transportation (0.199) have a positive impact on this dimension.

6 CONCLUSION

This paper presents the results of the first customer satisfaction survey of users of all rail public transit services (light rail, underground rail and commuter rail) in Alger. Some interesting results are extracted from this survey. Regarding the users' profile and travel patterns the main results are the following:

The three most important reasons for using rail transit services are speed, comfort and congestion of the road network. Work and studies are the main trip purposes. Access to and egress from stations are mainly based on walking and bus. The average trip time from origin to the stations and from the station to the final destination is 24.3 min and 22.1 min respectively. The users of these transport modes are mainly frequent users (more than 70% use the rail transit services more than 3 days/week). The main alternatives to the rail transit services are bus (51%) and taxi (20%). Most of the users (64%) have a driver license. However, only half of them (32.9%) have access to a private vehicle. Most of the users are employed (39.5%) or students (31.7%) and have a bachelor's degree or higher education (59.4%). Principal Component Analysis allows identifying five service quality dimensions (service operation, infrastructural comfort, safety and customer service, accessibility and personal comfort). However, only three of them (service operation, safety and customer service and personal comfort) present a significant influence ($p\text{-value} < 0.05$) on the overall service quality. Service operation presents the highest influence (0.227), followed by safety and customer service (0.171) and, finally, personal comfort (0.098). Finally, the socio-economic variables and travel patterns that present a highest influence on the service quality dimensions are the trip time from station to destination and the ticket price. The trip time has a negative influence on all the service quality dimensions and the ticket price also has a negative influence in four of the dimensions (all except the personal comfort). These results could be explained because the price of rail services is high if compared with buses in Alger, and because the rail network is undeveloped (see Figure 1). Although the results of this paper help in understanding the situation of the rail transit service in Alger, we only have a general overview of all rail transit modes. More studies should be done in order to improve the data collection and analysis of the situation by transport mode.

REFERENCES

- Alpu, O. (2015). A methodology for evaluating satisfaction with high-speed train services: A case study in Turkey. *Transport Policy*, 44, 151-157. doi:<http://dx.doi.org/10.1016/j.tranpol.2015.08.004>
- Baouni, T. (2015a). Les transports collectifs à Alger: une nouvelle stratégie face aux défis du développement durable", *séminaire national sur l'urbanisme*, Tlemcen -28 octobre 2015.
- Baouni, T. (2015b). Impacts des nouveaux TCSP sur la mobilité des usagers à Alger. *conférence internationale CODATU*, 2-5 février-Université Technique d'Istanbul-Turquie. Available at: <http://www.codatu.org/wp-content/uploads/PRESENTATION-Impact-des-nouveaux-TCSP-sur-la-mobilit%C3%A9-des-usagers-%C3%A0-Alger-EN.pdf>
- Baouni, T. & al (2014). Rapport des enquêtes portant sur les pratiques de la mobilité à Alger. laboratoire VUDD, Epau-Alger.

- Baouni, T., Bakour, M., & Berchache, R. (2014). Les effets de la multi modalité sur la mobilité des usagers. *Insaniyat*, No. °62, Editions CRASC.
- Berchache, R. (2011). Les enjeux des transports collectifs face au développement urbain durable d'Alger. *Mémoire de magister en urbanisme*, Epau – Alger.
- Berry, L., Zeitham, V.A. & Parasuraman, A. (1990). Five Imperatives for Improving Service Quality. *Sloan Management Review*, 31, 29-38. Available at: <https://search.proquest.com/openview/8b3a8e9fbf82128a35d092cf3a81003f/1?pq-origsite=gscholar&cbl=26142>
- BETUR & CENEAP. (2005). Enquête ménages transport Alger 2004. *Rapport final*, Alger.
- Charton, M. (2010). Le projet de réorganisation du réseau des transports urbains d'Alger: La pertinence de l'outil de modélisation. *Mémoire de master*, université de Bourgogne-France.
- Dessau-Soprin and Thalès. (2006). Rapport de synthèse plan de transport d'Alger. Ministère des transports.
- Direction de l'Administration Locale d'Alger. (2016). Statistiques du fichier électoral de la wilaya d'Alger. Janvier 2016.
- De Oña J., Baouni T., and De Oña R. (2013). The metro in Algiers: user profile and quality of service. *WIT Transactions on the Built Environment*, No. 130, 11. doi:<http://dx.doi.org/10.2495/UT130511>
- De Oña, J., de Oña, R. & Calvo, F.J. (2012). A classification tree approach to identify key factors of transit service quality. *Expert Systems with Applications*, 39 (12), 11164-11171. doi:<http://dx.doi.org/10.1016/j.eswa.2012.03.037>
- De Oña, J. & De Oña R. (2014). Quality of Service in Public Transport Based on Customer Satisfaction Surveys: A Review and Assessment of Methodological Approaches", *Transportation Science*, 2014. doi:<http://dx.doi.org/10.1287/trsc.2014.0544>
- De Oña R., Machado J.L., & De Oña J. (2015). Perceived Service Quality, Customer Satisfaction and Behavioral Intentions: A Structural Equation Model for the Metro of Seville, Spain", *Transportation Research Record*, Vol. TRB 94th, Annual Meeting Compendium of Papers, 2015.
- De Oña, J., de Oña, R., Eboli, L., Forciniti, C., & Mazzulla G. (2016). 'Key Transit passengers' behavioural intentions: the influence of service quality and customer satisfaction', *Transportmetrica A*, 12(5), pp. 385-412. doi: <https://doi.org/10.1080/23249935.2016.1146365>
- Dell'Olio, L., Ibeas, A. & Cecin, P. (2011). The quality of service desired by public transport users. *Transp. Policy* 18, 217–227.
- Diab, E., van Lierop, D. & El-Geneidy A. (2017) Recommending transit: Disentangling users' willingness to recommend transit and their intended continued use. *Travel Behaviour and Society* 6, 1-9
- Entreprise des Transports Urbains Algérois (ETUSA), (2014). Rapport d'exploitation", Direction d'exploitation-Alger.
- Entreprise du Métro d'Alger-RATP-El Djazair, 2014. Document portant sur la satisfaction des usagers du métro. EMA/RATP-Alger.
- Garrido C, de Oña R & de Oña J (2014). Neural networks for analyzing service quality in public transportation. *Expert Systems with Applications*, 41, 6830-6838. doi:<https://doi.org/10.1016/j.eswa.2014.04.045>
- Guirao G., García-Pastor A. & López-Lambas M.E. (2016) The importance of service quality attributes in public transportation: Narrowing the gap between scientific research and practitioners' needs. *Transport Policy*, 49, 68-77.
- Hadiuzzman M, Das T, Hasnat MM, Hossain Sm, & Musabbir SR (2017). Structural equation modeling of user satisfaction of bus transit service quality based on stated preferences and latent variables. *Transportation Planning and Technology*, 40 (3), 257-277
- Hair J.F., Black W.C., Babin B.J., & Anderson R.E. (2010). *Multivariate Data Analysis: A Global Perspective*. Prentice Hall, New Jersey.
- Hernandez S., & Monzon A., (2016). Key factors for defining an efficient urban transport interchange: Users' perceptions. *Cities*, No. 50, 158-167
- Mckelvey R.D., & Zavoina W. (1975) "A statistical model for the analysis of ordinal level dependent variables", *Journal of Mathematical Sociology*, No 4, 103-120. doi:<https://doi.org/10.1080/0022250X.1975.9989847>
- Office National des Statistiques (2010). *Annuaire des Recensements Généraux de la Population et de l'Habitat* 66, 77, 87 et 98.

Ojo, T.K., Nutsogbodo, R.Y. & Appiah-Mintah, R. (2014). Passenger's perspective of quality of intercity bus transport service Accra-Cape Coast route, Ghana. *GE International Journal of Management Research*, 267-287

Park J, Robertson R, & Wu CL (2004) The effect of airline service quality on passengers' behavioural intentions: A Korean case study. *J. Air Transport Management* 10(6):435-439

Román C, Martín JC & Espino R (2014). Using stated preferences to Analyze the Service Quality of Public Transport. *International Journal of Sustainable Transportation*, 8, 28-46

Talamali, A. (2018). Transports collectifs et métropolisation d'Alger. thèse de doctorat, USTHB-Alger.

IMAGE SOURCES. Railway Algiers (setram-algiers)

Fig. 1: Baouni,2015b

AUTHOR'S PROFILE

Tahar Baouni, PhD, is Professor and Research Director at the Ecole Polytechnique d'Architecture et d'Urbanisme (EPAU), Algiers. He has been the director of the research laboratory Ville, Urbanisme et Développement Durable of EPAU and a member of the Scientific Council of EPAU since 2006, and was a member of the EPAU administrative council from 2009 to 2012. He was also chair on the scientific council of Institut Supérieur de Formation Ferroviaire (ISFF), Algiers from 2005 to 2009. Baouni is also an associated professor in the department of Geography and Spatial Planning at Bab Ezouar in Algiers. He is a consultant to offices and agencies of urbanism and transport and has been responsible for numerous research projects in these fields. He has published widely on issues of transport planning, urbanism, and environment

Juan de Oña, Professor of Transportation and Director of the Transportation and Safety Research Group, University of Granada. He is the author of more than 150 journal and conference publications on transit service quality, travel behavior and road safety.

Rocío de Oña, Assistant Professor of Transportation, University of Granada. She has participated in numerous international research projects and is the author of more than 50 journal and conference publications on transit service quality, travel behavior and road safety.

Badra Merad, Lyes Tahraoui & José Luis Machado-Leon, students preparing thesis phd.

TeMA Urban Travel Behavior in the Middle East and North Africa
SPECIAL ISSUE 1.2018 | 83-94
print ISSN 1970-9889, e- ISSN 1970-9870
doi: <http://dx.doi.org/10.6092/1970-9870/5456>

review paper received 30 January 2018, accepted 07 May 2018

Licensed under the Creative Commons Attribution
Non Commercial License 3.0
www.tema.unina.it

Adeel, M. (2018). Travel behaviour variations across urban and rural areas of Pakistan. A national mobility analysis. *Tema Journal of Land Use, Mobility and Environment* 83-94

doi: <http://dx.doi.org/10.6092/1970-9870/5456>



TRAVEL BEHAVIOUR VARIATIONS ACROSS URBAN AND RURAL AREAS OF PAKISTAN

A NATIONAL MOBILITY ANALYSIS

MUHAMMAD ADEEL

LSE Cities, London School of Economics and Political Science, London WC2A
2AE, UK.

e-mail: m.adeel@lse.ac.uk

URL: <https://lsecities.net/>

ABSTRACT

This paper examines the 2007 Pakistan national time use survey to report the degree to which the national travel behaviour varies between urban and rural of Pakistan and how it is shaped by the socioeconomic and individual characteristics. Longitudinal analysis was performed on 37,830 time use diaries collected in the survey in Stata and the resulting travel behavior characteristics have been examined through household and individual socioeconomic variables. At the national level, walking remains the dominant mode of daily mobility across the country. Nearly 90 percent of daily travel is done by walk. However, the daily trip rate, mode choice and travel durations vary significantly across urban and rural geographies. Urban residents are slightly less mobile and exhibit greater use of personal automobile than rural residents. Rural residents make 4.6 trips per day as compared to 4.4 trips per day of urban residents. Similarly, rural population are found to travel 101 minutes per day as compared to significantly lower duration of 98 minutes among urban residents. While walking trips usually take same time, mean trip duration by automobiles is also much longer among rural population than urban (42.2 minutes vs 34.1 minutes). These differences become more pronounced across gender and urban women appear to be the least mobile while rural men appear most mobile as apparent from their daily trip rates of 2.6 and 5.7 per person, respectively. There exists slight local regional variation across provinces which are closely related to the local social and spatial drivers of mobility. The paper contends that the rural travel differences are mainly caused by difference in income levels. Urban built environment is more conducive to motorized mobility which results in greater automobile reliance in cities, particularly for women. Social and cultural environment also plays potentially significant and spatially explicit role which remains under addressed and calls for further research.

KEYWORDS:

Travel behavior; Accessibility; Mode choice; Walking; Time use

1 INTRODUCTION

Global population is rapidly urbanizing. While every second person was living in urban areas since year 2007, it is expected that the share of urban population will increase approximately 10 cars per 1000 persons to two thirds by year 2050 (United Nations, 2002). There also exists a great inter-continental and inter country difference in the share of urban population. In the developing countries, a significantly higher share of population still resides in the rural areas. Rural areas differ significantly from urban on the bases of their built environment in terms of the presence and arrangement of land uses (Morrill et. al., 1999). Urban areas usually exhibit higher densities and greater densities which are in sharp contrast to rural geographies. As a result, the mobility choices and travel behavior often varies subtly and significantly between these areas due to varying level of proximity and access to destinations (Millward & Spinney, 2011). Many studies have specifically examined these variations in travel behavior in the developed world which highlight that rural areas may have significantly different travel needs depending on their social, economic and spatial characteristics. For example, Pucher & Renne (2005) reported that the rate of car ownership and share of car based trips in daily travel was much higher in the rural areas of the United States as compared to the urban areas. See also Levinson, (2016), Houshmand, (2017) & Niglio et al., (2015) for more readings on it. This is linked with the lower level of accessibility and comparatively more 'dispersed' provision of services which results in higher mobility levels among rural population. Also the limited provision of public transport services and smaller levels of daily ridership also plays a significant role in increasing personal automobile reliance in rural areas (De Vos et. al., 2012). Pakistan is the most urbanized countries of south Asia where nearly forty percent of the population is estimated to live in urban areas. According to the latest population census, nearly two third of urban population is concentrated in ten large metropolitan areas (PBS, 2017). Until 1980s, urban mobility in Pakistan's was largely based on bus based urban public transport system and the British era intercity rail network. However, a consistent focus on road based transport policy since then has led to the deregulation of road based public transport system while the rail network saw a steep deterioration of its service (Imran, 2009). The country has steadily enlarged its network of inter and intra city urban roads over the years. A major share of ongoing investment in China Pakistan Economic Corridor is focused on highway development and related urban transport provision in cities. Increase in highway network has constantly favored the growing number of private automobiles, particularly in cities.

Currently, majority of urban transport demand is catered by privately owned fleet of buses and minivans which are often despised by the users for their poor quality service and lack of coverage (Adeel et al., 2016). While the government has prepared the Bus Rapid Transport network in few cities, it usually serves a limited number of urban travelers. In this scenario, personal automobile based mobility provides an ideal choice for the urban commuters (Haider & Badami, 2004). While the car ownership levels still remain low (approximately 10 cars per 1,000 persons in year 2015 when calculated from the official statistics. Metropolitan cities have higher car ownership than smaller cities due to their great dependent on automobility. Various studies have examined the travel behavior in the individual cities e.g. Russell & Anjum (1997) in Lahore, Qureshi & Lu (2007) in Karachi which state that nearly one third of trips are done by automobiles. A broader national level examination of the urban travel behavior is still missing from the policy discussions. Similarly, only a limited number of studies focus on rural mobility with a specific focus on transportation and urban planning. Due to lack of detailed knowledge, national urban and rural travel behavior remains understudied and largely over simplified. Secondly, a comparison between urban and rural areas within the same study will permit us more insights into the geographical variation that are usually not measurable but may be important for transport and development across the country.



Fig. 1 Bus based transport mobility remains the most popular mean of automobility in urban and rural areas of Pakistan

2 DATA AND METHODS

Travel behavior analysis and its surveys are not yet a common feature of transport policy analysis and data collection in Pakistan. The 2007 national time use survey is the first and the only national survey of its kind and it provides a useful opportunity to examine national travel behavior across urban and rural areas of the country (PBS, 2009). The survey was carried out during year 2007-08 and follows a multistage stratified random sampling procedure where sample households are selected randomly from a stratified list of national urban and rural areas. The data was collected through face to face, pen and paper based questionnaire survey by visiting the sample houses by the locally hired surveyors. Its data is statistically representative of the national population at the urban, rural and provincial level.

| CODE | CATEGORY | DETAILS |
|------|---------------|--|
| 180 | Subsistence | Travel to/from work and seeking employment in establishments |
| 280 | Subsistence | Travel related to primary production activities (not for establishments) |
| 380 | Subsistence | Travel related to services for income and other production of goods (not for establishments) |
| 780 | Subsistence | Travel related to learning, examination |
| 480 | Maintenance | Travel related to household maintenance, management and shopping |
| 581 | Maintenance | Travel related to care of children |
| 582 | Maintenance | Travel related to care of sick and disabled adult |
| 583 | Maintenance | Travel related to care of elderly adult |
| 680 | Maintenance | Travel related to community services |
| 880 | Discretionary | Travel related to social, cultural and recreational activities |
| 980 | Discretionary | Travel related to mass media use and entertainment |
| 80 | Discretionary | Travel related to personal care and self-maintenance |

Tab.1 Travel related activities and their survey code for Pakistan time use survey 2007

The time use diary files were provided publically free of cost in the Stata file format that were downloaded and analyzed in Stata software using the longitudinal data analysis techniques. The survey also noted if the activities were done simultaneously or one after another. Activity time was divided equally between all the activities in an episode if the activities were not carried out simultaneously. However, if the respondent participated in two activities at the same time, both the activities were given equal amount. For example, if a person was travelling while sleeping during an episode, thirty minutes were awarded to both sleep and travel activities. This ensured that the activity and travel time was not undercounted.

| Location code 1 | Location code 2 |
|--|--|
| 1 Own dwelling | 1 Inside |
| 2 Someone else's dwelling | 2 Outside |
| 3 Field, farm or other agricultural workplace | 3 Travelling on foot |
| 4 Other workplace outside private dwelling | 4 Travelling by private transport (car, van, motorcycle) |
| 5 Educational establishments | 5 Travelling by taxi (Rickshaw, Quinqui or other) |
| 6 Public area i.e. not in a private dwelling, workplace or educational establishment | 6 Travelling by train |
| 7 Travelling or waiting to travel | 7 Travelling by bus |
| 8 Other (specify) | 8 Travelling by bicycle |
| | 9 Travelling by other means (specify) |

Fig. 2 The time use survey noted travel activity in location 1 while the mode of travel was noted as location 2

With a sample size of 19,600 households, this survey collected one day time use diary form nearly 38,000 persons. The diary section noted all the activities, including travel activity, carried out by the respondent on the day before the survey. The survey day was divided into forty eight half hour long activity episode and each respondent was asked to recall three activities it did during each half hour episode of the diary day. Travel was a part of the activity classification a total of twelve variables noted travel activity by activity type.

The activities were recorded in the format of International Classification of Activities for Time Use Surveys (ICATUS). Table 1 enlists the travel related activities noted in the survey. For travel related activity, a location variable noted the travel mode in one of the following seven choices: walking, private transport, taxi, train, bus, bicycle and other means (Figure 2). Each travel activity noted in the survey has been treated as one trip as the survey does not differentiate between the two trip legs.

Results and discussion

| | TRIPS PER DAY | | MINUTES TRAVELLED PER DAY | |
|----------------------------|---------------|------------|---------------------------|------------|
| | URBAN | RURAL | URBAN | RURAL |
| Total non-motorized | 3.7 | 4.3 | 74 | 89 |
| Walking | 3.5 | 4.2 | 69 | 85 |
| Bicycle & other | 0.2 | 0.1 | 4 | 4 |
| Total Motorized | 0.7 | 0.3 | 24 | 12 |
| Private automobile | 0.5 | 0.2 | 15 | 6 |
| Public transport | 0.3 | 0.1 | 10 | 6 |
| All | 4.4 | 4.6 | 98 | 101 |

Tab. 2 Mobility levels across urban and rural areas

The time use survey measures a total of 122,673 trips and 2,632,480 travel minutes from 26441 mobile respondents who reported traveling on the dairy day. As the table 2 shows, walking remains the dominant mode of transportation across urban and rural areas. The share of walking trips is much higher in rural areas (93%) as compared to urban areas (84%). While motorized mobility accounts for the remaining 16 and 7 percent of total daily trips in urban and rural areas, respectively, public transport accounts for only one third

of motorized travel whereas personal automobile contribute the remaining two third of all motorized trips in the country. Mobility by 'Bicycle and other means' made a smaller share of up to 2 and 5 percent daily trips in rural and urban areas, respectively.

| Time Period | 1 to 3 Activities per time period | Activities S.No. | Code | Same time? Yes No | Location 1 | Location 2 |
|-------------|-----------------------------------|------------------|------|---|------------|------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 04h00 | | 1001 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1002 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 04h30 | | 1003 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 04h30 | | 1004 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1005 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 05h00 | | 1006 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 05h00 | | 1007 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1008 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 05h30 | | 1009 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 05h30 | | 1010 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1011 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 06h00 | | 1012 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 06h00 | | 1013 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1014 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 06h30 | | 1015 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 06h30 | | 1016 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1017 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 07h00 | | 1018 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 07h00 | | 1019 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1020 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 07h30 | | 1021 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 07h30 | | 1022 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1023 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 08h00 | | 1024 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 08h00 | | 1025 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1026 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 08h30 | | 1027 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 08h30 | | 1028 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| To | | 1029 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 09h00 | | 1030 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |
| 09h00 | | 1031 | | 1 <input type="checkbox"/> 2 <input type="checkbox"/> | | |

Fig. 3 Time use diary section noted three activities, their simultaneity and location codes in each activity episode

Mode disaggregated data highlights that the rural residents made 0.7 or 20 % more walking trips per person per day but their non-walking trips, including bicycle and motorized trips, were significantly lesser than urban households. Daily travel duration also exhibits similar but slightly wider geographical differences. Walking makes up to 70 percent of total daily travel time in urban areas (98 minutes) as compared to 84 percent (101 minutes) of that in rural areas. While the travel duration by 'Bicycle and other means' make only 4 percent across urban and rural areas, share of motorized travel duration is significantly higher in urban areas (24 percent) than rural areas (12 percent). Further, rural travellers exhibited equal share of daily travel duration

by public and private means of transport (6 percent, each), whereas urban travellers amassed 50 % more daily minutes by personal automobile than public transport (15 and 10 percent, respectively). Frequent walking trips in rural areas increase their overall mobility level as the motorized travel remain very low in the country.

| TRAVEL MODE | URBAN | RURAL |
|-----------------------|-------------|-------------|
| Non-motorized | 21.8 | 22.3 |
| Walking | 21.5 | 21.8 |
| Bicycle & other | 27.6 | 31.9 |
| Motorized | 34.1 | 42.2 |
| Private automobile | 30.3 | 38.9 |
| Public transport | 38.9 | 44.1 |
| All | 24.0 | 23.5 |
| Travel purpose | | |
| Subsistence | 25.7 | 25.3 |
| Maintenance | 19.2 | 13.8 |
| Discretionary | 21 | 20.6 |

Tab 3. Mean trip duration in minutes across urban and rural areas of Pakistan

The analysis shows that nearly 30 percent of respondents did not report any travel activity on the diary day. However, this immobility was largely concentrated on the female side and only three percent immobile respondents were male. However, urban men and women exhibited significantly higher immobility rates than rural counterparts. While these high instances of immobility are important part of larger transportation behaviour in the country and are consistent with similar findings from other studies of urban mobility in the developing country context, discussion on it does not lie in the scope of this article.

Walking remains the most dominant mode of transportation in rural areas. Recent work by JICA (2012) indicates that motorized travel makes up to half of the daily mobility in metropolitan areas like Lahore. However, these metropolitan studies tend to ignore the day to day short trips in local neighbourhoods and focus on motorized demand estimation. The above results provides a broader picture of daily mobility across urban and rural areas of the country which remains predominantly walking based society. Secondly, the results also highlight that rural areas might not suffer from low accessibility as earlier expected. As the results show, rural residents travel only 3 minutes more overall. Rather, it can be said that motorization has shortened walking time in urban areas by 10 to 15 percent and that rural areas lag behind in motorization by the same margin, probably due to lack of access to automobiles and a possible high accessibility to day to day activities such as mosques, workplaces and social contacts due to small size of rural settlements.

The urban rural differences in accessibility to services are well researched in the existing literature. It is known that the rural face limited accessibility that might increase their average trip duration than urban residents. However, a national picture of trip duration by mode and purpose of travel remains missing so far, which is provided in Table 3 above. The results confirm that mean trip duration of rural residents is significantly higher. The differences are more pronounced for personal automobile and do not exceed more than eight minutes per trip for personal automobile and five minutes for public transport, whereas walking trip duration is almost similar. Surprisingly, if we examine the trip duration differences by purpose of travel, urban rural differences are significant only for maintenance purpose travel while subsistence and discretionary trip duration are almost

similar. Subsistence trips take the longest travel time, 25 minutes, followed by discretionary and maintenance travel. It shows that the spatial mismatch is more pronounced for work and educational activities than to the services such as markets or recreational places. Another surprising finding is that the maintenance purpose trip duration is shorter in rural areas than urban, showing that urban accessibility to public services might be decreasing with time due to outward spatial expansion of cities and limited supply of new urban services for rising urban population.

| | TRIPS PER DAY | | | | MINUTES TRAVELLED PER DAY | | | |
|---------------|---------------|-------|-------|-------|---------------------------|-------|-------|-------|
| | FEMALE | | MALE | | FEMALE | | MALE | |
| | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL |
| Subsistence | 1.3 | 1.4 | 2.4 | 2.5 | 32 | 34 | 57 | 62 |
| Maintenance | 0.6 | 0.7 | 0.7 | 0.7 | 13 | 11 | 12 | 14 |
| Discretionary | 0.8 | 0.8 | 2.4 | 2.5 | 19 | 19 | 43 | 44 |
| All | 2.6 | 2.9 | 5.4 | 5.7 | 65 | 65 | 114 | 120 |

** Figures may not add correctly due to decimal rounding*

Tab 4. Mobility by purpose of travel

Table 4 presents mobility levels in urban and rural areas by gender and purpose of travel. Male mobility levels, both in terms are daily trip rate and travel duration, are nearly twice than that of female. Majority of trips among Pakistani men are made for sociocultural activities such as prayers or socializing with family and friends. Female mobility is dominated by subsistence travel. Learning remains the dominant purpose of travel among urban female that make up to 37% of all daily trips, followed by sociocultural activities and household maintenance purpose travel making up to 29% and 14% of their total trips, respectively. Whereas, mobility of rural female is dominated by work travel followed by sociocultural and learning purposes that make up to 32%, 27% and 18% of all daily trips, respectively. Increased involvement of rural women in farm related activity tends to differentiate their mobility patterns from their urban counterparts, who are not required to work in the fields. However, the urban women make more learning trips as they are more likely to be enrolled in school and college education than rural female, due to issues related to poverty, time availability and physical distance to educational institutions in rural areas. Among Pakistani men, sociocultural trips remains the dominant purpose of travel across urban and rural areas, that constitute up to 45% daily trips, followed by work and learning purpose mobility that make up to 37% and 10% of total daily trips, respectively. A higher level of rural mobility is caused by more frequent work related and sociocultural trips in the rural areas. For rural men, built environment might facilitate their frequent short trips to nearby fields and seeing relatives or friends which is often not the case in urban areas as workplaces and relatives might be located at increased distances in cities. Urban rural differences of daily travel duration among Pakistani men and women follows a similar pattern but the gaps are slightly more pronounced than daily trip rate (Adeel et al., 2017). Figure 4 describes the variation in mobility levels across ten different age groups. Generally, female mobility levels decrease while male mobility levels increase with the age, both across urban and rural area. Across each stage of life, both the trip rate and travel duration remain significantly higher in rural areas than those in urban areas, both for men and women. Rural women appear to be less effected by the mobility issues due to their increased familiarity with local environment and relatively fewer chances of facing unknown men in villages. On the other hand, urban women seem to be more conscious in making discretionary trips which is potentially shaped by their safety and security concerns in urban areas. Lack of accessibility to female friendly activities in cities might also be influential in reducing mobility of urban women. Table 5 describes gendered mobility levels by personal and household income of the respondents across urban and rural areas. Income also exhibits a significant yet often contrasting effect across gender and geography of residence. For men, increasing personal income tends to increase mobility levels, both in urban and rural areas, as persons without income make fewer daily trips and travel fewer minutes than those with some personal income. On the other hand,

for women, increasing personal income has a differential effect across geography. In urban areas, female trip rate decreases but travel duration increases slightly with rising personal income. However, in rural areas, daily trip rate and travel duration both decrease with personal income as rural women are less likely to continue participating in farm activities with higher incomes.

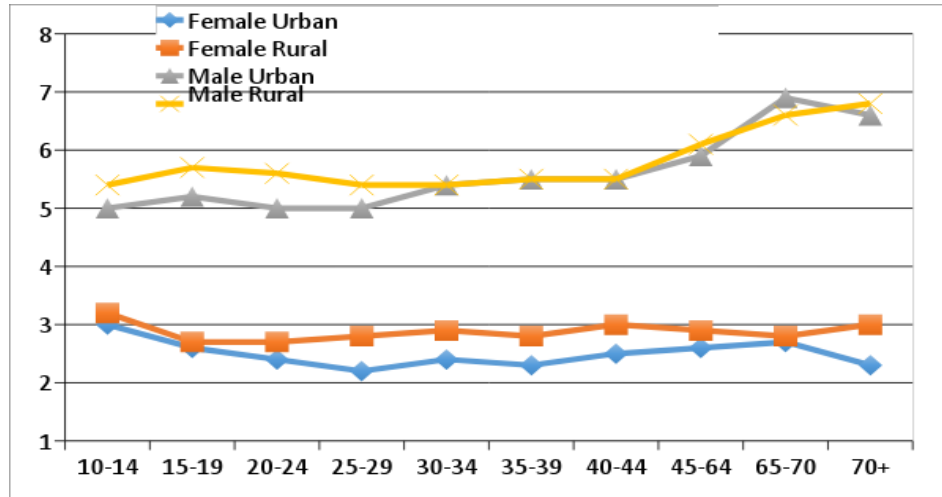


Fig 4. Mobility by age of respondent across urban and rural Pakistan

| | TRIPS PER DAY | | | | MINUTES TRAVELLED PER DAY | | | |
|----------------|---------------|-------|-------|-------|---------------------------|-------|-------|-------|
| | FEMALE | | MALE | | FEMALE | | MALE | |
| | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL |
| Personal | | | | | | | | |
| Zero | 2.7 | 2.9 | 5.1 | 5.4 | 63 | 63 | 110 | 114 |
| up to 4000 | 2.6 | 3.0 | 5.6 | 6.0 | 62 | 65 | 112 | 122 |
| 4000-7000 | 2.5 | 2.9 | 5.2 | 5.6 | 68 | 69 | 112 | 121 |
| 7001-10000 | 2.5 | 2.8 | 5.5 | 5.4 | 60 | 74 | 121 | 123 |
| Above 10000 | 2.6 | 2.4 | 5.7 | 5.9 | 80 | 59 | 120 | 134 |
| Overall Change | - | - | + | + | + | - | + | + |
| P-value | | | | | | | | |
| Household | | | | | | | | |
| Up to 4000 | 2.7 | 3.2 | 5.4 | 5.6 | 60 | 66 | 109 | 115 |
| 5001 - 5000 | 2.7 | 2.9 | 5.3 | 5.6 | 59 | 64 | 107 | 117 |
| 5001-7000 | 2.7 | 2.9 | 5.3 | 5.6 | 62 | 63 | 111 | 120 |
| 7001-10000 | 2.6 | 2.7 | 5.4 | 5.5 | 63 | 63 | 117 | 122 |
| Above 10000 | 2.6 | 2.8 | 5.4 | 6.0 | 66 | 62 | 115 | 128 |
| Overall Change | - | - | ~ | + | + | - | + | + |
| P-value | | | | | | | | |

Note: + increased significantly, - decreased significantly ~ change is insignificant

Group differences by one way ANOVA; Urban rural difference within gender: bold cells are significant at $p < .05$

Tab 5. Mobility by income level across urban and rural Pakistan

However, urban women tend to travel for work or education and if their households can afford to pay for transportation and activity costs, they might also travel longer distances, particularly in bigger metropolitan cities like Karachi, which results in increasing their daily travel duration in cities. Similarly, increasing household income tends to increase male mobility levels in rural areas as the men from well-off rural families increase traveling outside their villages for various purposes. On the other hand, household income does not change

daily trip rate in urban men and their travel duration also increases only marginally showing that the increasing income may not necessarily change mobility levels in urban men as they already get desired services from same locations, rather they might reduce their trips as their servant are able to perform minor household tasks such as grocery shopping. Increasing household income negatively affects female mobility levels for the same reasons as the honour related concerns become more important among rich rural families. In urban areas, female trip rates slightly decrease but travel duration increases suggesting that women might also be travelling farther from home, as they are more likely to get better quality education which is often at greater distance than normally available schools in residential areas.

| MODE | HOUSEHOLD INCOME QUINTILES | | | | PERSONAL INCOME QUINTILES | | | |
|---------------------|----------------------------|-------|--------------------|-------|---------------------------|-------|--------------------|-------|
| | LOWEST (BELOW 4000) | | TOP (ABOVE 10,000) | | LOWEST (WITHOUT INCOME) | | TOP (ABOVE 10,000) | |
| | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL |
| Total non-motorized | 91 | 94 | 72 | 88 | 85 | 94 | 65 | 80 |
| Walking | 87 | 91 | 70 | 86 | 83 | 92 | 64 | 78 |
| Bicycle and other | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| Total motorized | 7 | 4 | 26 | 10 | 13 | 4 | 32 | 18 |
| Personal automobile | 3 | 1 | 19 | 7 | 8 | 2 | 28 | 14 |
| Public transport | 4 | 2 | 6 | 4 | 4 | 2 | 5 | 3 |
| All | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Tab 6. Mode choice by income level across urban and rural Pakistan

Table 6 above describes the urban-rural differences in mode choice by household and personal income quintiles. Walking remains the dominant mode of transportation across all income groups. Automobile reliance increases with income, particularly in urban areas, resulting in a widening urban-rural gap of auto-mobility with rising income. Share of public transport based trips remain very low, even among the poorest, but still remains higher than personal automobile based trips, showing that lack of access to private vehicle and lack of affordability limits the automobility of majority of population. With increasing incomes, personal automobile based mobility increases rapidly while the public transport usage increase marginally. Automobility with income increases more rapidly in urban areas as the urban residents from top personal income quintiles made approximately one third of their trips by personal automobile as compared to only 18 percent automobile trips by their rural counterparts. Fewer number of earning members per household means that the automobility of every household member is not affordable for the poor and some personal income becomes necessary for daily mobility. This observation has an important implication for programs that aim to facilitate mobility and access to services among women and poor through household based financial support. Women have less control over the funds transferred to households which limit their automobile based accessibility to services such as hospitals and educational centres. Direct fare subsidies to individuals seem more effective than household based financial support as the individuals have greater autonomy in selecting appropriate mode of travel. Household vehicle ownership is presented in Figure 5. Nearly half of the sample did not report having any vehicle in household. Nearly 32 percent urban households reported having a bicycle as compared to 23 percent urban households. Other than this, rural households were less likely to be a zero vehicle household or report any motorized vehicle, car or motorcycle, than urban households. However, motorcycle and 8 percent reported owning a car as compared to only 14 and 2 percent rural households reporting so. Widespread rural poverty and somewhat limited demand of automobile mobility in rural areas prevents rural households from buying up automobiles.

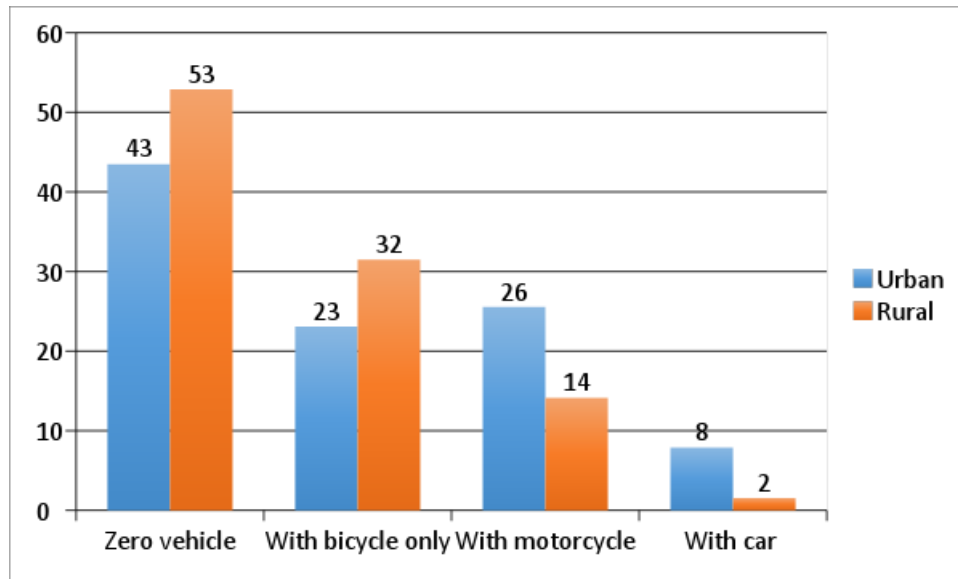


Fig 5. Household vehicle ownership

However, with increasing population and expansion in rural areas seem to increase automobile based travel in future as school enrolment is increasing gradually in rural area. Lack of personal automobiles make rural areas more dependent on public transport. Keeping in view the fact that the mean trip durations are also high in rural area, provision of public transport becomes more important for increasing accessibility and connectivity of rural settlements with marketplaces and bigger towns. Table 7 describes the modal split in urban and rural areas by household vehicle ownership. As evident, walking dominates the travel behaviour regardless of automobile ownership. Availability of car or motorcycle significantly increases share of motorized trips and that also more significantly in urban areas. Surprisingly, vehicle ownerships does not change the share of public transport based trips considerably, showing that the walking trips are converted into car or motorcycle trips. Keeping in view the fact that motorcycles are driven only by men and cars usually by head of households, almost mostly men, automobile ownership generally favours the mobility of male members of the household.

| MODE | ZERO VEHICLE | | WITH BICYCLE ONLY | | WITH MOTORCYCLE | | WITH CAR | |
|---------------------|--------------|-------|-------------------|-------|-----------------|-------|----------|-------|
| | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL |
| Total non-motorized | 87 | 93 | 90 | 93 | 72 | 84 | 52 | 86 |
| Walking | 86 | 92 | 82 | 87 | 69 | 80 | 51 | 85 |
| Bicycle and other | 1 | 1 | 8 | 6 | 3 | 3 | 1 | 1 |
| Total motorized | 11 | 5 | 8 | 5 | 25 | 14 | 46 | 13 |
| Personal automobile | 4 | 2 | 3 | 2 | 21 | 12 | 39 | 9 |
| Public transport | 7 | 3 | 5 | 3 | 4 | 2 | 6 | 3 |
| All | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Tab 7. Share by trips by mode and household vehicle ownership across urban and rural Pakistan

Share of motorized trips among households with bicycles is also higher than all motorized trips by these households showing the importance of bicycles for daily mobility of poor in the country. The discussion above presents the mobility and travel behaviour information across broader urban rural context in the country and the regional variation at sub national levels remain unexamined. Due to strong provincial differences in socioeconomic status and level of physical development, it is important to explore the provincial variation in urban rural mobility in the country.

| | PUNJAB | | SINDH | | KPK | | BALUCHISTAN | |
|--------------------|--------|-------|-------|-------|-------|-------|-------------|-------|
| | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL | URBAN | RURAL |
| Non-motorized | 3.3 | 3.9 | 3.4 | 4.4 | 5.8 | 6.1 | 3.1 | 3.4 |
| Walking | 3.1 | 3.7 | 3.3 | 4.3 | 5.7 | 6.0 | 2.9 | 3.3 |
| Bicycle & other | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Motorized | 0.8 | 0.3 | 0.9 | 0.3 | 0.6 | 0.3 | 0.6 | 0.3 |
| Private automobile | 0.5 | 0.2 | 0.5 | 0.1 | 0.3 | 0.2 | 0.5 | 0.2 |
| Public transport | 0.2 | 0.1 | 0.3 | 0.1 | 0.3 | 0.2 | 0.1 | 0.0 |
| All | 4.2 | 4.4 | 4.3 | 4.7 | 6.5 | 6.5 | 3.7 | 3.7 |

Tab 8. Provincial variation in daily trip rate

As table 8 describes below, KPK province exhibits the highest mobility levels while Baluchistan province exhibits least mobility. Urban residents nearly twice more automobile trips than rural residents. Urban residents in Punjab and Sindh make 0.8 to 0.9 automobile trips while those from KPK and Baluchistan make 0.6 trips per person per day. Rural residents make only 0.3 trips per day across every province, showing that the rural automobile is almost similar across the country while urban areas exhibit slight variation. As the walking remains the most common mean of mobility, it creates largest mobility differences across provinces as well. Residents of KPK make the most number of walking trips, while Baluchistan make the least, which largely shapes their overall mobility. Similarly, share of personal automobile and public transport based trips remain nearly similar across rural areas (0.1-0.2).

4 CONCLUDING REMARKS

This paper aims to provide a comprehensive examination of daily travel behaviour at the urban and rural geographies. The nationally reliable dataset of 2007 Pakistan time use survey provides a unique opportunity for this study as a leading example in a developing country context where walking still remains the most dominant mode of travel. Although rural areas make slightly more daily trip, their vehicle ownership and automobility is comparatively lower than urban areas. For the same income levels, urban residents are disproportionately more automobile dependent than their rural counterparts. There exists a significant geographical effect on automobility as the residents of richer provinces rely on personal automobiles slightly more than those from poor provinces. It implies that the rural population may not be essentially covering longer distances. Cross gender analysis finds that rural female appear to be more mobile than urban female. This finding has an important implication as well: it does not show a relatively smaller accessibility in the everyday lives of the rural population as compared to urban residents. More research is needed for examining the experiences for everyday accessibility at the individual and social group levels. Such studies are very useful for exploring the role of transport in ensuring access to services in urban and rural areas across the country.

REFERENCES

- Adeel, M., Yeh, A. G. O., & Zhang, F. (2016). Transportation disadvantage and activity participation in the cities of Rawalpindi and Islamabad, Pakistan. *Transport Policy*, 47, 1-12. doi:<https://doi.org/10.1016/j.tranpol.2015.12.001>
- Adeel, M., Yeh, A. G., & Zhang, F. (2017). Gender inequality in mobility and mode choice in Pakistan. *Transportation*, 44(6), 1519-1534. doi:<https://doi.org/10.1007/s11116-016-9712-8>

- De Vos, J., Derudder, B., Van Acker, V., & Witlox, F. (2012). Reducing car use: changing attitudes or relocating? The influence of residential dissonance on travel behavior. *Journal of Transport Geography*, 22, 1-9. doi:<https://doi.org/10.1016/j.jtrangeo.2011.11.005>
- Haider, M., & Badami, M. (2004, June). Public transit for the urban poor in Pakistan: Balancing efficiency and equity. In *Forum on Sustainable Infrastructure and Service Delivery for the Urban Poor, New Delhi*. Woodrow Wilson International Center for Scholars (WWICS), June (pp. 24-25).
- Houshmand, Masoumi, E. (2017) "Active Transport to School and Children's Body Weight: A Systematic Review." *Tema. Journal of Land Use, Mobility and Environment* 10(1), 95-110. doi:<http://dx.doi.org/10.6092/1970-9870/4088>
- Imran, M. (2009). Public transport in Pakistan: a critical overview. *Journal of Public Transportation*, 12(2), 4. doi:<http://dx.doi.org/10.5038/2375-0901.12.2.4>
- Kedir, M., Schmidt, E., & Wagas, A. (2016). *Pakistan's changing demography: Urbanization and peri-urban transformation over time* (Vol. 39). International Food Policy Research Institute (IFPRI).
- Levinson, D. M. (2016). A random walk down Main Street. *Tema. Journal of Land Use, Mobility and Environment*, 9(2), 163-172. doi:<http://dx.doi.org/10.6092/1970-9870/3914>
- Millward, H., & Spinney, J. (2011). Time use, travel behavior, and the rural–urban continuum: results from the Halifax STAR project. *Journal of Transport Geography*, 19(1), 51-58. doi:<https://doi.org/10.1016/j.jtrangeo.2009.12.005>
- Morrill, R., Cromartie, J., & Hart, G. (1999). Metropolitan, urban, and rural commuting areas: toward a better depiction of the United States settlement system. *Urban Geography*, 20(8), 727-748. doi:<https://doi.org/10.2747/0272-3638.20.8.727>
- Niglio, R., & Comitale, P. P. (2015). Sustainable urban mobility towards smart mobility: The case study of Bari area, Italy. *Tema. Journal of Land Use, Mobility and Environment*, 8(2), 219-234. doi:<http://dx.doi.org/10.6092/1970-9870/3009>
- PBS (2009). *Time Use Survey 2007*. Pakistan Bureau of Statistics. Islamabad.
- PBS (2017). Province wise provisional results of census – 2017. Pakistan Bureau of Statistics. Islamabad.
- Pucher, J., & Renne, J. L. (2005). Rural mobility and mode choice: Evidence from the 2001 National Household Travel Survey. *Transportation*, 32(2), 165-186. doi:<https://doi.org/10.1007/s11116-004-5508-3>
- Qureshi, I. A., & Lu, H. (2007). Urban transport and sustainable transport strategies: A case study of Karachi, Pakistan. *Tsinghua Science & Technology*, 12(3), 309-317. doi:[https://doi.org/10.1016/S1007-0214\(07\)70046-9](https://doi.org/10.1016/S1007-0214(07)70046-9)
- Russell, J. R., & Anjum, G. A. (1997). Public transport and urban development in Pakistan. *Transport Reviews*, 17(1), 61-80. doi:<https://doi.org/10.1080/01441649708716969>
- United Nations (2002). *World urbanization prospects: the 2001 revision* (Vol. 216). Population Division. United Nations Publications.
- JICA (2008). *The project for Lahore urban transport master plan in the Islamic Republic of Pakistan: Final report*. Japan International Cooperation Agency: ALMEC Corp.: Oriental Consultants Co., Ltd. Lahore.

IMAGE SOURCES

- Fig. 1 – Fig. 2 : Muhammad Adeel (Original image taken in 2017)
- Fig. 3: Pakistan Bureau of Statistics –Time Use Survey 2007- Final report, PBS (2009)
- Fig. 4: Pakistan Bureau of Statistics – Time Use Survey 2007- Final report, PBS (2017)

AUTHOR'S PROFILE

Muhammad Adeel is postdoctoral research officer at LSE Cities at the London School of Economics, United Kingdom. He holds a bachelor in City & Regional Planning (UET, Pakistan), Masters in Remote Sensing (NUST, Pakistan) and PhD in Urban Planning (University of Hong Kong, Hong Kong). In November 2017, his PhD dissertation, titled 'Transportation disadvantage and social exclusion in Pakistan' was declared as the joint winner of the inaugural 'CODATU prize of best PhD thesis on urban mobility in cities of developing countries'.

TeMA Urban Travel Behavior in the Middle East and North Africa

SPECIAL ISSUE 1.2018 | 95-108

print ISSN 1970-9889, e- ISSN 1970-9870

doi:<http://dx.doi.org/10.6092/1970-9870/5468>

review paper received 09 February 2018, accepted 22 May 2018

Licensed under the Creative Commons Attribution

Non Commercial License 3.0

www.tema.unina.it

Soltani, A., Hossein Pour, M., Sholeh, M. & Zare, P. (2018). The Development of a Walkability Audit. Based on Iranian Cities Pedestrian Environment. *Tema Journal of Land Use, Mobility and Environment*, 95-108. doi: <http://dx.doi.org/10.6092/1970-9870/5468>



THE DEVELOPMENT OF A WALKABILITY AUDIT

BASED ON IRANIAN CITIES PEDESTRIAN ENVIRONMENT

ALI SOLTANI ^a, MOHAMMAD HOSSEIN POUR^b, MAHSA SHOLEH ^c
PARISA ZARE ^d

^a Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN

e-mail: soltani@shirazu.ac.ir

^b Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN

e-mail: m_hosseinpour@shirazu.ac.ir

^c Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN

e-mail: msholeh@shirazu.ac.ir

^d Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN

e-mail: parisa.zare.16@gmail.com

ABSTRACT

Given its influence on public health and the vehicle usage, along with its negative consequences, walkability has attracted much attention in recent decades. Meanwhile, the development of a method to measure walkability of urban areas for the purpose of improving this feature is of utmost importance. Hence, after a comprehensive investigation of environmental measures which are related to the users' walking behavior, the researchers attempted to develop an efficient and reliable environmental audit tool based on these measures. Following the development of a protocol for utilization and management of the tool, we designed two different tests to validate it. The participants were taught how to use the tool, then, it was tested in the Eram neighborhood of Shiraz (Fars province, Iran). The statistical analysis of the obtained data showed that 13 of the environmental measures were not reliable to be used in various environments. However, given the remaining 50 items, the tool is valid for being applied to other urban areas.

KEYWORDS:

Walkability; Audit Tools; Design Quality

1 INTRODUCTION

Physical activity is an important requirement for a healthy lifestyle. Walking is the most common type of physical activity (Saelens et al., 2003a). Due to the relation existing between the form of the built environment, physical activity, and public health, much research has been encouraged to investigate public health, urban economics, transportation, urban planning and design, etc. (Durand et al., 2011; Ewing & Handy, 2009; Forsyth & Southworth, 2008; Glazier et al., 2014; Handy et al., 2002; Lee & Buchner, 2008; Lee & Moudon, 2006; Litman, 2003; Saelens et al., 2003b). In such studies, the characteristics of the environment in which physical activities are encouraged, including land use, public transportation, street patterns, population density, residential density, urban form, accessibility, and safety are identified and evaluated (Brownson, et al., 2009; Clifton et al., Durand et al., 2011; 2007; Ewing & Cervero, 2010; Frank, 2005; King & Clarke, 2015; Shbeeb & Awad, 2013; Witten et al., 2012). Moreover, studies were carried out on different ethnic and social-economical groups who might have different interactions with the built environment (Carlson et al., 2012; Jones et al., 2011; Leyden, 2003; Sallis et al., 2009; Panter et al., 2014). However, the way outdoor activities are affected by the qualities of the outdoor space needs to be noted (Gehl, 2011). Moreover, reliable methods for measurement of physical measures of the environment are needed to understand better the influence of the built environment on physical activities. It is due to the fact that a wide range of objective and subjective environmental measures can bring about an active lifestyle (Day et al., 2006a).

Many audit tools related to walkability and bike-ability have been developed to evaluate physical-activity-related environment measures (Brownson et al., 2004; Day et al., 2006b; Moudon & Lee, 2003). Nevertheless, the physical features of a place do not provide much information about its qualities, especially the perception of its patrons, despite the fact that such perception is in close relation to physical features. Many qualities which affect the walking environment are addressed in the urban design literature (Ewing & Handy, 2009). Considering the previous studies, five main urban design qualities that influence walkability were evaluated and tested. However, walkability audit tools always address broad measures such as density, education level, etc. or the physical details of the environment such as the physical conditions of the sidewalks. It means that walkability audit tools are not taking into account urban design qualities. Therefore, considering such qualities in the walkability audit is crucial in urban design and transportation. That said, solutions can be presented to enhance qualities related to walkability when designing urban streets based on their evaluation. Considering that the aim of the current study was to develop a comprehensive walkability audit tool which took both environmental qualities and quantities into account. It was the first attempt to develop the tool based on the studies conducted on urban context (environmental qualities which can affect the quality of users' experiences in an urban space include enclosure or transparency in a space; and environmental quantities such as traffic condition or land-use which can be measured quantitatively). Accordingly, the main question of this study was how we can develop a walkability audit tool that can measure built environment qualitatively and quantitatively. Following a review of the literature and similar tools in various urban contexts, we identified and categorized the measures required for the development of the tool.

The next step was to create the tool and determine how to use and manage the data it provided. The next aim of this study was to utilize the tool in a real urban environment to validate it. To this end, the tool was used to examine the walkability of 21 street segments in Shiraz. Furthermore, two different statistical methods were employed to test the reliability of the tool. In the Conclusion section, the modified tool was examined after presenting the results; ending with a conclusion on the preference of using this tool in urban planning and comparing it to the similar cases.

2 LITERATURE REVIEW

Different definitions have provided for walkability in transportation planning and urbanism literature. It shows that there is an ever-expanding meaning regarding the definition for them (Brown et al., 2007; Clifton et al., 2007; Talen & Koschinsky, 2013). Southworth (2005) seems to have provided a comprehensive definition for walkability based on which walkability is the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network (Southworth, 2005). Different walkability audit measures have been incorporated in the literature. These measures evaluate the built environment by considering different scales and different aspects of the subject. Some studies have used large-scale measures such as population, density, unemployment rate, land use, street network connectivity, and etc. which were extracted from various sources including consensus data. At the end, in order to evaluate the data, tools such as Geographic Information Systems were used (Adams et al., 2014; Brown et al., 2009; Blečić et al., 2014; Cerin et al., 2007; 2014; Giles-Corti et al., 2011; Hajna et al., 2013; Leslie et al., 2007; Soltani & Allan, 2006). On the one hand, this group of the studies did not consider the walking environment and the real conditions that the pedestrians went through. On the other hand, another group of studies addressed the walking environment and its quality. These studies addressed the micro-scale measures such as the sidewalk width, the street width, the quality of the sidewalk material, and urban furniture. In such studies, walkability measurement tools were applied to street segments to evaluate these measures (Brownson et al., 2004; Clifton et al., 2007; Day et al., 2006b; Emery et al., 2003; Millington et al., 2009). Moudon and Lee (2003) defined the walkability audit tools as “a tool used to inventory and assess physical environmental conditions associated with walking and bicycling” (Moudon & Lee, 2003). The walkability audit tool is, in fact, a method for evaluating streets based on measures of walkable environments. Moreover, micro-scale measures such as land use, road infrastructure conditions, security issues, lighting, beauty, and public transportation facilities are employed under categories such as street characteristics, street functionality, and aesthetics to create survey forms that can be rated by a few pedestrians. Ultimately, the sum of these scores shows the walkability of the street. It can also be used to give suggestions about the street and the quality of walking. Table 1 overviews the characteristics of the tools that are presented for urban design, transportation planning, and public health.

| Audit tool | Presented by | Characteristics |
|--|---|---|
| WSAF: Walking Suitability Assessment Form | University of North Carolina, Chapel Hill | This tool focuses on the safety of the pedestrians. To this end, measures such as route characteristics, traffic control devices, and pedestrian facilities are considered. This tool does not take into account measures such as land use, aesthetics, etc. and ranks the street segments by the safety of the pedestrian. |
| WPS: Walkable Places Survey | Baltimore Metropolitan Council | This method was developed for encouraging neighborhood unit planning. No attempts were made in this method to define specific measures and employ them in ranking. This tool consists of 30 visual street features that are rated based on the Likert scale. Measurement characteristics were categorized based on parking space, buildings, intersections, facilities, and perception. |
| SLU: Analytic Audit Tool | Saint Louis University | This tool incorporates 150 measures such as land use, distance from destination, etc. |
| SPACES: Systematic Pedestrian and Cycling Environmental Scan | The University of Western Australia | The tool includes a subjective evaluation of attractiveness and hardness of physical activity in the walking environment. |
| I-M Inventory: Irvine-Minnesota Inventory | University of California Irvine and University of Minnesota | More than 200 measures are incorporated in this method for evaluation. Similar to the SLU, this tool incorporates many questions about details of the land use and such. However, there are no measures in this tool to evaluate sidewalk quality. |

| | | |
|---|--|---|
| PBIC Checklist: Partnership for a Walkable America | - | This tool collects environmental information to be employed for evaluating the satisfaction of the residents by the walking environment and gathers details from every place but measures such as land use are not evaluated by this tool. |
| PEAT: Path Environment Audit Tool | Robert Wood Johnson Foundation | The PEAT is a computer-based tool that is used to evaluate the physical characteristics of paths and sidewalks by trained observers. Design, facilities, aesthetics, and maintenance are the evaluation measures assumed in this tool. |
| WABSA: Walking and Bicycling Suitability Assessment | University of North Carolina at Chapel Hill | WABSA is an evaluation tool for walkability and bike-ability in urban streets. The streets can have sidewalks or not. This tool is suitable for evaluation of green and pedestrian paths. In fact, less than 12 measures are examined in this checklist at the scale of a street segment. |
| SWAT: Scottish Walkability Assessment Tool | Scottish Physical Activity Research Collaboration (SPARColl) | The SWAT is used to evaluate the features of a physical environment in connection with walkability in Scotland. Features evaluated by this tool can be categorized into four general groups: functionality, safety, aesthetics, and destination. |
| Portland- PPI: Pedestrian Potential Index | Portland Office of Transportation | This tool evaluates the strength of the environmental factors associated with walking. This tool was developed for the city of Portland and is designed to audit road segments. Characteristics that are evaluated by this tool are categorized into three groups: political, proximity and the use. |
| AAT: Analytic t Audit Tool | - | The AAT is used to comprehend the relation between the built environment at the street-scale and physical activity. This tool, consisting of 24 questions, gathers information in five general categories: land use, transportation, aesthetics, and social environment. |
| Active Neighborhood Checklist: | Washington University | The Active Neighborhood Checklist tool is an observational tool that is designed to evaluate the characteristics of a neighborhood unit environment that are associated with physical activities at the street-scale. The tool consists of five parts: Land use, public transit stops, street characteristics, quality of the walking environment, and walking and bicycling places. |
| MAPS: Micro scale Audit of Pedestrian Streetscapes | University California San Diego | The MAPS is created based on previous tools. This tool consists of four general sections: The overall route, street segments (the area between two crossings), intersections, and cul-de-sacs. |
| PEDS: Pedestrian Environment Data Scan | University of Maryland, College Park | The environmental characteristics of a segment, such as information about the sidewalk quality, are gathered simultaneously with the large-scale characteristics such as the land use. |
| MIUDQ :Maryland Inventory of Urban Design Qualities | University of Maryland | According to the MIUDQ protocol, walkability can be measured reliably using 5 urban design perceptual qualities, namely imageability, enclosure, human scale, transparency and complexity/ |
| Walk Score | - | This tool is available at www.walkscore.com . After specifying a location, this tool measures the distance between that location and facilities such as schools, shops, parks, etc. and rates it on a scale of 0-100 showing the walkability of a place. |
| POLS | Highway Capacity Manual (HCM) | This tool uses three measures for walkability evaluation on urban street facilities; including average pedestrian space, average pedestrian speed, and pedestrian LOS score which is based on the typical pedestrian's perception of the travel experience. There are two common approaches for evaluating the last measure of PLOS: The first can be defined as a capacity-based model, and the second is a roadway characteristic-based model. The HCM designates six level of service from A to F. |

Tab.1: A summary of walkability audit tools

In addition to what is available in the literature on this subject, various environmental measures are investigated and categorized in the aforementioned tools. Therefore, considering the studied urban context, three categories of measures can be incorporated in this study. These categories are functionality, safety, and aesthetics. Each of these categories has sub-measures which can be used in order to audit walkability.

Street functionality can be investigated in three sections including, in order, land use, traffic, and permeability. These measures have to be evaluated on a larger scale compared to what considered by the current study; however, their importance at street-scale cannot be ignored. Although these items can be measured directly by other methods rather than in field evaluation, the rater perception of these measure plays an important role in this kind of estimations. Moreover, since the main objective of this research was to assess walkability in street scale and because in this scale none of the computer software could do such assessing in a proper manner due to their lack of considering real condition of pedestrian in environment, rater perception would find a higher importance. Land use refers to the distribution of activities, thus, it affects the traveling behavior by shortening destinations or decreasing the cost of reaching the destination (Handy et al., 2002). In this case, land-uses (residential, commercial, recreational and etc.), their distributions (accumulated in one point, accumulated in two points, accumulated in some points or distributed evenly) and combination of land-uses in each building (number of mixed use buildings) should be recorded by a rater for each segment. Traffic characteristics are the specifications of the street which include: Path specifications, the type and width of the street, traffic volume and speed, and the directness of the path in order to reach destinations (Pikora et al., 2003). Moreover, accessibility was evaluated based on street network connectivity and the manner of reaching destinations (block length, number of intersections, number of alternative routes to reach a destination, public transportation) (Schlossberg et al., 2006; Chin et al., 2008; Grasser et al., 2013). The safety of the pedestrian was always being one of the most important measures in the study of walkability. The safety is addressed both in the forms of personal safety against crimes and safety regarding traffic. Hence, in the current study, the researchers evaluated safety in both terms. According to the literature, the environmental variables which create crime-ridden areas can limit the social ties. Furthermore, the environmental variables can hinder the presence of people in the urban space include: demographic-gender variables, the social-economical state of the region, the lighting of the environment at night, the condition of the building parts, and their maintenance (Austin et al., 2002; Doyle et al., 2006; Foster & Giles-Corti, 2008a). At the street-scale, design characteristics that provide safety against traffic include the manner pedestrians travel along with the streets and intersections, the design of refuge islands, buffer space between pedestrians and vehicles, appropriate crosswalk width etc. (Clifton et al., 2007; Foster & Giles-Corti, 2008b). The aesthetics aspect is defined based on urban design qualities in connection with walkability. The quality of the public sphere is the most crucial measure to be considered when evaluating cities and urban areas. It is an inevitable fact that people judge their surroundings by what they see and experience (Tibbalds, 2003). The quality of a place specifies this experience. When a space has high quality, users have better understanding of that space and the surrounding spaces. The criteria which specify the quality of these spaces have been shifting during different times, including the last century. The qualities used in the current study were selected based on the book "Measuring Urban Design" authored by Ewing and Clemente (2013). The book identifies key perceptual qualities of the urban environment based on the classic urban design literature. Ewing and Clemente listed 51 perceptual qualities of the urban environment. Eight of the 51 qualities were selected for further study based on the importance they have been expressed in the literature, namely: Imageability, enclosure, human scale, transparency, complexity, coherence, legibility, and linkage. The first five qualities were measured and passed validity and reliability tests (Ewing & Clemente, 2013). In this study, it was attempted to evaluate the qualities in the urban environment of Iran considering the urban context. When considering the set of environmental characteristics associated with the walkable environment, and the information provided in Table 1, one can understand that none of the tools audit the built environment in detail. Each of the tools considers only a specific set of aspects in the environment.

| | | |
|-----------|---------------------|---|
| Function | Land Use Mix | Land Use Diversity |
| | | Land Use Distribution |
| | | Combination of Land Use in Building Scale |
| | Traffic Role | Characteristics of Riding Path |
| | | Volume, Speed & Type of Traffic |
| | | Characteristics of Pedestrian Path |
| | Accessibility | Urban Blocks Design |
| | | Streets Connectivity |
| | | Accessibility of Destination |
| Safety | Safety from Crime | CPTED |
| | | Social Characteristics |
| | Safety from Traffic | Intersection Characteristics |
| | | Pedestrian Crossings along Streets |
| | | Separation of Pedestrian from Traffic |
| Aesthetic | Imagability | Path Layout |
| | | Characteristics of Street Walls |
| | | Nodes Design |
| | | Land Marks Quality in Paths |
| | Enclosure | Height-to-Width Ratios in Streets |
| | | Specification of the Beginning and the End of Streets |
| | | Attributes of Street Walls |
| | Human Scale | Building Heights in Street Walls |
| | | Human Scale Moderator Elements |
| | Transparency | Predictability of Space |
| | | Portions of Windows at Street Level |
| | | Amount of Activity overflows into Street |
| | Complexity | Special Characteristics of Streets Design |
| | | Amount of Activity in Street |
| | | Combination of Land Use in Environment |

Tab. 2 Components and indicators of walkable environment

Some emphasize on pedestrian safety, while others address, for example, the characteristics of the pedestrian network. Furthermore, the studies that addressed the validity of these environmental measures reported ambiguous results (Clifton et al., 2007). The subjective and objective characteristics in walkability audit are also problematic issues regarding these measures. Some researchers have attempted to investigate the perception of the pedestrian from the environment, thus incorporating subjective methods in their studies (Ariffin & Zahari, 2013; Park et al., 2014). Nevertheless, others incorporated objective and measurement methods in their study of the walking environment (Day et al., 2006b; Clifton et al., 2007). Given the categorization for environmental factors affecting walkability, all tools which were discussed in this regard are not without deficiencies. Tools such as I-M or SLU redundantly evaluate the environmental characteristics; moreover, they are associated with inefficient management. The PBIC checklist collects environmental information by evaluating the satisfaction of the residents from the walking environment to be incorporated in behavior models. This tool is not designed for collecting details about environmental characteristics. The WSAF only focuses on the pedestrian facilities such as road markings for the pedestrian, or path characteristics, not evaluating various measures nor providing a rating system for quick evaluation of pedestrian safety. It is worth mentioning that the PEDS has the following advantages compared to other tools: Efficient management, time efficiency, more efficient and brief sizes, economic approach, and robust training protocol. PEDS is defined based on measures that assume purely physical aspects and they do not consider the quality of the pedestrian paths. However, Ewing and Handy (2009) attempted to evaluate the walking environment based on urban design qualities. The tool they presented was very capable in the qualitative audit of the built environment in terms of the attractiveness of walking. However, it did not consider the safety and functional aspects of walkability; moreover, it was developed based on the American urban context. That all said, the aim of this study was to present a walkability audit tool which took both

quantitative (path width, number of lanes, traffic speed and volume) and qualitative aspects (quality of walking in a space) of walkability into account. Considering what has been said about audit tools, none of them incorporate three general sections, which are functionality, beauty, and safety, (except for the SWAT which is developed based on European environment) or the number of the sub-measures they incorporate decreases their efficiency. This study emphasized on walkability; furthermore, it considered other aspects of the subject matter. To this end, two tools (PEDS and MIUDQ) were selected as the development basis for the tool. The walkability audit tool in this study was developed based on what was said about the audit tools. This tool incorporates three main components (namely functionality, safety, and aesthetics), and ten measures (land use, traffic role, permeability, personal safety, environmental safety, imageability, enclosure, human scale, transparency, and complexity). The items in this tool were created considering the introduced measures and the two mentioned tools. Finally, every measures had been contextualized based on Shiraz urban context as each city is unique in its own and for using this audit in other cities it should be revised. For measuring weight of each measures, 100 questioners were filled by urban science experts. the analysis of the responded questionnaires was done through using Structural equation modeling (SEM). The result of this study are presented in a research by Soltani et al. (2018).

Results of this study showed that safety feature had the highest impact in walkability of streets. The weights of each measures in that study have been used in calculating total walkability of segments for developing this audit tool.

3 THE CASE STUDY

For the purpose of doing this study, Eram neighborhood which is located in District 1 of Shiraz, Iran was selected to be studied. The region is 181 hectares and consists of 11 streets and 2101 building segments. According to the comprehensive urban plan of Shiraz (2016), Eram neighborhood houses a population of 14766. This region plays an important role in the traffic of the city. Two of the boulevards, called Jomhuri, and Daneshju, are recognized as the main arteries of the city. Given the fact that in the current study we considered only streets or what had a street-like nature, the main and side alleys were omitted from the walkability audi.

3.1 DATA COLLECTION AND ANALYSIS

Eleven streets exist in this region selected for the purpose of doing this study. Based on their characteristics, predominantly with respect to intersections, streets were divided into definite segments, resulting in 21 segments in total. Therefore, the data collection was carried out considering the aforementioned measures. The data collection included an evaluation form or the walkability audit tool which consisted of 63 items derived from 10 measures. The items of the questionnaire were either multiple choice or fill-in-the-blank questions for writing the number of elements or other information.

Most of the items were dedicated to the traffic characteristics of the street since the environmental items in connection with this section included details of the environmental measures. In order to guarantee the suitability of the items, four auditors from different fields of study were asked to fill the forms for the corresponding segments. Before performing the audit, the participants were trained about the concepts used in the evaluation form and how to answer its items. In this session, every section was explained in detail. Then after, a practice session was conducted to make sure the participants' answers are eligible. During this session, a few items were found not be useful since they seemed to ask for answers that are too much affected by the personal view of the participant. Hence, seven items were omitted from the audit after further examining the environmental characteristics and consulting urbanism experts. Ultimately, the audit was performed incorporating 56 items which were derived from the 10 main measures. To study the data collected by the auditors, all of the results from the four participants were analyzed using SPSS. Cronbach's

alpha was found to be above 0.7 for all four auditors, suggesting the reliability of the collected data for further investigation.

| | I-M | PBIC | WSAF | SLU | WPS | LOS | PPI | SWAT | PERS | SPACES | PEDS | PEAT | WABSA | AAT | MAPS | ANC | MIUDQ |
|------------------------------|-----|------|------|-----|-----|-----|-----|------|------|--------|------|------|-------|-----|------|------|-------|
| Characteristics | | | | | | | | | | | | | | | | | |
| Field Protocol | ✓ | x | ✓ | ✓ | x | ✓ | x | ✓ | x | ✓ | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ |
| Be Tested | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Context oriented | ✓ | x | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | x | x | ✓ |
| Time Required per Seg | 20 | 5-10 | 30 | 10 | - | - | - | 30 | - | - | 3-5 | - | 15 | - | 30 | 5-10 | 20 |
| Measuring Aspect | 1-2 | 1-2 | 1 | 1-2 | 1-2 | 1-2 | 1 | 1-2 | 1-2 | 1-2 | 1-2 | 1 | 1 | 1 | 1-2 | 1-2 | 2 |
| Item Measured | | | | | | | | | | | | | | | | | |
| Function | | | | | | | | | | | | | | | | | |
| Land Use | ✓ | x | x | ✓ | x | x | ✓ | ✓ | x | ✓ | ✓ | x | x | ✓ | ✓ | ✓ | x |
| Traffic | ✓ | B | ✓ | B | ✓ | ✓ | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x |
| Accessibility | ✓ | x | x | x | x | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | x | x | ✓ | x | x | x |
| Safety | | | | | | | | | | | | | | | | | |
| From Crime | ✓ | ✓ | x | ✓ | x | ✓ | x | ✓ | ✓ | ✓ | x | x | x | ✓ | x | x | x |
| From Traffic | ✓ | ✓ | ✓ | ✓ | x | ✓ | x | ✓ | ✓ | ✓ | ✓ | ✓ | B | ✓ | ✓ | ✓ | x |
| Aesthetic | | | | | | | | | | | | | | | | | |
| Public art | ✓ | x | x | x | ✓ | ✓ | x | ✓ | x | x | x | B | x | x | ✓ | ✓ | ✓ |
| Building architecture | ✓ | x | x | x | x | x | x | ✓ | x | x | B | x | x | x | ✓ | x | ✓ |
| Street design | x | x | x | x | x | ✓ | x | ✓ | ✓ | ✓ | x | x | x | x | ✓ | x | ✓ |
| Landscape | ✓ | | x | ✓ | ✓ | ✓ | x | ✓ | ✓ | ✓ | B | B | x | B | ✓ | ✓ | ✓ |
| Perceptual perception | | | | | | | | | | | | | | | | | |
| Attractivity | x | x | x | x | ✓ | ✓ | x | x | x | x | x | x | x | B | x | x | x |
| Pleasurability | x | ✓ | x | x | ✓ | x | x | x | x | x | x | x | x | x | x | x | x |
| Comfort | x | x | x | x | x | x | x | x | x | x | x | x | x | B | x | x | x |

Tab. 3 Audit comparisons (source: authors)

✓ : Consisting feature , x : Do not consisting feature , B: Considering some aspects of feature
1: Quantity aspects 2: Quality aspect

| Auditor | Cronbach's alpha | Number of items | Number of segments |
|---------|------------------|-----------------|--------------------|
| A | 0.874 | 56 | 21 |
| B | 0.870 | 56 | 21 |
| C | 0.860 | 56 | 21 |
| D | 0.853 | 56 | 21 |

Tab. 4 Reliability of the collected data

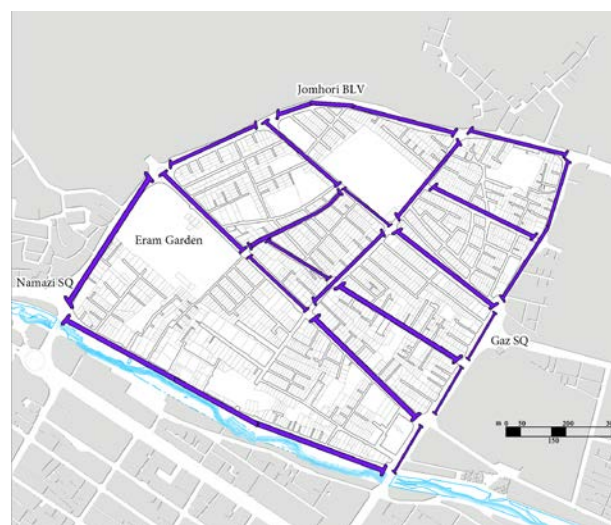


Fig. 1 Segments defined by the walkability audit tool

| Feature | Indicator | Kappa Score | Percent of Agreement |
|---------------------|---|--------------|----------------------|
| Land Use Mix | Land Use Type | 0.942 | 95.2 |
| | Land Use Distribution | 0.447 | 61.9 |
| | Combination of Land Use in Building Scale | 0.682 | 76.2 |
| Traffic Role | Number of Travel Lane | 1 | 100 |
| | Traffic Direction | 1 | 100 |
| | Condition of Road | 0.781 | 90.5 |
| | Riding Speed | 0.616 | 81 |
| | Traffic Volume | 0.798 | 90.5 |
| | Parking Amenities | 0.893 | 95.2 |
| | Walkway type | 1 | 100 |
| | Pedestrian Path Width | 0.696 | 85.7 |
| | Pedestrian Path Condition | 1 | 100 |
| | Pedestrian Path Obstructions | 0.741 | 81 |
| | Maximum Path Slope | 0.740 | 81 |
| | Pedestrian Facility | 0.834 | 90.5 |
| | Climate Comfort of Path | 0.840 | 90.5 |
| | Block Length | 0.864 | 90.5 |
| Accessibility | Viewable Start and End node | 0.445 | 71.4 |
| | Number of Alternative routs | 0.782 | 85.7 |
| | Public Transport Condition | 0.876 | 90.5 |
| | Presence of Different Social Classes in Space | 0.794 | 85.7 |
| Safety from Crime | Presence of the Elderly and the Children | 0.683 | 81 |
| | Variety of activities | 0.430 | 66.7 |
| | Sense of Security | 0.774 | 85.7 |
| | Maintenance of Buildings | 0.702 | 90.5 |
| | Lighting | 1 | 100 |
| | Blind Spots | 0.620 | 76.2 |
| | Street Surveillance | 0.398 | 61.9 |
| Safety from Traffic | Safety of Intersections | 0.847 | 90.5 |
| | Pedestrian Crossings along Street | 0.913 | 95.2 |
| | Separation of Pedestrian from Traffic | 0.775 | 90.5 |
| Imageability | Historical buildings | 1 | 95.2 |
| | Building with Identifier | 0.939 | 95.2 |
| | Landmarks | 0.920 | 95.2 |
| | Public Open spaces | 0.873 | 90.5 |
| Enclosure | Height-to-Width Ratios | 0.675 | 76.2 |
| | Proportion of Sky | 0.419 | 66.7 |
| | Break in street Wall | 0.781 | 85.7 |
| | Non-directional Building | 0.910 | 95.2 |
| | Rows of trees | 1 | 100 |
| | Trees spacing | 0.798 | 90.5 |
| | Break in street wall height | 0.603 | 71.4 |
| Human Scale | Building Height | 0.872 | 90.5 |
| | Recessed buildings | 0.806 | 85.7 |
| | Portions of Windows at Street Level | 0.672 | 76.2 |
| | Street Furniture | 0.831 | 90.5 |
| Transparency | Portions of Windows at Street Level | 0.735 | 81 |
| | Active edge | 0.765 | 81 |
| | Amount of Activity overflows into Street | 0.736 | 81 |
| | Predictability of Space | 0.826 | 90.5 |
| Complexity | Activity types in Streets | 0.555 | 66.7 |
| | Diversity of Facade Materials | 0.743 | 85.7 |
| | Façade Details | 0.272 | 71.4 |
| | Public Art | 0.753 | 90.5 |
| | Number of people | 0.655 | 71.4 |

Tab.5 Evaluation of the collected data

Items with $K < 0.4$ showed little agreement between the data corresponding to them. Data analysis results pertaining to this tool are presented in Table 4. Given the fact that the Kappa statistics is the only suitable estimation for ranking variables, and a few questions, such as the number of lines, crosswalk width, building height, etc. were not of this type, percent agreement was also employed. Percent agreement yielded similar results. In this method of statistical analysis, 100 indicates perfect agreement while 0 indicates full disagreement.

As evident from Table 5, items are associated with a value smaller than 0.4. These cases are related to the distribution of land use, the possibility of seeing the start of the path, varied activities, the possibility for monitoring the street from within the segments, the visible portion of the sky and details of the street walls. Meanwhile, two items are related to the functionality of the street, while two pertain to safety, and two are related to aesthetics. The poor reliability of data collection can be attributed to the relative subjectivity of the answers to the items, and the influence of personal judgment on the answers. Considering this fact, the items are not sufficiently valid to be used in the walkability audit tool. After the required modifications were made to the walkability audit tool considering that it was to be used in the studied region, it consists of 50 questions. Finally, the data can be incorporated in location-based maps to present the audit.

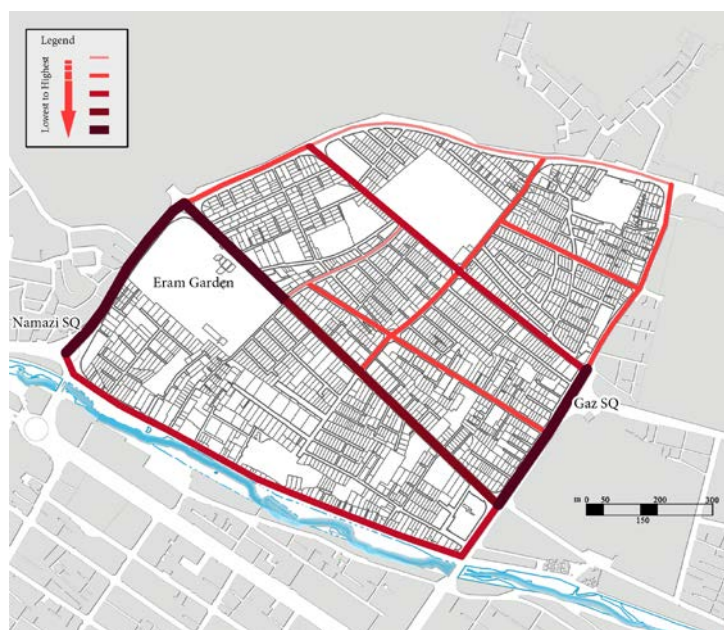


Fig. 2 Walkability of streets based on the walkability audit tool results

4 DISCUSSION AND CONCLUSION

Due to the fact that a wide range of environmental measures can influence the walkability of the urban environment, it was attempted to work out this measure to be used in the walkability audit tool considering the Iranian urban context and previous studies. In addition to functional and physical measure, qualitative environmental measures are also considered in the presented tool that can comprehensively audit the built environment in terms of walkability by combining the qualitative and quantitative aspects. However, some measures that were mostly subjective were found to be inefficient as the audit tool was tried in an urban environment. Moreover, a few questions were omitted as they were not validated by the Kappa statistic. However, the majority of the questions were valid to be used in various environments. Although this tool consists of fewer questions compared to the tools such as the IMI, it is capable of comprehensive environmental audit in connection with regard to walkability. Tools such as the IMI that incorporate a large number of items might evaluate the environment not as good as they are expected to. Since the many questions can distract the auditor from the main goal by unreasonably engaging their mind. Unlike PEDS, PEAT, or WAPSA that only consider the quantities and the functionality of the environment, this tool also takes into account the qualitative aspects of the environment, measuring the qualities of the urban design. Nevertheless, unlike the MIUDQ that only focuses on the quality of the environment, this tool includes other

environmental factors which are effective besides design quality. Furthermore, this tool is superior to similar tools given its great agreement percent in most measures. The aim of the present study was to evaluate the walking environment subjectively, as in other walkability audit tools. However, some questions such as the attractiveness or comfort-ability of the path were presented in the primary version of the audit. However, after initial steps, they were omitted due to the little agreement of the answers among auditors. Some other objective measures such as feeling safe, or the possibility of foreseeing beyond the spatial obstructions, were incorporated in the audit. They were not omitted because of their relative agreement. Overall, 53 questions of this tool are associated with sufficient agreement percent and reliability to be used in other Iranian urban environments. Even though all the mentioned measures influence the walkability of the urban environment, only the questions that have sufficient reliability can be used to audit the land use in such environments. This walkability audit tool can be used to evaluate the walking environment in field. The most important advantage of this method is to evaluate the actual situation of pedestrians in the built environment. Other measurement tools, such as those that measure the connectivity or number of destination with special software like GIS, evaluate the environment in large scale and they have a holistic approach in their assessment. Therefore, it is not possible to judge the degree of the walkability of the environment, properly. Moreover, the audit in this research had a very comprehensive approach as it considered the quality of streets along with other criteria and this made it very reliable in measuring walkability. Another advantage of this type of assessment is its easy and efficient management. In this method, it is easy to examine the walking environment by a rater and categorize the streets in terms of walkability without any complex calculations. The results of these tools can be incorporated in a location-based software such as GIS, by designating a code to each street segment that is combined with the statistical software input data. Finally, the software can rank the segments based on the items, measures, and in general, by walkability. This way, a comprehensive image is obtained from walkability in urban streets that can be presented to urban managers to help them make more efficient decisions about each street segment and contribute to the public health. In order to develop this method, it can be used in a mobile application so that data can be electronically entered and evaluated. Additionally, another part of this study can act as an objective assessment. Objective evaluation is an important part of the walkability and it is very important to consider it alongside subjective and specialized assessments.

REFERENCES

- Adams, M. A., Frank, L. D., Schipperijn, J., Smith, G., Chapman, J., Christiansen, L. B., ... Sallis, J. F. (2014). International variation in neighborhood walkability, transit, and recreation environments using geographic information systems: the IPEN adult study. *International Journal of Health Geographics*, 13(1), 43. doi:<https://doi.org/10.1186/1476-072X-13-43>
- Ariffin, R. N. R., & Zahari, R. K. (2013). Perceptions of the Urban Walking Environments. *Procedia - Social and Behavioral Sciences*, 105, 589–597. doi:<https://doi.org/10.1016/j.sbspro.2013.11.062>
- Austin, D. M., Furr, L. A., & Spine, M. (2002). The effects of neighborhood conditions on perceptions of safety. *Journal of Criminal Justice*, 30(5), 417–427. doi:[https://doi.org/10.1016/S0047-2352\(02\)00148-4](https://doi.org/10.1016/S0047-2352(02)00148-4)
- Blečić, I., Cecchini, A., Congiu, T., Fancello, G., & Trunfio, G. A. (2014). Walkability Explorer. An Evaluation and Design Support Tool for Walkability. *Tema. Journal of Land Use, Mobility and Environment*. <https://doi.org/10.6092/1970-9870/2535>
- Brown, B. B., Werner, C. M., Amburgey, J. W., & Szalay, C. (2007). Walkable Route Perceptions and Physical Features: Converging Evidence for En Route Walking Experiences. *Environment and Behavior*, 39(1), 34–61. doi:<https://doi.org/10.1177/0013916506295569>
- Brown, B. B., Yamada, I., Smith, K. R., Zick, C. D., Kowaleski-Jones, L., & Fan, J. X. (2009). Mixed land use and walkability: Variations in land use measures and relationships with BMI, overweight, and obesity. *Health & Place*, 15(4), 1130–1141. doi:<https://doi.org/10.1016/j.healthplace.2009.06.008>

- Brownson, R. C., Hoehner, C. M., Brennan, L. K., Cook, R. A., Elliott, M. B., & McMullen, K. M. (2004). Reliability of 2 Instruments for Auditing the Environment for Physical Activity. *Journal of Physical Activity and Health*, 1, 191–208. doi:https://doi.org/10.1123/jpah.1.3.191
- Brownson, R. C., Hoehner, C. M., Day, K., Forsyth, A., & Sallis, J. F. (2009). Measuring the Built Environment for Physical Activity. *American Journal of Preventive Medicine*, 36(4), S99–S123.e12. https://doi.org/10.1016/j.amepre.2009.01.005
- Carlson, J. A., Sallis, J. F., Conway, T. L., Saelens, B. E., Frank, L. D., Kerr, J., ... King, A. C. (2012). Interactions between psychosocial and built environment factors in explaining older adults' physical activity. *Preventive Medicine*, 54(1), 68–73. doi:https://doi.org/10.1016/j.ypmed.2011.10.004
- Cerin, E., Leslie, E., Owen, N., & Bauman, A. (2007). Applying GIS in Physical Activity Research: Community?Walkability? and Walking Behaviors. In P. C. Lai & A. S. H. Mak (Eds.), *GIS for Health and the Environment* (pp. 72–89). Berlin, Heidelberg: *Springer Berlin Heidelberg*. doi:https://doi.org/10.1007/978-3-540-71318-0_6
- Chin, G. K. W., Van Niel, K. P., Giles-Corti, B., & Knuiman, M. (2008). Accessibility and connectivity in physical activity studies: The impact of missing pedestrian data. *Preventive Medicine*, 46(1), 41–45. doi:https://doi.org/10.1016/j.ypmed.2007.08.004
- Clifton, K. J., Livi Smith, A. D., & Rodriguez, D. (2007). The development and testing of an audit for the pedestrian environment. *Landscape and Urban Planning*, 80(1–2), 95–110. doi:https://doi.org/10.1016/j.landurbplan.2006.06.008
- Day, K., Boarnet, M., Alfonzo, M., & Forsyth, A. (2006a). The Irvine–Minnesota Inventory to Measure Built Environments. *American Journal of Preventive Medicine*, 30(2), 144–152. doi:https://doi.org/10.1016/j.amepre.2005.09.017
- Day, K., Boarnet, M., Alfonzo, M., & Forsyth, A. (2006b). The Irvine–Minnesota Inventory to Measure Built Environments. *American Journal of Preventive Medicine*, 30(2), 144–152. doi:https://doi.org/10.1016/j.amepre.2005.09.017
- Doyle, S., Kelly-Schwartz, A., Schlossberg, M., & Stockard, J. (2006). Active Community Environments and Health: The Relationship of Walkable and Safe Communities to Individual Health. *Journal of the American Planning Association*, 72(1), 19–31. doi:https://doi.org/10.1080/01944360608976721
- Durand, C. P., Andalib, M., Dunton, G. F., Wolch, J., & Pentz, M. A. (2011). A systematic review of built environment factors related to physical activity and obesity risk: implications for smart growth urban planning: Smart growth urban planning and obesity risk. *Obesity Reviews*, 12(5), e173–e182. doi:https://doi.org/10.1111/j.1467-789X.2010.00826.x
- Emery, J., Crump, C., & Bors, P. (2003). Reliability and Validity of Two Instruments Designed to Assess the Walking and Bicycling Suitability of Sidewalks and Roads. *American Journal of Health Promotion*, 18(1), 38–46. doi:https://doi.org/10.4278/0890-1171-18.1.38
- Ewing, R., & Cervero, R. (2010). Travel and the Built Environment: A Meta-Analysis. *Journal of the American Planning Association*, 76(3), 265–294. doi:https://doi.org/10.1080/01944361003766766
- Ewing, R. H., & Clemente, O. (2013). *Measuring urban design: metrics for livable places*. Washington, D.C: Island Press.
- Ewing, R., & Handy, S. (2009). Measuring the Unmeasurable: Urban Design Qualities Related to Walkability. *Journal of Urban Design*, 14(1), 65–84. doi:https://doi.org/10.1080/13574800802451155
- Forsyth, A., & Southworth, M. (2008). Cities Afoot—Pedestrians, Walkability and Urban Design. *Journal of Urban Design*, 13(1), 1–3. doi:https://doi.org/10.1080/13574800701816896
- Foster, S., & Giles-Corti, B. (2008a). The built environment, neighborhood crime and constrained physical activity: An exploration of inconsistent findings. *Preventive Medicine*, 47(3), 241–251. https://doi.org/10.1016/j.ypmed.2008.03.017
- Foster, S., & Giles-Corti, B. (2008b). The built environment, neighborhood crime and constrained physical activity: An exploration of inconsistent findings. *Preventive Medicine*, 47(3), 241–251. https://doi.org/10.1016/j.ypmed.2008.03.017
- Frank, L. D. (2005). Multiple Impacts of the Built Environment on Public Health: Walkable Places and the Exposure to Air Pollution. *International Regional Science Review*, 28(2), 193–216. doi:https://doi.org/10.1177/0160017604273853
- Frank, Lawrence D., Sallis, J. F., Conway, T. L., Chapman, J. E., Saelens, B. E., & Bachman, W. (2006). Many Pathways from Land Use to Health: Associations between Neighborhood Walkability and Active Transportation, Body Mass Index, and Air Quality. *Journal of the American Planning Association*, 72(1), 75–87. doi:https://doi.org/10.1080/01944360608976725
- Gehl, J. (2011). *Life between buildings: using public space*. Washington, DC: Island Press. Available at: http://public.eblib.com/choice/publicfullrecord.aspx?p=3317590

- Giles-Corti, B., Wood, G., Pikora, T., Learnihan, V., Bulsara, M., Van Niel, K., ... Villanueva, K. (2011). School site and the potential to walk to school: The impact of street connectivity and traffic exposure in school neighborhoods. *Health & Place*, 17(2), 545–550. doi:<https://doi.org/10.1016/j.healthplace.2010.12.011>
- Glazier, R. H., Creatore, M. I., Weyman, J. T., Fazli, G., Matheson, F. I., Gozdyra, P., ... Booth, G. L. (2014). Density, Destinations or Both? A Comparison of Measures of Walkability in Relation to Transportation Behaviors, Obesity and Diabetes in Toronto, Canada. *PLoS ONE*, 9(1), e85295. doi:<https://doi.org/10.1371/journal.pone.0085295>
- Grasser, G., Van Dyck, D., Titze, S., & Stronegger, W. (2013). Objectively measured walkability and active transport and weight-related outcomes in adults: a systematic review. *International Journal of Public Health*, 58(4), 615–625. <https://doi.org/10.1007/s00038-012-0435-0>
- Hajna, S., Dasgupta, K., Halparin, M., & Ross, N. A. (2013). Neighborhood Walkability. *American Journal of Preventive Medicine*, 44(6), e55–e59. doi:<https://doi.org/10.1016/j.amepre.2013.01.033>
- Handy, S. L., Boarnet, M. G., Ewing, R., & Killingsworth, R. E. (2002). How the built environment affects physical activity. *American Journal of Preventive Medicine*, 23(2), 64–73. doi: [https://doi.org/10.1016/S0749-3797\(02\)00475-0](https://doi.org/10.1016/S0749-3797(02)00475-0)
- King, K. E., & Clarke, P. J. (2015). A Disadvantaged Advantage in Walkability: Findings From Socioeconomic and Geographical Analysis of National Built Environment Data in the United States. *American Journal of Epidemiology*, 181(1), 17–25. <https://doi.org/10.1093/aje/kwu310>
- Lee, C., & Moudon, A. V. (2006). Correlates of Walking for Transportation or Recreation Purposes. *Journal of Physical Activity and Health*, 3(s1), S77–S98. doi:<https://doi.org/10.1123/jpah.3.s1.s77>
- Lee, I.-M., & Buchner, D. M. (2008). The Importance of Walking to Public Health: Medicine & Science in Sports & Exercise, 40(Supplement), S512–S518. doi:<https://doi.org/10.1249/MSS.0b013e31817c65d0>
- Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A., & Hugo, G. (2007). Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes. *Health & Place*, 13(1), 111–122. doi:<https://doi.org/10.1016/j.healthplace.2005.11.001>
- Leyden, K. M. (2003). Social Capital and the Built Environment: The Importance of Walkable Neighborhoods. *American Journal of Public Health*, 93(9), 1546–1551. doi:<https://doi.org/10.2105/AJPH.93.9.1546>
- Litman, T. (2003). Economic Value of Walkability. *Transportation Research Record: Journal of the Transportation Research Board*, 1828, 3–11. doi:<https://doi.org/10.3141/1828-01>
- Millington, C., Ward Thompson, C., Rowe, D., Aspinall, P., Fitzsimons, C., Nelson, N., & Mutrie, N. (2009). Development of the Scottish Walkability Assessment Tool (SWAT). *Health & Place*, 15(2), 474–481. doi:<https://doi.org/10.1016/j.healthplace.2008.09.007>
- Moudon, A. V., & Lee, C. (2003). Walking and Bicycling: An Evaluation of Environmental Audit Instruments. *American Journal of Health Promotion*, 18(1), 21–37. doi:<https://doi.org/10.4278/0890-1171-18.1.21>
- Panther, J. R., Jones, A. P., Van Sluijs, E. M. F., Griffin, S. J., & Wareham, N. J. (2011). Environmental and Psychological Correlates of Older Adult's Active Commuting: Medicine & Science in Sports & Exercise, 43(7), 1235–1243. doi:<https://doi.org/10.1249/MSS.0b013e3182078532>
- Park, S., Deakin, E., & Lee, J. (2014). Perception-Based Walkability Index to Test Impact of Microlevel Walkability on Sustainable Mode Choice Decisions. *Transportation Research Record: Journal of the Transportation Research Board*, 2464, 126–134. doi:<https://doi.org/10.3141/2464-1>
- Pikora, T. J., Bull, F. C., Jamrozik, K., Knuiman, M., Giles-Corti, B., & Donovan, R. J. (2002). Developing a reliable audit instrument to measure the physical environment for physical activity. *American Journal of Preventive Medicine*, 23(3), 187–194. doi:[https://doi.org/10.1016/S0749-3797\(02\)00498-1](https://doi.org/10.1016/S0749-3797(02)00498-1)
- Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003a). Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Annals of Behavioral Medicine*, 25(2), 80–91. doi:https://doi.org/10.1207/S15324796ABM2502_03
- Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003b). Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Annals of Behavioral Medicine*, 25(2), 80–91. doi:https://doi.org/10.1207/S15324796ABM2502_03
- Sallis, J. F., Saelens, B. E., Frank, L. D., Conway, T. L., Slymen, D. J., Cain, K. L., ... Kerr, J. (2009). Neighborhood built environment and income: Examining multiple health outcomes. *Social Science & Medicine*, 68(7), 1285–1293. doi:<https://doi.org/10.1016/j.socscimed.2009.01.017>

Schlossberg, M., Greene, J., Phillips, P. P., Johnson, B., & Parker, B. (2006). School Trips: Effects of Urban Form and Distance on Travel Mode. *Journal of the American Planning Association*, 72(3), 337–346. doi:https://doi.org/10.1080/01944360608976755

Shbeeb, L., & Awad, W. (2013). Walkability of School Surroundings and its Impact on Pedestrian Behaviour. *Tema. Journal of Land Use, Mobility and Environment*. doi:https://doi.org/10.6092/1970-9870/1608

Soltani, A., & Allan, A. (2006). Analyzing the Impacts of Microscale Urban Attributes on Travel: Evidence from Suburban Adelaide, Australia. *Journal of Urban Planning and Development*, 132(3), 132–137. doi:https://doi.org/10.1061/(ASCE)0733-9488(2006)132:3(132)

Soltani, A., & Hoseini, S. H. (2014). An analysis of the connection between built environment, physical activity and health: comparing three urban neighbourhoods from Shiraz, Iran. *International Journal of Urban Sciences*, 18(1), 19–30. doi:https://doi.org/10.1080/12265934.2013.874546

Southworth, M. (2005). Designing the Walkable City. *Journal of Urban Planning and Development*, 131, 246–257. doi:https://doi.org/10.1061/(ASCE)0733-9488(2005)131:4(246)

Talen, E., & Koschinsky, J. (2013). The Walkable Neighborhood: A Literature Review. *International Journal of Sustainable Land Use and Urban Planning*, 1(1). doi:https://doi.org/10.24102/ijslup.v1i1.211

Tibbalds, F. (2003). Making people-friendly towns improving the public environment in towns and cities. Taylor & Francis.

Witten, K., Blakely, T., Bagheri, N., Badland, H., Ivory, V., Pearce, J., ... Schofield, G. (2012). Neighborhood Built Environment and Transport and Leisure Physical Activity: Findings Using Objective Exposure and Outcome Measures in New Zealand. *Environmental Health Perspectives*, 120(7), 971–977. doi:https://doi.org/10.1289/ehp.1104584

IMAGE SOURCES

Fig. 1 – Fig. 2: Authors.

AUTHOR'S PROFILE

Ali Soltani is professor of Urban Design/ Planning Faculty of Art and Architecture, University of Shiraz, Shiraz, IRA

Mohammad Hossein Pour is Assistant Professor of Urban Design/ Planning Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN

Mahsa Sholeh is assistant Professor of Urban Design/ Planning Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN

Parisa Zare is M.A. Student of Urban Design, Faculty of Art and Architecture, University of Shiraz, Shiraz, IRAN



TeMA

**Journal of
Land Use, Mobility and Environment**

Special Issue - June 2018