Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 00 (2018) 000–000

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2019 Mumbai 26-31 May 2019

The Role of Culture on Urban Travel Patterns: Quantitative Analyses of Urban Areas based on Hofstede's Culture Dimensions

Ali Enes Dingil*, Federico Rupi**, Joerg Schweizer**, Zaneta Stasiskiene*, Kasra Aalipour**

*Kaunas University of Technology, Institute of Environmental Engineering Gedimino St. 50, LT-44239 Kaunas, Lithuania
**University of Bologna, Civil Engineering Department, Viale Risorgimento,2, I-40136 Bologna, Italy

Abstract

Introduction - Aim of this study to investigate why built environment surrounded in each national society by a differentiated way. Culture is interpretation code of societies, which may explain common preferences in a place. Prediction of alternative transport system which can be adopted in a place with peace can help urban transport planners and policy makers to adjust urban environment in more sustainable manner. This paper attempts to investigate the role Hofstede's culture dimensions (HCD) on urban travel patterns in 87 urban areas and 41 countries. **Analysis** – This is the first, systematic analysis investigating effect of culture on urban travel patterns with open source data from different urban areas around the world. Relationship between HCD and some urban travel patterns such as mode choices (individual transportation and public transportation), car ownership and infrastructure accessibility (road infrastructure per capita) is demonstrated. Additionally, relationship between culture and some demographic indicators (population density and GDP per capita) which are closely associated with travel choices are checked. Relations between indicators are identified through correlations and regression models are calibrated, quantifying the relation between transport indicators. **Results & Conclusions** - Good correlation values between Hofstede's fundamental culture dimension: individualism/collectivism (IND/COL) and urban travel patterns have been demonstrated with a reasonable goodness of fit. Analysis has shown that countries with higher individualism have built more individualistic transport related environment which in turn results with more driving. On the other hand, collective nations tend to use more public transportation. There is a significant evidence that, in case of nations, an increase in triangle dimension score (collectivism, uncertainty and masculinity) results with more public transport usage.

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.

Keywords: *culture; urban transportation; mode choice; built environment; policy; planning.*

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY

1. Introduction

1.1 Definition of culture

Culture is common characterises of a society in which artists and creative thinkers have read and described reality of their citizens with an "interpretation code" [1]. Reflection of common attitudes, values, beliefs and behaviours can be defined as culture [2]. Culture is accumulated, experienced and rooted in the DNA of a community not only as tangible items, also as traditions of public life, rituals, food, conviviality, fests, landmarks and symbols [1]. Although it is still an open question, what exactly culture is. Some works related explanation of culture phenomenon is conducted with genetics science, shared heritage and social conditioning [2]. A Darwinian analysis of cultural change is proposed by Richard Dawkins (1976) in which "memes" are analogous to genes [3]. Furthermore, Dawkins described memes as to be discrete replicators, which can be worked on by natural selection. A robust cross-national correlation between the relative frequencies of variants in genes associated to social sensitivity and relative degree of individualism–collectivism in societies is reviewed [4]. Results have shown that genetic variation can interact with ecological and social factors to influence psycho-cultural differences.

1.2 Quantification of culture

In this paper, we analyse the role of Hofstede's culture dimensions on urban travel patterns. There is only one value-based culture index, based on the most well-known cross-cultural psychologist Hofstede's researches [5-9] conducted with one hundred billion employees of IBM from fifty countries with widen multi-national corporation based on specific surveys. As a result of ***factor analyses*** to examine worldwide survey, has been refined since and Hofstede described five culture dimensions such as "Power Distance (POD)," "Uncertainty Avoidance (UNC)," "Individualism versus Collectivism (IND/COL)" and "Masculinity versus Femininity (MAS/FEM)", ''Long-term orientation (LTO)''. Culture dimensions proposed in Hofstede's works are described with following sentences. IND/COL dimension of culture is the **degree of interdependence a society** maintains among its members. Hofstede stated IND/COL dimension as **fundamental dimension of culture,** called as patterns of me or we sense. The fundamental issue addressed by power distance (POD) dimension in community culture is **tendency level of equalities** or centralisation degree of power that higher power distance means there is high inequalities among community. Low score cultures with POD would not admit inequalities as easily. IND/COL and POD is strongly correlated with each-others. Collectivist cultures have low POD. When POD is high, community can emphasize citizens' status. The fundamental issue addressed by uncertainty avoidance (UNC) dimension is the **level of built-in worry** of community culture. Communities with high UNC have high level of anxiety in an uncertainty situation. MAS/FEM dimension demonstrates **level of competition** in community. Masculine culture would be less concerned with quality of life. Lastly, long-term orientation (LTO) dimension shows the level in culture of how every society has to maintain some links with its own past while **dealing with the challenges of the present and future**.

1.3 Literature review

Different cultural conditions lead to different choice evaluations because of varying 'value associations' [2]. National culture, a subset of culture, increasingly explored over recent decades, has been defined by Hofstede as 'the collective programming of the mind that distinguishes the members of one national group from another' [10]. There is very limited study on relationship between transportation and culture. A study tested Hofstede's culture dimensions (HCD) to explain travel behaviour differences on perceptions of and feelings about security as well as actual experience affect people's patronage of public transport. Results have demonstrated that HCD can be used to explain travel behaviour differences based on ethnicity background [11]. Another research using of Hofstede's cross-cultural indices – power differential & individualism between 14 cities from different nations, investigated if qualitative cultural differences does influence individual or group choices to procure and use hybrid and electric cars [10]. A recent research [12] examined the role of culture in modal choice for different migrant groups within Auckland and concluded that national culture was a strong motivator of how public transport is perceived differently by different national groups within a city.

1.4 Aim of study

Aim of this study to investigate why built environment surrounded in each national society by a differentiated way. Understanding how cities are shaped by setting the appropriate transport priorities can help to achieve terms of sustainable mobility objectives or policies [13-15]. There is not any research paper analysed the role of culture on urban travel patterns in a holistic way. The present analyses is to evaluate effect of culture on urban travel patterns in 87 urban areas from 41 countries. Some policy and urban transport strategies can be drawn by answering this question: which alternative transport systems can sustain under which cultural conditions? Relationship between *HCD* and *some urban travel pattern*s such as mode choices (individual transportation and public transportation), car ownership and infrastructure accessibility (road infrastructure per capita) is demonstrated. Additionally, relationship between culture and some demographic indicators (population density and GDP per capita) which are closely associated with travel choices is checked. The following section motivates the data collection for this work and explains the principle data processing steps. The analysis and results are presented and discussed in Sec. 3, while the conclusions in Sec. 4 summarizes the main findings.

2. Data collection and processing

The general approach is to collect, process and correlate publically available and comparable data from a large number of cities around the world. A variety of 87 sample cities from 41 countries are examined. Worldwide distribution of sample cities can be seen below in Fig 1 below.

2.1 Transport related indicators from cities

Commuting mode choice for cities is collected from a variety of different regions around the world. Data for drive mode share and public transport mode share is extracted from various

sources [16-32] for 87 cities between 2008 – 2016 and all values are turned into proportional expression. Actual car ownership (CO) data for cities is collected from some open sources [17, 18, 20, 25, 28, and 31] and all is turned into private car ownership per 1000 inhabitants for 87 cities. For US Cities, car ownership data is sourced as car per household, and turned into private car ownership per 1000 inhabitants with average household inhabitants database [16]. Road infrastructure accessibility (RIA - m per 10 inhabitants) is sourced from [33] for a clear majority of cities. Road infrastructure length is calculated for several cities from Openstreetmap (OSM) with using the OSMNx software package [34] and all are turned into m road per 10 inhabitants with population data [35].

2.2 Demographics related indicators from cities

After collection of transport related indicators, population density for 2017 and GDP per capita are sourced from [33] for a clear majority of cities. Population density and GDP per capita for several cities are collected from [35-37]. All GDP per capita values are expressed in american dollars, with an average value of the years 2010-2014.

2.3 Culture indicators

The value of five different culture dimensions (IND/COL, POD, UNC, MAS/FEM, LTO) of countries based on Hofstede's cultural dimensions theory are sourced from Hofstede-insights.com for 41 countries. HCD is scored a scale of 0–100. Meanwhile cities from same countries have similar travel patterns; an average value of variants is taken with summing cities' indicators from same countries. All countries represent an average indicator value of their cities in availability of data.

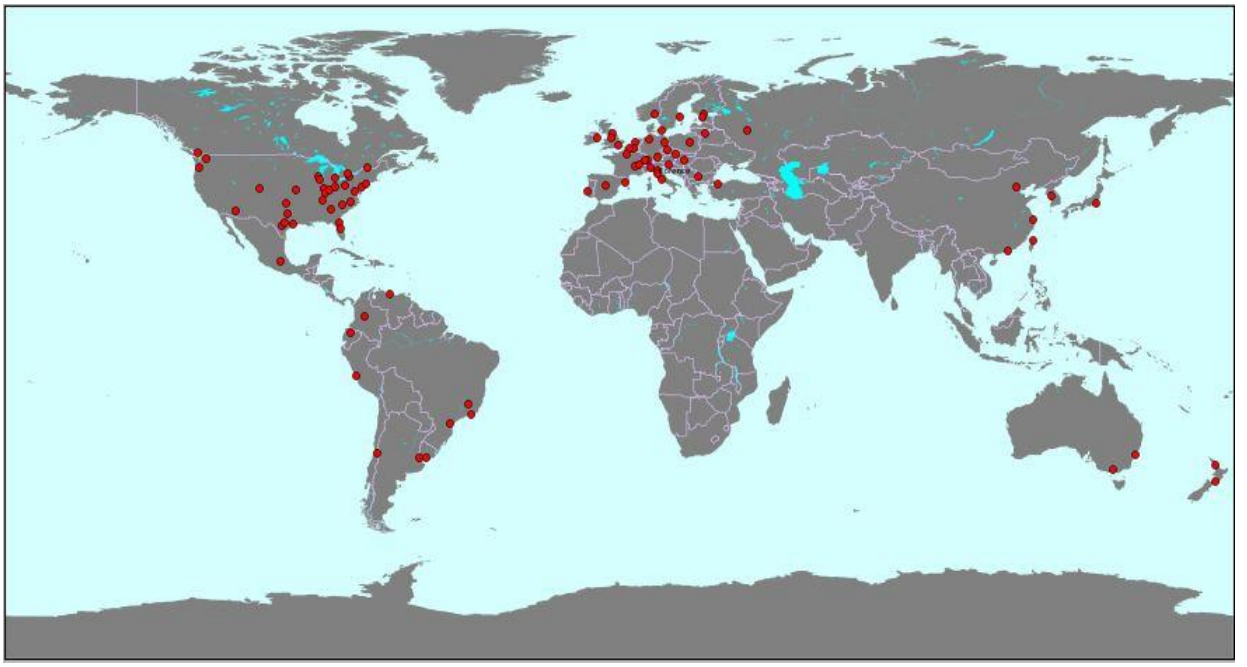

Fig 1: *Distribution of analyzed cities*

3. Analysis and results

In this section different analysis are performed and their results are discussed.

3.1 *Correlations*

The Pearson Correlation Coefficient between different indicators together with the number of samples are shown in Table 1 and Table 2. The software IBM SPSS 25 is used for the Pearson correlation analyses of variables, while the 95% confident level over 0.2 correlation is taken into account.

Pearson Correlation	Car Ownership	Drive %	Public Transport %	Population Density	Road Accessibility	GDP per capita
Individualism	N=41 0,646	N=41 0,615	N=39 -0,634	N=41 -0,351	N=41 0,450	N=41 0,670
Power Distance	N=41 -0,345	N=41 -0,469	N=39 0,591		N=41 -0,325	N=41 -0,502
Masculinity			N=39 0,320			
Uncertainty avoidance		N=41 -0,327	N=39 0,558			N=41 -0,324

Table 1: *Normalized correlation coefficient between indicators.*

As seen from Table 1, some cultural dimensions have high influence on urban travel patterns. Correlations suggest that culture can be a valuable tool to understand why societies shape, use and interact with their environment in different patterns. It is seen a strong positive relationship between individualism & GDP per capita and a negative relationship between population density & individualism in moderate levels. It can be hypothesized that individualist communities have higher income and prefer to live in sprawl cities in moderate levels. There is also positive moderate relationship between individualism and road network accessibility, which suggests that individualistic societies build more road. As seen, car ownership is higher in individualistic communities with strong correlation, 0.646. Also, a strong correlation between individualism and urban travel mode choices is demonstrated for driving mode as 0.615 and for public transit usage as -0.634. These findings suggest that individualistic societies prefer to drive while as collective places tend to use more public transport services.

The countries such as US, Australia, Canada, Italy, New Zealand, UK have the highest individualism meanwhile these countries have the highest car mode share %. The countries such as South Korea, Hong Kong, China, Thailand, Peru, Colombia and Brazil have the highest collectivism score meanwhile these countries has the highest public transport usage. However, note that there is some discrete countries such as Netherlands and Denmark have also high

individualism but in this countries, driving and public transport mode share are low comparing other countries. However, these countries have the highest bike usage within all countries [18]. Cycling can be called as environmental friendly individual travel mode that may explain why this travel mode is adopted in these nations as main mode choice. Also, Hungary has high individualism and at the same time high public transport mode share. Note that uncertainty dimension is highly correlated with public transport usage; 0.558 and Hungary has one of the highest uncertainty index with value of 82 within all countries. As expected, power distance negatively correlated with GDP in high levels. Inequalities in society may result with decreasing overall welfare and affecting people's choices. Also, power distance negatively correlated with car ownership, driving and road accessibility and positively correlated with public transport usage in high level. Note that power distance and individualism is negatively correlated here in very high level with value of -0,705 as stated in Hofstede's works, thus we base on fundamental culture dimension; IND/COL for statistical models in next section. LTO dimension did not show any significant correlation with any indicators.

Table 2 demonstrates correlations between some transport associated indicators and urban travel mode choices. As expected, there is a high positive correlation between GDP per capita and drive mode share while as a negative correlation is seen between public transportation usage and GDP per capita. There are strong correlation between drive mode share and individual transport needs (car ownership & road accessibility). Oppositely, a strong negative correlation between public transport mode share and individual transport needs is seen. Also, a strong correlation between mode choices and urban population density is demonstrated. These results suggest that communities both shape their cities and in turn shaped by them. Presumably, national culture could be the reason behind it.

Pearson Correlation	**Car Ownership**	**Population Density**	**Road Accessibility**	**GDP per capita**
Drive mode share %	N=87 0,689	N=87 -0,627	N=87 0,890	N=87 0,526
Public Transport mode share %	N=85 -0,578	N=85 0,598	N=85 -0,834	N=85 -0,458

Table 2: *Normalized correlation coefficient between indicators.*

3.2 *Statistical models*

As IND/COL dimension and individualistic transport indicators are well correlated, some statistical models have been calibrated with the entire set of samples. The best fit between drive mode share and IND/COL dimension of all samples is achieved with a linear function of the shape:

$$Drive\ mode\ share\ \% = c + d\ IND \quad (1)$$

The best fit between car ownership and IND/COL & between RIA and IND/COL of all samples is achieved with an exponential function of the shape:

$$RIA = a\ exp(b\ IND) \quad (2)$$

$$Car\ ownership = a\ exp(b\ IND) \quad (3)$$

However, the fitting errors with a linear model are only slightly superior. Also, IND/COL dimension and public transport share is negatively well correlated, as well as public transport share is considerably correlated with uncertainty dimension and moderately correlated with masculinity as different than individual travel patterns. The best fit between public transport mode share and IND/COL of all samples is achieved with a linear function of the shape:

$$Public\ transport\ mode\ share\ \% = c + d\ IND \quad (4)$$

These models have been plotted together with the data points in Figs. 1-4 where the regression analyses indicate a good fit.

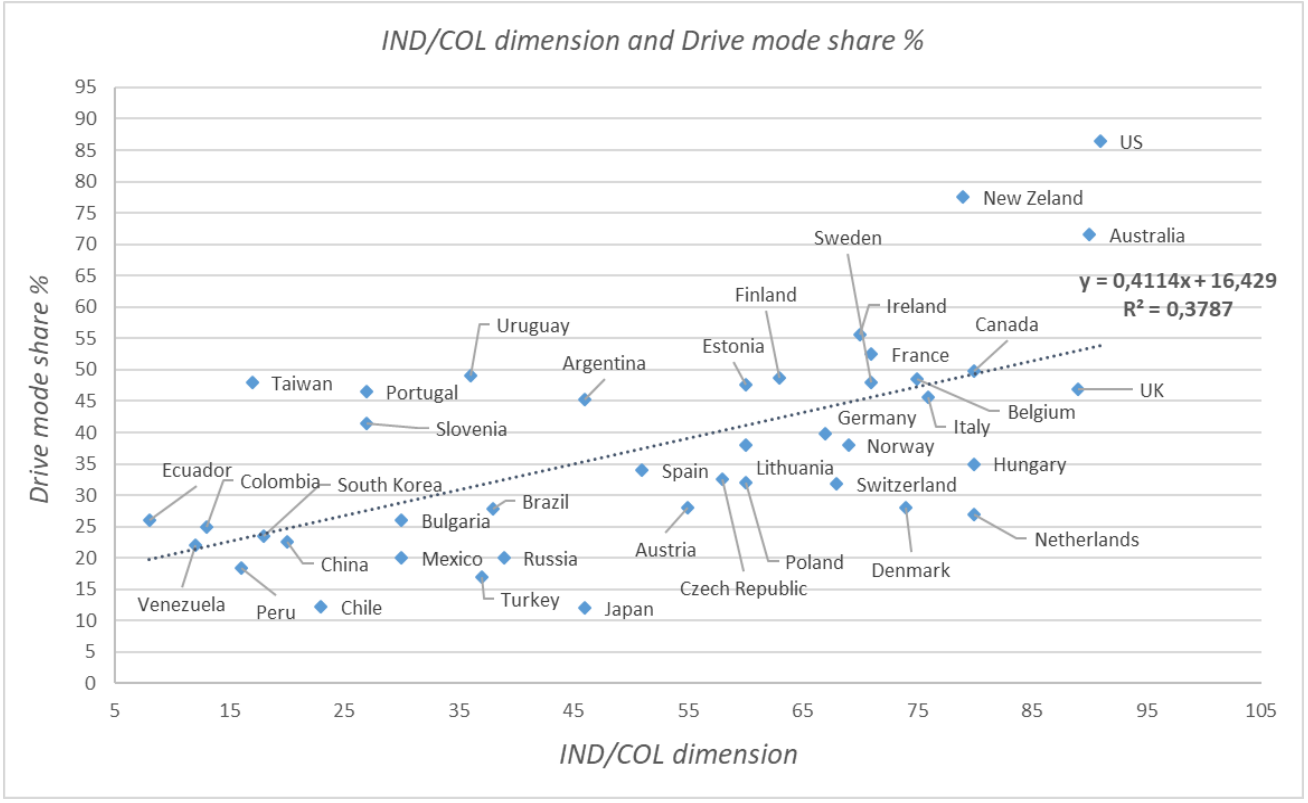

Fig 1: *Drive mode share over IND/COL dimension.*

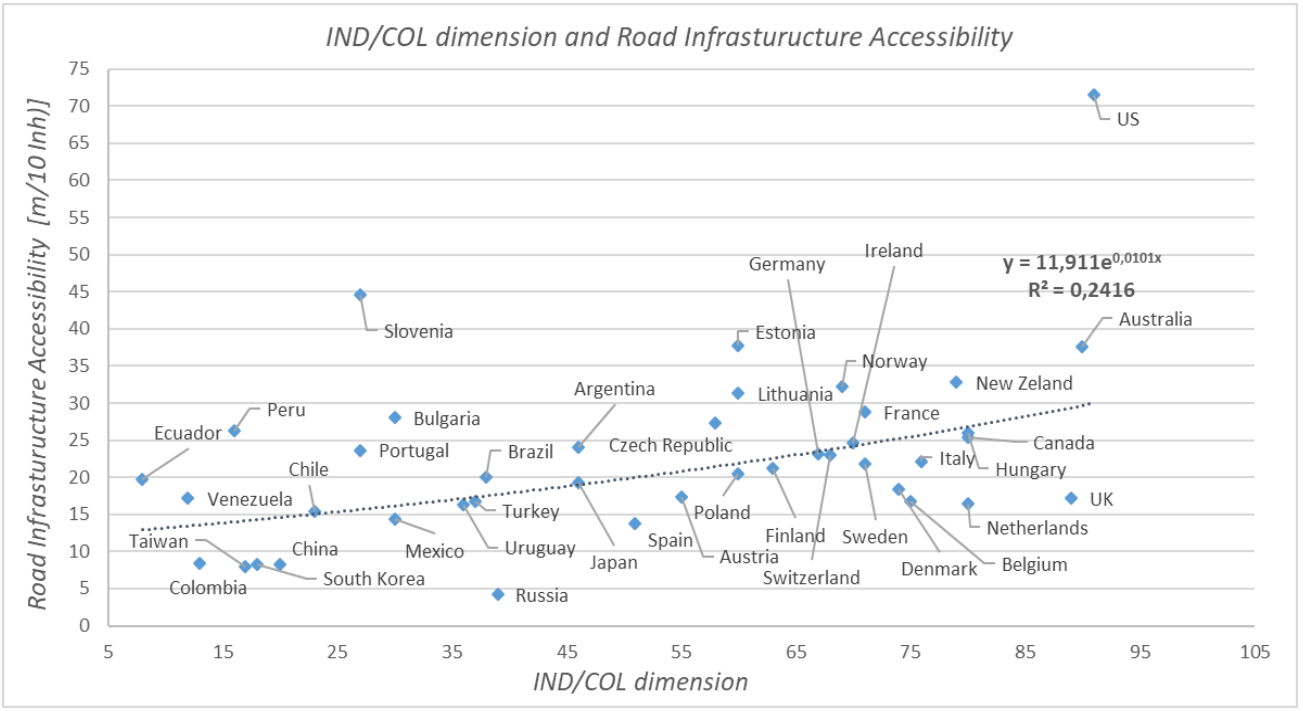

Fig 2: *Road network accessibility over IND/COL dimension.*

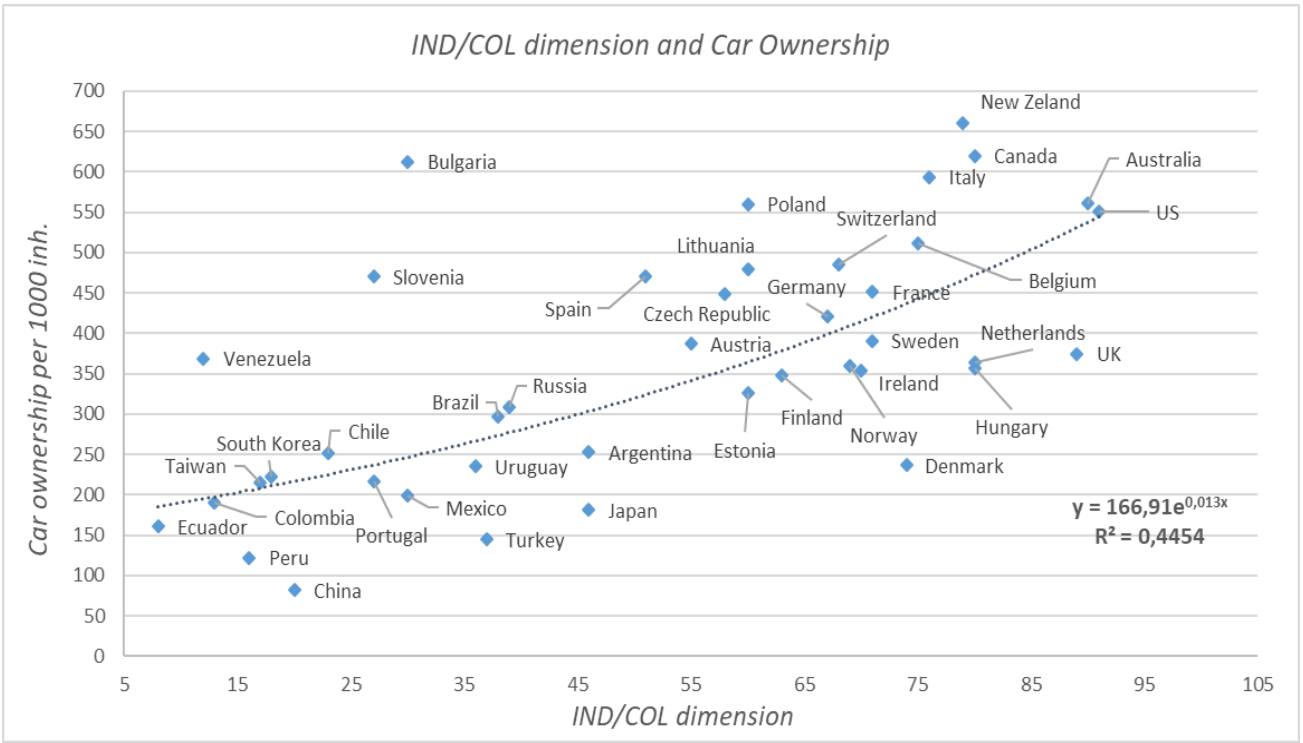

Fig 3: *Car ownership over IND/COL dimension.*

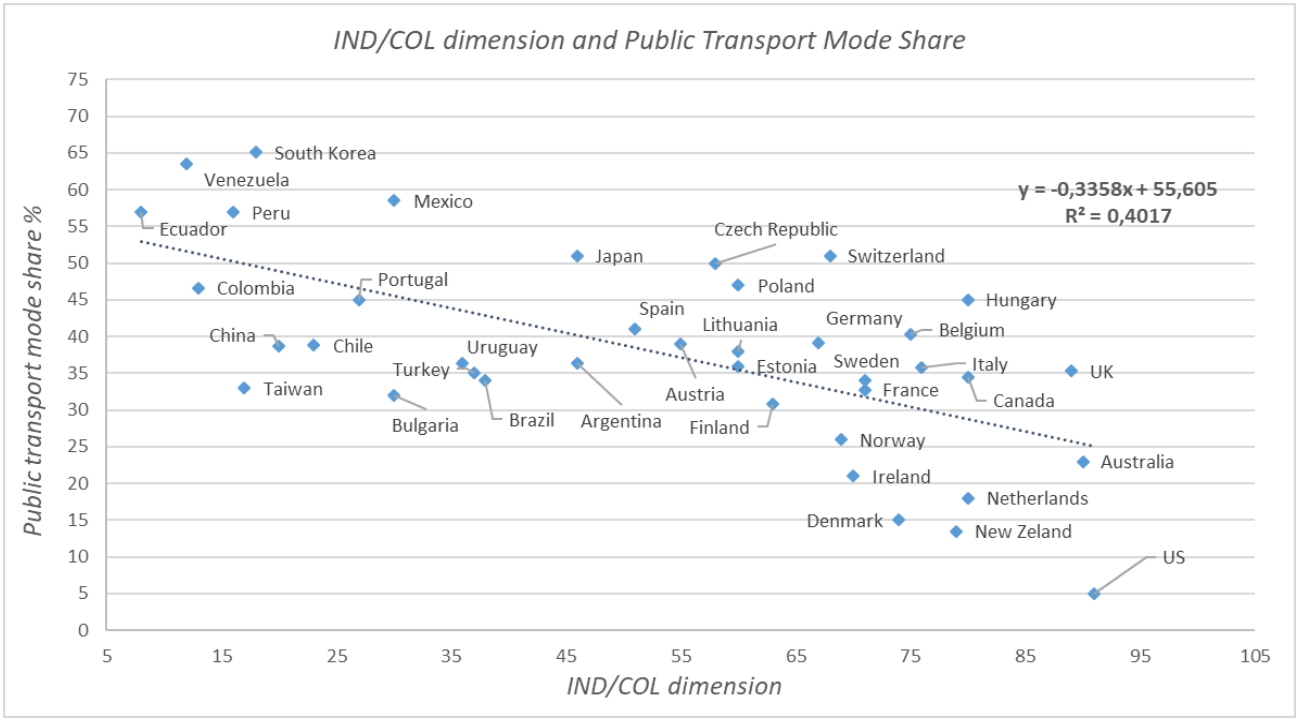

Fig 4: *Public transport mode share over IND/COL dimension.*

To explain better public transport choice in societies, a further model is built with the entire set of samples, which includes individualism, uncertainty and masculinity which have significantly effect on public transport usage:

$$Public\ transport\ mode\ share\ \% = c + d\ IND\ + e\ MAS + f\ UNC \quad (5)$$

The coefficients *d, e and f* quantify the effects on public transport usage due to an increase/decrease in independent variables. Further tables (2-6) demonstrate quantifications as the results of t-tests for linear regression models.

Results	**Coef**	**Std Err**	**Beta**	**t**	**P>|t|**
c	*16,429*	*4,834*		*3,399*	*0,002*
d	*0,411*	*0,084*	*0,615*	*4,875*	*0,000*

Table 2: *Results of linear function model Eq. (1).* $R^2 = 0{,}379$*, sample size N=39.*

Results	***Coef***	***Std Err***	***Beta***	***t***	***P>|t|***
c	*11,871*	*3,807*		*3,118*	*0,003*
d	*0,209*	*0,066*	*0,450*	*3,143*	*0,003*

Table 3: *Results of linear function model Eq. (2).* $R^2 = 0{,}202$*, sample size N=39.*

Results	*Coef*	*Std Err*	*Beta*	*t*	*P>|t|*
c	*158,878*	*42,551*		*3,734*	*0,001*
d	*3,929*	*0,743*	*0,646*	*5,289*	*0,000*

Table 4: *Results of linear function model Eq. (3).* $R^2 = 0{,}418$*, sample size N=39.*

Results	*Coef*	*Std Err*	*Beta*	*t*	*P>|t|*
c	*55,605*	*3,924*		*14,172*	*0,000*
d	*-0,336*	*0,067*	*-0,634*	*-4,984*	*0,000*

Table 5: *Calibration results of linear function model Eq. (4).* $R^2 = 0{,}402$*, sample size N=39.*

Results	*Coef*	*Std Err*	*Beta*	*t*	*P>|t|*
c	*32,018*	*8,155*		*3,926*	*0,000*
d	*-0,267*	*0,067*	*-0,504*	*-3,979*	*0,000*
e	*0,154*	*0,072*	*0,249*	*2,147*	*0,039*
f	*0,180*	*0,084*	*0,279*	*2,152*	*0,038*

Table 6: *Results of linear function model Eq. (5).* $R^2 = 0{,}554$*, sample size N=35.*

As seen from the tables (2-5), IND/COL dimension have high influence on urban travel patterns in perfect significance levels. The highest influence of individualism is seen on car ownership. Communities with high individualism shape travel environment for individual transportation in turn these areas are developed by individualistic travel needs. Decrease in individualism level means increase of collectivism level in society. It is seen that increase in collectivism resulting with more public transport usage in table 5. Table 6 demonstrates results of multiple linear regression model on prediction of public transport mode share. R^2 is higher than *linear function model Eq. (4)* and all coefficients are significant. Fig 5 shows normal P-P plot of regression standardized residual for linear function model Eq. (5). Plot demonstrates that the residuals of the multiple regression follow a normal distribution. Results of model indicate that societies with high three-dimensional (collectivism – masculinity - uncertainty) score tend to use more public transport. Masculinity and uncertainty dimensions have similar level of influence, more than half effect on an increase of public transport usage than individualism does decrease it.

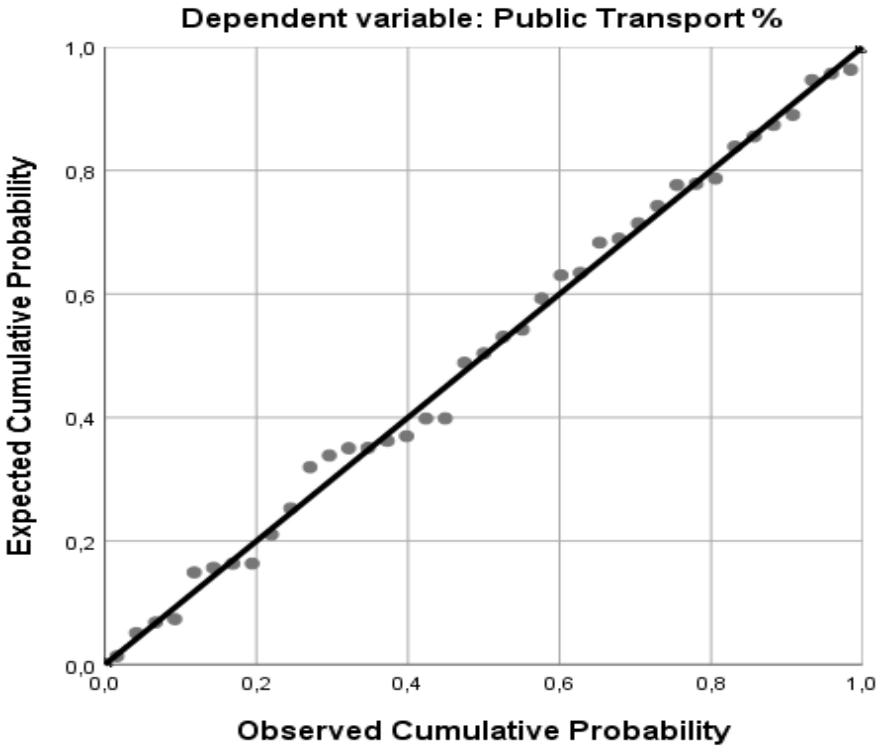

Fig.5 *Normal P-P Plot of Regression Standardized Residual*

4. Discussions and Conclusions

In the past, there is not any macroscopic analyses on relationship between national culture and urban travel patterns. The 87 analyzed cities are distributed over 41 countries. Relationship between culture dimensions and urban travel patterns have been investigated. Also, relationship between culture and some demographic indicators (population density and GDP per capita) which is closely associated with travel choices is demonstrated. Additionally, relations between urban travel mode choices (drive and public transport) and some transport-associated indicators are shown.

Some countries highlighted above with very high individualism and very low driving such as Netherlands, Denmark and Hungary. Netherlands and Denmark has adopted biking for urban transportation about long time. Cycling can be called as environmental friendly individual travel mode. This may suggest for urban planners and policy makers to consider adaptation of biking infrastructure to reduce car-dependant transportation in the countries with high individualism. Perhaps, culture may explain why public transportation is unsuccessful on patronage in places with high individualism. Hungary has one of the highest uncertainty score within all countries with high public transport usage. Uncertainty has the second highest influence on an increase in public transport mode share after collectivism. This result suggests that investment in public

transportation can be good option for the places with high individualism and high uncertainty to prevent car dependent mobility.

Describing culture at a country level to individual cities is only choice for now while there is not any culture scale for cities. However, errors may occur due to possible issues relating to group effects where several cities are included from the same country. Also, errors may happen for several reasons: representative selection of the population may diverse in term of nation as some cities have multinational community; compatibility problems related to data stems from different years and mixing data from several open sources.

Considering the many error sources and limitations mentioned, good correlation values between Hofstede's fundamental culture dimensions: IND/COL and travel patterns have been demonstrated with a reasonable goodness of fit. The analysis has shown that countries with higher individualism score have built more individualistic transport related environment which in turn results with more driving. On the other hand, collective nations tend to use more public transportation. It is also seen that uncertainty and masculinity culture dimensions does effect on public transportation usage. There is a significant evidence that, in case of nations, an increase in triangle dimension score (collectivism, uncertainty and masculinity) results with more public transport usage. Still, the highest influence on public transportation usage is IND/COL dimension. Lastly, this study has been demonstrated that culture can be key tool on urban transportation planning. If we can predict which alternative transport systems can be adopted in a place with peace, we can achieve sustainability in urban transportation.

5. Bibliography

[1] Van der Borg, J. & A.P. Russo (2005), The Impacts of Culture on the Economic Development of Cities, Rotterdam: European Institute for Comparative Urban Research (EURICUR), Erasmus University Rotterdam

[2] David P. Ashmore, Nicola Christie & Nicholas A. Tyler (2017): Symbolic transport choice across national cultures: theoretical considerations for research design, Transportation Planning and Technology, DOI: 10.1080/03081060.2017.1355882

[3] Newson, L., Richerson, P. J., & Boyd, R. (2007). Cultural evolution and the shaping of cultural diversity. In S. Kitayama & D. Cohen (Eds.), Handbook of cultural psychology (pp. 454-476). New York, NY, US: Guilford Press.

[4] Baldwin M. Way, Matthew D. Lieberman; Is there a genetic contribution to cultural differences? Collectivism, individualism and genetic markers of social sensitivity, *Social Cognitive and Affective Neuroscience*, Volume 5, Issue 2-3, 1 June 2010, Pages 203–211.

[5] Hofstede, G. (1979). ''*Value System in Forty Countries: Interpretation, Validation, and*

Consequences for Theory''. In L. H. Eckensberger, W. J. Lonner, & Y. H. Poortinga (Eds.) Cross-Cultural Contributions to Psychology. Lisse, The Netherlands: Swets and Zeitlinger.

[6] Hofstede, G. (1980). *''Culture's Consequences: International Differences in Work-Related Values''.* Beverly Hills, CA: Sage.

[7] Hofstede, G. & Bond, M. H. (1988). ''*The Confucius Connection: From Cultural Roots to Economic Growth''.* Organizational Dynamics, 16(4), 5-21.

[8] Hofstede, G. (2001). *''Culture's Consequences''.* (2nd Ed.) Thousand Okas, CA: Sage Publications.

[9] Hofstede G., Hofstede G. J. & Minkov, M. (2010). *''Cultures and Organizations: Software of the Mind''.* (Rev. 3rd ed.). New York: McGraw-Hill.

[10] D.P. Ashmore, D. Pojani, R. Thoreau, N. Christie, N.A. Tyler. (2018). The symbolism of 'eco cars' across national cultures: potential implications for policy formulation and transfer. Transp. Res. Part D: Transp. Environ., 63, pp. 560-575.

[11] Syam, A., Reeves, D., & Khan, A. (2011). The effects of cultural dimension on people's perception about security on public transport. Urban Transport 2011, Pisa, Italy.

[12] Syam, A., 2014. Cultural values: a new approach to explain people's travel behaviour and attitudes toward transport mode (Thesis). University of Auckland

[13] Newman P.W. (2015). *"Transport infrastructure and sustainability: a new planning and assessment framework",* Vol. 4 Issue: 2, pp.140-153.

[14] European Environment Agency (EEA). (2009). *"TERM 2008: indicators tracking transport and environment in the European Union".*

[15] Prashker J., Shiftan Y. and Hershkovitch S. (2008). *"Residential choice location, gender and the commute trip to work in Tel Aviv,"* Journal of Transport Geography 16, 2008, 332–341.

[16] American Fact Finder. (2018). *Database.*
Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

[17] Development Bank of Latin America (CAF). (2018). *Database*. Retrieved from: https://www.caf.com/es/conocimiento/datos.

[18] Eurostat. (2018). *Database.* Retrieved from:
http://ec.europa.eu/eurostat/web/cities/data/database?p_p_id=NavTreeportletprod_WAR_NavTreeportletprod_INSTANCE_KhPDfq283AOB&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-2&p_p_col_count=1.

[19] LTA (Land Transport Authority) Academy. (2011). *''Passenger Transport Mode Shares in World Cities''.* In: Journeys – Sharing Urban Transport Solutions, Issue 7, Singapore.

[20] New Zealand Stats. (2018). *Transport Database*.
Retrieved from: http://nzdotstat.stats.govt.nz/wbos/Index.aspx.

[21] Sootfreecities. (2018). *Dataset.* Retrieved from:
http://www.sootfreecities.eu/sootfreecities.eu/public/measure/traffic-mobility.

[22] Urban Land Institute. (2011). Moscow, Russia. A ULI Advisory Services Panel Report. 4-9.

[23] Urbanage. (2018). *LSE cities database.* Retrieved from: https://urbanage.lsecities.net/data.

[24] EPOMM. (2018). *Database.*
Retrieved from: http://www.epomm.eu/tems/result_city.phtml?city=341&list=1.

[25] Fietsberaad. (2009). *''Bicycle policies of the European principals: continuous and integral''.*
[online] available from: http://nia1.me/hc.

[26] APA-OTS. (2018). *Dataset.*
Retrieved from: https://www.ots.at/presseaussendung/OTS_20150210_OTS0091/modal-split-2014-radfahren-in-wien-immer-beliebter.

[27] Brno Municipality. (2012). Retrieved from:
https://www.brno.cz/fileadmin/user_upload/sprava_mesta/magistrat_mesta_brna/OD/dokumenty_OKD/delba_prepravni_prace/Delba_prepravni_prace_2012.pdf.

[28] Vilnius Gediminas Technical University. (2011). Report. *''Naujų transporto rūšių diegimo Vilniaus mieste specialusis planas''.*
Retrieved from: http://old.vilnius.lt/transportas/koncepcija/vilniaus_koncepcija_2011.09.15.pdf.

[29] LTA Academy. (2014). *''Passenger Transport Mode Shares in World Cities''*. JOURNEYS.
Retrieved from: http://www.lta.gov.sg/ltaacademy/doc/J14Nov_p54ReferenceModeShares.pdf .

[30] ChartingTransport. (2018) Retrieved from: https://chartingtransport.com/#mode

[31] Statistics Canada, (2018). *Database.* Retrieved from: http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E&TABID=1.

[32] Dipartimento Programmazione Settore Statistica, Comune di Bologna. (2014). Gli spostamenti quotidiani per studio e lavoro.

[33] Dingil A. E., Schweizer J., Rupi F. and Stasiskiene Z. (2018). *Transport indicator analysis*

and comparison of 151 urban areas, based on open source data. European Transport Research Review (ETRR**),** 10:58. https://doi.org/10.1186/s12544-018-0334-4.

[34] Boeing G. (2017). *"OSMnx: New Methods for Acquiring, Constructing, Analyzing, and Visualizing Complex Street Networks."* Computers, Environment and Urban Systems. 65, 126-139.

[35] Citypopulation, (2018). *Database*. Retrieved from: www.citypopulation.de.

[36] Brookings Institute. (2018). *Global Metro Monitor*.
Retrieved from: https://www.brookings.edu/research/global-metro-monitor/.

[37] OECD. (2018). *Regions and Cities Database.*
Retrieved from OECD: https://stats.oecd.org/Index.aspx?DataSetCode=CITIES.