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Transferring Urban Mobility Studies in Tehran, Istanbul, and Cairo to Other Large MENA Cities: Steps toward Sustainable Transport

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Abstract

The number of urban mobility studies and projects in the three large metropoles of the Middle East and North Africa (MENA) region, Tehran, Istanbul, and Cairo, is growing while other large cities do not enjoy a large share. It would be efficient for those other large cities to adapt the experiences, projects, and studies of Tehran, Istanbul, and Cairo to their own contexts. This paper can help facilitate that adaptation. It investigates the transferability and generalisability of the findings of a recent publication by the lead author on mobility choices in Tehran, Istanbul, and Cairo to some other large cities of more than one million inhabitants in the MENA region. The discussion provided here can provide decision-makers in the MENA region with guidance on how to utilise the findings from a recent study on Tehran/Istanbul/Cairo in their own contexts. T-tests were conducted to test the comparability of the three base cities with a sample 57 others with populations of over one million people. The results show that it would be possible to adapt the urban mobility studies of the three base megacities to 3 to 27 cities based on different criteria. Key suggestions identified by this study include providing local accessibility, neighbourhood facilities, and cycling facilities as well as removing social and legal constraints to cycling, advertising cycling, informing people about the harm arising from the overuse of cars, and increasing street connectivity by adding intersections. According to the findings, these evidence-based recommendations can enhance sustainable mobility for the inhabitants of up to 27 large cities.

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Introduction

The number of inter- and multidisciplinary mobility studies and related applied projects have recently increased in the Middle East and North Africa (MENA), with many such projects conducted with the aim of increasing the share of non-motorised, active, or sustainable transportation in the region's large cities (e.g. Hennig 2011; Vakili, Isaai & Barsari 2008; Masoumi et al. 2018; Masoumi 2019). However, many of the urban studies and practical transportation projects of the MENA region have been carried out or implemented in the three megacities of the region: Tehran, Istanbul, and Cairo (e.g. Yankaya 2011; Huzayyin & Salem 2013; Shoorcheh et al. 2016).

Iran, Turkey, and Egypt have all undergone phases of rapidly increasing population growth and urbanisation since the 1960s (Hosseini, Gouda & Masoumi 2016) and their three capital cities now accommodate millions of people in areas that are smaller than the large cities of western Europe and North America. However, each of the three countries experienced shifting population trends in different ways and consequently dealt with the increased amount of urban residents differently – in Egypt, for example, the *share* of urban residents in the country's total population remained relatively stable over time, yet 22 new cities still sprang up around Cairo to house the *overall* growing population (Hosseini, Gouda & Masoumi 2016). This contrasts with the situation in Iran and Turkey where both countries experienced peak urban population growth in the 1980s and then a subsequent rapid decline (Hosseini, Gouda & Masoumi 2016).

As the only three megacities in the MENA region and the foremost urban centres of their respective countries, Tehran, Istanbul, and Cairo necessarily have a complex organisation and structures to house and employ the increased number of inhabitants. Due to this, the results of research and applied projects in these three cities are not always readily transferable or generalisable to other large cities of the region. In other words, it might not be appropriate to directly transfer the results of a study in Cairo, Egypt to Tripoli, Libya or to generalise the findings of a study on Tehran to all other large metropolises in Iran. Thus, while the amount of formal research conducted in the MENA region is still scarce overall, the scientific information that does exist is somewhat limited to three megacities that differ from other large metropolises in the region in complex, nuanced ways. This makes it extremely difficult for urban planners and decision-makers in other localities to use data-driven approaches to inform their actions.

Given this background, this article attempts to address this problem by presenting a simple and flexible protocol to assess whether the findings from projects or studies conducted in Tehran, Istanbul, and Cairo could reasonably be applied to other large MENA cities when adjusted to fit their respective contexts. We applied a set of 16 indicators (of four different types: demographic, socioeconomic, climatic, and transport-related) in t-tests to determine which other large MENA cities are similar to the three base cities. Our data points for the 16 selected indicators date from the last five years, with some data points stretching further back to 2004.

The paper also draws on the results of recent studies on urban travel behaviour in the large cities of the MENA region to present a general roadmap to make urban mobility more sustainable in those cities designated as comparable to Tehran/Istanbul/Cairo. The objectives were (1) to determine the transferability of findings from existing urban mobility research on Tehran, Istanbul, and Cairo to other large cities in the MENA region by using similarity across several socio-economic, demographic, climatic/geographic, and mobility-related metrics as criteria and (2) describe a general framework of recommendations for promoting sustainable mobility in the large cities of the region.

This paper defines the 'MENA region' as the geographic band of territory between Pakistan in the east and Morocco in the west. On the Middle Eastern side of this region, this includes Pakistan, Afghanistan, Iran, Iraq, Syria, Turkey, Lebanon, Israel and Palestine, Jordan, Saudi Arabia, Kuwait, Bahrain, Qatar, United Arab Emirates, Oman, and Yemen. The countries of Central Asia and the Caucasus area were excluded. On the North African side, this includes Morocco, Algeria, Tunisia, Libya, and Egypt. All the countries directly south of the Mediterranean coastal nations (Western Sahara, Mauritania, Mali, Niger, Chad, and Sudan) were not included. Other Arabic- and Turkish-speaking nations (Eritrea, Djibouti, Somalia, Comoros, and Cyprus), included in some definitions of the MENA region, were also excluded.

The paper continues with a review of the status of urban mobility studies in the MENA region, especially in its three large metropolitan areas. Then the method of transferability analysis and the recommendation method of this study are explained. Following this, the numerical findings of applicability are presented and a compilation of recommendations on shifting toward sustainable urban mobility in the region is described. Finally, the characteristics of similar studies in other regions or countries are discussed.

Urban Planning and Urban Mobility Studies in the MENA region

As the region urbanises and the countries' respective population centres more and more concentrate in urban areas, it will become increasingly necessary to make planned decisions regarding urban development that preserve the social, environmental, and economic integrity of those urban areas for the long-term. For city-planners and decision-makers to take such forward-looking actions, reliable data is needed.

Compared to the global leaders in research (Europe, USA, Canada, Japan, China, Australia, and Korea), studies on urban transport in the Middle East and North Africa are sparse. This dearth of data makes it more difficult for decision-makers to orient their actions toward the long-term collective benefit of their communities. In the worst cases, ill-suited policies and urban development measures can be grafted from other cities onto dissimilar urban contexts and ultimately lead to adverse social, economic, and environmental impacts with weighty consequences for the city's residents.

From an ecological standpoint, urban sprawl is one of the most impactful drivers of adverse environmental effects in urban areas in recent years (Johnson 2001; Burchell et al. 2005). The increase in sealed, mostly impermeable surfaces through the construction of roads, utility infrastructure, and buildings disrupts crucial groundwater cycles and associated ecological functions (Burchell et al. 2005). In this way, rapid, unchecked development and sprawl transform (semi-)natural areas into urban ones, reducing biodiversity and environmental resilience. Thus, basing urban planning decisions on the experiences of other cities – especially those that have allowed urban sprawl to grow unchecked through their own planning decisions – could result in serious environmental changes.

Urban form also has impacts on residents' quality of life and the economy. Several studies have shown that factors in urban environments can have detrimental effects on residents' quality of life and well-being (Krefis et al. 2018) and that there is a link between urban green space and life satisfaction (e.g. Bertram & Rehdanz 2015; Brown, Oueslati & Silva 2016). Others have described the types of ecosystem services provided by open green spaces (Ciftcioglu & Aydin 2018) and established that various socioeconomic factors can influence people's preferences for and perceptions of urban green space (e.g. Qureshi, Breuste & Jim 2013). In general, there is evidence that in many geographical contexts, socioeconomic issues are correlated with urban travel behaviour (Meurs & Haaijer 2001; Stead 2001; Pucher & Renne 2003; Limtanakool, Dijst & Schwanen 2006). Thus, this paper involves this group of variables in the analyses. Land use and residential self-selections are also a large group of variables the correlations of which with urban travel behaviour and decision-making have been investigated, and in many contexts evidence of correlations have been found (Van Wee, Holwerda & van Baren 2002; Zhang 2004; Pinjari et al. 2007; Frank et al. 2008; Aziz et al. 2017; Ding et al. 2017). Moreover, people's attitudes, perceptions, behavioural norms, and beliefs have recently gained the attention of some of the scholars of the region. Urban form can also link to economic productivity directly (e.g. Li & Liu 2018) by affecting how and where economic processes are carried out. In this way, planning cities with foresight and evidence can reduce harmful environmental impact, maximise social access and provision of ecosystem services in line with people's preferences, and facilitate economic productivity by allowing for more social and natural resources to become available and be integrated into the urban economy. Thus, the development of sustainable, well-informed and appropriate urban development policies is indispensable. And while urbanisation and its consequent environmental effects are certainly not new concepts, the scale and intensity of modern urbanisation trends necessitates new and better modes of city planning that incorporate environmental sustainability for the sake of long-term integrity.

Some of the above findings about the correlations between different phenomena and urban travel behaviour are relevant to the cities in the MENA region. Socioeconomic issues are generally important in defining the urban travel characteristics of different socio-demographic groups in the region (Koushki 1988; Alkay 2011; Shokoohi, Hanif & Dali 2012; Masoumi 2013a; Etminani-Ghasrodashti & Ardeshiri 2015; Errigo & Tesoriere 2018; Hatamzadeh, Habibian & Khodaii 2019). For instance, in Tehran, Istanbul, and Cairo, social and cultural issues are a major barrier discouraging cycling (Masoumi 2019). Recent publications on the MENA cities have also focused on the relations between land use and urban travel specifications (Yankaya 2011; Soltani & Hoseini 2014; Aslam, Masoumi & Hussain 2019).

However, a crucial link is still missing for urban planners in the MENA region: the availability of legitimate and suitable data to inform urban development decisions. A number of recent research projects or practical projects have been carried out in the three large capital cities of the region. Academic studies have been undertaken on urban transportation planning and infrastructure (Mirbaha et al. 2014; Ayyoubzadeh et al. 2016; Iran-Nejad-Parizi & Khedmati 2016; Khalilikhah, Habibian & Heaslip 2016; Mamdoohi & Zarei 2016; Saeb, Malekzadeh & Kardar 2017; Azadeh, Salehi & Kianpour 2018), urban travel behaviour (Kashani Jou 2011; Masoumi 2013a, 2013b; Nikfalazar, Amiri & Khorshidi 2014; Masoumi 2015; Shirzadi Babakan, Alimohammadi & Taleai 2015; Faroqi & Sadeghi-Niaraki 2016; Shoorcheh et al. 2016), and urban transportation policy (Vakili, Isaai & Barsari 2008) in Tehran. A comparable number of studies have also been conducted on Cairo; some examples are on the conflict between transportation and urban dynamics (Khalifa & El Fayoumi 2012), a historical study of urban growth and urban transportation (Huzayyin & Salem 2013), and general transport strategies (*World Bank* 2006). An even larger volume of research has been carried out on Istanbul. Examples are studies on land use and travel characteristics (Yankaya 2011), data collection for promoting sustainable urban mobility (Hennig 2011), and the size of traffic zones and transport demand (Altan & Ayözen 2018).

Nevertheless, the number of studies and range of topics studied in other large and medium-sized cities of the same countries and other countries of the region are much smaller in comparison to Tehran, Cairo, and Istanbul. So it is not exactly clear if the studies done on these three megacities will be applicable to other large cities in the region because there is a dearth of evidence in the scientific literature to indicate how similarly (or differently) the same phenomena have manifested themselves in these other locations.

This begs the question: how feasible and viable would it be to apply the findings of such studies on large and complex metropolitan MENA cities to other large cities in the region? And if it is possible to transfer some of the findings from these cities to others, which ones? What recommendations could be made to ease the mobility problems of the recipient cities?

This study offers a partial stop-gap solution to deal with this lack of information in the MENA region: we apply a replicable method to explore which cities in the region are similar to the three base cities of Tehran, Istanbul, and Cairo using 16 indicators representing various aspects of urban life. This assessment provides an initial sketch of which cities are similar and in what respects. While no two urban contexts are ever perfectly comparable, our findings show where the results from other urban mobility studies in MENA could potentially be adapted and transferred to other large cities in the region.

The text continues by explaining the methodology taken for examining the transferability and generalisability of the findings stemming from the three base cities. Then the findings of recent studies on the three cities are generalised to form a short roadmap that could be used by planners in the eligible recipient cities as determined by the transferability assessment. The results are discussed thereafter. Lastly, some insights into the usefulness and applicability of our similarity assessment are discussed, and suggestions for how the process of studying transferability could be made better and more robust are provided.

Methodology

The first portion of the findings presented in this paper consists of a general guideline for orienting the urban mobility landscape in Tehran, Istanbul, Cairo, and comparable cities towards more sustainable modes. This guideline is based on a literature review of the limited number of journal papers that have been published or are being published in high-rank peer-reviewed international journals.

The second portion of the findings presented in this paper is the transferability assessment. In order to test for the transferability of the research findings from the three megacities to other cities in the Middle East and North Africa, 16 different variables were set up as indicators: city-specific population, national car ownership rate, national public-private investment in transport, city-specific population density, national gross domestic production per capita adjusted for purchasing power parity, national Gini coefficient, national absolute poverty rate at $3.20/day, city-specific high and low temperature and annual range, city-specific high and low precipitation amounts and annual range, national median age, national free choice sub-index, national perception of corruption sub-index, and the Human Development Index (HDI). The data for these 16 criteria were collected from various sources and are listed in Table 1.

While the facets of life in urban settings are diverse and hard to comprehensively quantify, these 16 indicators are meant to cover a wide range of aspects of urban life, including demographic, socio-economic, climatic, and transportation-related factors. Of these four types, three indicators are considered demographic metrics, six are socio-economic, five are climatic, and two are transportation-related – this is shown in Table 1. Generally speaking, the demographic indicators served to characterise what the potential ridership of each city would be, the socio-economic indicators characterised the capacity and feasibility of sustainable urban transport, the climate indicators reflected the city-specific environmental constraints/enablers for urban transport, and the transport-related indicators showed the predisposition to develop more sustainable urban transport. City-specific data were preferred, but such specific data were often not available from a single reputable and consistently measured source. When such data were not available, national-level data were gathered and applied if appropriate. The city-specific indicators included are population and population density, temperature, and precipitation; the national-level indicators are car per capita rate, public-private investment in transport, GDP per capita adjusted for purchasing power parity, Gini coefficient, absolute poverty, median age, free choice sub-index, perception of corruption sub-index, and HDI. Table 1 also shows how and from which sources the data of each one of these indicators were gathered and gives a brief note on the meaningfulness of using each indicator as a criterion for determining comparability between the base cities and comparison cities.

Accurate and representative data were not consistently available because they were drawn from various sources and were only partially available at a city rather than national level. Thus, the number of cities that could contribute data points to the t-test analysis varies for each category. The most difficult statistic to obtain was population density: only 15 cities had data available and national-level data was not a viable replacement. However, other statistics were also incomplete. The figures for Public-Private Investment in Transport were not available for Afghanistan, Israel, Saudi Arabia, Kuwait, UAE, and Libya – effectively excluding 13 cities from being analysed in relation to the base cities for that indicator.

As mentioned above, 57 cities were selected for a comparison of the overall conditions of urban life as expressed by the 16 indicators. These 57 comparison cities were selected based on their population – only those with a population of over one million inhabitants in their metropolitan area were considered large enough for inclusion in this study. Thus, the following cities were selected: Karachi, Lahore, Faisalabad, Rawalpindi, Gujranwala, Peshawar, Multan, Hyderabad, Islamabad, and Quetta in Pakistan; Kabul in Afghanistan; Mashhad, Isfahan, Karaj, Shiraz, Tabriz, Qom, and Ahvaz in Iran; Basra, Baghdad, Mosul, Erbil, and Sulaimaniya in Iraq; Aleppo, Damascus, Hamah, and Homs in Syria; Beirut in Lebanon; Amman in Jordan; Haifa and Tel Aviv in Israel; Riyadh, Jeddah, Dammam, Mecca, and Medina in Saudi Arabia; Kuwait City in Kuwait; Dubai, Abu Dhabi, and Sharjah in the United Arab Emirates; Sana'a in Yemen; Alexandria in Egypt; Tripoli in Libya; Tunis in Tunisia; Algiers in Algeria; Casablanca, Fez, Marrakech, Rabat, and Tangier in Morocco; and Adana, Ankara, Antalya, Bursa, Gaziantep, Izmir, and Konya in Turkey.

To test for significant similarities between the comparison cities and the three base cities, one-sample t-tests with a confidence level of 95 percent were applied. The tests compared the mean value of each indicator for the 57 comparison cities with the mean of the three base cities for the same respective indicator. When the p-value was more than 0.05, the first outlier city was eliminated from the sample, the t-test was rerun, and the procedure was continued until a p-value of less than 0.05 resulted. In this way, a list of cities was outputted that had a statistically similar mean to the base cities for each individual indicator.

Table 1

Indicators used to test the transferability of findings from Tehran, Istanbul, and Cairo to other large MENA cities

Type	Indicator	Description	Data Year	Data Source	Rationale for Inclusion
demographic	Population	City-specific Number of residents in city proper, urban agglomeration, or metropolitan area	2016	United Nations [UN] 2016	Proxy for the number of passengers that must be served by urban transport
demographic	Population Density	City-specific Number of residents per hectare of built-up area	2010–2014	Atlas of Urban Expansion (2016)	Indirect measure of the usefulness and viability of urban public transport
demographic	Median Age	National Age that divides the national population distribution into two equal parts	2015	United Nations Development Programme [UNDP] (2019)	Indirect measure of the demographic makeup of passengers
socio-economic	Gross Domestic Production per capita, adjusted for PPP (USD)	National The purchasing power parity value of all final goods and services produced by a domestic economy in a year per person	2016	World Bank International Comparison Program	Indirectly indicates the wealth that individuals have available for sustainable urban transport

Type	Indicator	Description	Data Year	Data Source	Rationale for Inclusion
socio-economic	Gini Coefficient	National The extent to which the distribution of income of individuals in an economy deviates from a perfectly equal distribution	2004–2016	World Bank Development Research Program	Proxy for the relative ability of less-wealthy passengers to afford (paid) public transport systems
	Absolute Poverty Rate (%)	National Share of population living on less than $3.20 a day at 2011 international prices, PPP	2004–2016	World Bank Development Research Program	Indirect proxy for the overall financial capability to prioritise urban mobility over poverty reduction
	Free Choice Subindex	National Average of Cantril ladder rankings of subjective perceptions of individual free choice	2018	World Happiness Report [WHP] 2018	Indirect measure of how free and able passengers might feel to use public transport systems
	Perception of Corruption Subindex	National Average of Cantril ladder rankings of subjective perceptions of societal corruption	2018	WHP 2018	Indirect proxy for (mis) appropriation of public monies for sustainable urban mobility
	Human Development Index	National Composite index of life expectancy, education quality, and Gross National Income per capita (PPP)	2015	UNDP (2016)	Indirect measure of how much public funds are accessible to sustainable transport systems
climatic	High Temperature (C)	City-specific Highest average monthly temperature (1901–2015)	2015	World Bank Climate Change Knowledge Portal	Proxy for climatic heat affecting passengers' mobility decisions
	Low Temperature (C)	City-specific Lowest average monthly temperature (1901–2015)	2015	World Bank Climate Change Knowledge Portal	Proxy for climatic coolness affecting passengers' mobility decisions
	Temperature Range (C)	City-specific Difference between the highest and lowest average monthly temperatures (1901–2015)	2015	World Bank Climate Change Knowledge Portal	Proxy for annual (seasonal) climatic temperature variability affecting the viability of sustainable urban transport systems
	High Precipitation (mm)	City-specific Highest average amount of monthly rainfall (1901–2015)	2015	World Bank Climate Change Knowledge Portal	Proxy for climatic precipitation affecting passengers' mobility decisions
	Precipitation Range (mm)	City-specific Difference between the highest and lowest average amounts of monthly rainfall (1901–2015)	2015	World Bank Climate Change Knowledge Portal	Proxy for annual (seasonal) climatic precipitation variability affecting the viability of sustainable urban transport systems
transport-related	Car Ownership Rate	National Number of registered vehicles per 1000 residents	2015	International Organization of Motor Vehicle Manufacturers(2015)	Proxy for the extent to which societies use cars; indirect measure of 'car-dependency'
	Public-Private Investment in Transport (USD)	National Total monetary commitments to transport infrastructure projects that have reached financial closure and serve the public	2008–2017	World Bank Private Participation in Infrastructure Project	Measure for investment activity in the transport sector as a whole

Source: own study based on the sources indicated in the table

Findings

General Guidelines for Improving Sustainable Mobility in MENA

The findings of this sub-section come from a study funded by the German Research Foundation (DFG) undertaken between 2016 and 2018 in Tehran, Istanbul, and Cairo, the results of which have been or are being published in international journals. The research was based on primary data collection in the three megacities, consisting of 8284 face-to-face interviews (Cairo: 2786, Istanbul: 2781, Tehran: 2717) with the residents of 18 neighbourhoods (six in each city). The neighbourhoods were located in different parts of the city characterised by different urban forms. The output dataset was comprised of the raw data obtained in the questionnaire and quantification of the area's land use. This resulted in a set of disaggregate data suitable for statistical modelling of urban travel behaviour and land use. The empirical analysis that is used for initiating a combined guideline for improving sustainable mobility in the MENA region includes four journal papers. The suggested recommendations can be summarised as follows:

1. Increasing residents' access to local amenities in the vicinity of their homes could promote walking trips. The evidence is that the most important option chosen by the interviewees in response to the question 'what is your main reason for not walking?' was 'destinations not near' (Masoumi 2019). The urban planning systems of the MENA countries may enhance local accessibilities by integrating approaches to land use and transport planning.

– Proposed transference protocol: identify key areas where residents lack access to local amenities (if any) and designate them as priority areas for integrated land use/transport planning in the future.

2. To strengthen cycling as a main transport mode, it is essential to address two key barriers: (1) the lack of cycling facilities such as routes, lanes, and cycle-sharing services, and (2) social/cultural obstacles (Masoumi 2019). As half of the population, women have legal or social challenges regarding cycling in many countries of the region. Removing such barriers and informing people about those legal and technical improvements could encourage them to cycle more.

– Proposed transference protocol: conduct audits of cycling facilities; prioritise women as key actors in all aspects of the improvement process by following female leadership when assessing the legal and social challenges to cycling and ensuring robust and meaningful representation as stakeholders in planning discussions.

3. There are two main reasons that discourage people in Tehran, Istanbul, and Cairo from using public transport: (1) a personal interest in driving a car and (2) a lack of comfort and convenience in public transit systems (Masoumi 2019). As far as the first reason is concerned, international literature has shown that habits related to car use are stable and difficult to change, making it a very complicated task for transport and urban planners to address. Literature related to mobility planning and behavioural change suggests providing passengers with information about the impacts that car overuse can have on them and on society. Thus, the recommendation to planners and decision-makers is to support campaigns against car use and inform people about other mobility options like public transportation. The second reason is easier to combat: municipalities and local government can improve comfort and convenience by making time schedules more precise and providing information about timing, improving the quality of the vehicles' interiors and adding more seats for the elderly and disabled, and operating a larger fleet to increase the number of seats available and reduce overcrowding.

– Proposed transference protocol: conduct preliminary studies on municipal car use/dependency; assess if public transport systems meet ridership demands regarding quality availability, and punctuality of the fleet.

4. The main reason for private car use in the three base cities is that it is more comfortable (Masoumi 2019). To guide urban passengers away from driving their cars, it will be necessary to use both push and pull factors. Push factors could include making car use more expensive, giving less priority to driving space in the form of highways and wide streets, and improving driving toll systems, etc. These push factors must be complemented by pull factors like improving public transportation and active transport facilities, ensuring public transportation is affordable and accessible to all, and making the cities' urban form more conducive to non-car transport. Pull factors are of critical importance because making car-driving difficult without providing sustainable transport alternatives will result in decreased quality of life that impacts poor and marginalised communities most adversely.

– Proposed transference protocol: assess how existing public transport systems can be made more inclusive, accessible, and affordable to those in need.

5. Shortening commuting trips is essential in order to make urban mobility more sustainable. The commute distance of the passengers investigated was 8825m (Tehran: 9096m, Istanbul: 10839m, and Cairo: 6670m).

According to the findings, changing land use and urban design can be effective in reducing commuting lengths (Masoumi, in press). This includes two urban planning interventions: providing entertainment places near residential areas and adding intersections and junctions to increase the connectivity of the street networks and shortening the lengths of street segments.

– Proposed transference protocol: identify key areas where residents lack access to local amenities (if any) and designate them as priority areas for integrated land use/transport planning in the future; assess where adding intersections/junctions within the city could shorten commuting distances.

6. According to the literature, reducing the overall number of commuting trips is also thought to produce good effects on the sustainability of urban mobility. In the three base cities, it has been observed that adding to the number of intersections (thereby increasing the connectivity of the street network) and increasing the number of local facilities and residents' accessibility to them are negatively correlated with the number of commuting trips generated (Masoumi, unpublished). Thus, strengthening these factors in the land use of large cities in the MENA region could be effective in reducing commuting trips.

– Proposed transference protocol: identify key areas where residents lack access to local amenities (if any) and designate them as priority areas for integrated land use/transport planning in the future; assess where adding intersections/junctions within the city could shorten commuting lengths.

7. According to the international literature, the presence of local public facilities and urban centres can increase active transportation. By quantifying the urban form and morphology of the neighbourhoods investigated in Tehran, Istanbul, and Cairo, it was observed that there has been a trend for neighbourhoods to lack a central point and their local facilities have become scarcer over the last one hundred years. This has occurred in parallel with fast and huge urban growth. Regaining the lost urban centres and adding local facilities could help promote sustainable transportation in the three cities (Masoumi, Terzi & Serag 2019).

– Proposed transference protocol: assess historical trends in municipal urban form to determine areas that have lost urban centres or require new ones and designate them as priority areas to receive reorganisation of urban form.

Transferability of the Studies to the Sample Cities

To determine the transferability of the findings between the base cities of Tehran, Istanbul, and Cairo to other large cities in the MENA region, data were collected for each of the 16 indicators. The descriptive statistics of the

Table 2
Descriptive statistics of the 16 selected indicators for Tehran, Istanbul, and Cairo

Indicator	Range	Minimum	Maximum	Mean	Std. Deviation
Population	10612000	8516000	19128000	14003000	5315253
Population Density	33	136	169	154.33	16.80
Median Age	5.1	24.7	29.8	28	2.86
GDP per capita, PPP	13437.23	10319.26	23756.48	17524.47	6771.27
Gini Coefficient	10.1	31.8	41.9	37.5	5.17
Absolute Poverty	14.3	1.8	16.1	6.8	8.06
Free Choice	0.15	0.31	0.46	0.37	0.08
Perception of Corruption	0.02	0.11	0.13	0.12	0.01
HDI	0.08	0.69	0.77	0.74	0.05
High Temperature	5	24	29	26.67	2.52
Low Temperature	14	0	14	6.67	7.02
Temperature Range	12	15	27	20	6.25
High Precipitation	107	4	111	55.33	53.63
Precipitation Range	78	4	82	44.33	39.07
Car Ownership Rate	132	63	195	145.67	72.04
Investment in Transport	544000000	235000000	779000000	551333333	282631091

Source: own study

three base cities are displayed in Table 2. It displays the minimum and maximum values as well as the range, average, and standard deviation of each indicator in the three cities. The average population of the three cities is 14 million people, which is considerably more than the inhabitants of all the other cities in the region. Tehran was the smallest city of the group with roughly 8.5 million inhabitants. The specific values for each indicator in the three base cities are displayed in Table 3.

The descriptive statistics of the sub-sample of 57 comparison cities are displayed in Table 4, where the statistics for the indicators for each city are presented.

Table 5 shows the results of the t-tests performed with the average value of the three base cities of Tehran, Istanbul, and Cairo for each category and the average value of the individual data points from the 57 comparison cities, whereas p-values of less than 0.05 indicate a statistically significant difference between the values

Table 3
Values and means of the 16 indicators for the three base cities

Indicator	Tehran	Istanbul	Cairo	Mean
Population	8516000	14365000	19128000	14003000
Population Density	158	136	169	154
Median Age	29.5	29.8	24.7	28
GDP per capita, PPP	18497.68	23756.48	10319.26	17.52
Gini Coefficient	38.8	41.9	31.8	37.5
Absolute Poverty	2.5	1.8	16.1	6.8
Free Choice	0.46	0.32	0.31	0.37
Perception of Corruption	0.13	0.11	0.11	0.12
HDI	0.77	0.77	0.69	0.74
High Temperature	27	24	29	27
Low Temperature	0	6	14	7
Temperature Range	27	18	15	20
High Precipitation	51	111	4	55
Precipitation Range	47	82	4	44
Car Ownership Rate	179	195	63	146
Investment in Transport	235000000	779000000	640000000	551333333

Source: owns study

Table 4
Descriptive statistics of the selected indicators for the 57 comparison cities

Indicator	Mean	Std. Deviation	Std. Error Mean
Population	8865000	4842977	2165845
Population Density	153.92	110.75	31.97
Median Age	27.01	3.82	0.54
GDP per capita, PPP	21344.15	18917.6	2623.4
Gini Coefficient	36.27	4.66	0.71
Absolute Poverty	8.56	7.37	1.25
Free Choice	0.37	0.14	0.02
Perception of Corruption	0.11	0.03	0.004
HDI	0.72	0.11	0.02
High Temperature	27.62	3.39	0.52
Low Temperature	10	6.13	0.81
Temperature Range	19.72	4.81	0.64
High Precipitation	63.18	32.44	4.59
Precipitation Range	50.69	21.69	3.35
Car Ownership Rate	165.21	116.47	15.43
Public-Private Investment in Transport	560977273	426725471	64331285

Source: own study

of the indicator of the three base cities and the 57-city sample. Table 6 shows which of the comparison cities were included in the final grouping of cities with a statistically similar average for the observed indicator and how often each comparison city was included in a final grouping. For the former, groupings ranged in size from only 5 cities (population) to all 57 (car ownership rate, temperature range, free choice, and perception of corruption). For the latter, cities were included in final groupings from a minimum of 10 times (Dubai, Abu Dhabi, Sharjah) to a maximum of 17 times (Alexandria, Algiers, Marrakech).

Discussion

This study's results indicate some interesting findings that are useful in understanding how transferable the results of previous studies in Tehran, Istanbul, and Cairo are on other large cities in the MENA region. The results show some patterns in the statistical similarity of large MENA cities. Several indicators were shared by all 57 comparison cities: car ownership rate, temperature range, and the free choice and perception of corruption sub-indices. This result shows that the average values of those indicators from the 57 comparison cities are statistically significantly similar and suggests that conclusions related to those specific indicators could theoretically be transferred from one city to another.

However, some indicators were city-specific and allowed for fairly robust comparisons: population, and the environmental indicators (high/low/range temperature and precipitation). One of these, temperature range, contained city-specific data points that produced a high frequency of unique values. T-tests showed that all 57 comparison cities were statistically significantly similar to the base cities. This seems to affirm the comparability of the comparison cities to the base cities in terms of temperature range. The other indicators – population, high/low temperature, high precipitation, and precipitation range – all produced somewhat more selective results. For population, only five cities could be considered comparable to the base cities, while high and low temperature produced 42 and 24 comparable cities, respectively. A fairly large number of the comparison cities are statistically similar to the base cities in terms of precipitation – high precipitation produced a list of 50 cities, and precipitation range a list of 41.

However, some indicators were hampered in their descriptive power because they contained gaps in information. Population density, for example, was only useful for our analysis when the data was on a city-specific basis but was only available for some of the 57 comparison cities. Due to this, only 12 cities could be deemed statistically similar to the three base cities. In this sense, the results of all the t-tests are contingent upon the data that was available for comparison in the first place. In other words, the large cities of Saudi Arabia, Kuwait, UAE, and Libya 'underperformed' because they were hampered by a lack of data in several categories. However, that is not to say

Table 5
Results of one-sample t-tests between the mean of base cities and the city sub-groups

Category	Test Value	t	df	p	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Population	14003000	-2.372	4	0.077	-5,138,000	-11,151,350	875,350
Population Density	154.33	-0.013	11	0.990	-0.413	-70.78	69.95
Median Age	28	-1.846	50	0.071	-0.988	-2.06	0.09
GDP per capita, PPP	17524.473	1.456	51	0.152	3820	-1447	9086
Gini Coefficient	37.5	-1.727	42	0.092	-1.2279	-2.663	0.207
Absolute Poverty	6.8	1.414	34	0.166	1.763	-0.77	4.30
Free Choice	0.365	0.442	56	0.660	0.008	-0.03	0.046
Perception of Corruption	0.115	-0.662	56	0.511	-0.003	-0.01	0.005
HDI	0.744	-1.886	50	0.065	-0.03	-0.06	0.002
High Temperature	26.67	1.817	41	0.077	0.949	-0.11	2.00
Temperature Range	20	-0.441	56	0.661	-0.281	-1.56	1.00
Low Temperature	6.67	4.100	56	<0.001	3.330	1.70	4.96
High Precipitation	55.33	1.711	49	0.093	7.850	-1.37	17.07
Precipitation Range	44.33	1.901	41	0.064	6.360	-0.40	13.12
Car Ownership Rate	145.67	1.267	56	0.211	19.541	-11.36	50.44
Investment in Transport	551333333	0.150	43	0.882	9643940	-120092461	139380341

Source: own study

Table 6
-test results (signed indicator/city pairs indicate similarity between that city and the base cities)

No.	Country	City	Population	Population Density	Median Age	GDP per capita (PPP)	Gini Coefficient	Absolute Poverty <$3.20	Free Choice	Perception of Corruption	HDI	High Temperature	Low Temperature	Temperature Range	High Precipitation	Precipitation Range	Car Ownership Rate	Public-Private Investment	Count
1	Afghanistan	Kabul		X		X			X	X		X	X	X	X	X	X		10
2	Algeria	Algiers		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	15
3	Egypt	Alexandria	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	15
4	Iran	Ahvaz		X	X	X	X	X	X	X	X			X	X	X	X	X	13
5	Iran	Isfahan			X	X	X	X	X	X	X	X		X	X	X	X	X	13
6	Iran	Karaj			X	X	X	X	X	X	X	X		X	X	X	X	X	13
7	Iran	Mashhad			X	X	X	X	X	X	X	X		X	X	X	X	X	13
8	Iran	Qom		X	X	X	X	X	X	X	X	X		X	X	X	X	X	14
9	Iran	Shiraz			X	X	X	X	X	X	X	X		X	X	X	X	X	13
10	Iran	Tabriz			X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
11	Iraq	Baghdad	X	X		X	X	X	X	X	X			X	X	X	X	X	13
12	Iraq	Basra				X	X	X	X	X	X			X	X	X	X	X	11
13	Iraq	Erbil				X	X	X	X	X	X	X		X	X	X	X	X	12
14	Iraq	Mosul				X	X	X	X	X	X			X	X	X	X	X	11
15	Iraq	Sulaimaniya				X	X	X	X	X	X	X	X	X	X	X	X	X	13
16	Israel	Haifa			X	X	X	X	X	X	X	X		X	X		X		11
17	Israel	Tel Aviv		X	X	X	X	X	X	X	X	X		X			X		11
18	Jordan	Amman			X	X	X	X	X	X	X	X		X	X		X	X	12
19	Kuwait	Kuwait City			X	X			X	X	X			X	X	X	X		9
20	Lebanon	Beirut			X	X	X	X	X	X	X	X		X			X	X	11
21	Libya	Tripoli			X				X	X	X	X		X	X		X		8
22	Morocco	Casablanca			X	X	X	X	X	X	X	X		X	X	X	X	X	13
23	Morocco	Fez			X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
24	Morocco	Marrakech		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	15
25	Morocco	Rabat			X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
26	Morocco	Tangier			X	X	X	X	X	X	X	X	X	X	X		X	X	13

No.	Country	City	Population	Population Density	Median Age	GDP per capita (PPP)	Gini Coefficient	Absolute Poverty <$3.20	Free Choice	Perception of Corruption	HDI	High Temperature	Low Temperature	Temperature Range	High Precipitation	Precipitation Range	Car Ownership Rate	Public-Private Investment	Count
27	Pakistan	Faisalabad			X	X	X		X	X	X		X	X	X		X	X	11
28	Pakistan	Gujranwala			X	X	X		X	X	X	X	X	X			X	X	11
29	Pakistan	Hyderabad			X	X	X		X	X	X	X		X	X	X	X	X	12
30	Pakistan	Islamabad			X	X	X		X	X	X	X	X	X			X	X	11
31	Pakistan	Karachi	X	X	X	X	X		X	X	X	X		X	X	X	X	X	14
32	Pakistan	Lahore	X	X	X	X	X		X	X	X	X	X	X			X	X	13
33	Pakistan	Multan			X	X	X		X	X	X			X	X	X	X	X	11
34	Pakistan	Peshawar			X	X	X		X	X	X	X	X	X	X	X	X	X	13
35	Pakistan	Quetta			X	X	X		X	X	X	X		X	X	X	X	X	12
36	Pakistan	Rawalpindi			X	X	X		X	X	X	X	X	X			X	X	11
37	Saudi Arabia	Dammam			X	X			X	X	X			X	X	X	X		9
38	Saudi Arabia	Jeddah			X	X			X	X	X			X	X	X	X		9
39	Saudi Arabia	Mecca			X	X			X	X	X			X	X	X	X		9
40	Saudi Arabia	Medina			X	X			X	X	X		X	X	X	X	X		10
41	Saudi Arabia	Riyadh	X	X	X	X			X	X	X			X	X	X	X		11
42	Syria	Aleppo			X		X	X	X	X		X		X	X	X	X	X	11
43	Syria	Damascus			X		X	X	X	X		X		X	X		X	X	10
44	Syria	Hamah			X		X	X	X	X		X		X	X	X	X	X	11
45	Syria	Homs			X		X	X	X	X		X		X	X	X	X	X	11
46	Tunisia	Tunis			X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
47	Turkey	Adana			X	X	X	X	X	X	X	X	X	X	X		X	X	13
48	Turkey	Ankara			X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
49	Turkey	Antalya			X	X	X	X	X	X	X	X	X	X			X	X	12
50	Turkey	Bursa			X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
51	Turkey	Gaziantep			X	X	X	X	X	X	X	X	X	X	X		X	X	13
52	Turkey	Izmir			X	X	X	X	X	X	X	X	X	X	X		X	X	13
53	Turkey	Konya			X	X	X	X	X	X	X	X	X	X	X	X	X	X	14

No.	Country	City	Population	Population Density	Median Age	GDP per capita (PPP)	Gini Coefficient	Absolute Poverty <$3.20	Free Choice	Perception of Corruption	HDI	High Temperature	Low Temperature	Temperature Range	High Precipitation	Precipitation Range	Car Ownership Rate	Public-Private Investment	Count
54	UAE	Abu Dhabi			X	X			X	X	X			X	X	X	X		9
55	UAE	Dubai			X	X			X	X	X			X	X	X	X		9
56	UAE	Sharjah			X	X			X	X	X			X	X	X	X		9
57	Yemen	Sana'a		X	X	X	X	X	X	X		X	X	X	X	X	X	X	14
			5	12	51	52	46	36	57	57	51	42	24	57	50	41	57	44	

Note: shaded count values indicate the city performed in the top half of cities

Source: own study

that the results of the t-test groupings are not descriptive – Tripoli, for example, had the fewest data points available overall for use in the t-tests but outperformed Dubai, Abu Dhabi, and Sharjah; Kuwait City had just as few data points available for t-test analysis as its counterparts in Saudi Arabia and UAE but still outperformed several of their cities: Jeddah, Dammam, Mecca, Dubai, Abu Dhabi, and Sharjah.

The geographical distribution of the t-test results is also noteworthy. For the most part, the high-income countries of the Arabian Peninsula – Kuwait, Saudi Arabia, and United Arab Emirates – were not comparable to the base cities as shown by our analysis, possibly because the socio-economic environments of these countries are very different from the base cities.

Taking all of this into account, it could be helpful for decision-makers and planners to impose even tighter restrictions on which cities could transfer the findings of previous studies on Tehran, Istanbul, and Cairo to their individual contexts. We impose two criteria thresholds in Table 7 to show a rough gradient of similarity among the 57 comparison cities.

By imposing a 15-criteria-minimum threshold, three cities in Algeria, Egypt, and Morocco are similar to the three base cities. Reducing the threshold to 13 indicators results in the number of similar cities increasing by nine-fold to 27. Table 7 shows that, as the required criteria threshold becomes less restrictive, the number of core criteria shared by the comparable cities decreases. So, as the cities become less comparable, the specific aspects in which they were similar to the three base cities become more diverse. This implies that planners and decision-makers in the cities that only became comparable after the lower threshold was imposed (ie. Ahvaz, Isfahan, Karaj, Mashhad, Qom, Shiraz, Tabriz, Baghdad, Sulaimaniya, Casablanca, Fez, Rabat, Tangier, Karachi, Lahore, Peshawar, Tunis, Adana, Ankara, Bursa, Gaziantep, Izmir, Konya, Sana'a) should account for the ways in which their city might not be similar to Tehran/Istanbul/Cairo before transferring findings to their respective localities.

As shown in Table 7, no cities located in the high-income countries of the Persian Gulf area were similar to the base cities (as measured by the 16 indicators). Within this area, cities in Saudi Arabia appear in the analyses only when the public-private investment in transport (PPI), Gini coefficient, and low precipitation indicators are eliminated. The cities of the UAE only appear after eliminating the PPI and Gini requirements. Sana'a in Yemen appears after eliminating the HDI barrier. Israeli cities appear after eliminating the PPI barrier. Beirut, Lebanon appears after eliminating the high precipitation barrier. Syrian cities only appear after eliminating the GDP and HDI requirements. Iraqi cities appear after eliminating the median age indicator. Based on our analysis, the large cities of Afghanistan, Libya, Saudi Arabia, and the UAE do not seem to be readily comparable to Tehran, Istanbul, and Cairo.

Limitations

There are some limitations to the power of our findings to show comparability between the base cities and comparison cities. The fact that three indicators (Car Ownership Rate, free choice, and perception of corruption) were shared by all 57 cities reveals the fallibility of the data collection process – the data points for those indicators

Table 7
Large MENA cities that pass criteria thresholds

Criteria Threshold	Cities above Threshold	Core Criteria
15	Algeria: **Algiers** Egypt: **Alexandria** Morocco: **Marrakech**	1. Population Density 2. Median Age 3. Gross Domestic Production 4. Gini Coefficient 5. Absolute Poverty 6. Free Choice 7. Perception of Corruption 8. Human Development Index 9. High Temperature 10. Temperature Range 11. High Precipitation 12. Precipitation Range 13. Car Ownership Rate 14. Investment in Transport
13	Algeria: **Algiers** Egypt: **Alexandria** Iran: *Ahvaz, Isfahan, Karaj, Mashhad, Qom, Shiraz, Tabriz* Iraq: *Baghdad, Sulaimaniya* Morocco: *Casablanca, Fez,* **Marrakech**, *Rabat, Tangier* Pakistan: *Karachi, Lahore, Peshawar* Tunisia: *Tunis* Turkey: *Adana, Ankara, Bursa, Gaziantep, Izmir, Konya* Yemen: *Sana'a*	1. Gross Domestic Production 2. Gini Coefficient 3. Free Choice 4. Perception of Corruption 5. Temperature Range 6. Car Ownership Rate 7. Investment in Transport

Source: own study

were only available at national level and thus had to be shared amongst the cities per country, resulting in a high frequency of non-unique values that might not accurately reflect the reality of each individual city. By extension, the high frequency of repeated values might have lessened the t-tests' power to accurately discriminate between cities with different conditions. On the other hand, one indicator (temperature range) was city-specific but t-tests showed that the average of all 57 cities was statistically significantly similar to the average of the three base cities. This could be interpreted in several ways, possibly indicating that the indicator itself does not have enough descriptive power to help us meaningfully discriminate between cities that are different from the base cities in reality.

There are also some weaknesses in the transport-related aspect of our analysis. The two indicators (Car Ownership Rate and public-private investment in transport) are limited in their description of the transport situation in each city/country. More specific indicators such as the size of a city's transit fleet, number and length of subway lines, etc. could not be obtained – either because the data did not exist at city-level or was not available across the cities in a language that the two researchers could understand. The public-private investment in transport indicator is also somewhat ambiguous in its descriptive power.

The metric itself is the sum of investments in four transport-related areas: airports, ports, railways, and roads. We use the figure as whole in order to serve as an indirect proxy for investment activity related to sustainable urban transport (by assuming that more transport-related investment in a country overall might also reflect investment activity in sustainable urban mobility specifically). However, that investment activity could be disproportionately characterised by road-building (which initiates car-focused modalities) or large projects like airports and rural mountain roads (possibly signalling a country's unlikeliness to invest in urban sustainable transit because of other priorities).

Conclusion

The objectives of this study were to (1) determine the transferability of findings of existing urban mobility research on Tehran, Istanbul, and Cairo to other large cities in the MENA region by using similarity across several socio-economic, demographic, climatic, and mobility-related metrics as criteria and (2) describe a general framework of recommendations for promoting sustainable mobility in the large cities of the region. This paper suggests a new approach to urban mobility studies in the MENA region: that some of the large cities of the region can use the existing studies or practices in Tehran, Istanbul, and Cairo as their pattern, depending on their comparability to those three base megacities. For example, how and in what conditions the cities of Fez and Marrakech in Morocco can apply the findings of research or practical work in Cairo or how Ankara and Bursa can use the results of Istanbul. This study contributes to a series of previous studies that address the implementation and transfer of urban transportation technologies and knowledge from inside the MENA region or from outside of it to the cities of the region. Examples of such works are the studies of X. Godard (2007) on the transferability of the LRT system in Tunis to other cities in Maghreb (Algiers, Casablanca) or the study of A. El-Geneidy et al. (2013) on sustainable urban mobility in the MENA region.

To fill the first objective of this study, this paper used a replicable, straightforward, malleable method to measure the potential transferability of the research findings in three megacities in the Middle East and North Africa (Tehran, Istanbul, and Cairo) to other regional cities with populations over one million inhabitants. This was done by collecting secondary data on the demographic, socio-economic, climatic, and transport-related aspects of urban life (e.g. population size and density, national GDP per capita and Gini coefficient, temperature and precipitation, car ownership rate, etc.) in the three base cities and 57 comparison cities in the MENA region. These urban life aspects were used as 16 indicators to compare the similarity of the base cities and comparison cities. This similarity analysis was performed via a one-sample t-test that used the average value for each data category in the three base cities and the average of the individual data points for each category from the 57 comparison cities.

The similarity analysis found that Algiers, Alexandria, and Marrakech had the highest number of statistically significantly similar indicators as the base cities and are thereby the most 'comparable' cities to Tehran, Istanbul, and Cairo. These cities had a relatively aligned set of shared core criteria (14) by which they were similar to the base cities. The 'less-comparable' cities of Ahvaz, Isfahan, Karaj, Mashhad, Qom, Shiraz, Tabriz, Baghdad, Sulaimaniya, Casablanca, Fez, Rabat, Tangier, Karachi, Lahore, Peshawar, Tunis, Adana, Ankara, Bursa, Gaziantep, Izmir, Konya, and Sana'a also had a less-aligned set of shared core criteria (7) that were statistically significantly similar to the base cities. In other words, the less 'comparable' cities were also more diverse in the ways that they were similar to the base cities. The countries of Iran, Turkey, and Morocco produced the most 'comparable' cities with seven, six, and five cities, respectively. The empirical findings presented in this paper are not a perfect measure of transferability but can orient decision-makers in their efforts to learn from other cities' experiences and spur researchers to further examine specific aspects of sustainable urban mobility in the MENA context.

To fulfil the second objective, this paper presents suggestions for improving sustainable mobility in large cities in the MENA region by drawing from previous scientific literature produced by the lead author (namely, Masoumi 2019) and briefly discussing their appropriateness and potential drawbacks. These key recommendations include (1) increasing residents' access to local amenities in the vicinity of their homes, (2) supporting campaigns against car use and informing people about other mobility options like public transportation while also improving the quality, quantity, and punctuality of the fleet, (3) using both push and pull factors to shift public behaviour by making car use more expensive while also ensuring that public transportation is affordable and accessible to all and making cities' urban form more conducive to non-car transport, (4) reducing the number of commuting trips performed by adding to the number of intersections (thereby increasing the connectivity of the street network) and increasing the number of local facilities and residents' access to them, and (5) regaining lost urban centres and adding local facilities.

Finally, this study addresses the question raised by H.E. Burchett et al. (2013): 'when can research from one setting be useful in another?'. Regarding urban transportation in the MENA region, this study shows that it is sometimes possible to transfer findings, policies, or technologies, but not always. Future studies should analyse the present study's overall ability to measure transferability and further refine its methodological effectiveness and suitability in the MENA context. This could be done by applying a more robust selection process when choosing data categories for use in t-tests. Other measurements of statistical similarity as well as entirely different modes of determining similarity between cities should be investigated. Future studies should research and analyse the linkage between city similarity and transferability – in other words, does similarity between cities (as indicated by the results of the t-tests performed on a limited selection of descriptors) truly indicate transferability of results from one urban context to another? Future studies should further define transferability and investigate what other factors (if any) it is contingent upon. Future studies should continue to analyse the MENA cities included in this paper as well as others, publish findings, and create critical discussion about urban form, residential self-selection, and transport mode choice in the Middle East and North Africa.

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