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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.

Special Issue 1.2018

URBAN TRAVEL BEHAVIOR IN THE MIDDLE EAST AND NORTH AFRICA

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Cover Image by Houshmand E. Masoumi of landscape in Teheran

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URBAN TRAVEL BEHAVIOR IN THE MIDDLE EAST AND NORTH AFRICA

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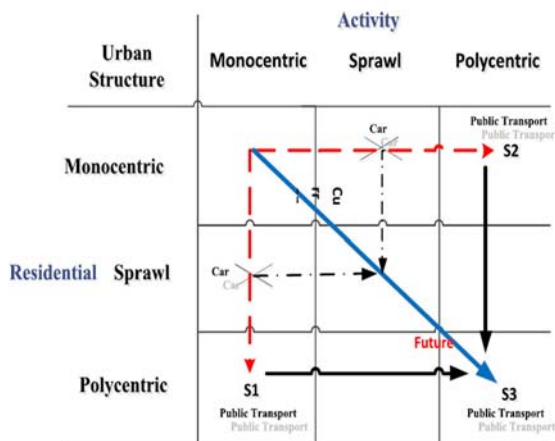
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ABSTRACT

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

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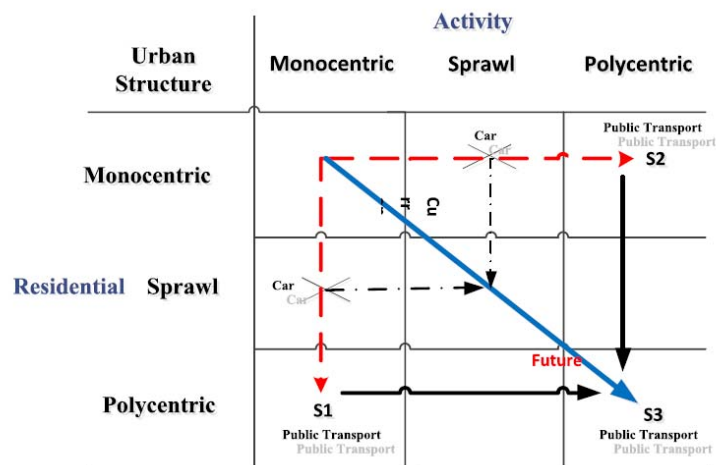
Fig. 1 Urban structure and population distribution scenarios process (Alqhatani, et al., 2014)

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).

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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

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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 destinated 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).

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Fig. 2 Urban configurations, Jeddah (UN-Habitat, 2016)
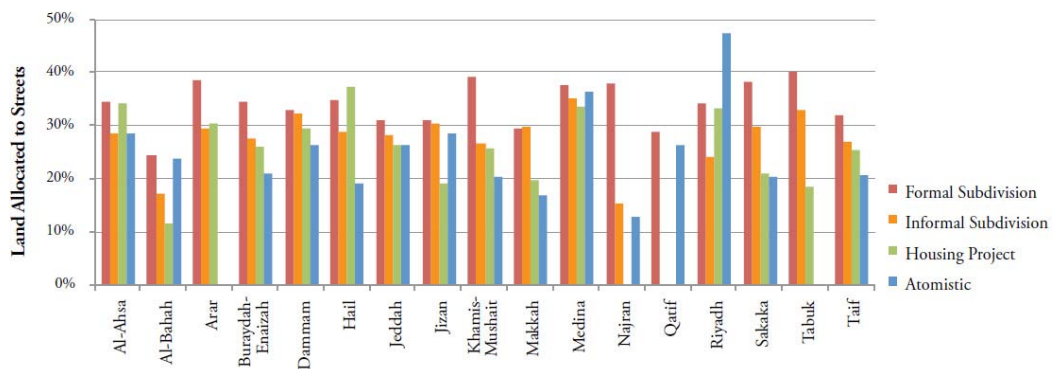
Tab. 3 Land allocated to streets in cities by residential typologies (UN-Habitat, 2015)

Dammam and Riyadh have the larger street in Saudi Arabia; the average width is around 18 meters in Riyahd 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 km^2 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)

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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.

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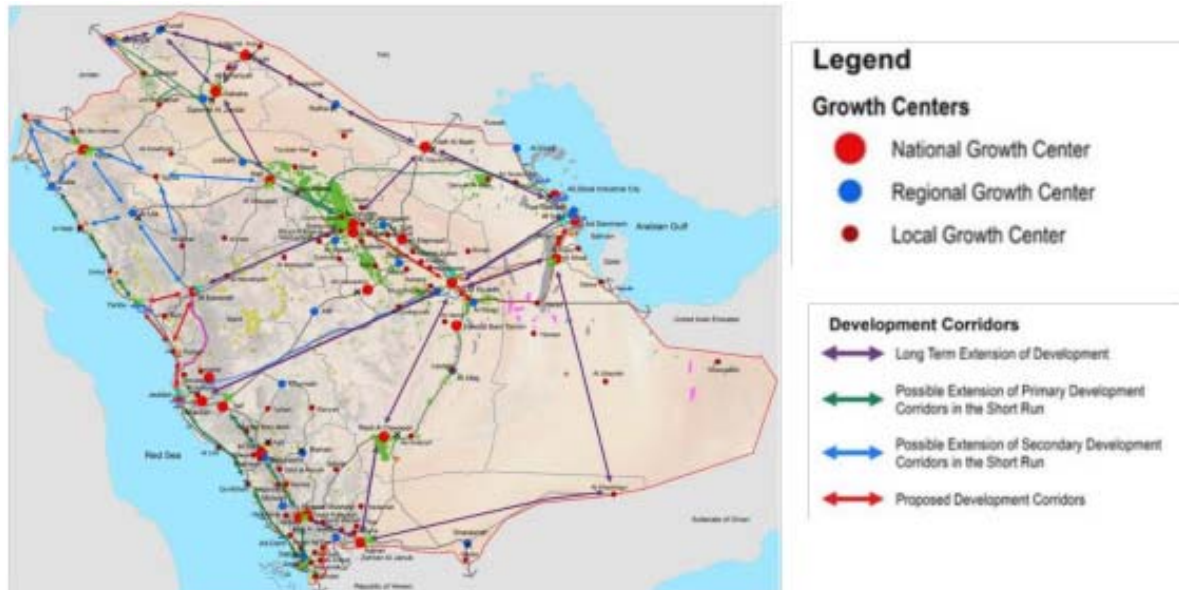
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Fig. 3 National Spatial Strategy (UN-Habitat, 2016)

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 though 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 BAHAVIOR 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

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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 ½ 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 exampled 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 pounds[1], and 46.15 euros[2] 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.

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[1] www. Gov.uk
[2] www.french-property.com

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$$y_{CDs} \quad f\left(PETROL_s, GOVI_s, SORUL_s, CLIM_s, CARMARK_s\right)$$

y_{CDs} Dependant variable is a measure of car dependence

$PETROL_s =$ Petrol share to National revenue

$GOVI_s =$ Government investments

$SORUL_s =$ Social rules

$CLIM_s =$ Climate

$CARMARK_s =$ 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 exampled 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 Ryiadh 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 abled 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 abled 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

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development. The extreme volatility of oil system, exampled 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 exampled 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 abled to reflect the recent socioeconomic transformations.

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

$$y_{CD_i} = f\left(PETROL_i, COVIPT_i, WOMENDRIV_i, CLIM_i, CARMARK_i\right)$$

y_{CD_i} Dependant variable is a measure of car dependence

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$PETROL_s$ = Petrol share to National revenue

$GOVIPT_s$ = Government investments for public transportation

$WOMENDRIV_s$ = Women drivers

$CLIM_s$ = Climate

$CARMARK_s$ = 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

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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.

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IMAGE SOURCES

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

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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.

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