Social impact assessment towards sustainable urban mobility in Qatar: Understanding behavioral change triggers

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ABSTRACT

In Qatar, majority of the citizens rely on private automobiles compared to public transport. For this reason, it is imperative to consider public views on sustainability issues within the transport sector. This study examines some behavioral change triggers as Qatar moves towards a sustainable public transport system. The dominant view is that using public transport is more sustainable; therefore, the objective of the study was two-fold: to assess public travel behaviors and attitudes with respect to the use of public transportation and to formulate strategies designed to encourage commuters to use sustainable public transport. For this purpose, the study employed a descriptive, correlational research design in the collection and analysis of pertinent data. Primary data was obtained using survey research. Electronic surveys created by Survey Monkey were sent to prospective respondents online with a total sample size of 435. The framework of the questionnaire was: the respondents' demographic profile, their overall knowledge about automobiles' impact on the environment, their opinion concerning metro acceptance and initiation about the possible use of a sustainable transport system to the public, their knowledge on the metro project challenges, and their willingness to use the metro. Results indicated that the majority of respondents resisted using public transport, as most of them owned automobiles. Only 24% of respondents said that they would consider using public transport for environmental conservation purposes. The four major setbacks to using the metro system were: the need to wait for the metro to operate (21.4%), lifestyle and culture (16.9%) – respondents used to drive their own cars, climate concerns (16.9%), and the location of metro stations (17.5%). The study concluded that much of the resistance to using the public transport system arises from individual's high dependency on automobiles. Many of the solutions to this high dependency were linked to land use and urban planning strategies.

1. Introduction and background

Magnetism of motorized automobiles as a mode of transportation is preferred by many individuals while larger portions of the population heavily rely on them (Anable, 2005). As the global population increases, the number of motorized automobiles on the road also increases significantly. Nevertheless, the increasing use of motorized automobiles has resulted in economic, social, and environmental challenges.

Health-related issues and environmental problems that are associated with increased use of motor automobiles are largely attributed to high levels of pollutants in the air, with greenhouse gas emissions greatly contributing to environmental pollution (Chatterton et al., 2009). Consequently, the high dependence on automobiles has caused massive damages to the environment such as air pollution emanating from emissions of harmful and toxic gases like Greenhouse Gases (GHGs) emissions to the air. Apart from air pollution, another impact is that the high dependence on automobiles encourages an inactive lifestyle that is considered to be a high-risk factor for social setbacks on the community level (Astrup, 2008).

From another perspective, one can argue that automobiles play a major role in the transportation sector, the increase in the number of automobiles also comes with the cost of expanding existing and creating new infrastructure. For instance, considering that the annual increase of private automobiles ownership between the years 2010–2015 is 7%, expansion projects of 8500 km will count as additional cost to the government due to this increased number of automobiles. This increase will impact the air quality which in turn poses a risk on human health. Another impact is an inefficient land use (Ministry of Statistics and Programme Implementation, 2017; MOTC, 2018).

Conclusively, most individuals in Qatar consider automobiles as an attractive and almost the only option of transportation aside to the inconvenient bus transport system. In Doha City, the bus lines are limited with no intermodal junctions which is considered inconvenient to majority of the population. Therefore, the high dependence and ownership of automobiles has resulted in economic, social, and environmental challenges. With the current trend of increasing population in Qatar as illustrated in Table 1, the country is on the path to lay down strategies that can help change it from being referred to as the country with the highest carbon imprint in the world to a country that expounds sustainable ideals. Based on this, there is the need to understand the social perceptions of the sustainable projects that were to be implemented as part of the country's millennial goals such as Doha metro project.

1.1. Public travel behavior assessment studies

A number of researches have shown that it is impossible to have a sustainable city without having a sustainable transportation system (Givoni and Rietveld, 2014). Such studies assert how transport is crucial in any city as it defines the means of moving individuals and goods from one place to another. The high demand of transport services within cities explains how unsustainable transport services lead to environmental degradation through air, water and soil pollution. However, some cities in the world have implemented sustainable transport projects that are aimed at enhancing sustainability practices within the transport sector. Extensive assessments on the social impact of a sustainable transport system have also been carried out through a review of existing literature with the objective of establishing whether the general public supports or opposes its implementation.

There is a general agreement among the various scholars on how transport systems contribute to environmental degradation through the release of harmful gases to the environment (Kennedy et al., 2005). These scholars explain how fossil energy sources that are used in running trains and automobiles release greenhouse gases that contribute to global warming (Hanson, 2010). With the current fear that the transport system is the main cause of environmental pollution in both small and big cities, sustainable transport systems and options have recently been implemented. These include: electric trains and automobiles, walking and the use of bicycles (Givoni and Rietveld, 2014).

Besides this, the challenges of heavily depending on automobile transport additionally promote an inactive lifestyle, which is largely considered one of the primary risk elements for non-communicable ailments. Even though there are avenues of addressing the costs associated with automobiles use through appropriate technology, such an approach demands that individuals commit a huge investment – in terms of finances and time (Steg, 2005). In light of this, some scholars have proposed the need to implement behavioral travel change at the population level, a situation that might call for different sectors such as the public health, environmental, and transportation sectors to collaborate. In addition, a number of governments have already started to encourage the development and use of sustainable transport systems through appropriate policies (Steg, 2005).

To convince individuals to change their current travel behavioral trends in favor of more environmental-friendly strategies is quite a challenge as many change factors affect individual travel behavior. Studies have confirmed that public's attitudes towards time, comfort, and flexibility could influence transport choices (Steg and Vlek, 1997). The choice of the mode of transport is also dependent on the destination and time management factors. In addition, studies demonstrated that automobiles are not just a means of transport, but also have a symbolic importance attached to them. Scholars have noted that automobiles have affective functions over and above being means of transport (Steg and Vlek, 1997).

Whereas there is growing concern and awareness among members of the public concerning the escalating environmental challenges today, the subject of how much environmental awareness programs impact public's travel behaviors are still a contentious issue. Studies have shown that ecological consciousness plays a significant role in the decisions made by locals regarding the choice of transport. Individuals who are environmentally conscious have a high likelihood of choosing a mode of transport that has a less adverse impact on the environment (Shen et al., 2008). Other studies have shown that despite socio-economic and socio-demographic variables explaining the reasons behind choices that the public make with regard to the type of automobile preferred, being aware of how much such automobiles contribute to environmental pollution is a primary explanatory variable (Steg, 2005). In light of this, being aware of environmental challenges would make a significant contribution to how individuals behave with regard to their choice of mode of transport.

Contrastingly, other studies have shown that even though individuals acknowledge climate change as one of the biggest threats to their health, when selecting a form of transport, they do not consider or acknowledge carbon emissions emanating from their selected mode of transport. According to a research conducted, participants' travel behavior choice was significantly affected by the convenience and the cost factor, with travelers apportioning more value to various short-term advantages such as comfort over long-term risks (Chatterton et al., 2009).

On a population level, policy interventions are deemed to be significant for purposes of enforcing travel behavioral change. Scholars have acknowledged two primary strategies of implementing transport measures, referring to them as "push" and "pull" forms (Steg and Vlek, 1997). According to Steg and Vlek, "push" traffic measures affect individual decisions with regard to their travel by the imposition of legal and technical constraints, as well as appropriate measures. "Pull" traffic measures, on the other hand, encourage individuals to adopt other means of transport other than their automobiles by use of incentives.

Table 1
Population within the State of Qatar at the end of months; it represents the persons within the boundaries of the State of Qatar (MDPS, 2019).

Particular	Unit	February 2018	January 2019	Feb 2019	Month over Month (MoM)	Year over Year (YoY)
Population by Gender						
Male	Person	2,017,612	2,055,002	2,059,355	0.2	2.1
Female	Person	682,778	711,457	713,592	0.3	4.5
Total		2,700,390	2,766,459	2,772,947	0.2	2.7
Population by age group						
Less than 15	Person	372,077	383,208	383,685	0.1	3.1
15–24	Person	337,698	335,233	332,045	−1.0	−1.7
25–64	Person	1,958,910	2,014,148	2,023,303	0.5	3.3
More than 65	Person	31,705	33,870	33,914	0.1	7.0
Total		2,700,390	2,766,459	2,772,947	0.2	2.7

The two strategies are vital for reshaping travel culture and trends for individuals.

Both external and internal factors can shape beliefs about individuals' travel behavior. The decision-making processes regarding the choices that individuals make for their transport mode is an intricate psychological activity. Scholars have tried to correlate the travel behavioral factors with each other – some concentrating on automobiles-dependency while others concentrate on active transport (Ajzen, 2002). Currently, scholars have not been able to define a comprehensive theory of travel trends owing to the intricate relationships among the different variables in play. The Theory of Planned Behavior (TPB) is however mostly applicable in this scenario, and it is used to predict a person's intention to engage or participate in an intentional behavior (Ajzen, 2002). The Theory of Planned Behavior contends that individuals' levels of perceived behavioral control, as well as their perceptions of subjective norms and their attitudes towards a behavior, are important variables that determine a person's intention to act. The theory further contends that although public beliefs and attitudes might not determine their travel trends directly, it indirectly does so through behavioral intentions (Ajzen, 2002).

The Australian Bureau of Statistics notes that Australia ranks second in the world when it comes to the rate of household automobiles ownership which is very similar to Qatar as the case of this paper. The Australian government launched a national travel behavioral change project titled TravelSmart in 2000. The program was intended to assist households reduce the number of automobiles by encouraging them to consider other modes of transport and thus change their travel choices. In the government-funded research, every participant household was provided with requisite tools to deal with their particular needs such as a kilometer monitor and an access guide to assist the disabled and children (Australian Bureau of Statistics, 2012). Subsequent evaluation of this research reported a significant reduction in the use of automobiles by participant households and consequently increased rates of public transport use, as well as cycling, and walking in the short-term. Nevertheless, the Australian Bureau of Statistics reports that active public transport only constitutes 6% of total trips made by Australians with regard to commuting trends. The report further notes that almost 80% of Australians commute through private means (Australian Bureau of Statistics, 2012). The project, therefore, never achieved its intended target of behavioral change with regard to the use of private automobiles, and as such, there is a need for additional effort to motivate individuals to amend their behavioral trends.

Another study conducted a survey in multiple neighborhoods in Berlin in 2016 with a sample size of 1098 and a growing population of 3.55 million shows that the public transport patterns of integrated transport system is defining their commuting daily trips and travel behaviors. However, the time variable is to be considered in urban public transport planning to create efficient and effective intermodal public transport to suit public needs (Oostendorp and Gebhardt, 2018). Reviewing the existing studies is imperative in identifying the most effective assessments and the challenges and opportunities that arise from such assessments.

1.2. Problem statement and motivation

With the rapid population growth in Qatar, transport needs are on the rise thereby necessitating the determination of whether sustainable transport can be opposed or supported by the general public. This study seeks to understand the social impact of a sustainable transport system through the assessment of public views towards launch of the new metro project. The environmental analysis conducted for Doha Metro System is prompting a major reduction in the overall environmental impacts; the higher the number of individuals riding the metro, the higher the likelihood of achieving a more sustainable, healthier environment (Al-Thawadi and Al-Ghamdi, 2019). With the alignment

of the launch of the metro system, and due to the diverse views among scholars on whether the public supports sustainable transport or are opposed to its implementation, this study will provide more reliable opinion on whether or not individuals support the implementation of sustainable transportation policies and strategies. There is the need to assess the public travel behaviors and attitudes to increase the awareness and use of public transportation and resolve all setbacks that will prevent the public from using sustainable transport systems.

2. Methods and procedures

The study was conducted within Qatar's metropolitan region, Doha. Just to mention, Qatar's population as at May 2019 was 2,740,479 (MDPS, 2019). Qatar is one of the multinational districts in the world. Table 1 illustrates the Planning and Statistics Authority population counts as well as the monthly and yearly ratios categorized by gender and age group for the total population in Qatar. The current travel patterns and behaviors in Doha metropolitan city are highly dependent on private automobiles regardless of the cultural differences among the residents of Qatar. Due to the increase in the population, the number of driving licenses released in May 2019 alone was 8383 for locals and expatriates proving that the dependence on automobiles is relatively high in the Doha metropolitan city (MDPS, 2019).

2.1. Data collection and data setting

The research was built up using computer aided surveying software Survey Monkey where all responses were administered and stored. Since Arabic is the main language in Qatar, "Poedit" software was used to generate a translation coding that allows to create an Arabic translation version of the survey that will maximize the diversity of the sample using two languages. Survey Monkey can generate multiple links for different groups of individuals to be shared and distributed among respondents reaching a sample of 530 respondents. The data collection was intended to scan the most diverse societies in a multicultural district as Doha metropolitan city. The main source of data collection was social media influencers; in fact, they will allocate the survey to diverse societies due to the variation of their audience and the backgrounds and perspectives of each are distinct. The secondary supporting source of data collection was through focal points in major academic institutions and organizations that shared the survey with colleagues on all organizational levels. Lastly, social media and networking such as WhatsApp, Twitter and Instagram acquired part of the share of respondents in the survey as well.

2.2. Research framework and questionnaire design

According to the existing travel behavior and transport system, social ecological model, planned behavior theory and the prevailing literature, the final survey involved five main sections. The survey questions aimed to analyze and investigate the participants' travel behaviors and attitudes towards public transport and the metro project as an alternative convenient mode and measuring setbacks and drives to reduce car use and ride the metro project as a sustainable mode of transport. Some questions are formulated to allow single and some others allow multiple answers based on the nature of the question. The survey will allow setting a strategic plan for policy change and urban development towards the shift to sustainable public transport.

Demographic characteristics and travel behavior: The very first part of the survey collected socio-demographic information such as: gender, age, education level, medical conditions…etc. together with the recent travel behavior. The travel behavior was assessed and measured by considering the overall modes of transport used and the number of automobiles owned or leased per Household Further, the participants was asked to self-report the number of regular trips on a

weekly basis. Additionally, for those who are either employed or students, they are requested to self-report the average time per trip and the mode of transport besides the frequency of commuting per week as commuting is granted as a core trip for employees and students. As a preliminary results, participants were using transportation for commuting mainly in Doha where the nature of the city has a great influence on its residents. The other type of trips were mainly for education purposes such as driving student schools. Other type of trips included leaisure and a specific purpose oriented such as going to the hospital. More details were discussed later in this paper.

Insights of overall knowledge of automobiles impact on health, environment and economy: The second fragment of the survey questions the participants' perceptions on automobiles. The initial questions determine the importance of understanding the reasons behind the high dependence on automobiles for mobility in Doha metropolitan city whilst the subsequent section is focused on measuring the issues created from environmental, social and economic perspectives when using automobiles for transport in Doha metropolitan city. In the last section, perspectives towards public transportation are measured against a quantification of environmental impacts of different transportation modes.

Metro acceptance and initiation to the public: This section commences with an introductory figure of the metro project services and facilities provided with schematic metro routes and stations location. Participants referred to the metro map to locate the nearest stations to their preferences and trips. An assessment of the change in travel behavior towards the use of metro is followed by questioning them on the frequency of using the metro for their usual trips.

Understanding metro project challenges (setbacks and drives): This section is one of the most important sections as it explores the participants' perceptions to the Metro project from different perspectives. The question type was 'checkbox' whereby the participant can choose the answers that they find most suitable. These questions were designed to help the participants understand and weigh the challenges and setbacks alongside with drives and motives. Analyzing the different viewpoints and preferences on the metro project will allow the creation of a baseline towards strategic development and policy change.

Willingness to use the metro and reduce the use of automobiles: Lastly, participants' willingness to use the metro under different circumstances was evaluated. The elements of evaluation were tackling common contextual, cultural and climatic issues in the city. The first measure is the availability of an integrated public transport system with feeder buses that are allocated within the contextual area to allow individuals to reach the station from the nearest air-conditioned bus stop to the station. The second measure is walking in different climatic conditions; public's willingness to walk will be different based on the weather. Additionally, change of travel behavior could be influenced by others – which means that friends, colleagues and family could support the change in travel behavior. Lastly, safety, cost and convenience were weighed against participants' willingness since practical individuals are focused on such measures. Participants' level of willingness was weighed on 4-point Likert-scales (from "Definitely will" to "Definitely won't").

2.3. Participation rates

The residents of Doha metropolitan city were the targets of this study. Both household members and visitors of Doha metropolitan city above the age of 18 years were questioned via online survey. Besides the age restrictions, there was no other limitation for the respondents regardless of their backgrounds, country of origin, employment status, medical conditions as well as any other influencing conditions. This implies that it is possible to have more than one participant for a single household as travel behavior and perspectives differ from one person to another. However, the survey questions avoided the questions that could be biased or lead to each other. Initially, 586 prospective respon-

dents received the survey, out of which 10 refused to participate and 151 terminated the survey. Lastly, 435 successfully completed the survey which means that 70% accounts for the participation rate within three weeks period.

2.4. Statistical analysis

The first section of the analysis was descriptive-based where calculations of percentages and frequency representations related to demographic information and travel behavior were performed. Secondly, A Pearson chi-square statistic was used to test the association between row and column variables that comprise the R-by-C table (categorical variables). The test hypotheses were:

H_0 : *no relation between the variables in the source of population*

    Against

H_a : *the null hypothesis is false*

    Pearson's chi-square statistic is:

$$X_{stat}^2 = \in_{all} \left[\frac{(O_i - E_i)^2}{E_i} \right]$$

where O_i represents the observed count in table cell i and E_i represents the expected count in cell i.

The analysis of the survey data was done using the STATA 12 Statistical Package and the significance level was set to p = 0.05.

3. Results and discussion

The results of the study are presented in three sections: (1) Descriptive analysis of socio-demographic information and travel behavior characteristics. (2) Pearson chi-square statistical analysis to test whether different indicators will influence public travel behavior towards more sustainable alternatives or fails each hypothesis. (3) Discussions and interpretations of the results.

3.1. Socio-demographic and travel behavior characteristics

Table 2 illustrates the participants' demographic and travel patterns. Explicitly, private automobiles are shown to be the primary mode of transportation for different journeys. Specifically, 87.5% of the participants use private automobiles where 56% among them use their own private automobiles, 18.8% travel with private automobiles with private drivers while the remaining 2.4% rent automobiles for mobility. When it comes to commuting, 93.2% of the total participants use private automobiles; additionally, 1.3% accounts for private automobile services such as taxis and Uber. However, more sustainable approaches such as the use of buses accounts for 3.9%, while walking decreases to 1% and 0.3% for the least used options of carpooling and cycling.

3.2. Perceptions of different automobiles assessment measures

Fig. 1 represents the participants' responses in regard to different measures of automobile use. The first aspect discusses participants' views on the causes of the high dependence on automobiles – privacy, weather conditions, culture and luxury top the list. The participants' perceptions on the issues created from using automobiles in Qatar are also discussed – traffic congestions is recognized by the majority of participants followed by parking issues and environmental issues. This implies that the public opinion on major issues are based on traffic, inefficient land use and environment. Additionally, public views were measured against the mode of transport to reach the metro station – higher resistance towards the use of public transport was noted as most individuals tend to either use their own automobiles for the

Table 2
Demographic and travel patterns of the participants.

Question(s)		Counts	Percent (%)	Question(s)		Counts	Percent (%)
Gender				**Number of household members**			
	Male	189	35.2%	1–3		88	16.4%
	Female	348	64.8%	4–7		230	42.8%
				8–10		129	24.0%
				10 +		90	16.8%
Age group				**Number of automobiles owned/leased in household**			
	18–24	101	18.8%	1		50	9.3%
	25–34	199	37.1%	2		123	22.9%
	35–44	147	27.4%	3		78	14.5%
	45–54	71	13.2%	More than 3		269	50.1%
	55–65	13	2.4%	No member own/lease automobiles		17	3.2%
	65 +	6	1.1%				
Nationality				**General transport modes options**			
	Qatar	381	70.9%	Private automobiles		473	56.0%
	GCC	27	5.0%	Private driver		167	19.8%
	Middle East, Arabic non-GCC	77	14.3%	Rented automobile		20	2.4%
	Middle-Eastern, non-Arabic	2	0.4%	Limo/Taxi		40	4.7%
	Asian, non-Middle-Eastern nor Arabic	22	4.1%	Careem/ Uber		65	7.7%
	African, non-Middle-Eastern nor Arabic	11	2.0%	Public transit		10	1.2%
	European	9	1.7%	Bicycle		4	0.5%
	North American	1	0.2%	Motorcycle		1	0.1%
	South American	2	0.4%	Walking		30	3.6%
	Oceanian	2	0.4%	Carpool		15	1.8%
	Other	3	0.6%	Telecommuting		0	0.0%
				Vanpool		1	0.1%
				Company/school bus		13	1.5%
				Other		6	0.7%
Education				**Medical/health Conditions**			
	High school graduate or less	135	25.1%	Physically Disabled, or using wheelchair		3	0.5%
	Bachelor's degree or equivalent	305	56.8%	Visual impaired		13	2.4%
	Master's degree or equivalent	90	16.8%	Asthma/allergies/respiratory problems		33	6.0%
	PhD degree or above	7	1.3%	I don't have any medical condition		501	91.1%
Occupation				**Commuting mode of transport option**			
	Student	98	18.2%	Private automobile		357	93.2%
	Employee	341	63.5%	Limo/Taxi		3	0.8%
	Unemployed/Resigned	15	2.8%	Careem/ Uber		2	0.5%
	Self-employed	10	1.9%	Company/school bus		15	3.9%
	Retired	15	2.8%	Bicycle		1	0.3%
	Housewife/Househusband	48	8.9%	Walking		4	1.0%
	Military	10	1.9%	Carpool		1	0.3%
	Visitor/Tourist	0	0.0%	Vanpool		0	0.0%
Monthly income				**Commuting average time per single trip**			
	Less than QAR 10,000 per month	94	24.6%	Up to 10 min		39	10.2%
	QAR 10,000 – 19,000 per month	79	20.7%	11–20 min		88	23.0%
	QAR 20,000 – 29,000 per month	95	24.9%	21–30 min		99	25.8%
	QAR 30,000 – 39,000 per month	68	17.8%	31–45 min		99	25.8%
	QAR 40,000 – 49,000 per month	46	12.0%	More than 45 min		58	15.1%

entire trip or to reach the nearest park and ride facility to the station. More sustainable options to reach the station such as walking, carpooling and transfer buses were in fewer percentages.

On the other hand, perceptions towards public transport through environmental awareness measure were tested against quantitative values shown in the survey. This question targeted the participants' consideration to use public transport when compared to the high impact of automobiles. According to the responses, 24% of the participants reported that they would use public transport in order to maintain the environmental conditions in Qatar, while 27% indicated that they would not use public transport for the same cause. However, the remaining majority of the participants were uncertain whether the use of public transport is linked to the environment.

Lastly, the participants different views on the metro project were investigated as represented in Fig. 2. The first part involved an examination of the different factors that make the metro project less convenient. It was evident that one of the major setbacks to the use of the metro system is that participants need to wait for operation to judge with 21.4% of the total responses. Another highly influential factor is the lifestyle and culture, where 16.9% of the participants prefer to drive themselves, while climate concerns such as the hot

harsh summer accounts for 8.5%. The second highest percent of the hindrance factors scoring 17.5% was related to the location of the station as it is more than 4 km away from the feeder buses routes.

The second part focused on how the metro can be made to be more convenient. This calls for awareness through marketing and advertisements campaigns to show the facilities and services in the stations as well as the sustainable benefits towards the environment, society and economy were at high rates; however, the highest agreed aspect is the environmental awareness and educational campaigns. This can be related the previously discussed issues as individuals were uncertain to use the metro when it comes to issues pertaining the environment. Secondly, culture and climate come at higher rates of 15.4% each, as participants believe that provision of integrated air-conditioned public transport will allow both minimal walking distance and maximum use in summer. Lastly, government can participate in terms of changing travel behavior. Similar studies were conducted and reported that "Pull" measures will effectively support the use of more sustainable transportation options (Eriksson et al., 2006; Nordlund and Garvill, 2003). On the other hand, "Push" measures by means of incentives to encourage individuals to use the metro were
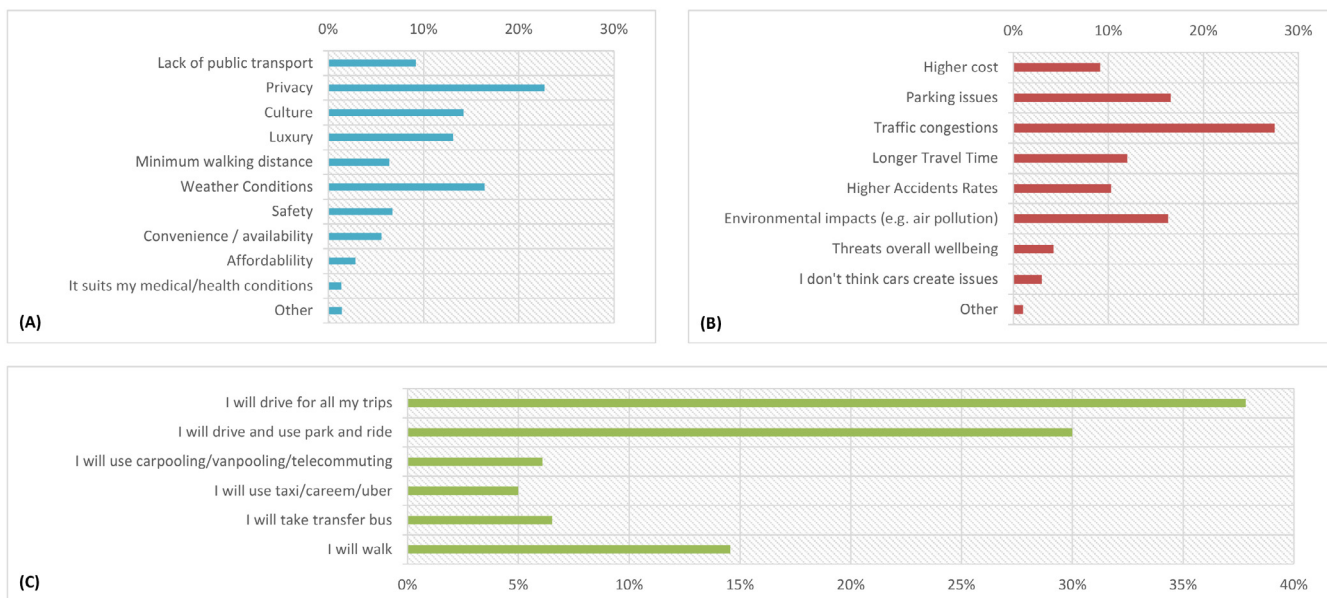
Fig. 1. Public Perspectives on different automobiles measures. (A) Public perspectives on the reasons for high dependence on automobiles in Qatar, ((B) Public perspectives on the issues caused by automobiles in Qatar, (C) Public preferences on mobility options to reach the Metro station in Qatar.

Fig. 2. Public perspectives measures on the metro systems. (A) Public perspectives on what makes metro systems less convenient, (B) Public perspectives on what makes metro systems more convenient.

more preferred among participants. It is clear that "Push" governmental policies such as taxes are less likely to be desired among the public.

3.3. Prognosticators to the change in travel behavior

Table 3: Summary Table of the Chi-Square tests for predictions in change of travel behaviors; *indicates levels of significance at (* = 0.05, ** = 0.01, and *** = 0.1) provides the Pearson chi-square statistical analysis related to the prognosticators of public intent to change their travel behavior. The results showed that based on gender,

female participants are more willing to change and adopt the metro system compared to male participants (Chi-square = 3.256, P-value = 0.071). Environmental awareness emanating from public transportation would be more likely to shift public's travel behavior towards more sustainable alternatives. This is evident in the fact that there is a significant relationship between participants' use of public transportation after measuring the environmental impact and the use of metro in their trips (Chi-square = 41.176, P-value = 0.000).

Another hypothesis test concludes that travel behavior towards sustainable metro system is more likely to change if accessible transfer

Table 3

Summary Table of the Chi-Square tests for predictions in change of travel behaviors; *indicates levels of significance at (* = 0.05, ** = 0.01, and *** = 0.1).

Null hypothesis	Chi-square and p-value	Decision at 5%, 1%, and 10%
There is no association between participants' gender and the use of metro for their trips.	3.256*** 0.071	Reject the null hypothesis.
There is no association between participants' age and the use of metro for their trips.	7.227 0.204	Accept the null hypothesis.
There is no association between participants' nationality and the use of metro for their trips.	8.193 0.610	Accept the null hypothesis.
There is no association between participants' education level and the use of metro for their trips.	2.682 0.443	Accept the null hypothesis.
There is no association between participants' household size and the use of metro for their trips.	3.368 0.338	Accept the null hypothesis.
There is no association between participants' automobiles numbers and the use of metro for their trips.	1.778 0.776	Accept the null hypothesis.
There is no association between participants' income and the use of metro for their trips.	10.736 0.151	Accept the null hypothesis.
There is no association between participants' use of public transportation after measuring the environmental impact and the use of metro for their trips.	41.176*** 0.000	Reject the null hypothesis.
There is no association between transfer buses availability from the nearest air-conditioned bus stop to the station and participants' use of metro for their trips.	32.02*** 0.000	Reject the null hypothesis.
There is no association between participants' willingness to walk for up to 5 min in summer to the nearest air-conditioned transfer bus/metro station and the use of metro for their trips.	13.286*** 0.000	Reject the null hypothesis.
There is no association between participants' change in travel behavior to use the metro and the participants' influence from friends, family and colleagues' when using the metro.	21.844*** 0.000	Reject the null hypothesis.
There is no association between participants' willingness to walk for up to 5 min to the nearest air-conditioned transfer bus/metro station and the availability of transfer buses from the nearest air-conditioned bus stop to the station.	26.399*** 0.000	Reject the null hypothesis.
There is no association between participants' age and influence from friends, family and colleagues to the use of metro.	13.0842* 0.017	Reject the null hypothesis.

buses can drive individuals from the nearest air-conditioned bus stop to the station (Chi-square = 32.02, P-value = 0.000). There is no doubt that walking is very uncomfortable and not advisable during the extreme hot summer in Doha. However, optimistic results show that individuals are willing to walk for up to 5 min in summer to the nearest air-conditioned transfer bus or metro station to use the metro for their trips (Chi-square = 13.286, P-value = 0.000). Moreover, participants are more likely to walk if there are transfer bus stations available within 5 min walking distance to drive them from the bus station to the metro station (Chi-square = 26.399, P-value = 0.000). It was also evident that social influencers play a major role in changing individuals' travel behavior. Also, it was found that public are more likely to change their travel behaviors to use the metro if participants' friends, family and colleagues' use it for their trips (Chi-square = 21.844, P-value = 0.000). Apparently, social influence varies based on the age factor; the influence is higher for younger age groups than for those who are older (Chi-square = 13.0842, P-value = 0.017).

There are many predictors in this study that were found to be less effective to change the travel behavior. Age, nationality, education

level, household members and number of automobiles as well as income were not found to be significant prognosticators for the intention to reduce the use of automobiles and adoption of the metro system.

4. Discussion

The study allows exposure to individuals' travel patterns and the high dependence on the use of automobiles for different trips in Doha city. Aspects such as time, walking distance, culture as well as climate have been found to hinder the use of public transport and justify the high dependence of automobiles. Considering that governments make transport policies on two measures ("Pull" and "Push" measures), this study shows that "Pull" measures are more effective and desirable among the public. However, both measures need to be implemented together as joint policies to avoid public opposition.

The general public prefers the use of automobiles for many reasons, most importantly privacy, weather conditions, culture and luxury. These results contradict with other studies where time, comfort and safety are predominant reasons for relying on private automobiles (Grdzelishvili and Sathre, 2011; Nilsson and Küller, 2000). The findings suggest that the public's awareness on the environmental issues that arise from the use of automobiles would stimulate the use of public transport. This result matches the findings of another study which showed that the provision of awareness on emissions to the public could act as benchmark to change public's travel behavior (Gaker et al., 2011). Conversely, a similar study reported that environmental awareness could have minor and indirect impact on automobiles' ownership as well as its use (Flamm, 2006). Also those participants are aware of the issues created from the high dependence of automobiles; they still consider driving as a preferable mode of transport. As a result, participants might not consider environmental and other impacts coming from their travel behaviors due to the fact that most of these behaviors have become habitual and hence more likely to be difficult to change (Owen et al., 2008).

The study's findings on the participants' perceptions towards the metro system's setbacks and motivations were analyzed. For the recent years, individuals' tendency to drive their own automobiles for shorter walking distances together with the uncertainty of operational ridership have kept them unsure to use the metro for their trips. However, awareness campaigns on economy, society and the environment would likely motivate the public to use the metro system. It was found that the predictors to change travel behaviors according to multiple demographic characteristics such as age, nationality, education level, household members and number of automobiles as well as income were insignificant in terms of reducing automobiles use. However, predictors to change in travel behavior were positive when it comes to environment concerns, social influence as well as shuttle services.

The results of the conducted study show potential inferences for the government and transport authorities. Solutions to reduce the high dependence on automobiles should be linked to land use and urban planning strategies to be implemented with all involved stakeholders. Additionally, policy makers and planners with greater influence on public could reform their policies towards changing of travel behavior towards more sustainable transport (Xia et al., 2017). More suitable measures can be developed by shaping the urban fabric of the city to achieve maximum acceptance amongst the public.

5. Conclusion and outlook

This study focused on assessing public views on sustainability issues related to the transport sector. The environmental analysis conducted for the Doha Metro System will only be maintained if higher number of passengers will ride the metro. The assertions necessitated

for sustainable transportation policies and implementation of strategies among various sectors based on the support by the public view.

The results of the socio-demographic and travel behavior characteristics showed that private automobiles were the primary mode of transportation for different journeys. It revealed that more sustainable approaches, such as the use of buses, were not conventional among members of the public. Moreover, other sustainable methods like walking, carpooling, and cycling were used by fewer participants.

It was observed amongst the participants that the significant factors causing the high dependence on automobile in Qatar's urban centers included the need for privacy, weather, culture, and luxury. Also, a significant resistance towards the use of public transport as a more substantial majority used their automobiles for the entire trips.

Furthermore, the travel behavior towards sustainable metro system was more likely to change if accessible transfer buses were to be used together with positive social influences. However, the predictors to change the travel behavior were many, although a significant number of them would be less effective when assessed individually.

While it was a fact that the use of automobiles had adverse effects related to traffic congestions, parking issues and environmental pollution, the public's perception towards the transport systems and their relation to the environment yielded contradicting results. Significantly, low proportions of respondents would use public transport to maintain environmental conditions.

Focusing on the limitations of this study, there is the fact that the survey was online-based and the higher frequency of the participants who terminated the survey at a certain point. Second, the unweighted nationality and age distribution could have led to a higher portion of Qatari mid-age responses which somehow can cause skewness against a well distributed age variety.

Lastly, long term planning and designing strategies for effective and integrated transportation systems in Qatar are required to encourage the use of public transport and lower the high dependence of automobiles. In parallel, the travel behavior is linked to the culture and lifestyle; therefore, any changes in the travel patterns will require awareness and education of new transport culture to the public. Furthermore, policies strategies implementation to change in travel behavior can be investigated in support to this study.

CRediT authorship contribution statement

Fatima E. Al-Thawadi: Conceptualization, Methodology, Validation, Formal analysis, Writing - original draft. **Abdul-Aziz A. Banawi:** Investigation, Writing - review & editing. **Sami G. Al-Ghamdi:** Conceptualization, Methodology, Supervision, Funding acquisition, Writing - review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trip.2020.100295.

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