Qatar 2050 قطر
الخطة الشاملة للنقل
Transportation Master Plan

وزارة المواصلات
MINISTRY OF TRANSPORT

TRANSPORTATION MASTER PLAN FOR QATAR

DATA COLLECTION, INVENTORIES AND SURVEYS

Book One: The Summary

Qatar 2050 قطر
الخطة الشاملة للنقل
Transportation Master Plan

وزارة المواصلات
MINISTRY OF TRANSPORT

TRANSPORTATION MASTER PLAN FOR QATAR

DATA COLLECTION, INVENTORIES AND SURVEYS

Book One: The Summary

ملاحظة:

يرجى العلم أن أي إشارة أو ذكر لـ "وزارة المواصلات والاتصالات" واختصارها "MOTC" في هذا التقرير، أصبحت تشير حالياً إلى "وزارة المواصلات" و اختصارها "MOT".

Note:

Please note that any reference or mention of the "Ministry of Transport and Communications" and its abbreviation "MOTC" in this report, now refers to the "Ministry of Transport" and its abbreviation "MOT".

Disclaimer

The Ministry of Transport and Communications (MOTC) of Qatar has developed this document with due diligence, using information, statistics and survey data available at the time of writing and following the International Best Practices.

The use of content contained herein and its supplementary data for any work purpose, does not relieve the user from exercising due diligence and sound engineering practice per the International Best Practices, nor does it entitle the user to claim or receive any kind of compensation for damages or loss that might be attributed to such use.

Without any minimum liability to MOTC, under no circumstances does MOTC warrant or certify the contents of this document to be free of errors or deficiencies of any kind.

Access to this Version (1.0) document is available from MOTC head office and via their official website.

Future changes, amendments and versions of this document will be made available on the MOTC website. Users are therefore advised to check with MOTC that they have the most current and up to date version.

Note: New findings, technologies, and topics related to transportation planning, design, operation, and maintenance will be used by MOTC to update the reports. Users are encouraged to provide feedback through the MOTC website. Feedback will be reviewed, assessed, and possibly included in the next version.

تنويه

قامت وزارة المواصلات والاتصالات بإعداد هذا التقرير وفقاً لأحدث الممارسات العالمية في هذا المجال وبناءً على المعلومات والإحصائيات والبيانات المتوفرة عند كتابة هذا التقرير. وعليه وجب التأكيد على أن وزارة المواصلات والاتصالات، وتحت أي ظرف من الظروف، لا تجيز أو تتعهد أو تُصادق على أن تكون المعلومات المتضمنة في هذا التقرير خالية من أي نوع من الأخطاء أو العيوب.

إن استخدام هذا التقرير لأي عمل، لا يعفي المستخدم من اتباع أحدث الممارسات العالمية، والأساليب الهندسية الصحيحة والمتبعة وفقاً لأحدث التقنيات العالمية، كما أنه لا يخول للمستخدم المطالبة أو استلام أي نوع من التعويض عن الأضرار أو الخسائر التي يمكن أن تُعزى إلى هذا الاستخدام.

قامت وزارة المواصلات والاتصالات في دولة قطر بتوفير النسخة الأولى من هذا التقرير كنسخة مطبوعة وعلى الموقع الرسمي لوزارة المواصلات والاتصالات.

بالنسبة إلى التغييرات أو التعديلات المستقبلية، فسوف تقوم الوزارة بتوفيرها على الموقع الرسمي للوزارة. وعليه يتوجب على المستخدمين التحقق بشكل متواصل بأن لديهم أحدث إصدار من هذا التقرير.

ملاحظة: ستقوم وزارة المواصلات والاتصالات بمواصلة تحديث وتعديل هذا التقرير مع الأخذ بعين الاعتبار النظريات الجديدة وأحدث الأساليب التكنولوجية والمواضيع المَستجدة التي تتعلق بتخطيط وتحليل وتصميم أنظمة النقل والمرور.

إن وزارة المواصلات والاتصالات تشجع المستخدمين على تقديم الملاحظات والاقتراحات والتعليقات وردود الأفعال وذلك من خلال الموقع الرسمي للوزارة حيث سوف يتم مراجعة هذه الملاحظات والاقتراحات ومن ثم تقييمها وإمكانية إدراجها ضمن الإصدار القادم من التقرير.

Contents

Tables

Figures

GLOSSARY

Glossary

Annual Average Daily Traffic	Daily number of vehicles on all lanes of a road, estimated from annual traffic observations
Activity- Based Household Interview	A survey where families provide details of the activities carried out over the course of a single day especially those that require travel
Activity-Based Model	A model that uses detailed information of personal travel from a sample of people to simulate travel demand
Automatic Traffic Counts	An automated count of the number of vehicles by vehicle type over a period of at least 24 hours but preferably longer.
Bus Rapid Transit	A public transit service that runs in dedicated corridors or with high levels of bus priority, and can also act as a feeder service to MRT or LRT train stations
Computer-Assisted Personal Interviewing	An interview with individuals using a computer-based questionnaire
Confidence Intervals	A boundary around the average which captures a given percentage of the observations
Confidence Level	The confidence level (95%) within which an estimated outcome from a survey sample would be expected to be within say 10% of the actual value of the population as a whole
Corrective & Preventive Action Request	A request to implement a corrective or preventive measure during the deployment of an interview or survey
Gulf Cooperation Council	Group of countries from the Gulf Region
Geographic Database	A spatial database where polygons, polylines or points are used to represent elements or events
Geographic Information Systems	A map-based database
Global Positioning System	A system to acquire the spatial location of objects on the surface of the planet
Highway Development and Management Version 4	The World Bank software to manage the development, maintenance, and rehabilitation of highways
Heavy Goods Vehicles	A truck used to move heavy amounts of freight (merchandises, bulk goods, or cargo)
Household Interview	An interview where demographic, socio-economic, and travel characteristics of a household are recorded

(Continued on the next page)

International Organization for Standardization	The international organization that regulates the standard ways and means to conduct processes
Light Goods Vehicles	A truck used to move light amounts of freight (merchandises, goods, or cargo)
Light Rail Transit	A train-based transit mode for passengers
Land Transport Planning Department (Qatar)	Department responsible for planning transportation systems in Qatar
Manual Classified Counts	A detailed count of vehicles by classification
Peak Hour Factor	A numeric value relating the proportion of traffic in the peak hour to daily traffic
Revealed Preference	Recording of the actual travel choices made by people and used to capture the actual preferences of individuals and willingness to pay for travel options
Roadside Interview	An interview that captures the origin and destination of vehicles passing by a given control point
Stated Preference	An interview based on games where hypothetical travel scenarios are used to capture the preferences of individuals and willingness to pay for travel options
Transportation Data Management System	A system that records all transportation data and provides means to visualize it, synthesize their characteristics and export data for further analysis
Turning Movement Counts	A count of the number of vehicles turning right, left, going straight on, or u-turning from a given approach of an intersection
Transportation Master Plan for Qatar	Long-term plan with the sequence of transportation projects and expected benefits
Travel Time Survey	A survey to measure the amount of time required to reach important destinations, for example offices in the downtown area

CHAPTER 1

PROJECT BACKGROUND AND OBJECTIVES

Chapter 1 Project Background and Objectives

The State of Qatar has experienced extremely high growth in its economy and population driven by increasing gas and oil revenues and guided by the Qatar National Vision for 2030 (QNV) of "Transforming Qatar into by 2030; capable of sustaining its own development and providing for a high standard of living for all its people for generations to come". To sustain this growth the State of Qatar is investing in the construction of a network of expressways and freeways, in the improvement of the existing road network, in a country-wide rail network and in a comprehensive public transport system that includes Metro Rapid Transit and Bus Rapid Transit.

Pursuant to this vision, the Ministry of Transport & Communications (MOTC) – Land Transport Planning Department (LTPD, formerly the Transportation and Infrastructure Planning Department of the Ministry of Municipality and Environment) completed in 2008 a major study known as the Transportation Master Plan of Qatar (TMPQ).

It is time to update the 2008 TMPQ to address the forecasted population, economic and land use growth that result from the Qatar National Master Plan (QNMP) and associated documents including Qatar National Development Framework (QNDF) and Municipal Spatial Development Plans (MSDP).

The update of the Transport Master Plan for Qatar (TMPQ) consisted of the following parts:

1. Data Collection: Inventories and Surveys.
2. Assistance Consultancy Services.
3. Qatar Strategic Transportation Model (QSTM); and
4. Transportation Master Plan

The primary objectives of the Data Collection, Inventories and Surveys were:

1. To consolidate all data necessary for the update of the Transportation Master Plan.
   - Gather and consolidate all available historical data.
   - Collect new data in the form of surveys and interviews.
2. To develop a Transportation Data Management System and a Traffic Data Geographic Information System-Portal, and.
3. To undertake an analysis of the collected data to produce a set of local factors and parameters for use in transport studies in Qatar, a summary of the traffic volumes and composition from the traffic count data collected, and the travel characteristics and behavior of different categories of travelers within Qatar.

The data collection, inventories and surveys covered:

1. Review and Assessment of Existing Data, Conditions, and Literature
2. Data Collection and Surveys
3. Existing Conditions, Surveys, and Data Analysis

This report provides a summary of the outcomes of each part of the study.

CHAPTER 2

REVIEW AND ASSESSMENT OF EXISTING DATA, EXISTING CONDITIONS, AND LITERATURE


أنت في الطابق
You are on Level
-2
خروج
Way Out
-1
إلى القطارات
To Trains
-2

Chapter 2 Review and Assessment of Existing Data, Existing Conditions, and Literature

2.1 Overview

The objective of this stage was to undertake a comprehensive review of the current conditions and available information to support the update of the Transportation Master Plan. In addition, this stage reviewed international best practices to guide the acquisition of inventories, undertaking surveys, and the data analysis. Inputs and feedback from stakeholders were collected and used to support the products of this project.

2.2 Review of Existing Documents and Conditions in the State of Qatar

A comprehensive review was carried out for current and existing guidelines, studies, and other related documents being used by various agencies in Qatar, including Ministry of Transport and Communications, Ministry of Municipality and Environment, ASHGHAL, and other agencies concerned with master planning, and the development and operation of the transport system. This involved the compilation of the available information, a qualitative comparison of the information against current needs, and the identification of shortcomings. The review covered all aspects related to the Transport Masterplan of Qatar, including:

1. The 2008 Transport Masterplan of Qatar and associated documents, reports, and models.
2. Planning policies (at the national, municipal, and local levels).
3. Design guidelines and standards.
4. Enforcement policies.

5. Regulations.
6. Interim zoning guidelines.
7. Future population and land use spatial distributions within the Qatar National Development Framework (QNDF); and
8. Review of future capital centers, metropolitan centers, town centers, and district centers, as detailed within the Municipal Spatial Development Plan (MSDP).

In addition, the review examined the existing transport and travel data sources in the State of Qatar, including spatial information, and identified which of these are still of relevance, and which needed to be replaced by new data collection. Existing documents containing material relevant to the development of a transportation master plan in the State of Qatar are listed in **Table 2-1.**

Table 2-1: Summary of Available Information and its Applicability

Document Title	Purpose	Applicability	Regulates Development?	Conditions Transport Needs?
National Documents and Information				
Qatar National Vision (2008)	National Vision.	Broad perspective of the future.	Only to the extent to which more detailed plans implement its vision.	Yes, in global context without specifics.
Qatar National Master Plan: Integrated Transport Strategy (2008)	Implements the National Vision through transportation strategy.	Transportation as one of its components.	Only to the extent to which more detailed plans implement the strategy.	Yes, through major transportation projects.
Qatar National Master Plan: Qatar National Development Framework (2008)	Implements the National Vision through development framework.	Nation-wide built environment and land development.	To the extent to which more detailed plans implement the strategy.	Yes, because land development requires the support of transportation systems.
Qatar National Master Plan: Municipal Spatial Development Plans	Implements the National Vision through municipal development.	Land development at municipal scale.	Yes, permitted land uses per zone.	Yes, because land development requires the support of transportation systems.
Ministry of Transport and Communications Documents and Information				
Qatar Interim Bus Action Plan (2014 – 2020) (QIBAP)	Dictates actions to ramp up bus services in preparation for Metro system arrival.	All bus systems across the country.	In a limited manner by indirectly encouraging development near to stops and stations.	To the extent to which it changes attitudes towards public transportation.

(Continued on the next page)

Table 2-1: Summary of Available Information and its Applicability (Continued)

Document Title	Purpose	Applicability	Regulates Development?	Conditions Transport Needs?
Qatar Pedestrian Crossings Master Plan (QPCMP) 2017	Promotes active transportation.	State of Qatar - concentrates on Doha and other urban areas.	By enforcing consideration to support pedestrian movements to/ from and within new developments.	Complementing attitude change to use public transportation and active modes.
Qatar Highway Design Manual (QHDM) 2015	Guides design of road facilities in all aspects.	All Qatar.	Not directly, it complements development.	Design for increased capacity conditions future establishments and developments.
Qatar Traffic Control Manual (QTCM) 2016	Guides design of traffic signs, markings, and signals.	All Qatar but concentrates on urban areas.	It facilitates traffic circulation and so could accommodate new establishments.	Triggers need for upgrade of junctions and other road facilities.
Qatar Public Transport Master Plan (QPTMP)	Plans future public transportation and regulates it.	All Qatar for the movement of passengers.	Indirectly encourages development in areas adjacent to stations and stops.	To the extent to which it changes public attitudes towards public transport.
Qatar Freight Master Plan (QFMP)	Regulates and provides for freight movement.	All Qatar.	Complements industries and economic development.	Defines locations of major generation and attraction centers.
National Road Safety Strategy (NRRS)	Dictates actions to reduce accidents and improve safety.	All Qatar.	No.	Significant improvements in safety.

(Continued on the next page)

Table 2-1: Summary of Available Information and its Applicability (Continued)

Document Title	Purpose	Applicability	Regulates Development?	Conditions Transport Needs?
Intelligent Transportation Systems Strategy (ITSS)	Dictates actions to improve driver and passenger information to improve the efficiency of transport movements.	All Qatar.	No.	Significant, as it contributes to the efficiency of transport movements.
Qatar Transport Master Plan	Regulates transportation through future vision and scenarios.	All Qatar.	Supports development.	Yes, because it requires the support of transportation.
Interim Zoning Guidelines	Specify the land use allocations by type and plot at municipal level.	Municipal scale.	Yes, permitted land uses per zone.	Yes, because it requires the support of transportation.
Qatar Parking Master Plan (QPMP)	Dictates actions to regulate and improve the availability and usage of parking supply.	All Qatar.	No.	Yes, as it can complement public transport development and aid in travel demand measures.
Guidelines and Procedures for Transportation Studies	For assessing impact of development on transportation.	All Qatar.	Yes.	To the extent to which the guidelines influence development decisions.
Ministry of Transport and Communications traffic impact studies	For assessing impact of development on transportation.	All Qatar.	Yes.	To the extent to which the guidelines influence development decisions.

(Continued on the next page)

Table 2-1: Summary of Available Information and its Applicability (Continued)

Document Title	Purpose	Applicability	Regulates Development?	Conditions Transport Needs?
Ministry of Transport and Communications traffic counts database	Assessing current traffic flows.	All Qatar.	No.	No, but provides traffic trends which will aid future forecasting.
Municipalities and Other Agencies Document and Data				
Al Khor Master Plan	Specifies the land use allocations by type and plot at municipal level.	Municipal scale.	Yes, permitted land uses per zone.	Yes, because it requires the support of transportation.
Al Wakra Master Plan	Specifies the land use allocations by type and plot at municipal level.	Municipal scale.	Yes, permitted land uses per zone.	Yes, because it requires the support of transportation.
MASARAK list of Data Products and System Architecture Manual	Private entity holding traffic data and routing applications.	All Qatar, public access.	No.	No, but served to assess current conditions.
Land Use Detailed Establishment Data	Current registry of building establishments.	All Qatar.	Provides picture of current development.	As departure point for analysis.
Population Model	Population forecast.	All Qatar.	Provides picture of current development.	As departure point for analysis.
Land Use Survey	Land use zoning at parcel level.	All Qatar.	Provides picture of current development.	As departure point for analysis.
Municipal Land Use Plans	Zoning details.	Municipal	Yes, permitted land uses.	Modeling element for scenarios.

(Continued on the next page)

Table 2-1: Summary of Available Information and its Applicability (Continued)

Document Title	Purpose	Applicability	Regulates Development?	Conditions Transport Needs?
Census 2010	Characterize residents.	All Qatar.	No, assesses current socioeconomics.	Yes, serves to measure changes and forecast attitudes.
Road Inventory	Current road inventory.	All Qatar.	No, it provides inventory of roads.	Modeling Element.
2015 Interim Population and Establishment Census	Establishes 2015 population and building status.	All Qatar.	No, assesses current socioeconomics.	Yes, serves to measure the current situation from which trends can be extrapolated.
ASHGHAL Road Designs and Studies	Future expansion of road network.	All Qatar.	Encourages development by improving travel time.	Encourage more use of automobiles.
Mowasalat Plans and Studies	Current and future operation.	All Qatar.	Encourages development by improving transit ridership.	Promote modal shift.
Qatar Trip and Parking Generation Rates Manual (QTGPRM)	Travel rates and parking demands.	All Qatar.	Yes, once linked to mitigation measures and provision of parking.	Rates for modeling and forecast future.
Qatar Rail Studies and Data	Defines future metro and rail operations; and provides data on predicted travel choices.	All Qatar.	No, but supports movements between development centers.	Yes, as it defines the transit network and operational strategy.

The development of the Transportation Data Management System (TDMS) required the import of several Geographic Information System (GIS) layers to provide the information of interest to the transportation professional. The existing Geographic Information System (GIS) layers that were available for the development of the Transportation Data Management System (TDMS) are summarized in **Table 2-2. Table 2-3** on the other hand, includes a summary of the Data Needs to support the transportation master plan process and the Existing Data Status.

Table 2-2: Summary of Existing Geographic Information System Data Status

Typical Data Needs to Support TMPQ	Existing Data Status
Geographic Information System Layers – Base Mapping	Administrative boundaries: • Coastline. • Municipalities. • Census zone. • Census blocks (2010 and 2015). • Geographic names; and, • Qatar Strategic Transportation Model Traffic Analysis Zone. Urban features: • Parking areas. • Green areas. • Building database for residential and commercial establishments. • Water areas; and, • Census plot identification and boundaries. Physical road network for base mapping: • Flow line covering primary, secondary, tertiary, and local roads. • Airport runway and apron; and • Street names.

(Continued on the next page)

Table 2-2: Summary of Existing Geographic Information System Data Status (Continued)

Typical Data Needs to Support TMPQ	Existing Data Status
Geographic Information System Layers – Feature Layers	Road network data: • Road class and standard; and • Speed limit. Public transport network data: • Bus stop locations (type and standard). • Bus service routes. • Metro stations (type and features); and • Metro lines (frequency, stopping pattern etc.). Existing and future planning data by land parcel Landmarks – point of interest files for major buildings/locations Qatar Area Referencing System (QARS) – for building geo-referencing

Table 2-3: Summary of Data Needs and Existing Data Status

Typical Data Needs to Support TMPQ	Existing Data Status
Household Interview Survey	2006 Transport Masterplan of Qatar that was outdated and only useful for trend analyses and not Activity Based Model development.
Laborer Surveys	2006 Transport Masterplan of Qatar that was outdated and only useful for trend analyses and not Activity Based Model development.
Roadside Interviews	2006 Transport Masterplan of Qatar outdated due to major development changes.
Public Transport Demands and Attitudes	Mowasalat data on passenger demands was up to date and comprehensive. Some attitudinal surveys carried out by Qatar University, which provides useful background.
School Travel Perceptions and Attitudes	Recent Ministry of Transport and Communications survey is highly relevant and comprehensive.
Walking and Cycling Perceptions and Attitudes	Surveys in 2015/16 for Qatar Pedestrian Masterplan remain of relevance.

(Continued on the next page)

Table 2-3: Summary of Data Needs and Existing Data Status (Continued)

Typical Data Needs to Support TMPQ	Existing Data Status
Stated Preference (New modes and policies in particular)	Work done for the previous Transport Masterplan of Qatar is now outdated. However, the updated Transport Masterplan of Qatar requires consideration of wider policies than simply the demand for Metro.
Non-Residents – tourists/business/ border traffic	Annual data on non-resident activity such as airport and port, demands, hotel occupancy, and tourist attraction numbers is up to date.
Traffic Counts **Automatic Traffic Counts** **Manual Classified Counts** **Turning Movement Counts**	In view of the rapid growth in population, and land use distribution in the past five years, the 2006 Transport Masterplan of Qatar and the extensive 2010/11 ASHGHAL surveys are now out of date. They have some relevance in examining trends in demand across major screen lines over time but cannot be used as indicators of current network demands. The data that is available in the Traffic Impact Studies submitted to Ministry of Transport and Communications cover the period 2010 to 2017 and as with the above data sources much of this is now outdated given the rapid pace of development.
Travel Times	The 2006 Transport Masterplan of Qatar travel time surveys were limited, covering only 4 routes, and only useful for limited trend analysis using the 2014 ASHGHAL data and new survey data. The 2014 ASHGHAL travel time data, whilst comprehensive in coverage, is considered out-of-date due to the rapid development changes in the past six years.
Demographic Data	2010 census and the 2015 Interim Population Census provide a rich source of data on household and personal characteristics and a picture of the population distribution and the respective points in time.
Land Use Data	2015 Land Use Survey and 2015 Interim Population Census provides a basis for deriving base year land use. The Qatar National Development Framework and the Municipality Spatial Development Plan zoning regulations provide the framework for future land use and population projections.
Socio-Economic Data	Municipality Spatial Development Plan statistics on a wide range of socio-economic data are up-to-date and provide extensive historic data for the analysis of trends and in the relationships between factors such as GDP and car ownership for example.

2.3 International Best Practices Literature Review

Transport master plans for various countries were reviewed from a data collection perspective to identify best practices and use them during the data collection inventories and surveys in Qatar. Data collection and analysis practices were ranked, and the top six selected to produce a detailed analysis of significant and exceptional features, and comment on their applicability to Qatar. The review concentrated on the data and data products (factors, rates, matrices, parameters, etc.) required to develop, calibrate, and/or validate the transport model that supports the creation of the transportation master plan, its actions, projects, strategies, and policies.

The Literature Review Report covers international best practice master plans from various countries with the master plans identified as the 'top six' being from the United Kingdom, United States of America, Ireland, France, Switzerland, and Dubai (the United Arab Emirates) to satisfy the requirement of having a Gulf Cooperation Council (GCC) country as part of the evidence base.

The detailed analysis of the top-six country-systems included data collection guidelines for activity-based modeling, household activity-based interviews from national travel surveys and trip diaries, data collection methods, data needs for long term models and Transportation Data GIS portals. It provided an overview of the international best practices, with a comparison against the data collection requirements for Qatar, an identification of other sources of data not currently being collected for Qatar, and local factors used to calibrate the transport model.

The International Best Practices report identified best practices and where these have particular applicability to Qatar (**Table 2-4**).

Table 2-4: Best Practice and Applicability to Qatar

Type of Data	Best Practice	Applicability to Qatar	Additional Recommendations
Zones	1. Use finer zones at urban areas (higher density population). 2. Create zones around significant parking sites (multi-story parking and park and ride facilities) and main transit terminals.	1. Yes, it is. Verify if enough information is available for parcel level data for socio-economic and demographic characteristics to build synthetic population. 3. Zones for multi-story parking should be considered. Zones around transit stops should be considered in the future for the metro main stations	Model zoning to be defined to a level that progressively transitions from fine zones to medium level to high level in very rural areas
Network	1. Road Network (inventory) 4. Public Transportation Networks (inventory)	1. Yes, it is. Qatar should develop a road network to model traffic and congestion. 5. Yes, it is, Qatar must model bus-network for base scenario and metro network for future.	All streets must be used in zones where trips of less than 2 miles (3.3 km) from walk and cycle are expected.
Traffic	Locate ATC and TMC at boundary-intersection of zones and network. Some counts should be done along validation screenlines, between major junctions, to be explicitly covered for model calibration.	Yes, this must be done	-

(Continued on the next page)

Table 2-4: Best Practice and Applicability to Qatar (Continued)

Type of Data	Best Practice	Applicability to Qatar	Additional Recommendations
Roadside Interviews	MCC must coincide with roadside interviews.	Yes, this must be done	-
Household Interview	For residents. Sampling based on stratification to ensure representability of all groups according to main mode choice needs. Spatially balanced to have more at higher density areas.	Yes	Weighting used for stratums to be used to expand HHABI and produce the synthetic population
RP / SP	Use of a payment card elicitation that asks the respondent to identify the maximum willingness to pay from a list of increasing values.	Yes, this must be done	-
Travel Time Delays	Use for validation at main junctions which should be explicitly modelled.	Yes, this must be done	Use GPS to acquire time stamp, speed, etc.
Pedestrian and Cycle Counts	On short trips where all streets will be modelled.	Yes, this must be done	-
On-Board Survey	Preferably by face-to-face interview. Must be short, and randomly sample from people boarding.	Yes, this must be done	Have additional surveyor counting people on board and use Mowsalat data on boardings. GPS to check route timings.
Hotel Visitor	A travel diary to capture trips made during stay.	Yes, this must be done	Undertake travel diary for hotel visitors, also captures length of their stay and how often they are in Qatar
Airport Visitor	Not in all surveys.	Yes, this must be done	Can be used to estimate flow of international travelers

(Continued on the next page)

Table 2-4: Best Practice and Applicability to Qatar (Continued)

Type of Data	Best Practice	Applicability to Qatar	Additional Recommendations
Border Crossing	Found in Ireland and France. Ireland model actually has network and zones along with population coming from and going to them from Northern Ireland (part of UK).	Yes, this must be done	Considerations must be given to having some additional zones outside Qatar to model attraction and generation of trips
New Technology	GPS must be implemented for a good sample of interviews. Mobile data collected through existing apps (CAREEM, commercial freight GPS, taxi GPS), and by other stakeholders such as insurance companies should be used. In future, check data coming from navigation apps	Yes, this is for the future, see recommendation	This should be tested in the future after a study identifies and matches available sources for Qatar, such as the one done for Sweden

2.4 Stakeholder Input

Stakeholder inputs were collected during an initial workshop in May 2017 and through various meetings attended with numerous stakeholders for data collection. The stakeholders were presented with the scope of the project along with its significance, and their concerns about the current Transport Masterplan Guidelines of Qatar and any other issues they may have regarding the project were listed and considered during the project. The aim of the workshop was to achieve buy-in and wide support for the development of the project, first in the form of obtaining required data and information as necessary, and later, in terms of local adoption of the Transport Masterplan Guidelines of Qatar.

Stakeholders included representatives from the Ministry of Municipality and Environment, the public works authority (ASHGHAL), the Ministry of Development Planning and Statistics (MDPS), the Ministry of Education and Higher Education, the Ministry of Health, the national committee for traffic safety the Ministry of Interior, Qatar Rail, Mowasalat, Qatar University, Qatar Centre for GIS, and various private engineering offices, transportation consultants and real estate developers.

Stakeholders indicated that all transportation data being collected would be useful to them, specially traffic counts. Stakeholders requested access to the TDMS for their day to day work and to have the ability to download entire GIS layers or datasets, as opposed to site by site information or data. Stakeholders suggested the system needed to be constantly updated. Stakeholders also suggested the system should have the ability to save previous searches, to compare datasets/sites and that the system should contain transportation and traffic parameters and performance indicators such as delays at junctions, density on the mid-block road sections, road capacity, road condition, and road protection scores. Finally, the need for pictures of each site where data was collected was suggested, especially because "the infrastructure is going to change in the future and or when we have different years of survey - a photo can assist this differentiation."

Figure 2-1: Stakeholder Workshop held on 22 May 2017

CHAPTER 3

DATA COLLECTION AND SURVEYS

Chapter 3 Data Collection and Surveys

3.1 Overview

Comprehensive data in the form of: traffic counts (ATC, TMC and MCC), household activity based interviews, hotel interviews, pedestrian and cyclist interviews, roadside interviews, stated preference, bus on-board interviews, travel time surveys, airport interviews, border crossing interviews, were collected during 2017, 2018 and 2019. The objective of the data collection was to gather all data inputs (inventories, counts and surveys) necessary for the update of the Transport Master Plan and to save them in a transportation data management system that facilitated data visualization and analysis. It is recommended that the TDMS is updated periodically and that mobile-device cooperative applications support future data gathering. **Figure 3-1** shows the process of data collation, collection, and verification prior to inclusion in the Transportation Data Management System.

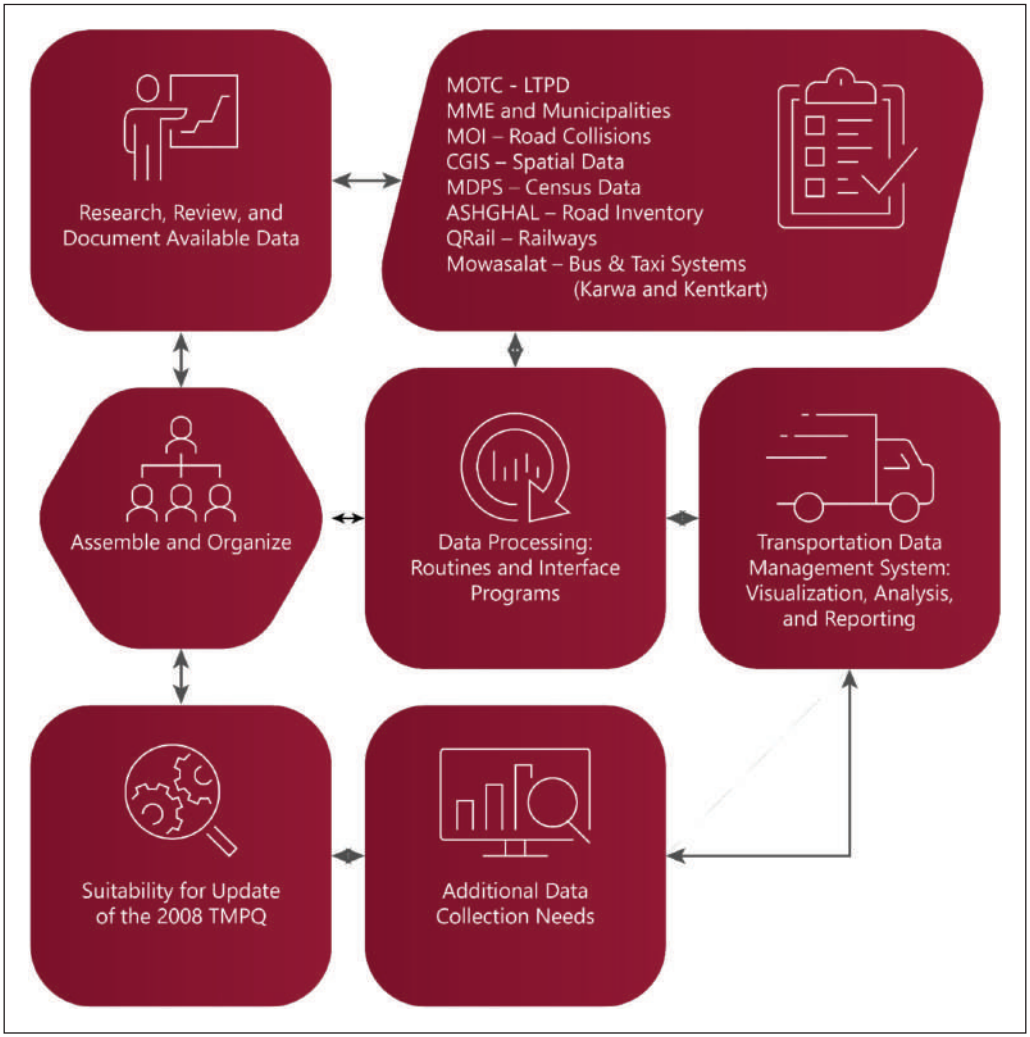


Figure 3-1: Process of Data Collection

3.2 Review and Document Existing Data

Table 3-1 provides a summary of the main types of data reviewed, the review outcome, and the recommended way forward.

Table 3-1: Summary of Main Types of Data and Review Outcome

Type of Data	Review Outcome	Conclusions
Transport Masterplan of Qatar 2008	Travel surveys and road topology. Useful for historical comparison and as starting point for the update.	Preserve in the Transportation Data Management System as historical data for estimation of growth rates, and to observe changes in the transportation structure and demands for the country.
Statistical Data	Census from 2010 and 2015 will be the source of population, and employment figures. Some socioeconomic characteristics also available.	Recommend Ministry of Development Planning and Statistics to preserve employment by census block figures for future census. This was done in 2010 but aggregated in 2015.
Land Use Data	Establishments and land use available to complement employment figures for trip attractions.	Recommend Ministry of Municipality and Environment to map Al Wakra and Al Khor land uses to complete spatial gaps.
Speed Data and Travel Time Data	Use for historical comparison of travel times from most popular origin-destination pairs.	Obtain data to characterize fluctuations during the day of travel time and operational speeds. This could come from police enforcement cameras, Bluetooth services, and navigation platforms.
Traffic Counts	Multiple sites and historical information since 2006 are available.	Define locations for permanent traffic counts and install traffic counting mechanism, preferable Weigh in Motion for major arterials and expressways (highways) and perhaps pneumatic tubes for collectors.

(Continued on the next page)

Table 3-1: Summary of Main Types of Data and Review Outcome (Continued)

Type of Data	Review Outcome	Conclusions
Public Transport Data	Current conditions are accurately characterized in the 2017 Qatar Bus Route and Operations Study.	Future conditions would require a new characterization, especially as the Mass Rapid Transit and Light Rail Transit (Lusail) systems become available.
Pedestrian and Cyclist Data	Some data available but Doha Central Business District data was not found.	Request/process Doha region data to complete the inventory of non-motorized network.
Airport and Port Data	Some data available, but insufficient to properly characterize, or model flows of trucks and freight within the country.	Traffic cameras information plus weigh in motion data could be used to complement this information. A weigh in motion facility near the access points of the ports and airport cargo terminal would be useful.
Road Infrastructure Data	ASHGHAL data seems amongst the most complete and best documented in the country.	It was concluded that a rolling process of periodic update is necessary for keeping up with the fast-paced evolution of the road network from geometric changes of existing roads to upgrade and expansion of highways and arterials.

A summary of the transport data review and documentation of existing data is presented in **Table 3-2**.

Table 3-2: Transportation Data Management System – Transport Data

Stakeholder	Data
Public Works Authority (ASHGHAL)	Excel files with traffic counts.
	Previous traffic studies.
	Existing and future roads and roads furniture.
	Traffic signal operation data.
Urban Planning Department (Ministry of Municipality and Environment)	Geographic Information System data (base maps).
	Trip generation data from West Bay Traffic Study.
	Ortho-images, shapefiles for Right of Ways (ROW) for greater Doha.
Ministry of Transport and Communications	Signal installations.
	Urban Traffic Control System.
Ministry of Transport and Communications	Automatic Traffic Counts, Manual Classified Counts and Turning Movement Counts.
The Center for Geographic Information Systems (CGIS) **(Ministry of Municipality and Environment)**	Zoning and detailed land use and establishment data, topographic maps, digital elevation maps, ortho-images, various scales, satellite images and contours.
Planning and Statistics Authority (PSA)	Census information for various years and demographics.
Ministry of Transport and Communications	Transport Masterplan of Qatar 2008 including, Household survey, roadside interview, commercial vehicle survey, Automatic Turning Count, Turning Movement Count, travel time study and saturation flow rate study. Pilot data hotel surveys.
Mowasalat	Bus occupancy, bus network, bus frequency, and other operational information.
Qatar Rail	Metro lines and rail lines.
Ministry of Transport and Communications	Traffic counts, road inventory, behavioral data, and travel data

The review outcomes and recommendations are documented in a report called "Review and Document Existing Data". This includes the current state of the transportation and traffic data availability and the review outcomes of the available historical data. This report covered the review of the data format and their suitability.

The review of existing data concluded that there was sufficient information to update the Qatar Strategic Transportation Model (QSTM) for a base year of 2015 and with some extrapolation to 2018, when combined with the new data collection carried out in the study.

The main findings of the report "Review and Report Existing data" are that new data collection will be necessary after the BRT, LRT, and MRT are operational. The planned upgrade of transportation systems will affect transport demands and also signify behavioral changes and modal shift, which should be captured through a new round of HHABI to enable adjustments to be made to modeling procedures based on evidence with MRT in place. A new data collection campaign, similar to the one carried out for the update of the TMPQ would include traffic data (ATCs, TMCs, MCCs), interviews with pedestrians, cyclists, transit riders, household activity-based interview, and revealed preference surveys in order to quantify the mode shift.

When importing the existing transportation and traffic data it was found that they were in different formats depending on the date and the entity who conducted the survey. This required processing of the data to convert it from these various formats to the standardized TDMS format for importing into the TDMS database. Sometimes the same site may be surveyed on different dates but with slightly different coordinates and a different site ID. In order to collate historical surveys for the same site, data that belongs to the same site had to be identified and entered into the system manually with the same location and site ID.

3.3 Road Inventory

The road inventory covers all physical transport links and nodes for private cars, freight, transit, and non-motorized modes. Other transport elements including traffic counts, link volume-delays, queue lengths, travel times and delays along routes, observed speeds, delay times at junctions, and turning movement counts, at selected locations were provided as part of the data collection and parameter estimation, but did not form part of the road inventory. The steps carried out for the completion of the road inventory are shown in **Figure 3-2**.

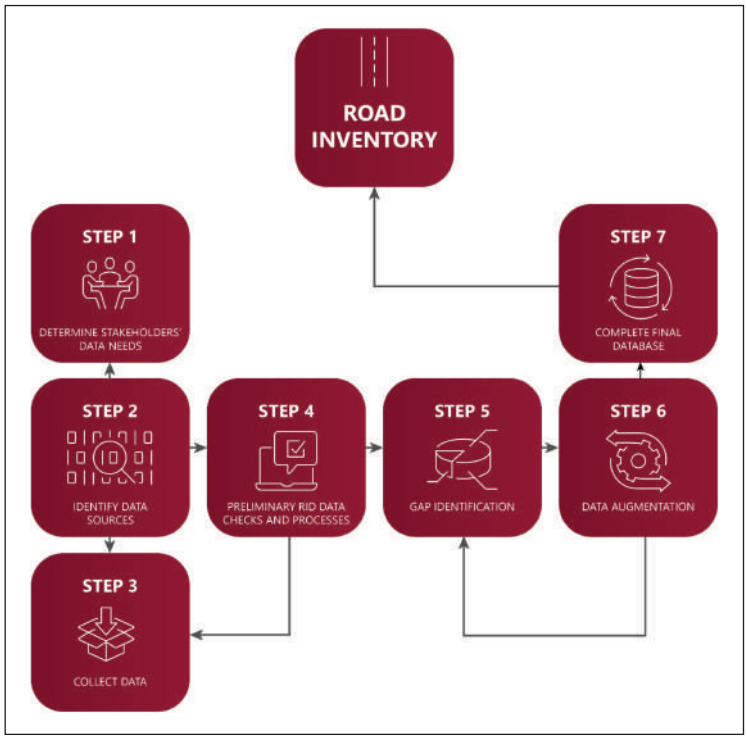


Figure 3-2: Road Inventory Methodology

A road inventory gap analysis was undertaken to identify any gaps, inconsistencies and/or discrepancies in the existing data.

The project team checked all the existing streets in the layer (Links) and fixed and updated the local roads and minor collectors that intersect with the main roads (major collector and above). The project team updated the road network based on the available resources including the provided layer, aerial photographs, and field investigations.

The above procedures are documented in the Gap Analysis Report which explains in detail the source of the data, the layers used for checking and updating the road network, the topology rules used to check the data, and the field investigations that were carried out.

It was concluded that a rolling process of periodic update is necessary to keep up with the fast-paced evolution of the road network from geometric changes of existing roads to the upgrade and expansion of highways, junctions, and transit systems and services.

3.4 Pilot Studies

Pilot studies took place for the most complex surveys:

1. The Household Interview (HHI) survey.
2. The Stated Preference (SP) survey.

All the other surveys were undertaken using well-established questionnaire designs and procedures and as such did not require the need for pilot surveys.

At the end of each pilot survey, a de-briefing process took place with the survey staff. All challenges, obstacles and issues experienced during the survey were registered and reviewed

and actions considered to improve the survey design, survey process, or training, to eradicate them or mitigate them. Changes to the survey designs and the survey fieldwork procedures were then initiated to address the issues encountered before the main survey fieldwork was commenced.

A pilot survey was carried out in May 2017 to test the household interview questionnaire, tablet application, survey procedures and the effectiveness of the staff training. A separate report on the HHI Pilot Survey was prepared, Household Interview Survey Pilot Study Report, and can be referred to for further details but some of the key findings are summarized below.

Training for the pilot survey was divided into the following sessions over a period of two weeks.

1. Introduction to Survey and Questionnaire – The first training session consisted of an introduction to the project, purpose of the surveys and a detailed run-through, of the paper questionnaire and all the dropdown options.
2. CAPI Training – Once the staff understood the questionnaire and purpose of the study they were then introduced to the application. This training included a run-through, of the CAPI and Geo-coding tool.
3. Workshops – Multiple workshops were held in smaller groups to train the staff on practical skills, such as how to approach a household, mock scenarios and practising on the CAPI Tool. The interviewers were then allowed to take the tool home to practise on their friends and family.
4. One-on-One Mock Interviews- The final stage of the training was to conduct a one-on-one interview with a member of the survey management team in which they were tested for the general interview approach, knowledge and understanding of the questionnaire and CAPI usability.

During the pilot survey 663 households were approached resulting in 291 interviews. Based on the fieldwork experience in the pilot surveys there were two main issues resulting in relatively high numbers of refusals/incomplete surveys compared to previous experience in the region. The first was gaining access into the household and the second was the length of the survey once access had been obtained.

The following observations were made relating to partial and refused surveys:

1. A high rate of refusals in particular on Thursday and Friday evenings. Households that were willing to participate requested the surveyors to come back during the week or on Saturday.
2. Many households that were initially willing to participate subsequently refused after being told the approximate duration of the interviews.
3. Often interviewers were allowed into the household but were then requested to leave 30 minutes into the survey leading to a high number of partial responses.
4. Respondents agreed to participate in the survey, however, were then not willing to provide specific activity-based behavior stating that it was too personal, in particular, for activities conducted at home.
5. Respondents did not feel comfortable giving exact travel timings due to security concerns of having young children at home.
6. Head of households often refused to allow women and young family members to be interviewed, particularly with regard to information regarding activity behavior. Some of the reasons for this included cultural restrictions and privacy concerns.

As a result of the pilot survey a number of changes were made to the survey process with the main aims being to improve efficiency, reduce the interview time, ensure a greater degree of access to the households (to reduce the refusal rate), and to de-personalize the interview questions to some extent in order to allay respondents' privacy concerns. Respondents were

assured that all of the information that they provided would be treated as confidential and that the final data would be stored in a format that could not be linked to an individual household or person within that household (would be anonymized).

During the iterative development of the SP design, three separate pilot surveys took place to test refinements to the design and the App. A summary of the outcomes from the pilot surveys that had an effect on the final Stated Preference design is provided below.

The first SP pilot survey involved:

1. The pre-selection of a set of household interview (HHI) addresses to be approached that included respondents who had agreed to partake in the SP survey.
2. The linking of the SP App to the HHI database so that all the HHI respondents' personal characteristics and travel information could be extracted from the database to enable the selection of appropriate individuals for the SP survey.
3. Population of the SP App with the above data so that the SP scenario presented to the SP respondent was tailored to their travel characteristics; and
4. Undertaking an SP survey with a single member of the pre-selected HHI address.

Over 570 HHI addresses were approached over the five-day period, resulting in 143 completed SP surveys. The main issues encountered in the fieldwork were:

1. Many respondents were confused regarding the attitudinal questions and interviewers had to take extra time to explain the questions for the respondents to provide an informed response.
2. Due to the summer holiday period, the survey team found it difficult contacting people from the pre-prepared list of HHI addresses.

3. There were several instances where the original HHI respondents had moved out of their house and been replaced by new tenants.
4. Once the people that were selected for the SP had been contacted, it still needed to be confirmed that they were willing to participate, and understood the SP game clearly; and
5. The overall response rate from the pre-selected HHI addresses was 25 percent.

The SP App performed well in the field with the SP respondents' details being successfully retrieved and the correct SP designs being selected based on the personal and travel characteristics of the respondent. Analysis was undertaken of the SP data to identify whether the respondents had understood the survey and whether the SP design was capable of producing reasonable model parameter estimations.

The outcome of the SP pilot study was encouraging; the general indication was that the SP App functioned as expected during the fieldwork and the respondents appeared to understand the study aims. The preliminary model estimation exercise, given the limited amount of data obtained, produced sensible parameter estimates.

The primary objective of the pilot survey was to identify areas where changes might be needed to the SP App, the SP designs, and the way that the survey was conducted. Several issues arose and were examined prior to the full SP survey being undertaken.

These were as below:

1. SP Application

- For consistency with the way that journey time is presented in the public transport alternatives, it was proposed to present the car travel time split between free flow and congested time.
- Sequence of presentation of Metro - Park and Ride - Pick-up/Drop-off time attributes would be adjusted to make them a logical progression, walk to station, wait time, n-vehicle time, invterchanges, walk from station and fare
- Contingent valuation exercise was to be reviewed, because the outcomes, albeit on a small sample size, were counterintuitive for higher income respondents. Additional explanation by the interviewers was to be provided to aid the respondent.
- General wording of the descriptions of the alternatives and the attributes to be refined where necessary.
- Attitudinal questions to be reviewed since SP interviewers' feedback was that they had to be explained to the respondent. However, the analysis of the data indicated that the obtained responses were generally sensible.
- Include header on SP games that summarizes the trip being considered. Trip purpose, time of travel, and journey time for example, to assist respondent in putting the SP games into context.

2. SP model estimation issues that may relate to SP designs

- The model estimation produced poor estimates of the interchange parameter and this needed to be reviewed in terms of how it was presented in the designs.

As it was included under the travel times, some respondents had taken it to be interchange time, rather than the number of interchanges (the attribute levels presented were 0, 1, and 2).

- Wait time parameter estimation was not significant in all cases and even where it was close to being significant, the value of wait time was essentially equal to that for in-vehicle time, which was counterintuitive. It might be that as the wait time for Metro is generally a small proportion of the overall travel time and cost by Metro, that respondents did not place a great deal of emphasis on this. Furthermore, in the SP design process, to ensure that realistic alternatives were presented, it was necessary to constrain the wait time to be the same for each of Metro, Park and Ride, and Pick-up/Drop-off when they are presented in the same SP scenario.
- Access time (in-vehicle access time to Park and Ride, and Pick-up/Drop-off) was again generally not significant in the estimations undertaken. This might be due to the small proportion of total time that this attribute represents in the designs, or simply that it is not valued as being significantly different to in-vehicle time.

Based on the above, adjustments were made to the SP designs. The second round of pilot surveys was undertaken with the adaptive feature of the SP designs implemented. In this version of the SP, instead of the attributes being drawn from a fixed attribute design the attributes were pivoted off the base journey times for the respondent's current trip.

Having made the relevant changes to the SP design and App, a further 250 SP surveys were undertaken and analyzed. The outcome of the second round of SP surveys was that while some improvements occurred in the estimation of the parameters there was still problems with deriving meaningful estimates of the interchange, wait time and access time parameters. There was also an issue with the adaptive process with a small number of the SP surveys generating illogical attribute values for some trip elements.

After reviewing the second pilot survey it was decided to:

1. Revert to using fixed SP designs based on selection from separate designs for short, medium, and longer distance trips, whether Metro as walk access was an option, and income (Low/Medium/High).
2. Simplify the SP designs by reducing the number of separate attributes presented to the respondent, for example combing access and egress time, and removing parking charges at Park and Ride sites. This reduced the number of variables that people had to consider.
3. During the presentation of the 9 SP scenarios there would be alternative combinations of 4 modes from the 6 separate modes being considered, rather than each of the 9 games covering the same modes.

The above changes were implemented and a further sample of 250 SP interviews carried out. As the analysis of these produced encouraging model parameter estimates and values of time, the decision was taken to proceed with the full survey.

3.5 System-Wide Data Collection

Four main types of data were collected, to cover motorized traffic, non-motorized traffic, traveler choices and preferences, and external trips:

1. **Motorized users traffic data**: Automatic Traffic Counts and Manual Classified Counts to measure traffic volumes on links and Turning Movement Counts to capture traffic at intersections. Travel time surveys to quantify travel times along designated routes. Parking interview surveys to obtain additional travel behavior data on demographics, socioeconomics, car occupancy, and parking times. Data from roadside interviews to collect travel patterns (origin-destination data) of vehicle users.

2. **Non-motorized user's traffic data**: Public transportation on-board survey data collecting origin-destination, demographic profile, transfers and fares and ridership information. Pedestrian and cyclist count and interviews to identify user travel behavior and to collect demographic and socioeconomic characteristics of this group of travelers.
3. **Traveler's choices and preferences**: Household activity-based interview survey and visitor survey to capture household characteristics, personal demographic and socioeconomic (including employment) characteristics, daily activity travel patterns including trip characteristics by time and duration, travel mode, and main purpose of travel. Stated Preference (SP) surveys with selected members of the household survey but with hypothetical travel situations being presented to obtain preferences for alternative modes of transportation, including existing modes such as car, taxi, and bus, and planned options such as metro, Light Rapid Transit, park-and-ride, and rapid-bus.
4. **External trips**: Air passenger surveys and intercept surveys at road borders and ferry harbor crossings to capture information from non-residents of Qatar. These covered travel patterns (origin destinations) and movements connecting to other modes of transportation, where the travelers stayed, when they enter or leave Qatar, trip frequencies, lengths, duration and destinations, and characteristics of travelers to build access/egress demand models. Surveys of hotel guests took place with the primary aim of identifying trips made, and activities undertaken by visitors to Qatar during their stay.

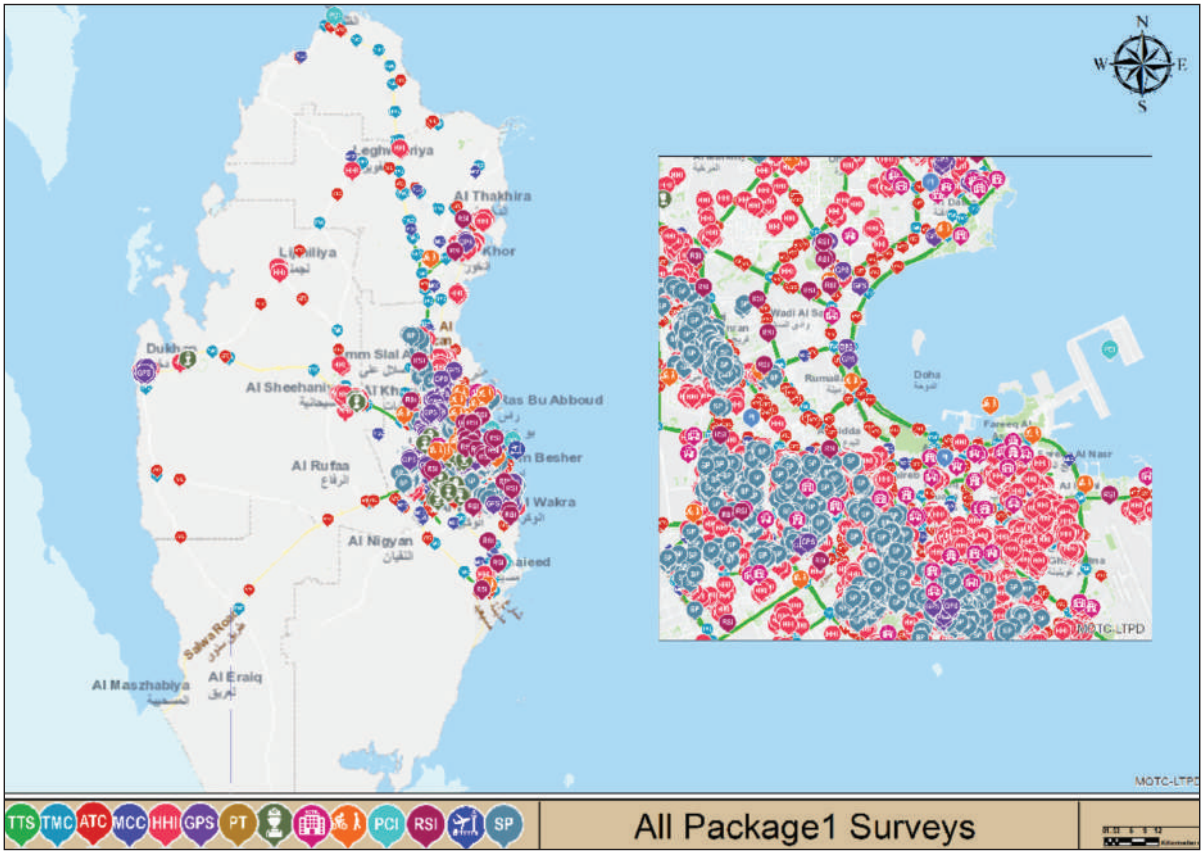


Figure 3-3: Spatial visualization of Surveys

A summary of the target and completed data collection is presented in **Table 3-3**.

Table 3-3: Target and Completed Surveys

Type of Survey	Dates Covered	Number of Surveyors	Target	Completed
Automatic Traffic Counts – Counter	Oct 2017 – Dec 2018	30	424 Locations	424 Locations
Automatic Traffic Counts - Video	Oct 2017 – Dec 2018	15	76 Locations	76 Locations
Turning Movement Counts	Nov 2017 – Dec 2018	30	500 Locations	500 Locations
Manual Classified Counts	May 2017 – Jun 2018	30	100 Locations	100 Locations
Travel Time Surveys	Apr 2018 – May 2018	2	75 Routes	75 Routes
Roadside Interviews	Nov 2018 – Mar 2019	20	10,000 Surveys 50 locations	18,599 Surveys 50 locations
Household Interviews (Weekday Travel & Activity Diaries)	Nov 2017 – Dec 2018	80	9,000 Interviews	10,082 Interviews
Household Interviews (Weekend Travel & Activity Diaries)	Nov 2017 – Dec 2018	80	1,500 Interviews	2,146 Interviews
Laborer Interviews	Apr 2018 – May 2018	20	1,000 Interviews	1,044 Interviews
Stated Preference Surveys	Apr 2019 – May 2019	25	3,000 Interviews	3,123 Interviews
Pedestrian and Cyclist Counts	May 2018 – Dec 2018	6	25 Locations	25 Locations
Pedestrian and Cyclist Interviews	May 2018 – Dec 2018	16	1,000 Surveys	1,233 Surveys
Public Transport On-Board Surveys	Oct 2018 – Dec 2018	20	1,500 Surveys	1,589 Surveys

(Continued on the next page)

Table 3-3: Target and Completed Surveys (Continued)

Type of Survey	Dates Covered	Number of Surveyors	Target	Completed
Parking Interviews	Apr 2018 – Nov 2018	20	1,000 Surveys	1,148 Surveys
Hotel Visitors Surveys	Mar 2018 – Nov 2018	20	1,000 Surveys	1,067 Surveys
Air Passenger Interviews	Nov 2018	20	1,000 Surveys	1,174 Surveys
International Border Crossing Surveys	Feb 2019	20	1,000 Surveys	1,842 Surveys

3.6 Survey Database Construction

All survey related data have been stored using a relational database, together with integrated tables, queries, macros, and programming scripts to maintain consistency between records, variables, and keys and enable the data to be managed in an efficient and optimal manner. The survey data was collected using iPad applications and then processed using excel to produce cleaned and verified data records for importing into the relational database.

All the data which is uploaded into the database goes through critical testing and validation checks to mitigate any duplications and insertion of erroneous data.

The design of internal file structures, data types, data processing procedures, and output forms and graphs are based on best practice guidelines. **Figure 3-4** shows the dashboard view of surveys database.

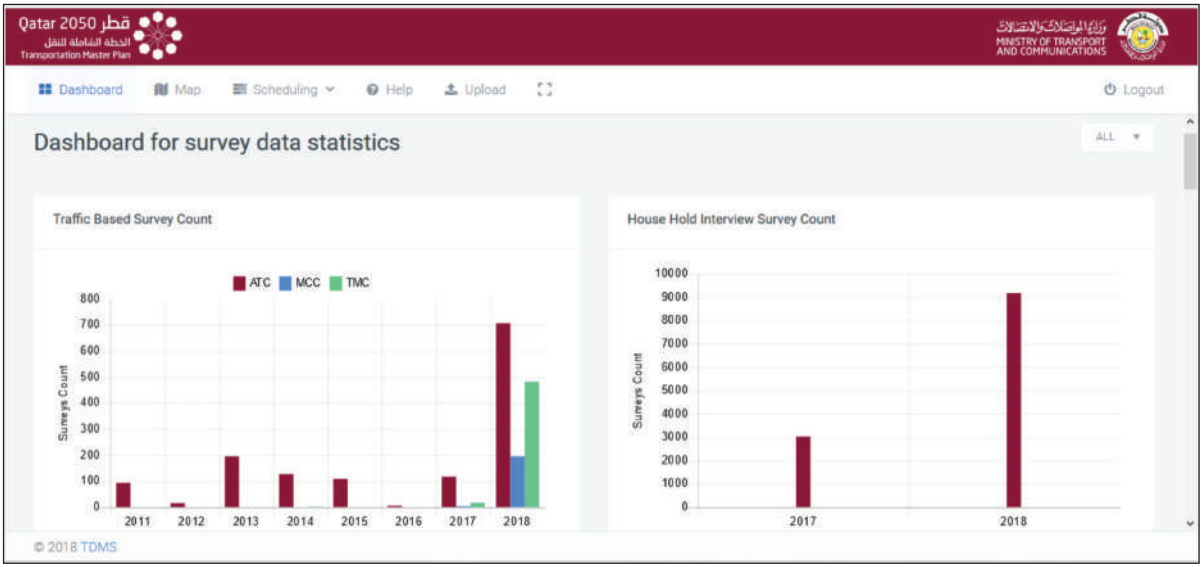


Figure 3-4: Dashboard view of Survey Database

The database design and maintenance include:

1. The documentation follows a user-friendly format for the programming code and algorithms, including scripts and macros after the checking of the code according to the Ministry of Transport and Communications auditing processes. Reusability was the main principle that database design and structure implementation followed, and.
2. The database (non-spatial) holding the survey data is compatible with the Geographic Information System database (spatial) holding geospatial data including boundaries, traffic data etc., ensuring their inter-operability. Both databases complement each other in a way that whenever a survey is uploaded into the system, the survey information is stored in non-spatial database and relevant geographical information is stored in the spatial database.

3.7 Transportation Data Management System (TDMS)

The Transportation Data Management System consists of a geospatial database with a web-based application and a user interface that facilitates visualization, analysis, and extraction of information from the geospatial databases. Visualization is achieved through tables and maps with the information represented through feature layers. The main tool for analysis is a pivot table that filters the information and produces bar charts, scatterplots, heatmaps and line graphs. Extraction of data can be accomplished through table exporting from the pivot table or raw data download for traffic data.

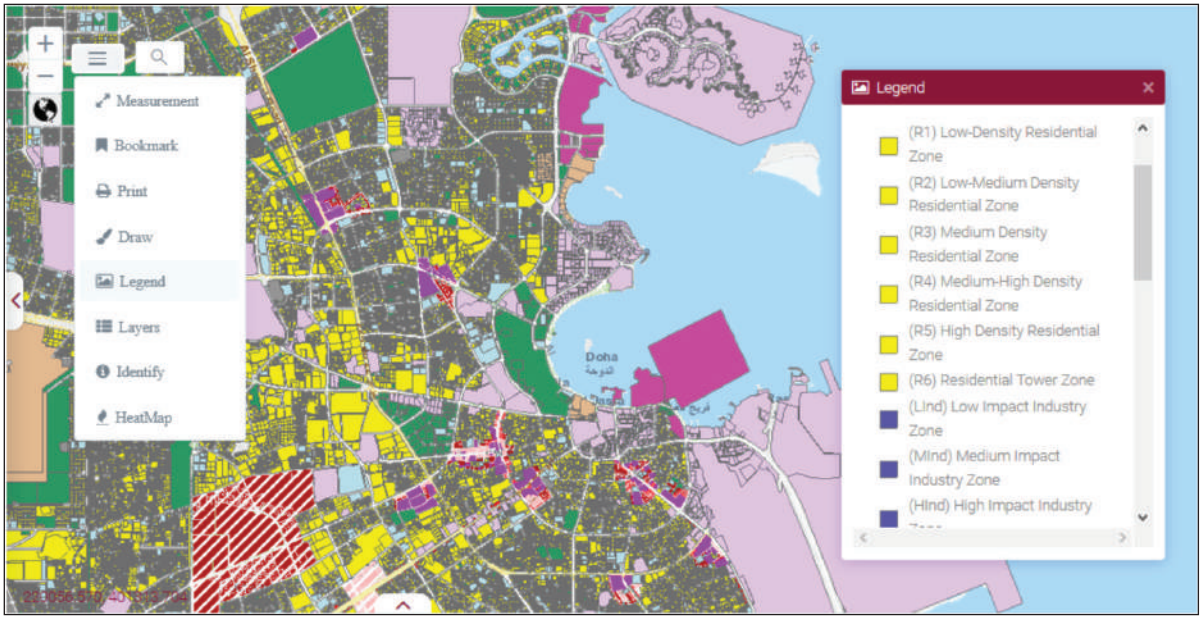


Figure 3-5: Data Visualization on the TDMS

The Transportation Data Management System database includes the following data:

1. Road Inventory.
2. Automatic Traffic Counts (ATCs).
3. Manual Classified Counts (MCCs).
4. Turning Movements Counts (TMCs).
5. Household Interview (HHI) Surveys.
6. Pedestrian and Cyclist Interview Surveys.
7. Travel Time Surveys.
8. Stated Preference Surveys.
9. Public Transport On-board Surveys.
10. Parking Interview Surveys.
11. Hotel Visitor Surveys.
12. Airport Passenger Surveys.
13. Border Crossing Intercept Surveys.
14. Sidewalk and Bike Paths Inventory.
15. Rail/Bus Routes Inventory.

The Transportation Data Management System will be made accessible to internal and external users with various degrees of accessibility, which can be adjusted as needed.

All new data collection can be scheduled through the system and added directly. A standard data collection format for each type of survey is available from MOTC and must be used to ensure standardization and compatibility of data for import to TDMS.

3.8 Geographic Information System (Traffic Data GIS-Portal)

The Traffic Data GIS-Portal is implemented as a module within the Transportation Data Management System for traffic data management, visualization, and analysis. The data contained in this module is exportable in other formats. The Traffic Data GIS-Portal provides transportation professionals with traffic counts including vehicle volumes, classification, and speed. This information can be used to calibrate travel demand models, estimate congestions levels, determine traffic loading on the pavement structure, aid the determination of the timing of phases at signals, and assess the level of service of roads and lanes through the day. The information also contains speeds which can aid the preparation of safety studies.

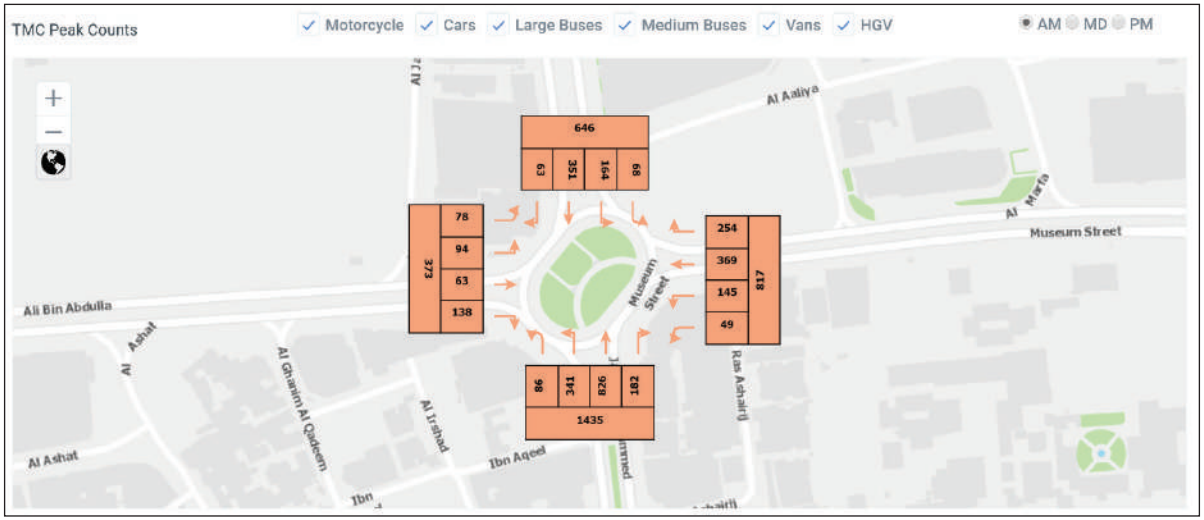


Figure 3-6: Traffic Data GIS-Portal

CHAPTER 3

3.9 Documentation

Comprehensive documentation was prepared to support the development of the Transportation Data Management System and the Geographic Information System Portal including the TDMS Methodology, the TDMS Software Development Manual, the Installation and Deployment Guide.

These documents summarize the entire process of the specification and development of the Transportation Data Management System including the surveys, inventories, and the geospatial data

Following are a brief introduction for each report:

3.9.1 TDMS Methodology

The TDMS Methodology report outlines the main features and methodology for developing the Qatar Transportation Data Management System (TDMS) while focusing on user needs and international best practices in order to assist the MOTC-Land Transport Planning Department in their day-to-day work analyzing network traffic flows and operating conditions

The report discusses recommendations for Transportation Master Plan of Qatar (TMPQ 2008), highlights the international best practices followed across the world, identifies, and recommends approaches to fill the Gaps in the available data and development of TDMS.

The report defines a strategic roadmap for TDMS development, so it should provide sufficient flexibility to accommodate refinement of the detailed design during software development and to allow for future enhancements/upgrades to the system.

The report also contains a section for the TDMS Software Requirements Specifications (SRS) that describes what functionalities the TDMS application will do and how it will be expected to perform and fulfill all stakeholders needs.

3.9.2 TDMS Software Development Manual

The purpose of the TDMS Software Development Manual is to describe the technical aspects of Transportation Data Management System (TDMS) software development and to provide a detailed insight into the software architecture, components, services, and flows.

This document serves as a comprehensive guide for any technical personnel who intends to understand, utilize, and/or enhance the Transportations Data Management System (TDMS) software system implementation.

This Software Development Manual is intended to be used by technical stakeholders of the project with IT background who will be responsible for development, enhancement, support, or maintenance of Transportations Data Management System (TDMS) software system, such as Software Developers or Software Architects.

3.9.3 Installation and Deployment Guide

The purpose of the TDMS Administration and Operation Manual is to describe the following:

1. The steps involved in installation and deployment of the Transportation Data Management System (TDMS) software.
2. The TDMS synchronization batch scripts needed to synchronize information between

the spatial and non-spatial databases.

3. The User Security administrative interfaces for managing and administering applications, Users, and system access.
4. Configuration of the TDMS application.
5. Configuration of User Security application and integration with LDAP and Email services.

The TDMS administration and operation manual, is intended to be used by technical specialists responsible for planning or performing TDMS installation or deployment, and its ongoing maintenance. It is also intended to help stakeholders (Systems Administrator(s), Chief Information Officer (CIO), Analysts, or Developers) to coordinate their efforts based on a shared understanding of its deployment architecture and configuration requirements.

The TDMS User Manual explains in detail how a user is to use the TDMS application from a business function perspective. The User Manual uses a non-technical and step-by-step approach to help the audience understand and utilize the key features and functions of the TDMS application.

This document serves as a reference guide for any business user who intends to use the TDMS application for observing and analyzing network traffic flows, operating conditions, and survey data.

3.10 System Testing and Operation Staff Training

The Transportation Data Management System is hosted on the Ministry of Transport and Communications server and went through extensive testing and debugging to ensure it performed as designed for the Ministry of Transport and Communications platform. In addition, easy to follow test routines were developed with standards for future system testing and troubleshooting in the event of future issues.

3.11 Additional Client Training

Training sessions were conducted to enhance MOTC's staff capabilities and to brief MOTC's staff and selected stakeholders' members on the operation of the Transportation Data Management System, including data input, analysis, and production of GIS outputs for transportation and traffic studies.

The training sessions covered all aspects of transportation/traffic data analysis focusing on practical problems in data collection, the Transportation Data Management System, error trapping and correction, system operation, interpretation of results, and data presentation through reports, drawings, statistics, and the Geographic Information System.

CHAPTER 4

STAGE 3: EXISTING CONDITIONS, SURVEYS, AND DATA ANALYSIS

Chapter 4 Existing Conditions, Surveys, and Data Analysis

4.1 Overview

The final stage of the Data Collection: Inventories and Surveys study covered the analysis of the data collected in the study to produce a set of reports as follows:

1. Local Factors and Transportation Parameters Report
2. Traffic Survey Analysis Report
3. Modelling Data Analysis and Estimation Report
4. Household Interview Data Analysis Report
5. Parking Interview Analysis Report
6. Other Survey Analysis Report
7. Behavior Based Survey Analysis Report

These reports are briefly described in the following sections with some key points from each report highlighted within the respective summaries. These are a short snapshot of the type of information available from the extensive analysis undertaken and presented in the respective reports.

4.2 Local Factors and Transportation Parameters

This task provides a range of important traffic and transportation factors and parameters that are commonly used by professionals in transport studies. Where practical and applicable, the factors are derived from the collected local data from the Data Collection, Inventories and Surveys to represent local conditions. Some comparisons with information from other

resources are included. However, the emphasis is on the use of local data to derive the relevant factors and parameters.

With the extensive surveys carried out there is no reason to believe that the outcome factors from the analysis should be adjusted by referring to other external data or historic data over ten years old. The rapid change in Qatar in the past 15 years means that measuring what is happening today is most important and any benchmarking should mainly be used to show how Qatar may differ from other areas, or how it was in the past.

Hence, the recommended values in this task are derived from the extensive data collection exercise that was designed specifically to generate the full range of traffic related parameters and factors. **Table 4-1** provides a brief summary of the local factors and transport parameters that resulted from this task.

Table 4-1: Local Factors and Transportation Parameters

Local Factor	Description
Temporal Adjustment Factors	Temporal adjustment factors relate to the development of factors that enable the conversion of traffic counts to reflect the time of day, day of the week, and month of the year. The Annual Average Daily Traffic (AADT) is the total volume of traffic on a highway segment for one year, divided by the number of days in the year. The design hour volume is defined in the Qatar Highway Design Manual as the flow of traffic through a road segment or junction during a 1-hour period and is the basis for characterizing its quality of flow, and for designing the basic features of the road. Roadway facilities are sized with reference to design hour volume (DHV).
Ramadan/Eid and Summer Adjustment Factors	Adjustment factors for travel demands in the Ramadan/Eid and Summer periods are derived from a comparison of the 50 ATC counts that have been repeated during separate periods of the year. The adjustment factors are derived by vehicle type (cars/others), day of week (weekday, weekend, and average weekday), and time period so that a comprehensive set of adjustment factors are available for use by the transport practitioner.
Peak Hour Factors	The Automatic Traffic Counts traffic data collected across Qatar has been analyzed to provide information on peak period and peak hour factors by day of week, road class and region.
Road Capacity Levels	The range of lane capacity values used by road class within the 2018 Qatar Strategic Transport Model. These values are to be adopted in any modelling exercise using the Qatar Strategic Transport Model.
Saturation Flow Rates (Traffic Signals)	Local saturation flow rates by lane type have been derived from the surveys undertaken at selected traffic signals. Relationships to show the impact of Heavy Goods vehicles on the saturation flow rates are also presented.
Speed/Flow Density Curves	The speed and flow data provided by the Automatic Traffic Counts was used to derive locally calibrated speed/flow relationships for use in transport analysis and modelling in Qatar.
Parking Capacity Restraint Curves	The parking surveys enabled the development of a relationship between the time required to find a parking space and the demand/capacity ratio of the car park at the time respondents were trying to park. This relationship is used in modeling parking supply constraints.
Design Vehicle Characteristics	Design vehicle standards are used in many aspects of the design of the roadway, and parking facilities and it is important to establish a set of design vehicle characteristics such that they represent at least 95 percent of the expected vehicle mix that will use any facility. The data collected in the study has been used to derive revised design vehicle standards for Qatar.

(Continued on the next page)

Table 4-1: Local Factors and Transportation Parameters (Continued)

Local Factor	Description
Vehicle Equivalency Rates	Vehicle equivalency rates are used to convert traffic flows by different vehicle types to a consistent measure based on each vehicle's equivalent contribution to the take up of road space, or junction capacity. The data collected from the Automatic Traffic Counts has been used to derive local factors for use in transport studies.
Trip Generation Rates	Trip generation rates have been derived from the Household Interviews and provide household and person-based trip generation rates. The household data was analyzed to produce person weekday and weekend trip rates segmented by: • Qatari/non-Qatari. • Gender. • Occupational status (employed/students/others). • Income band (low/medium/high). • Car availability (car ownership); and • Trip purpose.
Residential Parking Generation Rates	Parking generation rates are derived from the Household Interviews for residents' parking rates. The Household Interview surveys collected detailed data on the vehicles owned/used by the households and hence their parking needs overnight at their place of residence. The parking rates per household are derived by: • Qatari/non-Qatari households. • Household type (villa, apartment etc.); and • Household size.
Vehicle Occupancy Rates	Vehicle occupancy values have been derived from the Household Interview and Roadside Interview data by trip purpose and vehicle type and then compared to each other and evidence from elsewhere in the region and a set of vehicle occupancy values recommended for application in Qatar covering all vehicle types.

(Continued on the next page)

Table 4-1: Local Factors and Transportation Parameters (Continued)

Local Factor	Description
Journey Purpose Compositions	Journey purpose compositions were derived from an analysis of the Household Interview and Roadside Interview data and carried out separately at the person and vehicle level to provide a comprehensive set of factors. The Household Interview person journey purpose splits are carried out by: • Weekday/weekend. • Gender. • Nationality (Qatari/non-Qatari); and • Time of day o AM (0600-1000). o MD (1000-1600). o PM (1600-1900). o Evening (1900-2200); and o Night-time (2200-0600) A detailed analysis of journey purpose compositions has also been undertaken by nationality, gender, time period, and mode of travel. These show the different proportions of travel by purpose at differing times of the day. As would be expected there are significant differences between weekday and weekend journey purposes
Qatar Population Classification	The Qatar population structure has been defined and how it is projected to change in the future as the proportions of Qatari citizens, expatriate residents and laborers significantly changes to reflect the development of Qatar and its diversifying economy. It is projected that the proportion of the population by category will change between 2020 and 2050 as follows: • 2020 11.6% Qatari, 41.5% expatriate and 47% laborer; to • 2050 13.5% Qatari, 64.4% expatriate and 22.1% laborer
Hotel Occupancy Rates and Tourism	Hotel occupancy rates and projections of tourism are provided by hotel class.
Values of Time	Value of time (VoT) is an important element used in the modeling and evaluation of transport schemes, as timesaving is an important measurable benefit in most transport schemes. The willingness to pay for travel time savings is also an important factor in assessing pricing strategies such as parking charges, tolls or enhanced fuel costs on peoples travel choices.
Modal Preferences	The Stated Preference surveys undertaken in the study enabled the preferences that travelers may have regarding new modes to be derived and included in the modeling of new transport features.

(Continued on the next page)

Table 4-1: Local Factors and Transportation Parameters (Continued)

Local Factor	Description
Demand Model Coefficients	The Stated Preference analysis has also revealed some important relationships for inclusion in models to test future policies. These are: • That parking charges and toll charges are perceived as a bigger deterrent than fuel costs and as such including cost coefficients separately by these elements is essential to test parking and toll policy scenarios. • That congested travel time is consistently valued higher than general travel time across all categories and modes. This is also of high importance for the derivation of congestion charging toll strategies; and • That walk access to Metro is an impedance compared to Metro in vehicle time. The Stated Preference results have provided some very important insights into how model parameters should be defined in the utility equations and that separate time and cost parameters by attribute are likely to be critical to the modeling of the future modes and policies.
Fuel Consumption Parameters, Fuel and Non-Fuel Resource Operating Costs	Detailed analysis of the vehicle fleet in Qatar has been undertaken to derive appropriate vehicle operating costs by vehicle type. All aspects of the cost of operating a car have been derived including fuel prices, fuel consumption by vehicle type, maintenance, licensing, and depreciation.
Socio-Economic Assessment Factors	The following socio-economic inputs have been derived for inclusion in modelling and appraisal. • Population • Consumer Price Index (CPI) measuring inflation • Real GDP o Real oil/gas-related GDP o Real non-oil/gas-related GDP • Oil price (already referred in previous sections covering VOC) • Income (Household Income and Expenditure Survey) and • Car ownership rate (cars per 1,000 people)

(Continued on the next page)

Table 4-1: Local Factors and Transportation Parameters (Continued)

Local Factor	Description
Economic Appraisal Factors	The following economic appraisal factors for use in appraisal are also defined. • Evaluation period. • Appraisal horizon year. • Price basis (year). • Discount base year. • Social discount rate per annum. • Financial discount rate per annum. • Annualization factors. • Prices o Basis for future price inflation rates. o Cost changes due to wage changes. o Revenue rate increase i.e. fares, tolls, and parking. • Residual values of scheme assets at end of appraisal period – proportions by investment type; and • Optimism Bias in relation to scheme capital and operating costs.
Accident Rates and Valuation	Accident rates by road type and severity have been derived from the available data and revised estimates of the valuation of accidents by casualty severity have been derived for use in appraisal.
Environmental Parameters and Valuations	Strategic environmental parameters for use in Ministry of Transport and Communications scheme appraisal cover vehicle emissions and noise. The main environmental parameters normally used in strategic appraisal are: • Emissions o Emission rates by vehicle type and by emission type (air and carbon). o Value of emissions; and • Change in value of emissions by year. • Noise o Rates by vehicle type; and o Change in values by year.

4.3 Traffic Surveys Analysis

An understanding of the scale of traffic demand by vehicle type across the Qatar road network is of fundamental importance in terms of managing the current network and identifying future improvements. Extensive traffic count data were required, and was collected to meet the following needs:

Table 4-1: Local Factors and Transportation Parameters (Continued)

1. The development of a series of cordons/screen lines covering all traffic passing across them as a source of calibration of the updated Qatar Strategic Transport Model demand models and the validation of the highway assignment model.
2. The future monitoring of trends in traffic growth across a consistent set of traffic count locations. This is the basis for a forward-looking traffic monitoring program, where counts at specified locations should ideally be performed on an annual, or (at least bi-annual) basis.; and
3. The counts extended beyond those required to meet the above aims to provide a wider picture of traffic flows on all major links in the highway network. Major links are defined by either their level in the road hierarchy or the expected volumes of traffic that they carry.

The aim was to provide detailed traffic information by vehicle type across the whole Qatar road network which will then form a database of traffic demands that can be used in subsequent studies.

Table 4-2 shows the number of traffic surveys by type that were carried out.

Table 4-2: Summary of Traffic Surveys

Survey Type	Objective	Coverage	Number of Surveys			
			Timing	**Tube**	**Video**	**Total**
ATC Counts	To provide traffic count data to determine the volumes of traffic by day of week and vehicle type.	Across Qatar providing information that can be used to examine traffic demands by location and cordon.	**Neutral Months**	382	19	401
			Ramadan	22	28	50
			Summer	20	29	49
			Totals	424	76	500
MCC Counts	To provide more detailed classification of vehicle composition for use in verifying ATC counts.	Primarily located adjacent to a sample of ATC counts.	100			
TMC Counts	To provide turning movement counts for localized analysis of junctions.	All major traffic signals and roundabouts in Qatar.	500			
RSI Sites	To provide patterns of traffic movement across various points in the network to assist in developing information to cross check against HHI data and to be used in validating distributions within the QSTM	Sites providing closed cordons to capture all traffic crossing the cordons. West Bay/CBD, Al Khor, and an Outer Cordon.	50			
Travel Time Routes	To collect travel time and delay measurements.	Covers the strategic road network in Qatar with an emphasis on the Greater Doha region.	75			

Figure 4-1 to **Figure 4-7** show some typical examples of the type of analysis that has been undertaken on the traffic survey data and is presented in the detailed Traffic Analysis Report. These figures show:

1. **Figure 4-1** shows daily traffic volumes by road from the counts undertaken in central Doha. Similar figures in the report provide the summary of the count information across the whole of Qatar. The traffic flow data can be used to identify the main corridors of demand by day of week and time of day. For example, in **Figure 4-1** the high traffic flows on the ring roads around central Doha and on the radial routes into the center are clearly evident.
2. **Figure 4-2** to **Figure 4-4** show the daily profile of traffic by vehicle type and by day of week and show how the traffic profiles are quite different by day. The figures show the clear differences in traffic patterns across the different days of the week. On a weekday the traffic flow peak occurs in the morning but sustains a high volume for most of the day before gradually declining through the evening. However, on a Friday traffic flows are much lower during the morning period before gradually building up through the day to reach their peak in the evening. The traffic pattern on a Saturday is a composite of the weekday and Friday patterns with the peak occurring in the evening but with higher activity in the morning period than seen on a Friday.
3. **Figure 4-5** shows examples of AM peak traffic volumes through junctions indicating where the busiest junctions exist. The figures show that the most heavily trafficked junctions occur, as expected, along the expressway network and at the intersection of the main radial arterial roads and the ring roads around the Central Business District. The information from the traffic surveys enables such plots to be produced by day of week and time of day thereby providing a substantial database of information to identify the main traffic flows across the road network.
4. **Figure 4-6** shows an example of junction delays which can be used to identify congestion hotspots. The figures clearly show where the main junction delays are being encountered across the network and these plots can be produced by day of week and time of day. Combining the junction delay information with the junction volume data enables the major bottle necks on the road network to be identified so that in developing the transport strategy mitigation measures can be considered. It is

important to combine the data in this way so as to prioritize interventions in the areas where the delays and volumes are the highest to optimize the impact of investment in the network in reducing congestion.

5. **Figure 47** shows an example of the patterns of area to area movements derived from the roadside interview surveys. These plots show the main corridors of movement.

The Traffic Survey Analysis report provides an overview of the scale of traffic demands on the road network by time of day and day of week, the operating conditions that exist on the road network by time of day and area, and the pattern of travel demands. It is an extensive database of travel demands and operational data that enables the transport professional to understand the pressures on the road network and then have available the information needed to them to develop solutions to the delays that occur across the network.

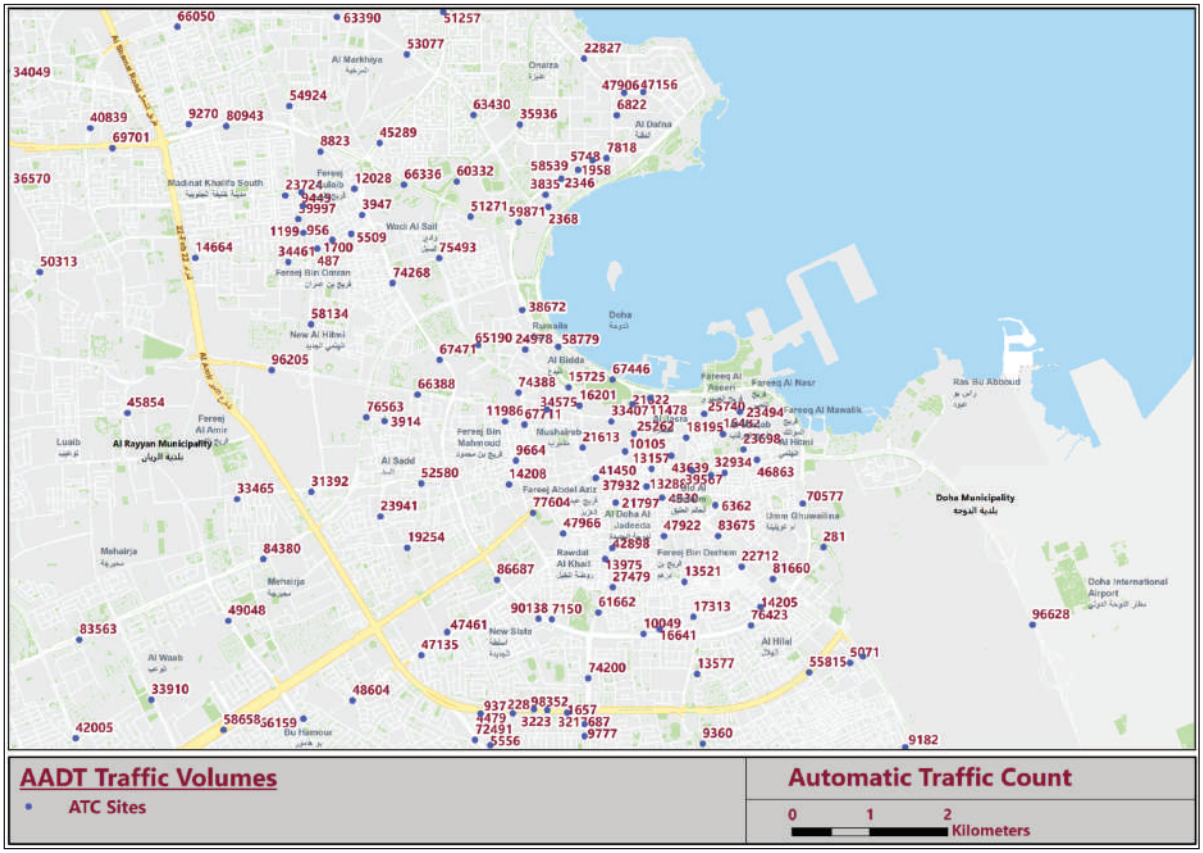


Figure 4-1: Example of Daily Traffic Flow Volumes derived from the Traffic Surveys

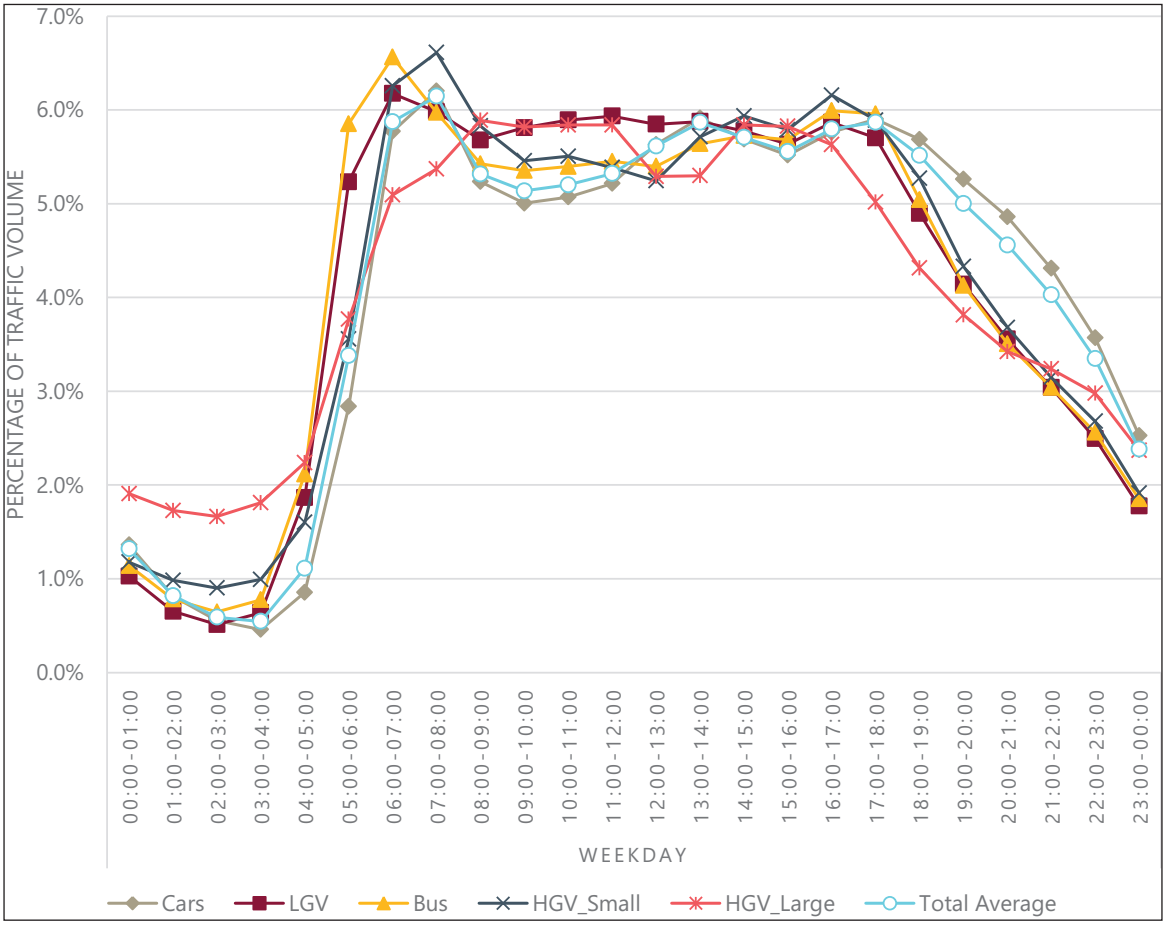


Figure 4-2: Average Daily Traffic Flow Profiles by Vehicle Type - Weekday

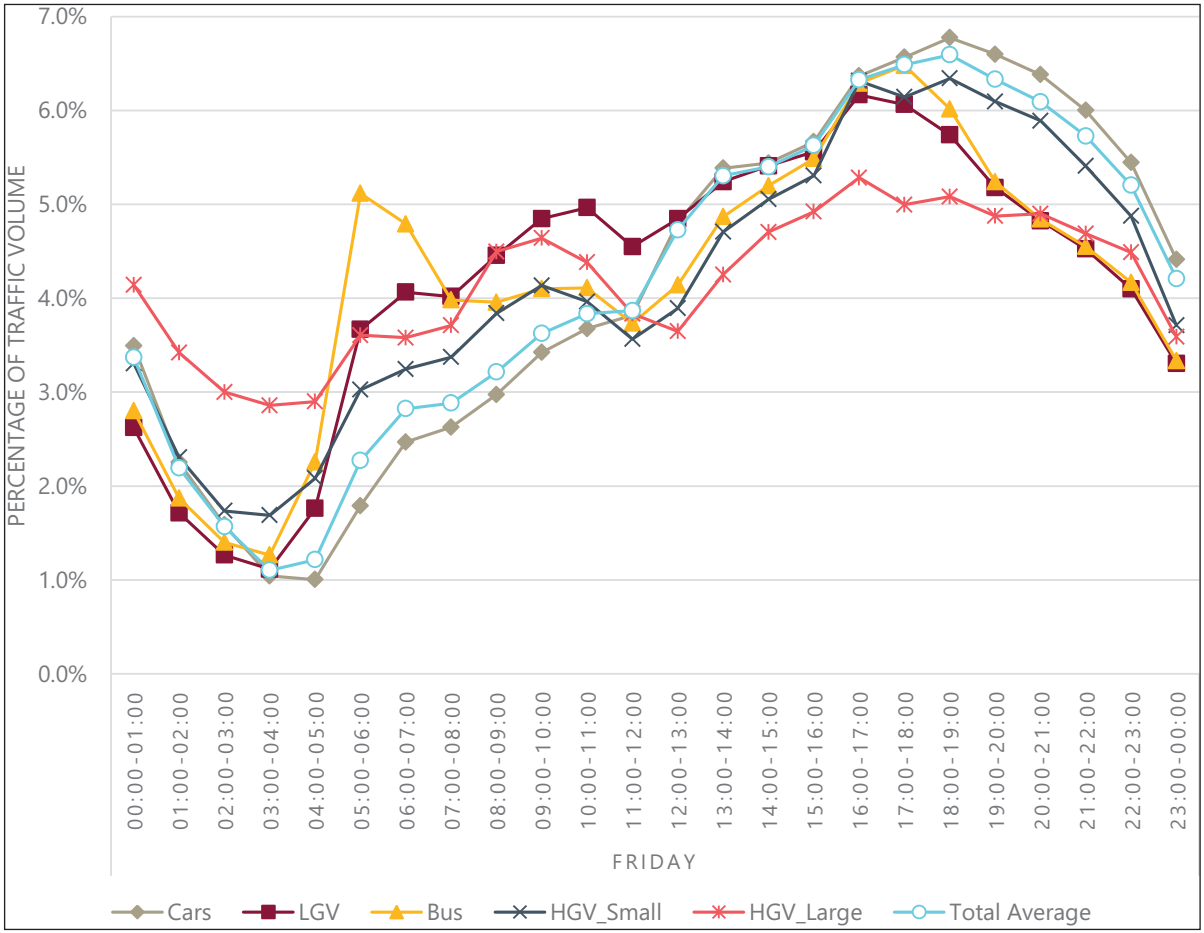


Figure 4-3: Average Daily Traffic Flow Profiles by Vehicle Type - Friday

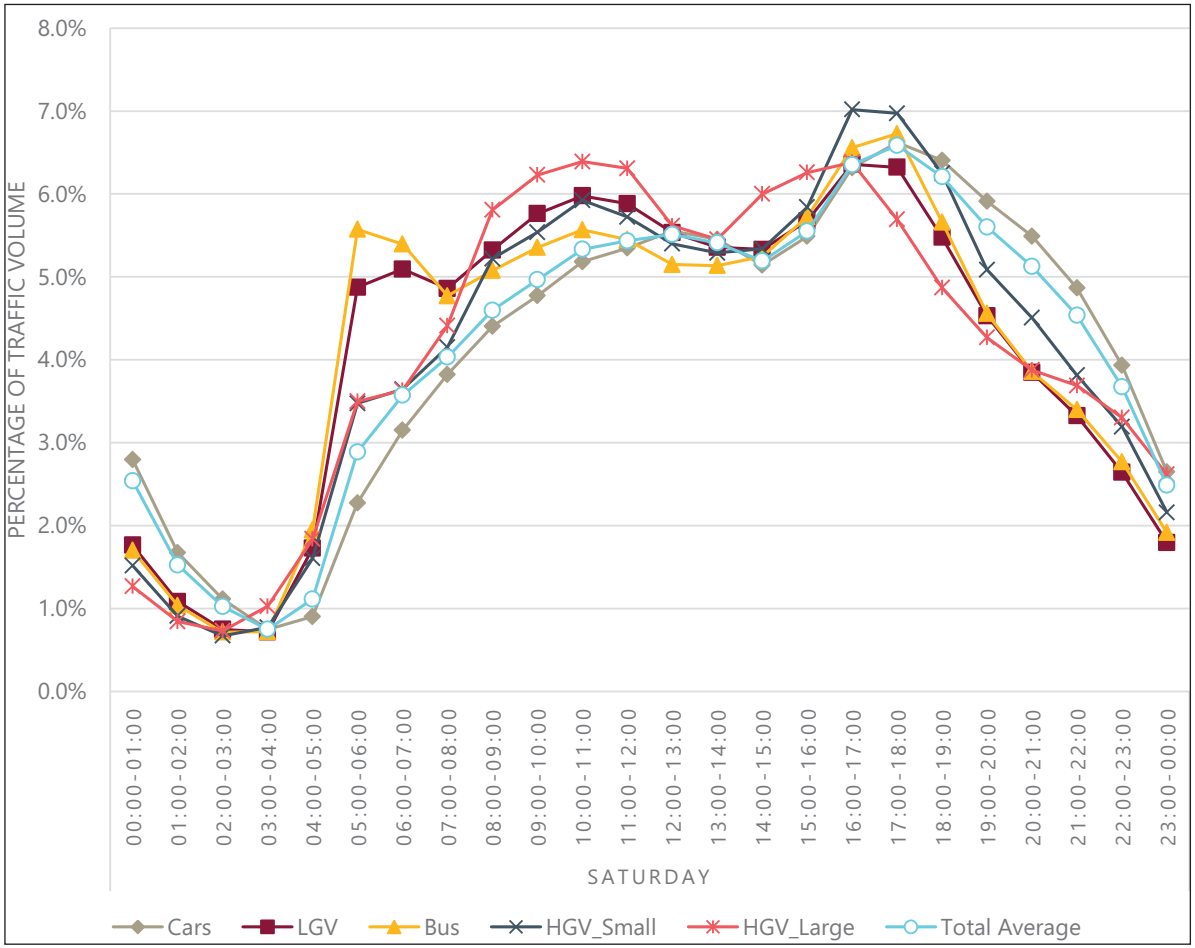


Figure 4-4: Average Daily Traffic Flow Profiles by Vehicle Type - Saturday

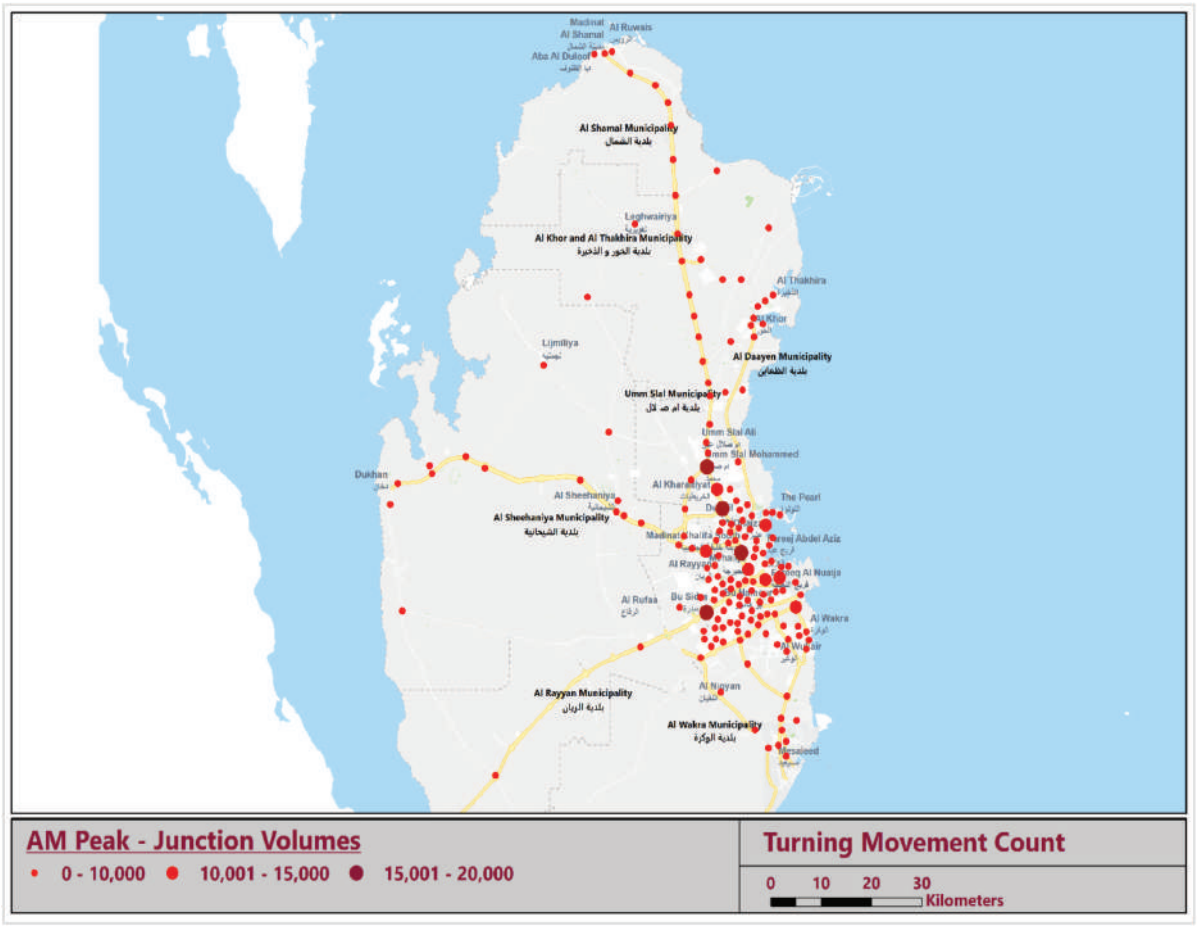


Figure 4-5: Example of AM Peak Hour Junction Volumes

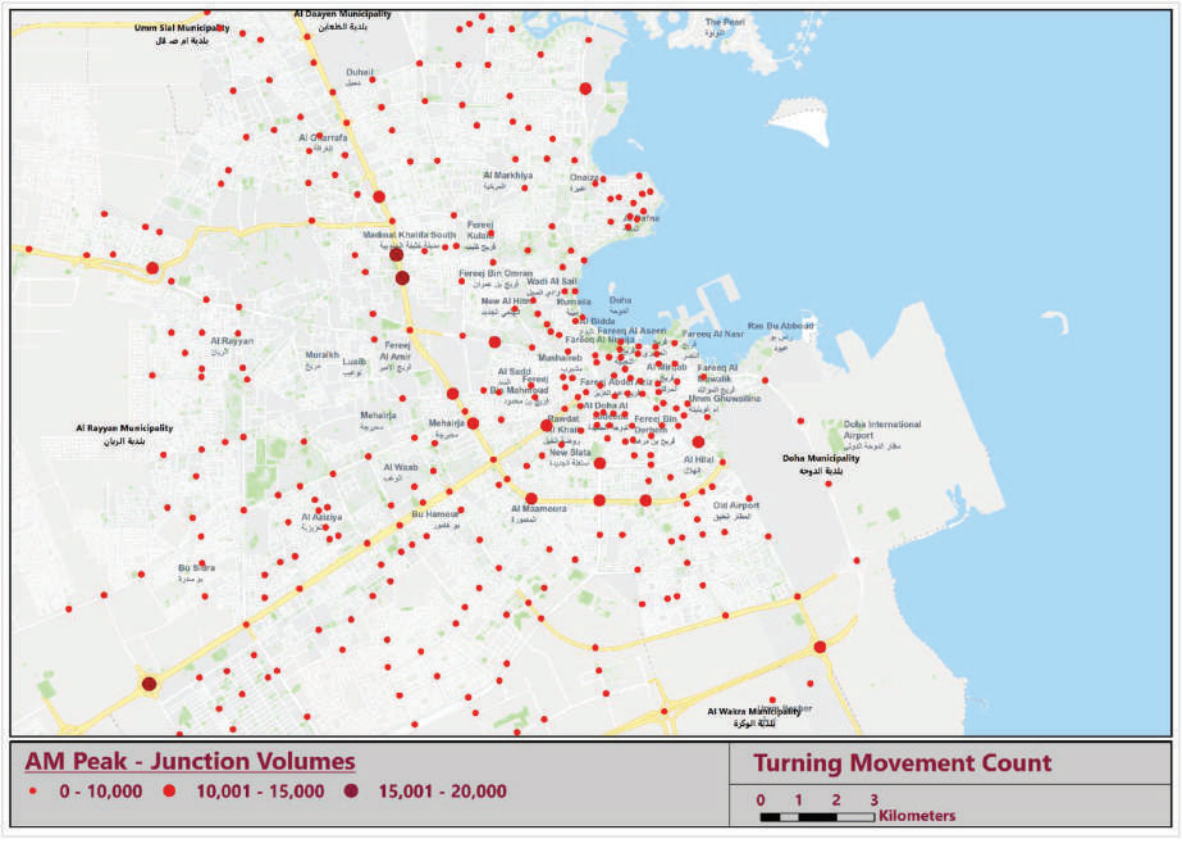


Figure 4-5: Example of AM Peak Hour Junction Volumes (Continued)

CHAPTER 4

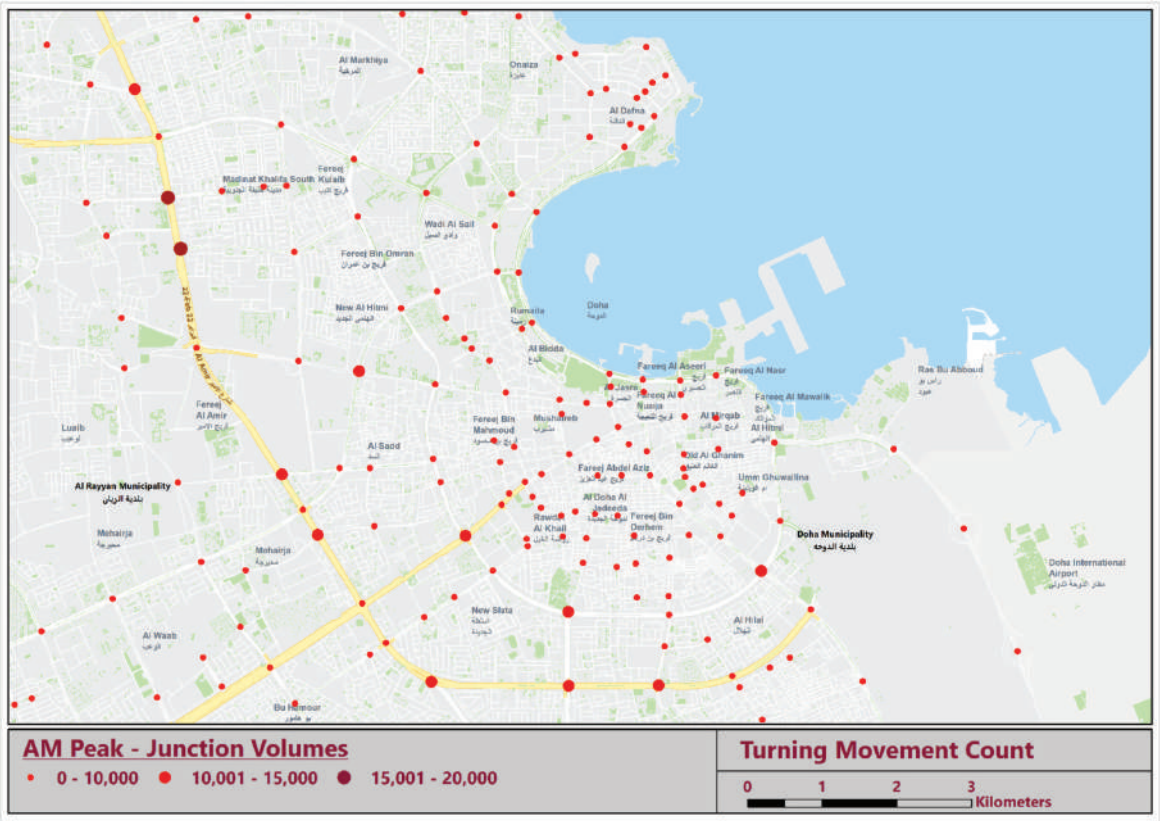


Figure 4-5: Example of AM Peak Hour Junction Volumes (Continued)

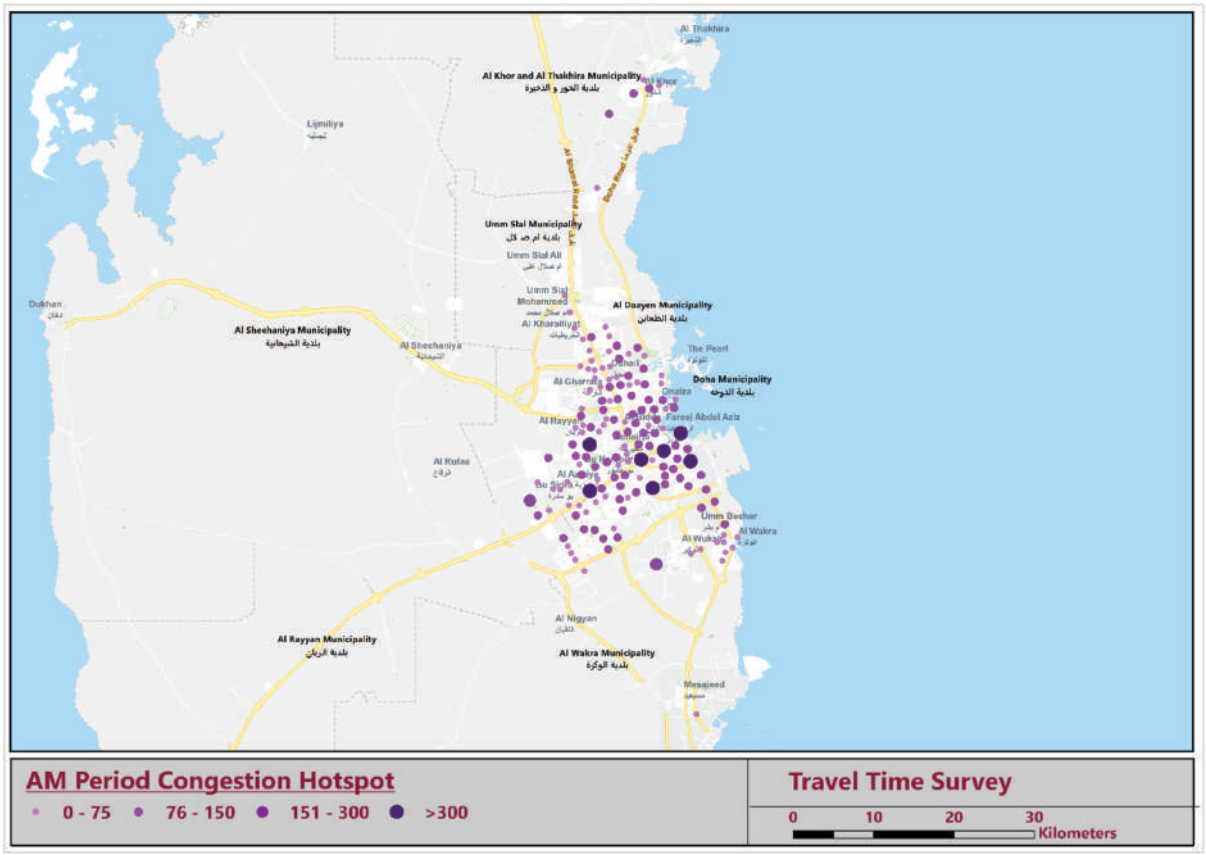


Figure 4-6: Example of Average Junction Delays – Congestion Hotspots

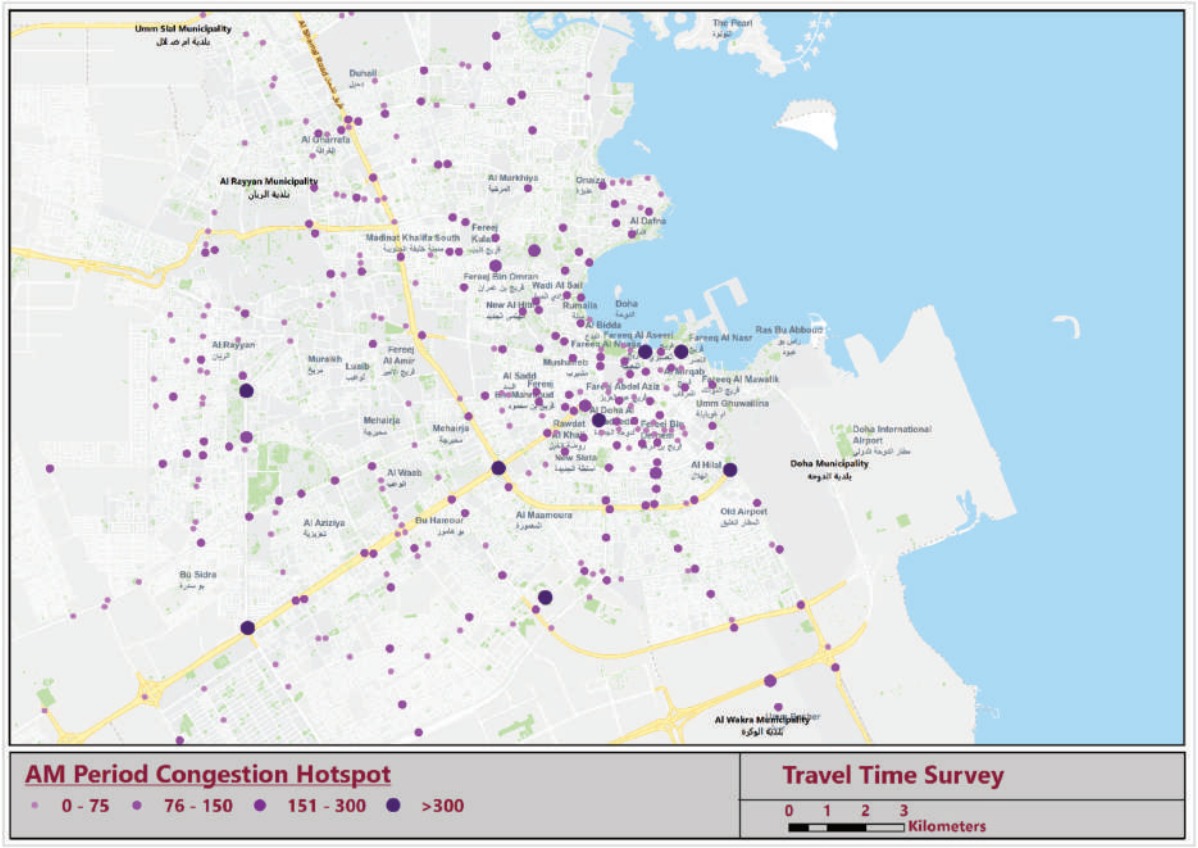


Figure 4-6: Example of Average Junction Delays – Congestion Hotspots (Continued)

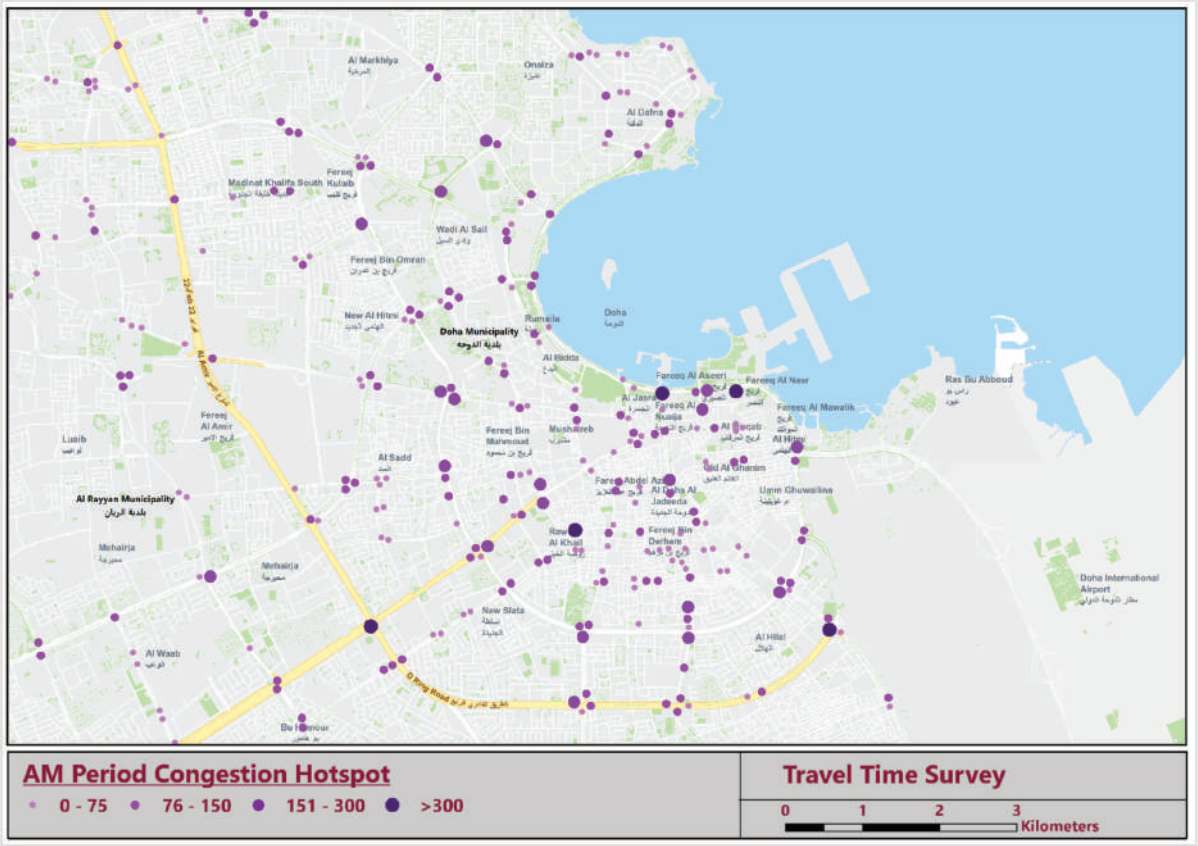


Figure 4-6: Example of Average Junction Delays – Congestion Hotspots (Continued)

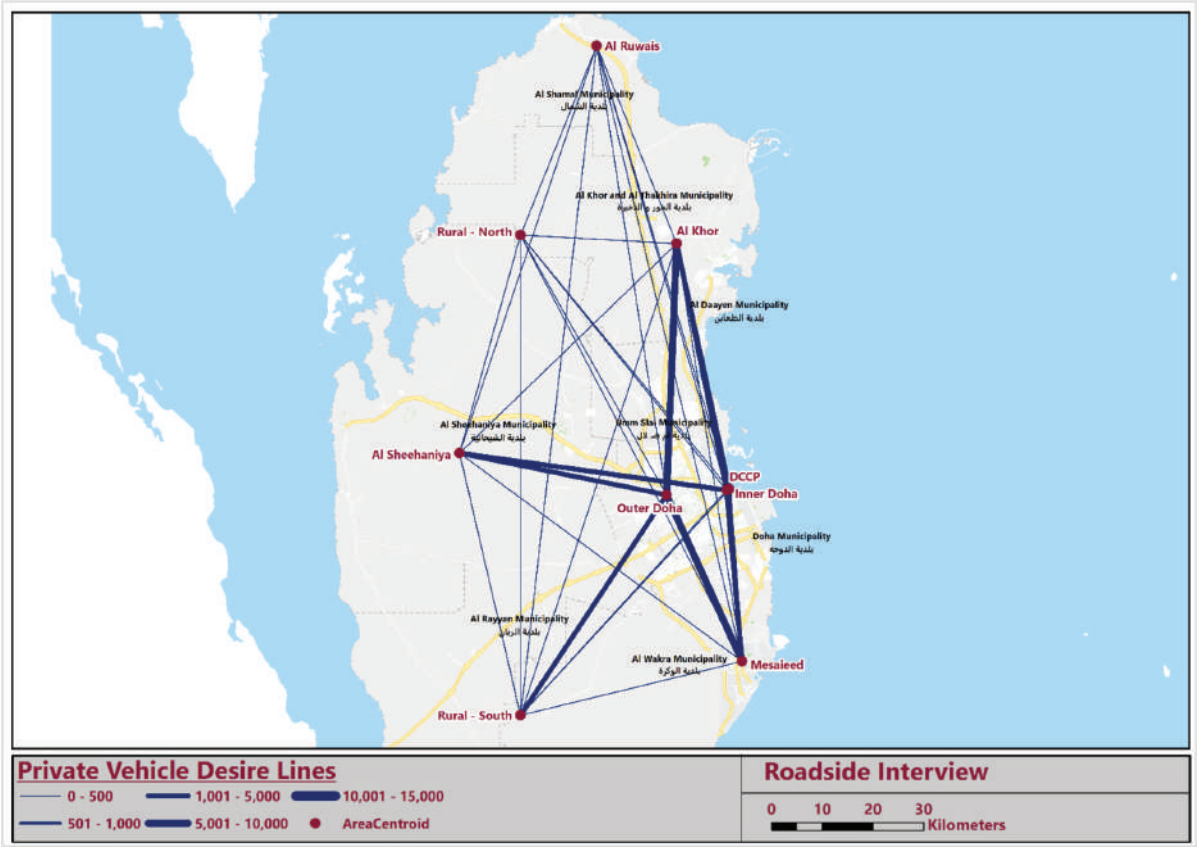


Figure 4-7: Example of Traffic Movements based on Roadside Interview Survey Data

The 85th speed percentile averaged close to 120 km/h across all Rural Freeways, just below 90 km/h on Expressways and Rural Roads, around 80 km/h on Arterials and Distributors, and just over 50 km/h on Collectors and Other Roads, as can be seen in **Figure 4-8**, which shows the average of the 85th percentile traffic speeds by different road classes and various time of day.

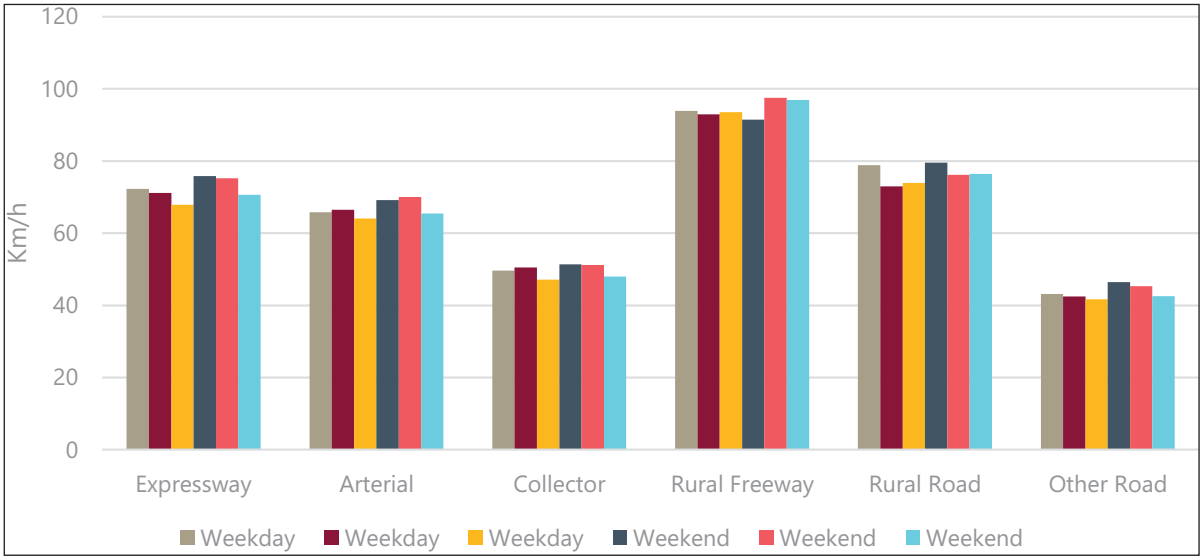


Figure 4-8: Average and 85th Percentile Speeds by Road Class and Time of Day

Manual Classified Counts (MCCs) were collected over a 16-hour period on representative weekdays. The recorded proportion of traffic flow by hour of day for each vehicle class (taken across all count sites) are shown in **Figure 4-9**.

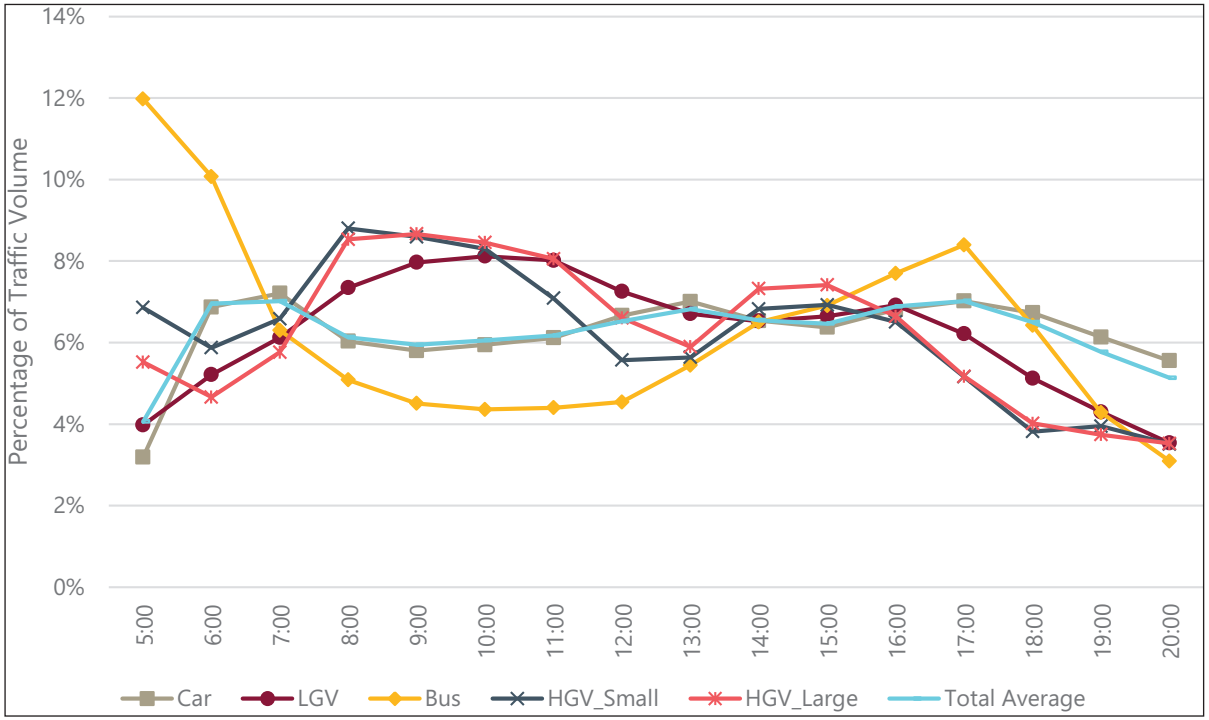


Figure 4-9: MCC Weekday Daily Traffic (16hr) Profile by Vehicle Type

The variation in daily traffic flows across a typical week (for Car, LGV, Bus, and HGV separately), is shown in **Figure 4-10**. This is based on average flows across all of the ATC sites.

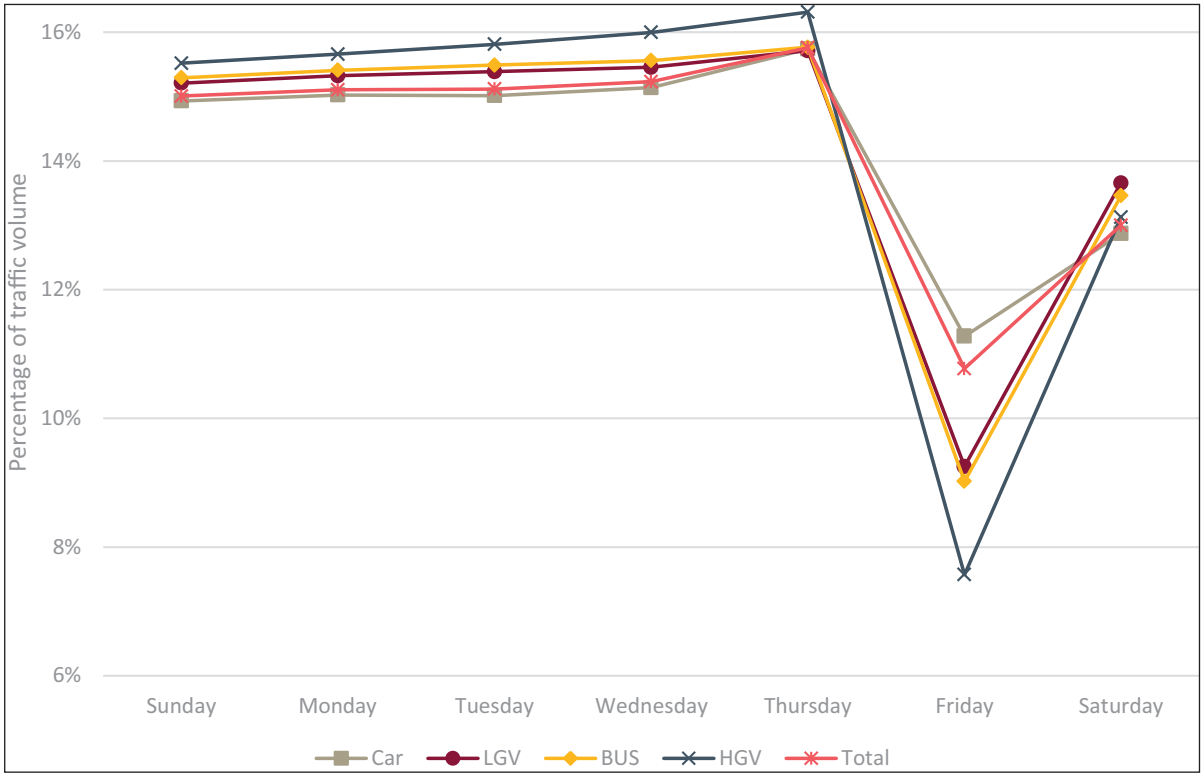


Figure 4-10: Daily Traffic Variation by Vehicle Type

Traffic flows appear to increase gradually across the working week (Sun to Thurs), with the highest peak observed on Thursday. The lowest peak is observed on the Friday (weekend day). Approximately 16 percent of total traffic for the week occurs on a typical weekday compared to 8-11 percent on Friday and 13 percent on Saturday.

4.4 Modelling Data Analysis and Estimation

This task covered the Revealed and Stated Preference data and its analysis. This includes a description of the development of the Revealed Preference data and the design and collection of the Stated Preference data to meet the primary objectives of the study. The primary objectives of the model estimation was to derive parameters that were based on local evidence that can then be used in the determination of the parameter values for the utility functions in the mode choice context, to derive coefficients and ASC values for new travel modes such as Metro and Park and Ride, to determine the willingness to pay travel costs such as tolls and parking charges and how these costs are weighted by respondents in their decision making, and finally to determine Value of Time (VOT) for different categories of traveler.

To understand people perceptions and preferences respondents were presented with a number of statements relating to transport and asked to state whether they agreed with the statement. The aim of these attitudinal statements was to gather an understanding of the decision processes that people considered when making their travel choices. **Table 4-3** summarizes the proportion of respondents who agreed or disagreed with the respective attitudinal statements and in many cases, this gives a good indication of the perceptions of certain travel attributes.

Table 4-3: Response to Attitudinal Questions

Statement	Agree	Disagree
Transport has a major role to play in our efforts to control climate change	77.5%	11.0%
I would use public transport if my friends and colleagues did	56.0%	25.5%
I like using my car as I feel safe in my car	71.7%	10.4%
Air pollution due to increased traffic volumes is a serious issue	78.7%	9.0%
Having to wait for a bus or metro is uncomfortable	37.8%	39.8%
My family and friends would think it odd not to commute by car	31.8%	46.3%
Using public transport is more unreliable than the car	40.7%	33.8%
Using bus/train means sharing my personal space which I would not find comfortable	32.9%	49.6%
My personal travel decisions have an impact on others and wider society	29.8%	49.8%
I would willingly pay to park closer to my destination	49.5%	30.8%

The main points discerned from the Stated Preference respondents' answers are:

1. Strong agreement on the impact that transport has on the environment.
2. Some lack of awareness that personal travel decisions impact wider society (which to some extent contradicts above).
3. No perception of public transport (PT) being more unreliable than car, which probably reflects current congestion levels at pWeak periods.
4. Liking the personal safety of the car but interestingly not being averse to sharing space on Public Transport.
5. Waiting for Public Transport is seen as an issue; and
6. Parking is seen as an issue, in the local climate context, with a high proportion willing to pay to reduce walking distance and park close to their destination.

This task also describes the analysis of the behavioral data obtained from the Household Interview survey, the Revealed Preference data, the Stated Preference data, and the outcomes from a joint model estimation using the Revealed Preference/Stated Preference data. The report concentrates on identifying the following important aspects:

1. The willingness to pay for different categories of traveler in the form of the varying Value of Time (VOT) that different travelers bring to their decision-making process.
2. The relative importance of different elements of a trip, for example congested time, wait time, interchange, toll, or parking cost, within the definitions of the utility of travel to be used in future modeling exercises; and
3. The parameters that need to be incorporated into the modeling framework to reflect new modes of travel and any specific preference that different categories of traveler will have for each mode of travel as expressed through the ASC values.

Three types of analysis were carried out as follows:

1. Revealed Preference analysis to explore current values of time based on the mode choices made by people at the present time. Simple aggregate time and cost-based Revealed Preference models, including ASC values by mode, were shown to provide logical Value of Time values for most categories of traveler. However, there are issues in using the Revealed Preference due to the strong dominance of car usage within the Revealed Preference database. Within the Qatari citizen Revealed Preference database car use is over 95% of all travel with only education travel showing any significant use of alternative modes in the shape of school bus.
2. The Stated Preference analysis with its carefully designed tradeoffs of time and cost by mode was able to produce estimates for both aggregated time and cost and disaggregate time and cost by mode models. These have enabled the relative importance of a range of trip attributes to be examined such as separating out car

costs by fuel, parking and tolls, and car time into congested and free flow time. The Stated Preference analyses have also enabled the derivation of utility weights and ASC values for the new modes examined of Metro with walk in access, Park and Ride and Drop-Off and Ride. Within the Stated Preference analysis alternative model forms were examined including multinomial and nested logit model forms.

3. The joint Revealed Preference/ Stated Preference analysis proved difficult due to the car dominance in the Revealed Preference data and this limited what could be derived from the joint estimation. The basic premise of the use of Revealed Preference / Stated Preference techniques is to overcome the issue of the scale factor that exists to some extent in all SP experiments. While the Stated Preference can deliver relative values of time from the ratio of the coefficients within the Stated Preference, and relative valuations of the separate trip attributes, it can be subject to error in the absolute estimation of the value of the time coefficient for inclusion in the utility function which can distort predicted mode shares. To overcome this combining the Stated Preference with Revealed Preference data determines the Stated Preference scale factor by anchoring the Stated Preference to the base year mode shares.

The following sections briefly summarize the main findings from the model estimation analyses that have been undertaken by highlighting the more important outcomes from the perspective of potential future transport policy initiatives and interventions.

Table 4-4 summarizes the value of time estimates and as expected shows that nationality, income, and car ownership have significant influences on the values of time.

Table 4-4: SP – Summary of Value of Time Estimates

Category		Value of Time (QAR/hr)
All Respondents		41.8
Nationality	Qatari	63.7
	Non-Qatari	29.7
Non-Qatari Household Income	Low Income	47.4
	Medium Income	26.2
	High Income	31.8
	Very High Income	57.6
Household Car Ownership	1 Car Household	35.2
	2+ Car household	44.7
Gender	Male	39.1
	Female	50.4
Employment Status	Qatari – employed	58.2
	Non-Qatari - employed	28.8
	Non-Qatari – not employed	54.2
Trip Purpose	Qatari - Commuting	65.6
	Non-Qatari - Commuting	29.8
	Non-Qatari - Other	35.4

Table 4-5 summarizes the value of the Alternative Specific Constants (ASC's) by mode for different population categories. As with the values of time there are clear trends in that the ASC's increase as incomes and car ownership levels increase. The relative attractiveness of the alternatives to car remains relatively constant across all the categories with the Metro walk in access ASC values

always lower than the other alternatives. The need to use an additional motorized mode to the Metro as one would expect has a detrimental effect through an increased ASC against Park and Ride and Drop off and ride options for Metro use. Taxi ASC values are consistently the highest across all categories.

Table 4-5: SP – Summary of Modal Constants (Value in minutes)

Category	ASC Values (minutes)				
	Car Passenger	Drop off and Ride	Metro	Park and Ride	Taxi
Qatari	61.7	105.7	39.9	89.2	162.4
Non-Qatari	23.0	22.4	-11.9	15.0	47.3
Medium Income	23.7	19.2	-10.9	12.8	38.8
High Income	24.0	23.8	-8.8	19.0	57.6
Very High Income	16.1	38.3	-3.3	33.5	123.3
1 Car Household	37.4	52.8	6.9	46.5	97.5
2+ Car household	61.7	105.7	39.9	89.2	162.4

Table 4-6 summarizes the coefficient ratios by mode for different population categories based on a disaggregate Stated Preference model estimation where time and cost parameters are separated out into their various components. This table reveals some important relationships and insights for inclusion in transport models to test future policies. These are:

1. That parking charges and toll charges are perceived as a bigger deterrent than fuel costs and as such including cost coefficients separately by these elements is essential to test parking and toll policy scenarios.

2. That congested travel time is consistently valued higher than general travel time across all categories and modes. This is also of high importance for the derivation of congestion charging toll strategies; and
3. That walk access to Metro is an impedance compared to Metro in vehicle time.

The Stated Preference results showed that separate time and cost parameters by attribute are likely to be critical to the modeling of the future modes and policies to be considered in Qatar.

Table 4-6: Stated Preference – Coefficient Ratios from Disaggregate Stated Preference Model Estimation

Category	Coefficient Ratios					
	All	Qatari	Non-Qatari	Non-Qatari-Low Income	Non-Qatari-Medium Income	Non-Qatari-High Income
Car Passenger Congested Time/Time	1.5	1.8	1.4	1.7	1.3	1.6
Car Driver Congested Time/Time	0.9	1.6	1.3	1.4	1.4	1.4
Taxi Passenger Congested Time/Time	2	2	2.1	1.8	2.3	2
Walk access/Metro in Vehicle Time	1.3	1.6	1.4	2	1.6	1.2
Parking Cost/Fuel Cost	2.5	*	3.6	*	2.2	1.5
Toll Cost/Fuel Cost	2.7	*	3.9	*	2.4	1.6

4.5 Household Survey Data Analysis

The household interview survey data comprises an extremely rich source of data providing household characteristics for over 12,000 households and personal and travel data for almost 45,000 people. The information contained in the Household Interviews enables household composition to be defined for different categories of household, for example by nationality, household type, and income. It also contains full personal and travel details for each household member enabling detailed analysis of mode of travel by person type, travel by purpose, the activities that drive travel needs, and the characteristics of the individuals that influence their travel decisions.

The analysis covers:

1. Household and personal characteristics.
2. Trip rates.
3. Tour and activity.
4. Distribution, mode of travel, and time of travel analysis; and
5. Walk, parking, and taxi usage characteristics.

Typical examples of the type of analyses undertaken using the Household Interviews data are shown below.

Figure 4-11 shows the relative proportions of households in each income band, split between Qatar and non-Qatari households. This shows that the two subpopulations have markedly different income distributions. That for non-Qataris mirrors the overall distribution (which reflects that they make up most households). By contrast, the median income being noticeably higher for Qataris (in the range QAR 20,001 to 35,000) and their distribution having a negative

skew (significant number of households with an income lower than the median). Around 14% of Qataris fall into the highest two income groups compared to less than 1% of non-Qataris.

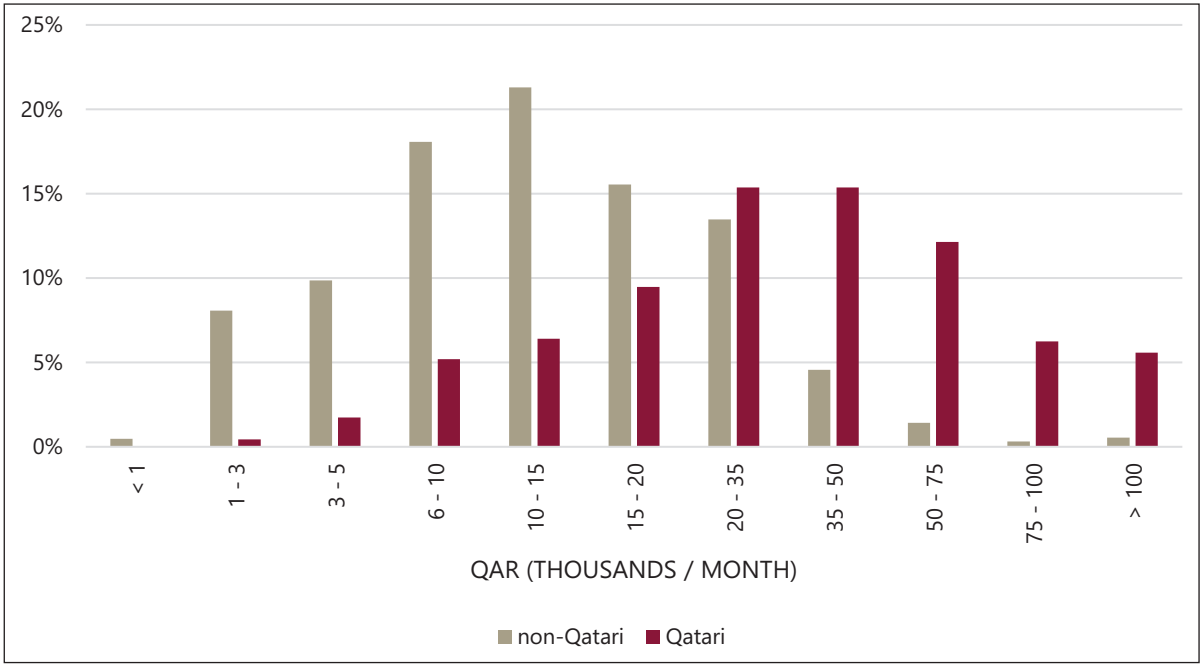


Figure 4-11: Household Income (Qatari / non-Qatari)

Table 4-7 shows how overall trip rates per person, for all those over five years old, vary by nationality, gender, car availability and day of week. The main points to note from this are that:

1. Weekend trip rates are much lower than weekday trip rates due to the absence of school trips and a much lower level of commuting at weekends.
2. On average males make significantly more trips than females in all categories.

3. Car available people generally make significantly more trips than non-car available people; and
4. Non-Qatari males make more trips per day than non-Qatari males and this may be due to higher number of workdays.

It is clear from the trip rates in this table that the composition of the population and its socio-economic characteristics are important drivers in the levels of travel.

Table 4-7: Person Trip Rates by Nationality, Gender, Car Availability and Day of Week

Nationality	Gender	Weekday		Weekend	
		Car Available	Non-Car Available	Car Available	Non-Car Available
Qatari	Male	2.496	1.896	2.196	1.200
	Female	1.698	1.476	1.080	0.924
Non-Qatari	Male	3.036	2.424	2.328	2.058
	Female	1.332	1.146	1.170	1.140

Note: All persons over 5 years of age.

Table 4-8 shows the proportion of trips made by each model of travel by nationality and day of week. This shows the extremely high dominance of car for trips made by Qatari households at 92% on weekday and at weekends. The use of car is still dominant in non-Qatari households, 73% on a weekday and 82% at the weekend. It must be noted that these figures reflect the situation at the time of the Household Interview surveys which pre-date the opening of the Doha Metro. They also relate to residents of households and exclude laborer's travel which is dominated by non-car modes.

Table 4-8: Proportion of Trips Nationality, Aggregated Mode of Travel, and Day of Week

Nationality & Day of Week	Mode of Travel				
	Car	School Bus	Company Bus	Taxi / Public Bus	Walk / Other
Qatari Weekday	91.7%	4.6%	0.2%	0.2%	3.3%
Qatari Weekend	92.0%	0.2%	0.0%	0.1%	7.6%
Non-Qatari Weekday	73.4%	9.8%	5.4%	2.8%	8.5%
Non-Qatari Weekend	82.4%	1.5%	2.3%	3.1%	10.7%

Figure 4-12 shows how household income influences the choice of travel mode with the proportion using car increasing with income. The Household Interview analysis contains extensive information that enables the development of relationships between socio-economic factors and how they influence the extent of travel made, the way in which that travel is undertaken, the timing of the travel, and the way that respondents view specific attributes of travel options such as parking cost, and walk access to public transport for example.

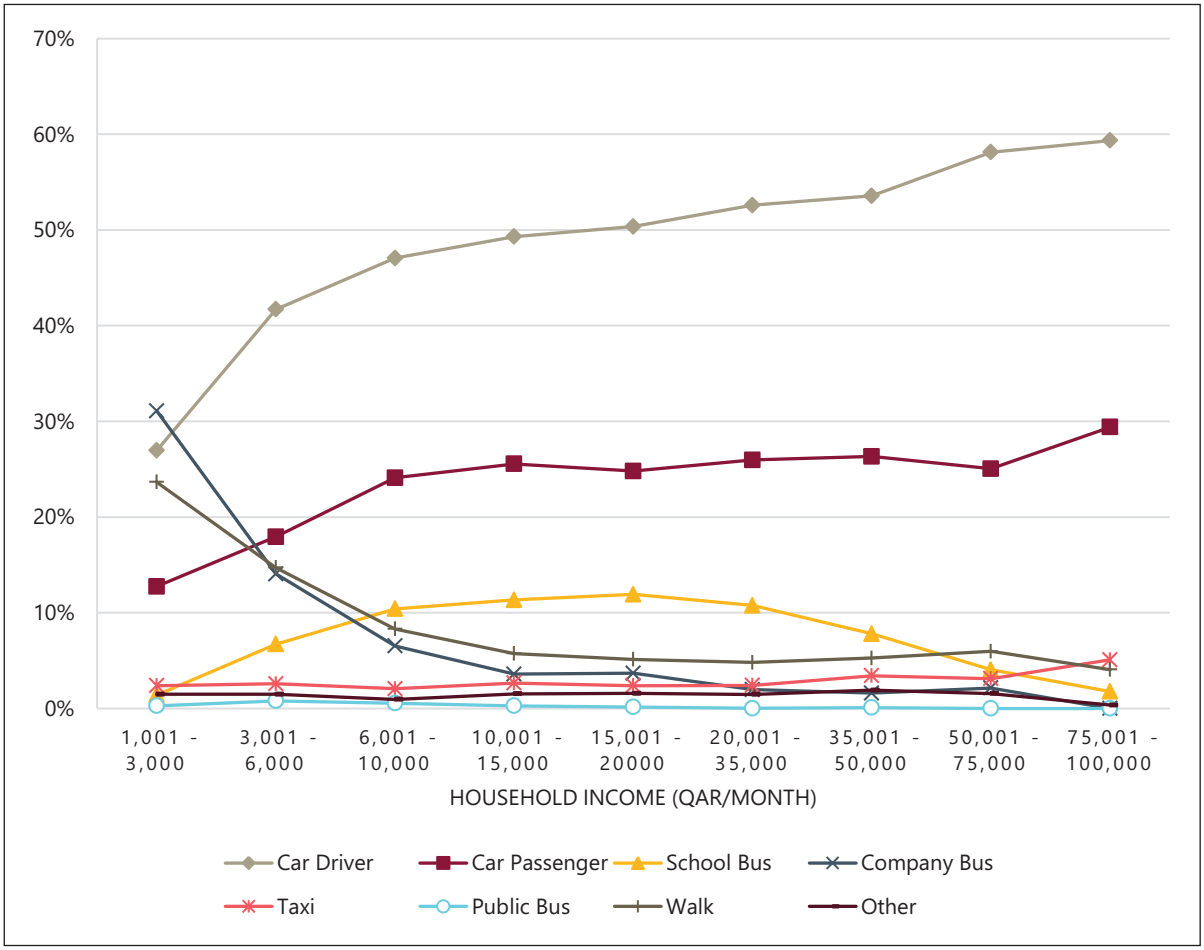


Figure 4-12: Proportion of Trips by Household Income, and Mode of Travel – Non-Qatari Weekday

Table 4-9 shows how overall trip rates per person over the age of five vary by nationality, gender, car availability and day of week. It is also clear that the composition of the population and its socio-economic characteristics are important determinants of travel behavior.

Table 4-9: Person Trip Rates by Nationality, Gender, Car Availability and Day of Week (All persons)

Nationality	Gender	Weekday		Weekend	
		Car Available	Non-Car Available	Car Available	No-Car Available
Qatari	Male	2.496	1.896	2.196	1.200
	Female	1.698	1.476	1.080	0.924
Non-Qatari	Male	3.036	2.424	2.328	2.058
	Female	1.332	1.146	1.170	1.140

Note: All persons over 5 years of age.

Figure 4-13 shows the estimated number of Home-Home weekday tours, based on the expanded resident household surveys. The results are split between the two nationality groups and by gender. From these splits, the estimated average person tour rates for each of the four sub-groups is derived. The average number of weekday home-based tours per male falls in the range 0.62-1.07 (being higher for Non-Qataris). The corresponding range per female is 0.420.47 (being slightly lower for Qatari nationals).

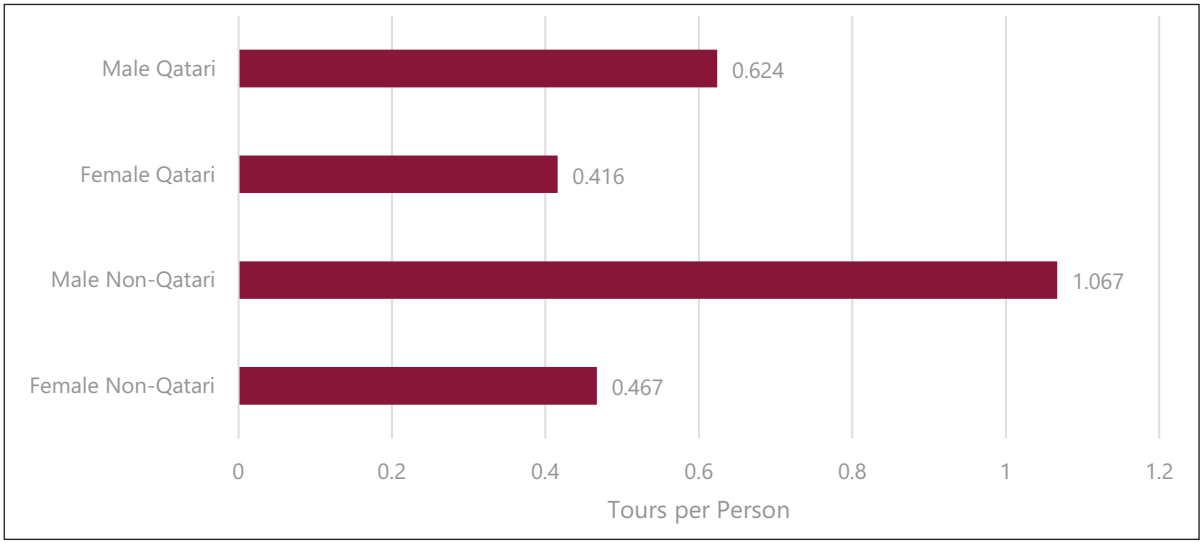


Figure 4-13: Average Number of Home-Based Weekday Tours

Table 4-10 gives the median weekday travel time by trip purpose. Typically, half of Commuting trips and half of Business trips are completed in under 35 minutes. Home-Based Education trips take on average 37 minutes, whilst the discretionary trips tend to involve shorter journey times, typically in the range 25-29 minutes.

Table 4-10: Median Weekday Travel Time by Purpose and Travel Mode

Trip Purpose	Median Journey Time, min					
	Bus	Car	Other	Taxi	Walk	All Modes
Home-Based Work	41	35	26	32	15	35
Home-Based Education	40	35	33	31	29	37
Home-Based Shopping	40	25	22	19	15	25
Home-Based Other	24	29	19	28	10	27
Employers Business	27	36	-	50	36	36
Non-Home-Based Other	36	29	36	61	16	29
All Purposes	**39**	**32**	**23**	**31**	**13**	**33**

The percentage of walking trips as the selected choice of mode for different trip purposes are summarized in **Table 4-11**. The walking trips are recorded as standalone trips or as access to another mode, public transportation (PT). The result shows that individuals are willing to walk for educational trips more than the other types of trips.

Table 4-11: Mode Share for Walking as Main Mode or Access to PT

Trip Purpose	Total Trips			Mode Share	
	Walking Only	Access to PT	All Modes	Walking Only	Access to PT
Weekday Walking Trips					
Home-Based Work	30,564	53,417	**581,740**	5.3%	9.2%
Home-Based Education	5,116	116,967	**350,126**	1.5%	33.4%
Home-Based Shopping	6,855	8,677	**131,075**	5.2%	6.6%
Home-Based Other	56,046	21,314	**628,168**	8.9%	3.4%
Non-Home-Based Other	6,200	2,698	**224,926**	2.8%	1.2%
Weekend Walking Trips					
Home-Based Work	17,075	14,264	**174,226**	9.8%	8.2%
Home-Based Education	1,394	3,709	**17,176**	8.1%	21.6%
Home-Based Shopping	9,696	1,895	**211,707**	4.6%	0.9%
Home-Based Other	129,816	13,693	**995,450**	13.0%	1.4%
Non-Home-Based Other	10,915	5,968	**188,024**	5.8%	3.2%

4.6 Parking Interview Data Analysis

The parking surveys collected data on the origin-destination of the traveler, their demographic profile, and the details of their parking activity. Additional information was collected on their perceptions of, and satisfaction with, the parking facilities and the importance the driver attached to different aspects of parking facilities. A pricing exercise was also carried out to identify the parking charge thresholds at which different categories of people will begin to consider using other modes of travel.

Figure 4-14 shows the average parking duration by trip purpose. The average parking duration for home-based work, commuting trips, is just over five hours. It should be noted that the duration relates to each separate parking act, hence if someone had gone out from work for a meeting or to lunch and taken the car then the average commuting parking time would reflect this. The average parking duration for the other trip purposes was very similar ranging from one hour 20 minutes to two hours and 3 minutes.

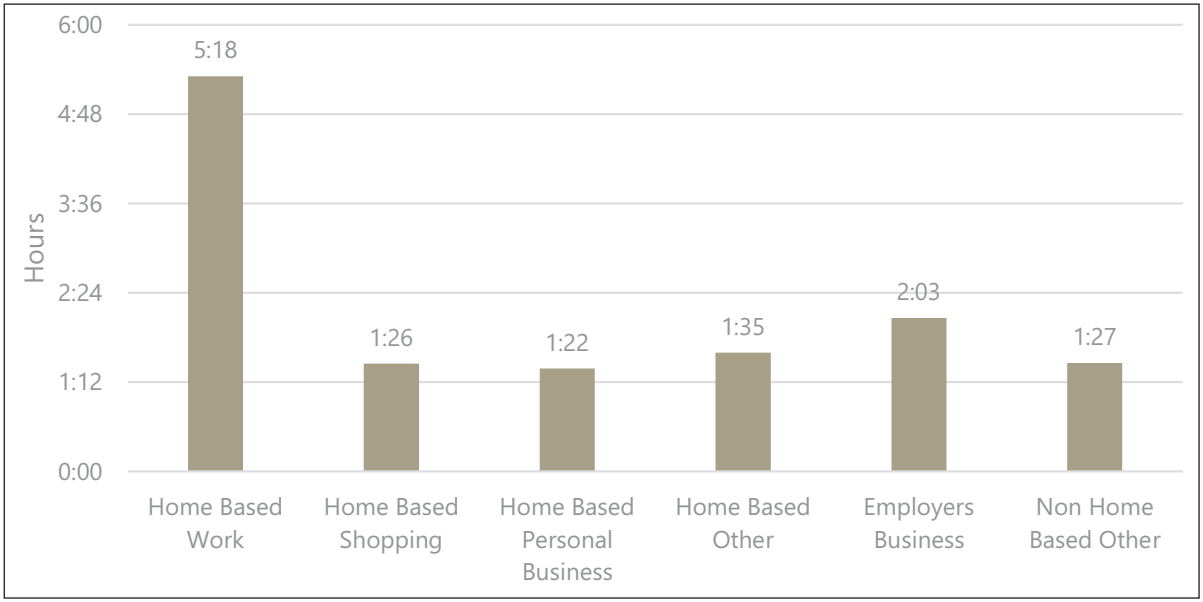


Figure 4-14: Average Parking Duration by Trip Purpose

The findings show that there is a clear income related effect in the willingness to pay parking charges as shown in **Figure 4-15**.

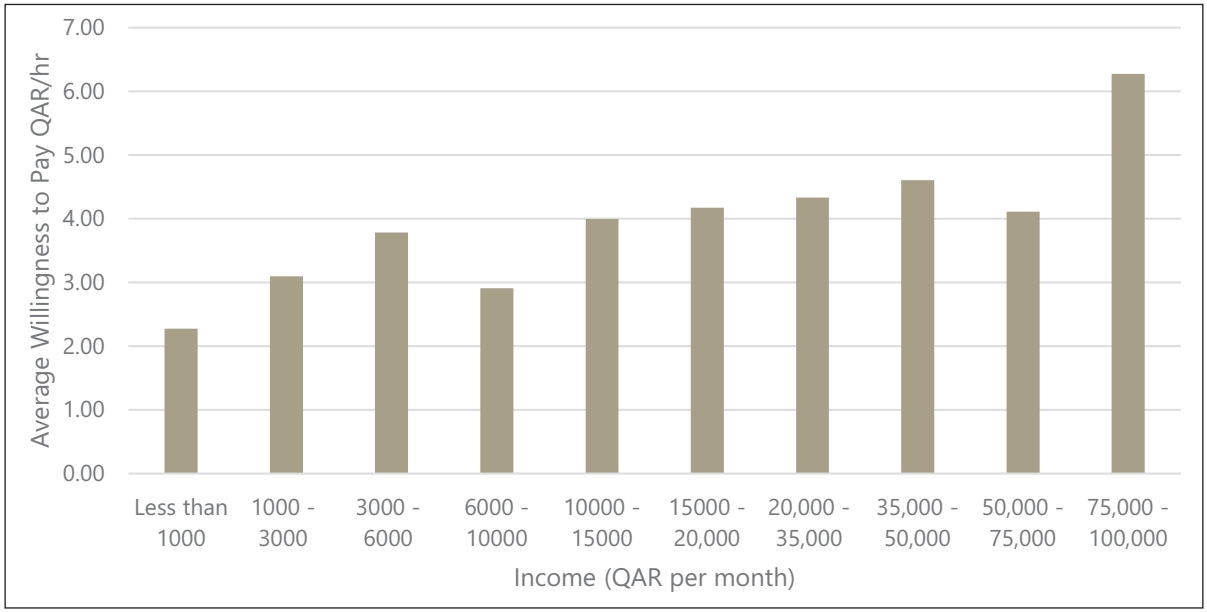


Figure 4-15: Average Hourly Parking Charge People Were Willing to Pay by Income Band

Respondents were presented with a range of potential hourly parking charges and asked to indicate whether they would consider changing their travel mode in response to the proposed level of parking charge. **Figure 4-16** shows the proportion that responded yes or no to the possibility of mode shift for the different parking charge levels presented.

The implication of this is that there is a threshold of parking charges beyond which different types of respondent will start to make alternative choices. Initially people will pay moderate charges if there is an improvement in the parking environment but then as charges further increase, they may start to travel to alternative destinations to minimize the parking costs. To encourage modal transfer as part of a wider policy the implications of the analyses carried out are that charges will need to exceed 6 QAR per hour on average.

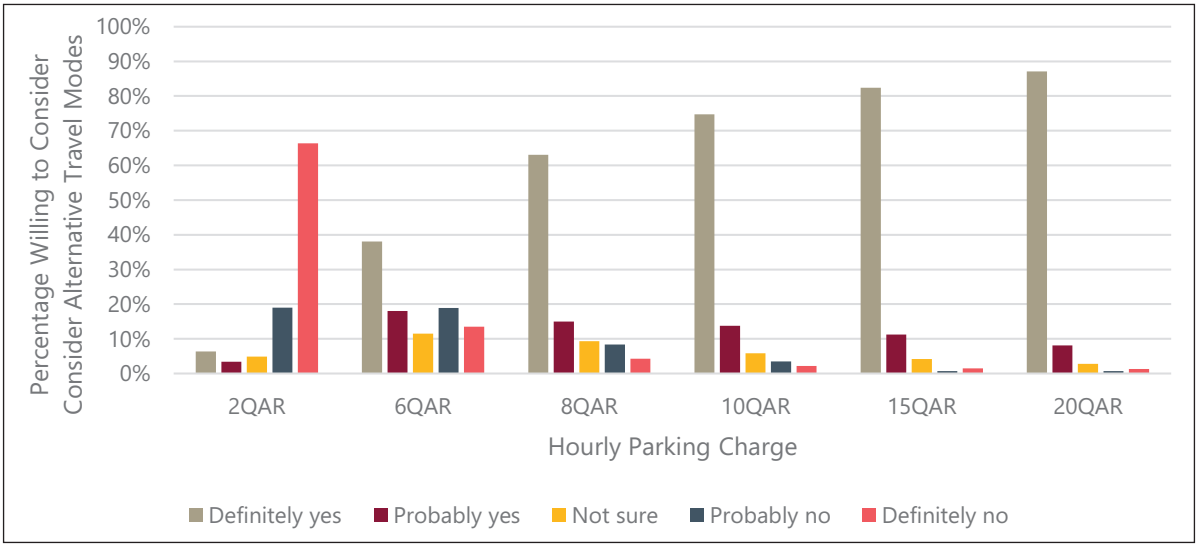


Figure 4-16: Willing to Consider Alternative Travel Modes by Hourly Parking Charge

The main findings of the parking surveys and the analyses undertaken on them can be summarized as follows:

1. Average parking duration by purpose is:
    - 5 hours 18 minutes for commuting trips.
    - 1 hour 26 minutes for shopping trips.
    - 1 hour 22 minutes for personal business trips.
    - 1 hour 35 minutes for leisure/eating out and other trips; and
    - 2 hours for employer's business trips.

2. Low willingness to walk from the parking location to one's destination with people reporting an average value of just under 4 minutes. Only 20% of people were willing to consider walking for more than 5 minutes from where they parked to their destination.
3. Willingness to pay parking charges as part of measures to control parking and its management varies by nationality ranging from as low as 40% for those from Asian backgrounds to 85% for Qatari nationals. The data indicated a clear income-based effect as would be expected.
4. The average hourly parking charge that people were willing to consider paying varied by income level from 2.3QAR per hour for low income respondents to 6.3QAR for very high-income respondents.
5. Regarding the importance of car park features and people's satisfaction with them, the most common theme was a lower satisfaction regarding parking charges and payment facilities reflecting an aversion to paying for parking. Other issues were raised regarding ease of entry /exit, availability of spaces, and manoeuvrability within the car park. The issues identified varied by car park and may well have reflected the differing design standards within the respective car parks with old car parks and newly designed car parks showing differences in levels of satisfaction.
6. When asked about their willingness to consider alternative modes in response to parking charges it was clear that low levels of parking charges less than 3 QAR per hour would be insufficient to promote mode transfer and that charges in excess of 6 QAR per hour would be required before people would begin to consider alternative options for their travel mode; and
7. Finally, it has been possible to develop a parking search time restraint curve for application in a modelling framework. The relationship has been developed from observed data on search times provided by respondents which were then linked to the prevailing car park occupancy at the time they were looking for a space.

4.7 Behavior Based Survey Analysis Report

The Behavior Based Survey Analysis Report presents the key findings in relation to travel behavior across all categories of travelers within Qatar and comprises a comprehensive summary of the findings from the various behavior surveys carried out in the study and draws on previous reports where the survey analysis has been described in greater detail. For further information on any aspect of the survey analysis the following reports can be referenced.

1. Household Interview Survey Analysis Report.
2. Model Estimation Analysis Report.
3. Other Survey Report.
4. Parking Survey Report.
5. Local Factors and Transportation Parameters Report.

Almost all the information presented in this report are drawn from the information in the above reports to provide as concise a picture of the travel behavior characteristics across all sectors in Qatar including.

1. Household Tour and Trip Analysis.
2. Public Transport Market Analysis.
3. Pedestrian and Cyclist Behavior and Attitudes.
4. Parking Behavior Analysis.
5. Visitor Survey Analysis.
6. Demand Analysis for Special Generators.
7. Analysis of the Stated Preference Analysis.
8. Labor Market Tour and Trip Analysis.

4.7.1 Household Tour and Trip Analysis

The 2017/18 Household Interview (HHI) survey program was designed to capture typical travel behavior for households across Qatar. The primary survey instrument used for data collection was a one-day travel diary which recorded activities (and their locations), and trip chains together with major travel determinants (such as demographic, socioeconomic, and car availability profiles), both at the household and the individual level. The travel diary surveys were augmented by stated preference experiments (used to measure the relative attractiveness of new public transport modes). A total of 10,122 weekday and 2,132 weekend surveys were successfully completed. A further 3,123 stated preference surveys were conducted on subsets of the full household sample.

Table 4-12 below shows the total number of weekday tours, based on the expanded resident household surveys that start and end at home. The average number of weekday home-based tours per male falls in the range 0.62–1.07 (the highest is recorded for non-Qataris) and that per female is 0.42–0.47 (the highest is recorded for non-Qataris).

Table 4-12: Weekday Home-Based Tours by Gender and Nationality

Nationality	Gender	Population	Trips	HH Tours	Average Tours/Day
Qatari	Male	154,183	215,689	96,166	0.6237
	Female	154,944	139,813	64,468	0.4161
Non-Qatari	Male	337,257	819,485	359,959	1.0673
	Female	349,987	353,581	163,597	0.4674
All household residents		**996,371**	**1,528,568**	**684,190**	**0.6867**

Table 4-13 shows the median travel time split by trip purpose and mode of travel. The results indicate that there is variation not only between purposes but, for the same purpose, between modes. For example, whilst Walk trips in general tend to be shorter (in duration) than Car trips (13 minutes vs 32 minutes), Business trips made on foot, take on average, the same length of time (36 minutes) as a car trip.

Table 4-13: Median Weekday Travel Time by Purpose and Travel Mode

Trip Purpose	Median Journey Time (min)				
	Bus	Car	Other	Taxi	Walk
Home-Based Work	41	35	26	32	15
Home-Based Education	40	35	33	31	29
Home-Based Shopping	40	25	22	19	15
Home-Based Other	24	29	19	28	10
Employers Business	27	36	-	50	36
Non-Home-Based Other	36	29	36	61	16
All Activities	**39**	**32**	**23**	**31**	**13**

Table 4-14 shows the proportion of each trip purpose made by each of the main travel modes. For all purposes other than Home-Based Education, car trips make up 80-95% of the total. For Home-Based-Education the share is only 65%, most of the remainder being made by bus.

Table 4-14: Mode Share by Trip Purpose

Trip Purpose	Mode of Travel				
	Car	Taxi	Bus	Walk	Other
Home-Based Work	82.3%	2.5%	9.2%	5.3%	0.7%
Home-Based Education	64.6%	0.4%	33.4%	1.5%	0.2%
Home-Based Shopping	85.9%	2.0%	6.6%	5.2%	0.2%
Home-Based Other	85.9%	1.1%	3.4%	9.0%	0.6%
Employers Business	93.8%	1.2%	0.4%	4.5%	0.0%
Non-Home-Based Other	94.6%	1.4%	1.2%	2.6%	0.1%
All Activities	**82.0%**	**1.5%**	**10.6%**	**5.5%**	**0.5%**

4.7.2 Public Bus Passengers

The aim of the Public Transport Passenger Interview surveys was to collect travel data from passengers using the public bus services operating in Qatar. Origin-Destination data were collected from a representative sample of travelers, including their demographic profile, modes of access to/from the bus service, and how many interchanges were required to complete their journey, perceptions of service satisfaction, intention to continue using the bus services, the importance they attached to different aspects of the bus service and how well the current bus services performed on these aspects. The data from the operator of bus services (Mowasalat) showd that on average, the number of boarding passengers was 65,440 for weedays, 70,400 for Fridays and 58,220 for Saturdays.

Figure 4-17 shows the daily distribution for each day type (i.e., typical weeday, Fridays and Saturdays) for the boarding and alighting passengers who are using the public bus service.

It can be seen that there are two demand peaks, for the morning and the evening. There are clear morning and evening peaks, the latter being more pronounced. Also, the alighting trend is very similar to the boarding one, with almost one-hour shift, which reflects the average bus journey time.

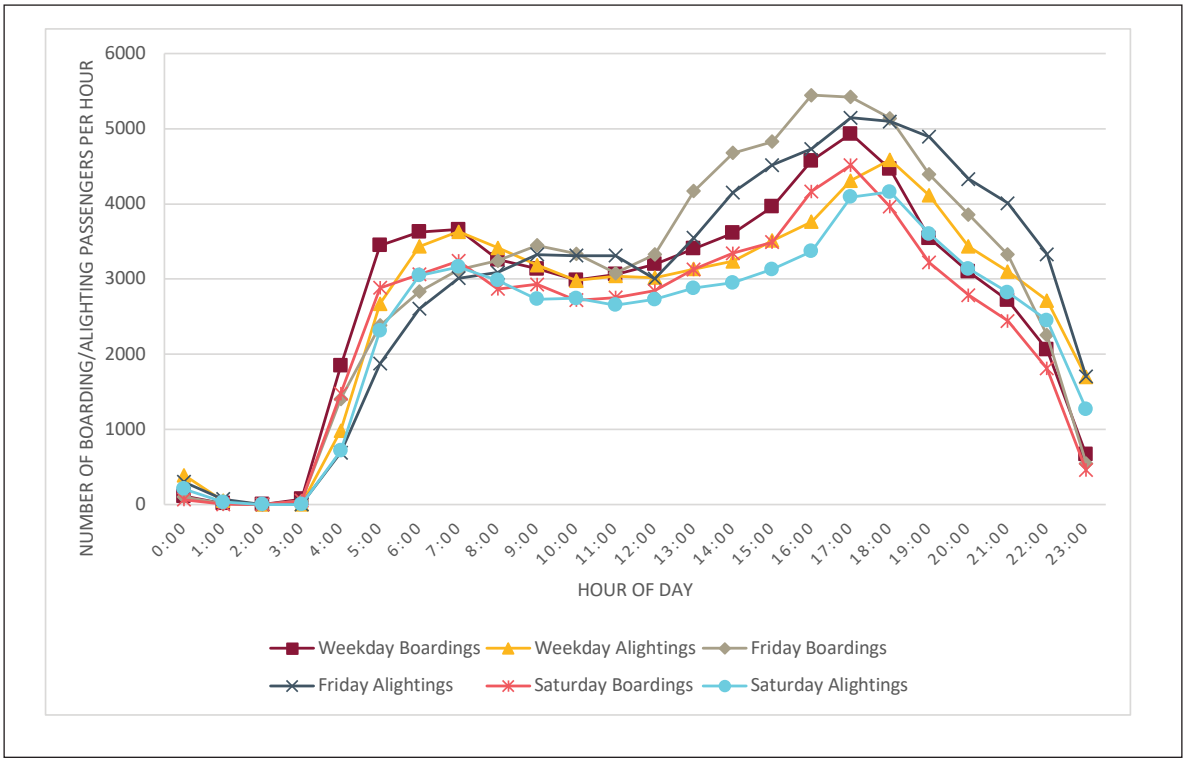


Figure 4-17: Qatar Public Bus Weekday Boarding and Alighting Profiles

Figure 4-18 shows the variation in waiting times across the day (based on the data for all bus services combined). The longest wait times appear to have occurred either during periods of high demand or when services were less frequent.

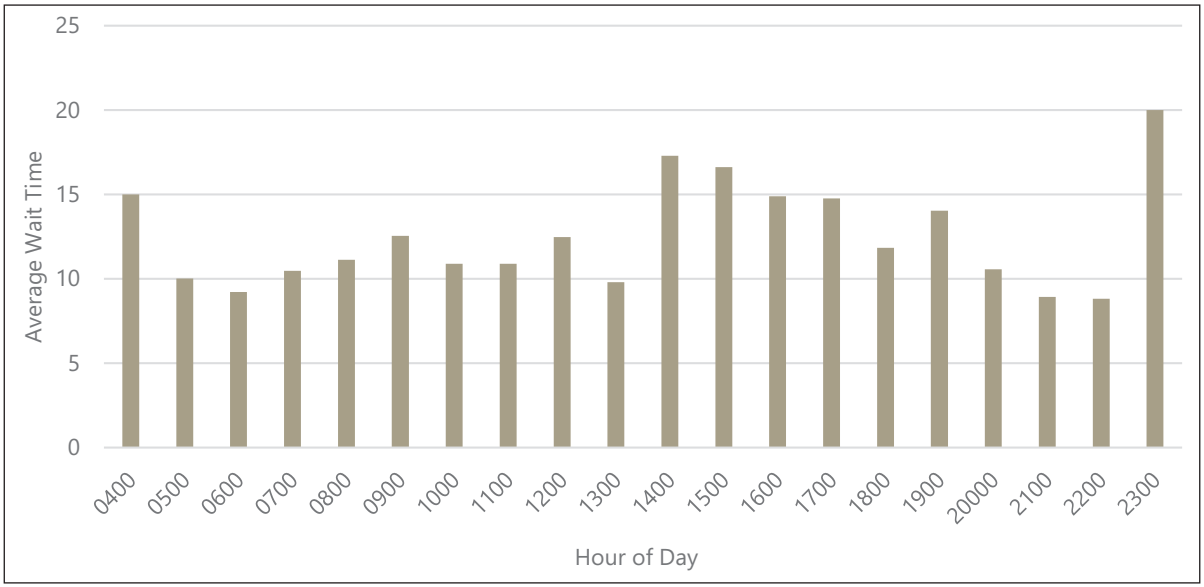


Figure 4-18: Average Wait Time in Minutes by Hour of Day

An important aspect in relation to public transport usage is the concept of the first mile/last mile which depicts the process of accessing Public Transport services. This is critical to the use of Public Transport and especially where environmental conditions, either extreme heat or cold, can make getting to/from the bus or Metro stop uncomfortable. The main factors that emerged from the surveys regarding first mile/last mile are:

1. That access to the bus stop was dominated by walking, 85.9%, with a relatively small number of people having interchanged from another bus service, 7.9%. Taxis as an access mode to PT is low, 2.1%, as is drop-off at 2.3%;
2. Amongst those that walk to the bus stop the average walk time was 8 minutes and 12 seconds with an 85th percentile time of 13 minutes. Based on a walking speed of 4kph the catchment area of the bus stops was from 550m to 860m;
3. After arrival at the bus stop the next element of the first mile is the waiting time encountered before boarding the bus service and at the present time this was on average between 10 and 15 minutes but with a range from 5 minutes to over 40 minutes; and
4. On leaving the bus 97% of respondents walked to their destination and on average this took 7 minutes with an 85th percentile time of 10 minutes. Based on a walking speed of 4kph the catchment area of the bus stops was from 500m to 750m.

On average to use the current bus system people have around 21 minutes to reach and board the bus and then another 7 minutes from leaving the bus to getting to their destination, a total time of 28 minutes on average.

The attitudinal questions highlighted the importance that travelers place on the ease of access to the stops and the waiting time required, and the waiting environment. Encouraging the use of Public Transport requires the 'off-system' features to be considered as simply getting to/from the system can be the biggest deterrent to its use. Reducing the first mile/last mile time and/or improving the conditions in which that element of the trip is made can have a significant impact on Public Transport usage.

Measures can include decreasing access times by decreasing the distance between stops and/or making the routes to the stops more direct and reducing pedestrian crossing times at junctions. Provision of adequate shade on the primary routes to/from bus and Metro stops

can make a difference to the walking experience. More frequent services would reduce waiting times and where this approach is not practical, real time information can be used to allow passengers to schedule their arrival at the stops by knowing when the service they want to use will arrive.

Other key points from the public passenger transport surveys can be summarized as follows:

1. Most Public Transport bus movements are to/from Doha City Center and this is dictated by the nature of the services originating or terminating at the main bus station in Mushereib;
2. The daily use of the respective bus services varies widely with some services carrying over 2,000 passengers per day whilst others have less than 250 passengers per day;
3. Total daily patronage on a weekday in 2018 was 65,440 boarding passengers, which rise to 70,400 on a Fridays when laborers have their main day off as they comprise a significant proportion of the bus patronage;
4. Passengers are mainly expatriates, 96.7%, and only 1.4% are Qatari citizens, and 1.7% tourist/leisure travelers;
5. 91.7% of bus passengers were full-time employed and almost do not have access to a car as a driver;
6. 51.5% of trips are commuting and most of the rest are shopping/leisure/other personal trips (45.6%) but very few education trips, 1.2%;
7. Only 4.4% of people transferred indicating a desire for direct point to point services due to the impedance provided by the need to transfer;
8. 82% of the passengers quoted their monthly salary as being less than 6,000 QAR indicating a high proportion of lower income users;
9. When asked about the ranking of Public Transport service attributes and their satisfaction with them, the following were identified as the main areas where the main concerns existed:

- Service reliability and punctuality
- Waiting times
- Timetable information
- Comfort at the bus stop
- Access / egress time to bus

4.7.3 Pedestrian and Cycle Surveys

The Pedestrian and Cyclist Interview surveys aimed to understand people's attitudes toward both walking and cycling, and the issues that need to be addressed to encourage and promote active and sustainable travel in Qatar, both for recreational and non-recreational purposes. The survey was designed to collect data on the origin and destination of each respondent, their demographic profile, their perceptions of the importance of current walking and cycling facilities, and the reasons why they do not walk or cycle more often. A total of 24 sites were selected to collect this type of surveys.

Figure 4-19 show the daily flow profile for pedestrians and cyclists across all 24 survey sites. Most of the pedestrian activity took place in the evening, reflecting the proximity of shopping and leisure facilities.

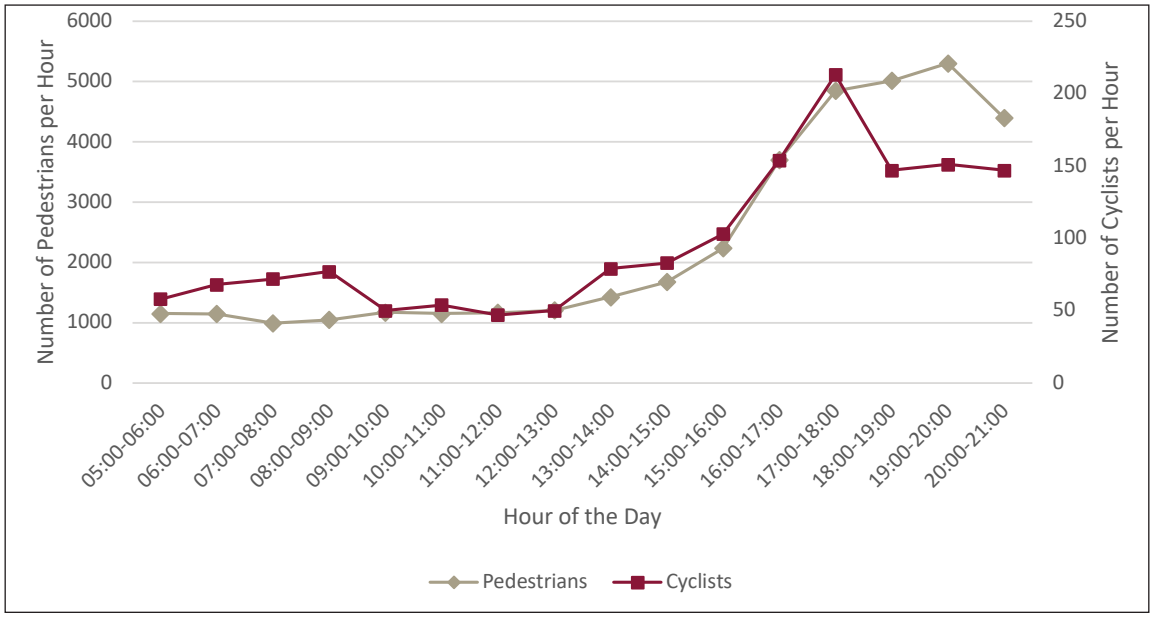


Figure 4-19: Daily Flow Profile for Pedestrians and Cyclists across All Survey Sites

Figure 4-20 presents the distances traveled to work by the pedestrian respondents. A significant number (27.6 percent) reported traveling less than 5 km. **Figure 4-21** on the other hand shows the distribution of travel distances for Commuting trips for the cyclist survey respondents. The average distance was 11.2 km across all travel modes. These were derived from the distances quoted by respondents (i.e., self-reported).

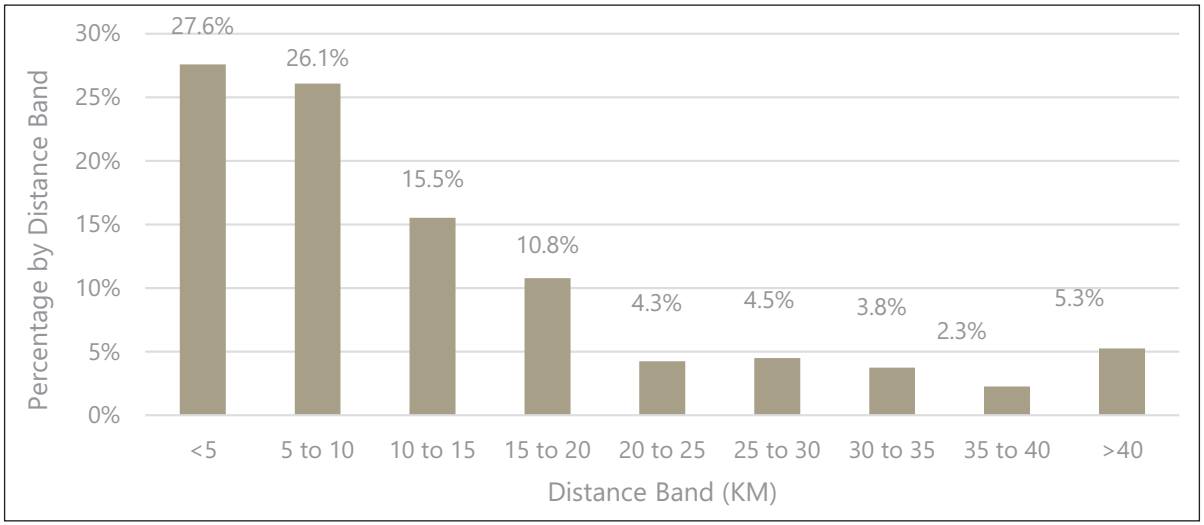


Figure 4-20: Distribution of Distance to Work: Pedestrian Survey Respondents

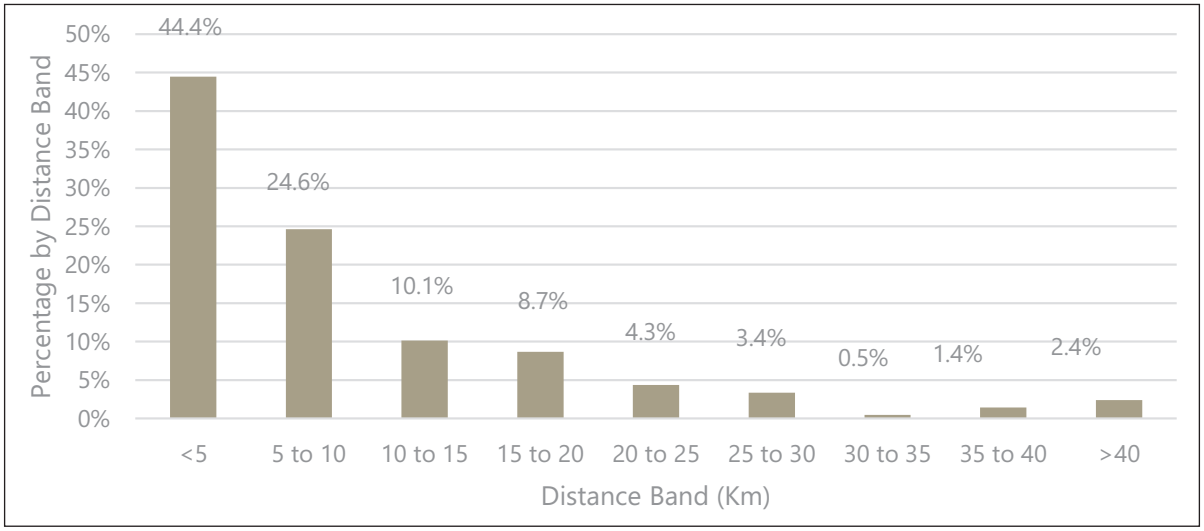


Figure 4-21: Distribution of Journey Distance to Work - Cyclist Respondents

Some of the main points to note regarding the pedestrian and cycling surveys are as follows:

1. Most of the pedestrian and cycle activity at the 25 survey sites was recorded in the evening period between 1700-2200. Pedestrian activity was around five times higher at these times than earlier in the day.
2. Of people who were cycling to work 82.4% of the trips were less than 5 kms.
3. Overall 42.4% of males said they had a bicycle available compared to only 26.3% for females.
4. Respondents frequency of cycling was generally low except for exercise/leisure where 20% of people said they used their bike daily. The areas chosen for the surveys covered locations which facilitated cycling, so this was not unexpected.

5. When asked about future likelihood of cycling, if cycle facilities were enhanced, many people said they would do so for exercise/leisure but there were also some people who stated that they would for other purposes as well, 14% for commuting, 7% for school trips, and 24% to go shopping/eat out.
6. Important reasons given for not cycling more often include heat with 82% stating this was an important issue but the next most important reasons all related to the facilities available for cycling such as limited bicycle lanes, condition of the bicycle lanes that are available, unsafe intersections and roads, and driver behavior towards cyclists.
7. Investigation of the effect of the ambient temperature on cycling showed that there was a greater willingness to cycle in the period Oct-Apr than May-Sep with people willing to cycle on average 31 minutes and 24 seconds in winter compared to 23 minutes and 6 seconds in summer.
8. As with the cycle survey results, the issue of heat is the most important reason provided for 73% of respondents for not walking more often. Other factors that were considered important were that their destination was too far away to walk, 48%, no sidewalks, 42%, driver behavior and poor intersection facilities.
9. The most important attributes relating to walking were:

    - More sidewalks and increased shade on sidewalks
    - Better maintenance of sidewalks
    - Improved connections to transit
    - Better intersections with improved priority for pedestrians

10. The influence of temperature on the average walking times was clearly seen in the comparison of willingness to walk by time of year with walk times in Winter much higher than Summer.

4.7.4 Hotel Guest Surveys

The objective of the hotel guest surveys was to capture daily trip and travel/personal characteristics of both tourist and business travelers, across a range of hotel classes and locations. The activity-based travel diary collected information on each of the activities undertaken by a sample of hotel guests in the course of the day, the places where those activities took place, their timing, and the modes of travel used to move from one place to another. The surveys revealed that hotel guests were (in descending order) 48% Europe/Australia/Americas, 31% Asian, 11% Arab and 10% others; **Table 4-15** show the weekday trip purpose by nationality for the hotel guests.

Table 4-15: Hotel Guests Weekday Trip Purpose by Nationality

Trip Purpose	Arab Nations	Asian Nations	Europe, Australasia Americas	Other	All
Home Based Work	13.3%	21.7%	18.4%	11.9%	18.4%
Employers Business	10.8%	19.5%	14.7%	14.2%	15.8%
Home Based Shopping	10.8%	10.6%	7.8%	13.7%	9.6%
Home Based Other	38.6%	33.2%	41.3%	32.3%	37.6%
Home Based Personal Business	7.9%	2.4%	2.2%	5.3%	3.2%
Non-Home Based Other	18.6%	12.6%	15.6%	22.6%	15.4%

Table 4-16 shows the estimated weekday trip rates by purpose. Taken across all nationalities, these ranged between 2.096-2.442, with an average rate of 2.311 trips per day.

Table 4-16: Hotel Guests Weekday Trip Rates by Trip Purpose by Nationality

Trip Purpose	Arab Nations	Asian Nations	Europe, Australasia Americas	Other	All
Home Based Work	0.278	0.527	0.401	0.255	0.411
Employers Business	0.226	0.476	0.346	0.302	0.368
Home Based Shopping	0.226	0.260	0.182	0.292	0.222
Home Based Other	0.809	0.812	0.970	0.689	0.874
Home Based Personal Business	0.165	0.060	0.053	0.113	0.074
Non-Home Based Other	0.391	0.307	0.364	0.481	0.362
All Trips	**2.096**	**2.442**	**2.316**	**2.132**	**2.311**

The other hotel guest surveys revealed the following key information:

1. Daily trips by guests are leisure 37.6%, shopping/other personal business 28.3%, work 18.4% and employer's business 15.8%.
2. On average hotel guests made 2.311 trips per day whilst in Qatar.
3. The modes of travel used by the hotel guests are taxi (35.6%), car (23.8%), walk (19.4%), private shuttle buses (19.8%), public transport buses (0.4%, and other modes (1.0%).
4. The average travel time per trip ranges from 32.6 minutes and 36 seconds to 38 minutes and 54 seconds depending on trip purpose.
5. Hotel guests average taxi fare paid per trip ranged from 20.4 QAR to 27 QAR.

4.7.5 Air Passengers

The main objective of the airport surveys was to collect information on the mode of travel used by air passengers (both residents and visitos) to get to or leave the airport, and the

passengers' demographic profiles. This data can then be used to construct an air passenger surface access model suitable for forecasting future travel demands generated by the airport under a range of scenarios. The survey excluded air passengers who were in transit and did not leave the airport. A total of 1,174 air passenger surveys were carried out.

Figure 4-22 shows the destination purpose for the arriving air passenger. Home was the primary purpose for all returning residents of Qatar, while Holiday Home/Hotel was the dominant purpose for both business travelers and tourists. A small number of business travelers were destined for Work (10 percent) while just under 10 percent of tourists were staying with friends or relatives.

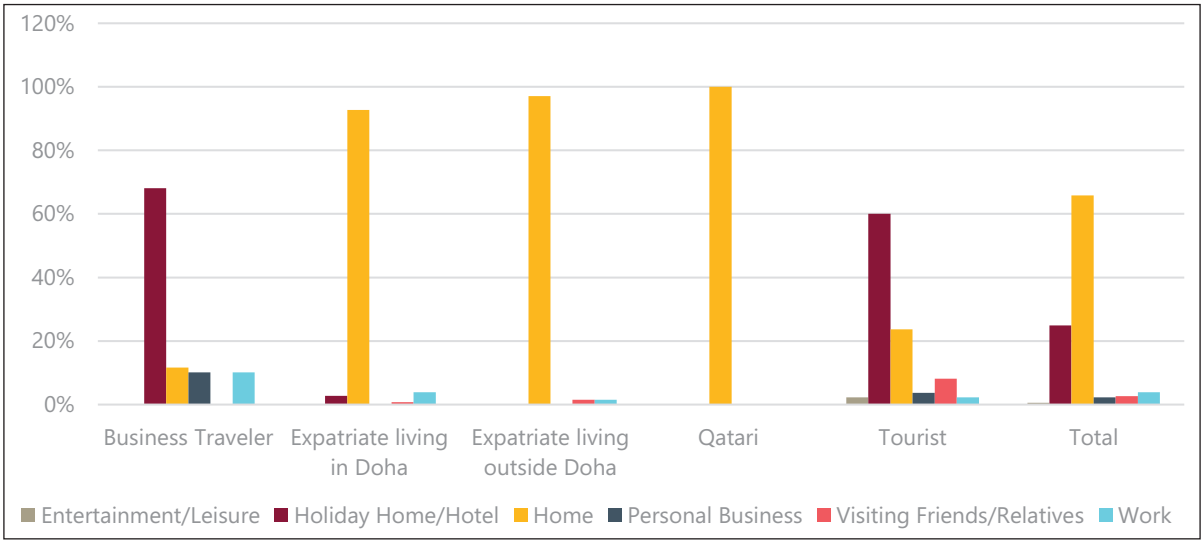


Figure 4-22: Destination Purpose for Arriving Passengers on Leaving the Airport by Category

Figure 4-23 shows the proportion of departing passengers by their origin purpose (i.e. prior to travelling to the airport). The dominant purposes were Home for residents of Qatar and Holiday Home/Hotel for business travelers.

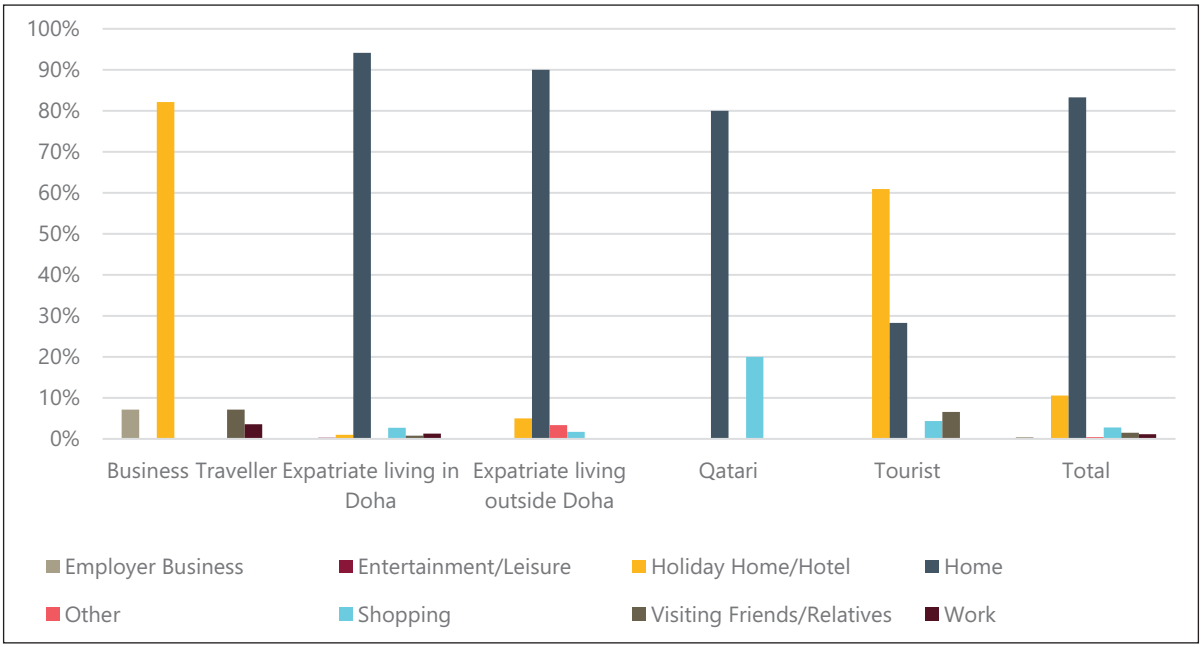


Figure 4-23: Origin Purpose for Departing Passengers before Arriving at the Airport by Category

The main points arising out of the air passenger surveys can be summarized as follows:

1. Between 40.6% and 53.3% of passengers by type of travelers were being met at the airport implying a significant amount of inbound traffic associated with this activity;
2. The majority of arriving passengers were heading to their home address for residents, 65.9%, but a significant number were also going to hotel/holiday home, 24.9%
3. The mode of travel from the airport is dominated by car, 37.3%, taxi 32.8%, and 26.2% by private or public shuttle buses;
4. The proportion of air passengers who are accompanied to the airport ranges from 25.5% to 39.1% by type of travelers which is lower than the proportions meeting passengers but still adds a significant extra number of trips from the airport;
5. The mode of travel to the airport shows 25% by car, 31.1% by Karwa/Careem/Uber, and 39.5% by private/public shuttle buses.;
6. An analysis of travel times to the airport shows that 60% of journeys are less than 30 minutes, but can be anything up to two hours;
7. The distribution of air passengers in terms of place of destination in Qatar is dictated by residential accommodation locations for Qatari residents but concentrated in Doha City Centre and West Bay for tourist and business travelers.

4.7.6 Cruise Terminal Passengers

Similar to the air passengers, the Cruise Terminal surveys were conducted to understand the profile of cruise passengers. **Figure 4-24** shows the age distribution of the combined arriving and departing cruise terminal passengers. The majority (74 percent) were over the age of 45. This is consistent with the profile of cruise passengers generally encountered.

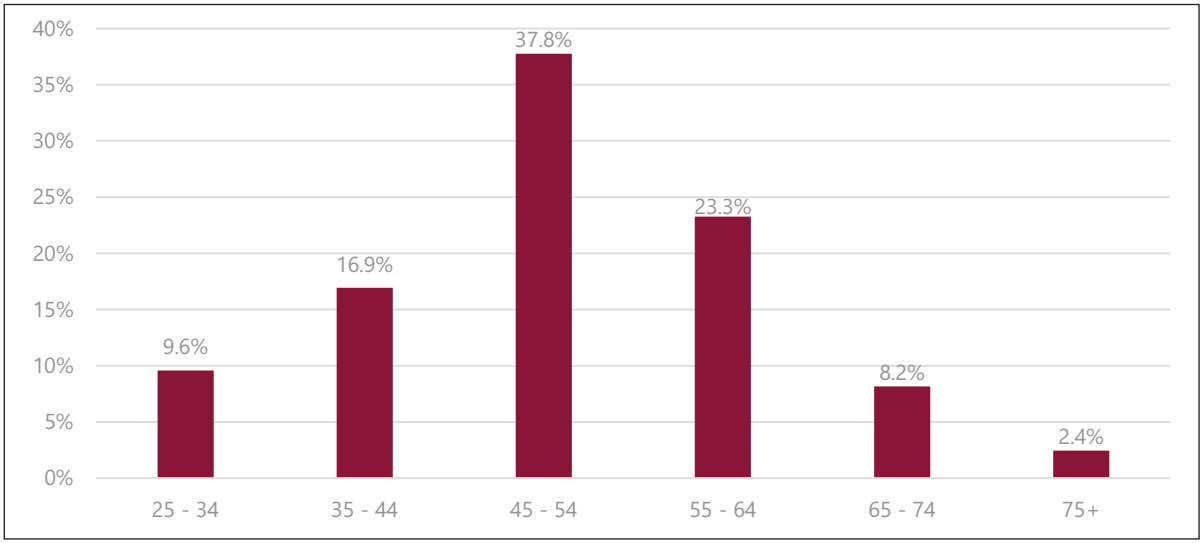


Figure 4-24: Cruise Terminal Passenger – Age Group

Figure 4-25 shows the travel mode used by passengers leaving the cruise terminal to reach their destination in Qatar. Shuttle buses and public buses were the most popular (over 86.3 percent). This is consistent with a high proportion of organized tours (typically day trips).

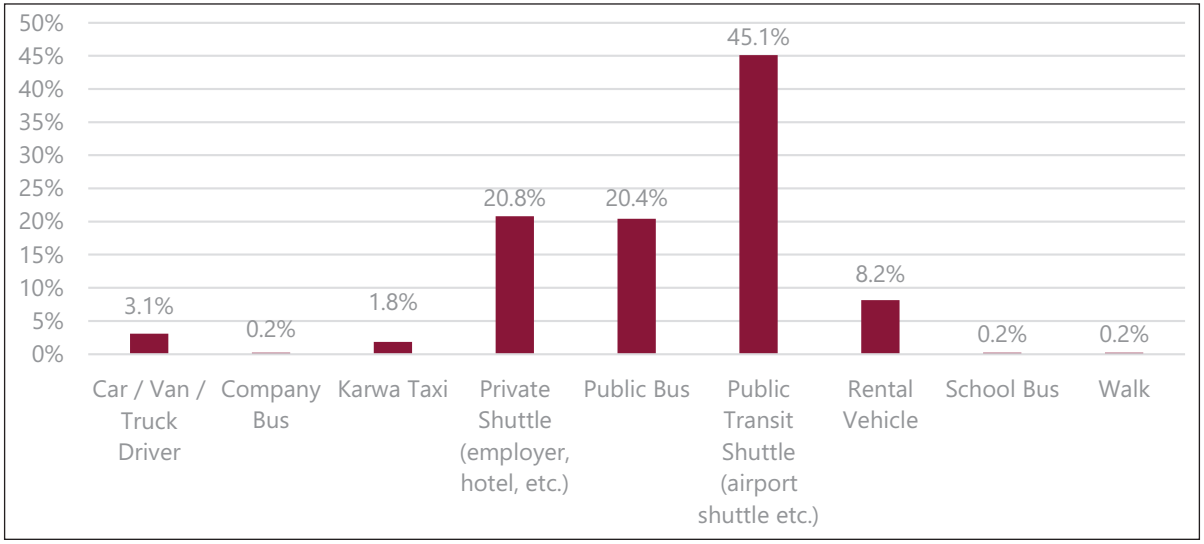


Figure 4-25: Cruise Terminal Passenger – Mode of Departure from the Terminal

Most passengers (95 percent) interviewed entering or leaving Qatar via the cruise ship terminal stayed on board their ship overnight. The most popular locations visited by the cruise ship passengers were Souq Waqif, The Corniche, The Pearl, Dhow Harbor, Museum of Islamic Art, and Katari Cultural Village.

Most cruise passengers (86.3 percent) interviewed leaving the terminal were traveling to their destinations by Bus (either private or public shuttle buses), a further 11.3 percent by Car, and 1.8 percent by Taxi. For cruise passengers interviewed arriving back at the terminal Bus was still the most commonly reported travel mode (73.7 percent) and the Car mode share was similar (12.1 percent). However, Taxi trips were significantly higher (14.1 percent).

4.7.7 Air and Port Commercial Cargo Vehicles

The State of Qatar has three major commercial hubs, Hamad International Airport, Hamad Port and Al-Ruwais Port, and it is important to characterize the freight movements to/from these three main hubs. Therefore, surveys were designed to profile those freight vehicles. **Figure 4-26** show a breakdown of vehicle types recorded at each of the three surveyed commercial border points. The air cargo terminal was mainly served by the smaller commercial vehicles, predominantly those with 2 or 3 axles (81 percent). Hamad Port handled a higher proportion of larger vehicles, 4 axles or more (36 percent) while the majority of trucks through Ruwais Port (approx 80 percent) fell in the larger vehicle categories. A total of 854 interviews took place at the seaports and 87 interviews at the air cargo terminal.

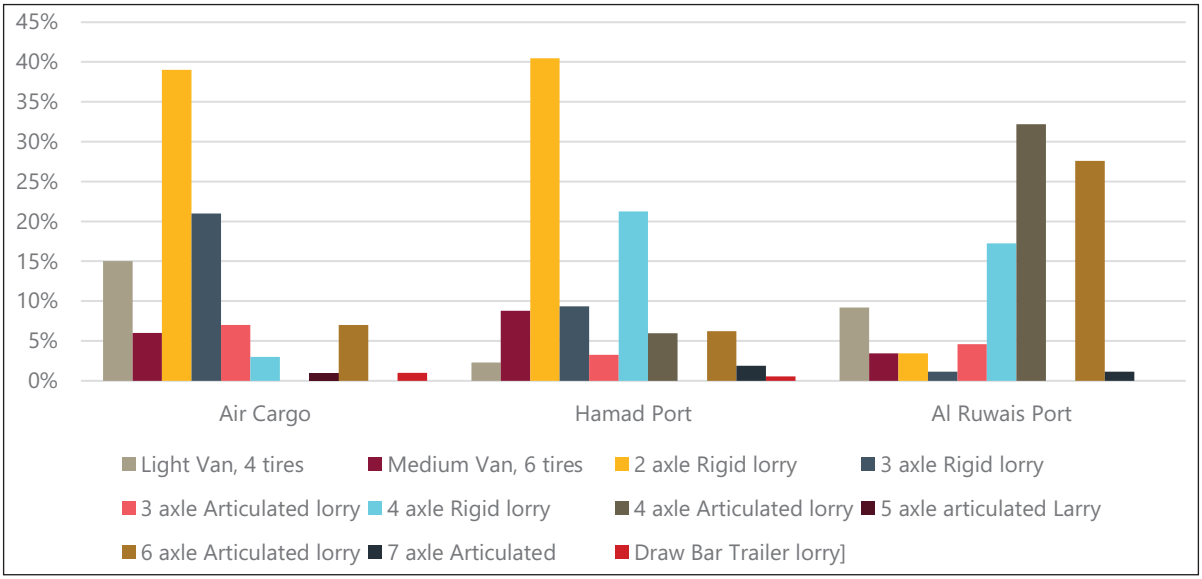


Figure 4-26: Vehicle Type – Air Cargo/Ports

Figure 4-27 shows the loading status of the vehicles accessing each of the three border entry points on the survey days. The proportion of empty vehicles fell in the range 50 to 57.5 percent, and fully laden vehicles in the range 23.2 to 32.6 percent.

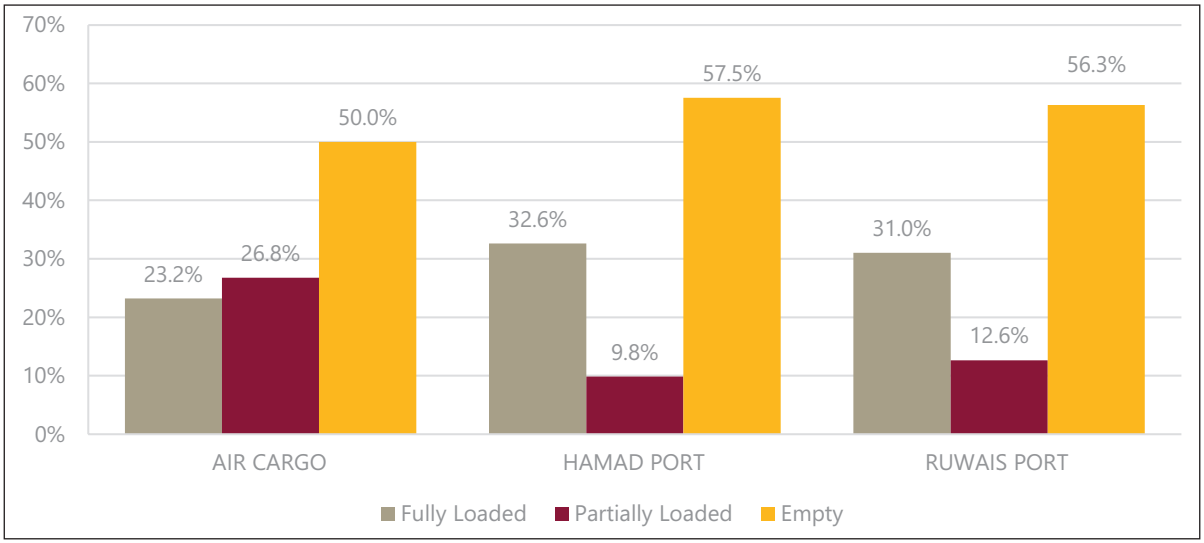


Figure 4-27: Air Cargo/Ports – Loading Status

The results revealed that airport cargo terminal appears to handle mainly small trucks and vans, Hamad Port a wider range of vehicle types, and Al Ruwais Port mainly large trucks (4 axles or more). The majority of vehicles (63-85 percent) reported making only a single delivery on the survey day.

The two most common types of cargo being carried were Miscellaneous goods (34 percent) and Animals/Foodstuffs (30 percent). Moreover, 50 and 60 percent of vehicles surveyed were traveling empty.

Across all three cargo terminals/ports, the most common origin-destination pairs reported were Outer Doha to Outer Doha, Al Ruwais to Al Ruwais, Outer Doha to Al Ruwais, Outer Doha to Al Sheehaniya, Mesaieed to Outer Doha, Inner Doha to Inner Doha, and Inner Doha to Outer Doha.

4.7.8 Laborer Surveys

The aim of the laborer survey was to collect the personal characteristics, activity patterns, and modes of travel for laborers engaged in different sectors of the economy, namely construction, industry, and service-based occupations.

Table 4-17 shows the proportional distribution of laborers per economic sector. The data relating to laborers by economic sector were based on 2010 Census data. they excluded employees engaged in domestic households as drivers/maids/gardeners since these will have been captured by the HHI surveys.

Table 4-17: Distribution of Laborers by Economic Sector

Economic Sector	Percentage of Total Laborers
Agriculture	1.9%
Mining/Quarrying	8.9%
Manufacturing	11.2%
Construction	56.6%
Wholesale and retail, and vehicle repair	15.2%
Transportation	3.3%
Accommodation and food services	2.9%

Figure 4-28 shows the distribution of laborers by nationality. The largest group represented was people from India, followed by those from Nepal, and Bangladesh.

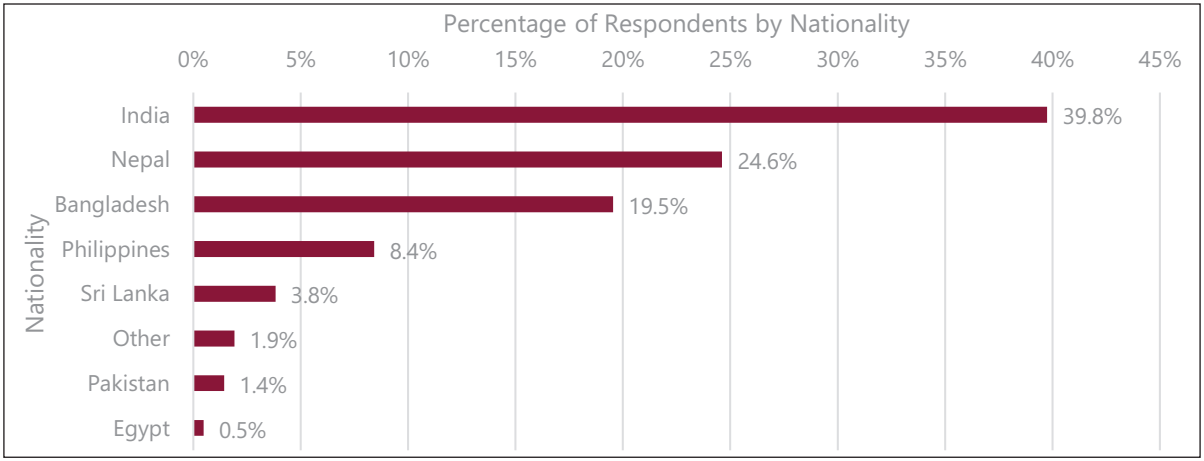


Figure 4-28: Labor Respondents Nationality

Figure 4-29 shows the age distribution of the laborers with 59.8 percent being below 34 years of age and only 12.4 percent over the age of 44. This reflects the high number of industrial and construction workers within the labor market who tend to be younger due to the physical nature of the work involved. There are also visa regulations that apply to older laborers.

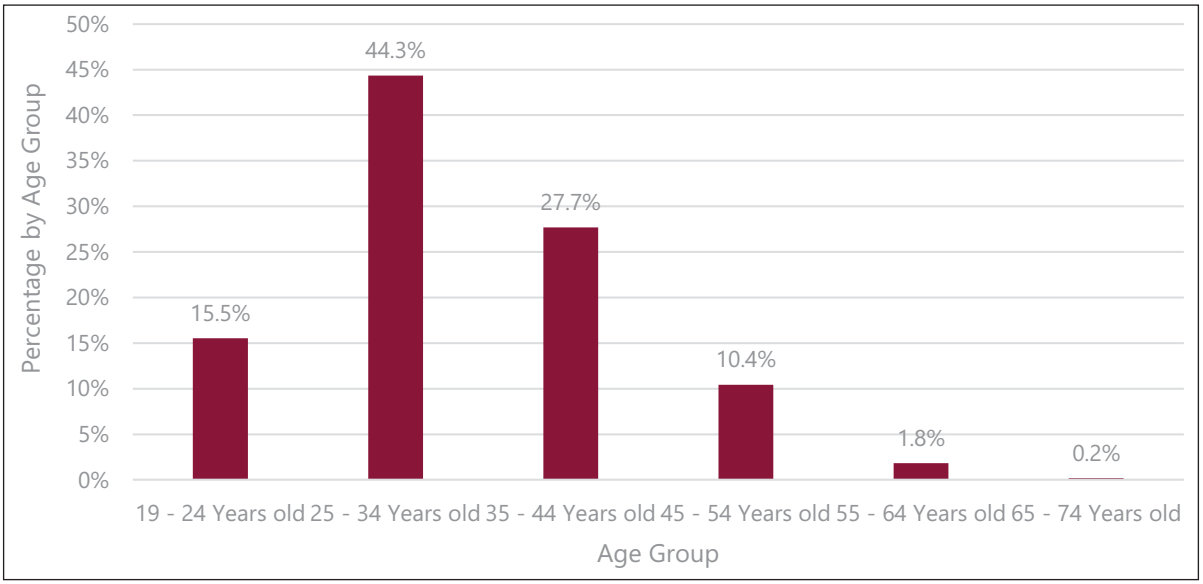


Figure 4-29: Labor Respondents Age Group Distribution

Table 4-18 shows the daily trip rate for laborers on a weekday by trip purpose. This shows that most of the trips on a weekday are trips to and from work (73%). There are some non-home-based trips during the day that are either employer's business or lunchtime trips to local areas. The volume of activity outside of working hours on a weekday is relatively low compared to that exhibited by household residents.

Table 4-18: Laborer Weekday Trip Rates by Purpose

Trip Purpose	Trip Rate per Day
Home Based Work	1.720
Home Based Shopping	0.093
Home Based Other	0.305
Home Based Personal Business	0.007
Non-Home Based	0.255
Total	**2.379**

The main points to note from the Laborer surveys are:

1. That the interviewed laborers were mainly from India (39.8%), Nepal (24.6%), Bangladesh (19.5%) and the Philippines (8.4%);
2. Laborers incomes were primarily below 3,000 QAR per month, 95%;
3. In terms of travel to work 63% is by company bus/private shuttle, 19.1% walking, and 17.3% was by car/truck;
4. On a typical weekday the main trip purposes for laborers is 72.3% work; and
5. The departure times for laborers trips to work are highest between 0400-0600 in the morning with the return trips in the evening being between 1600-1900.

CHAPTER 5

FINAL REMARKS


Qatar

Chapter 5 Final Remarks

This Executive Summary Book demonstrates the tremendous effort made to collect, analyze, study and summarize transport data and other technical issues related to Updating Qatar Transport Master Plan as part of Package 1, "Data Collection, Inventories and Surveys".

The importance of this package is envisioned by presenting a thorough understanding of nationwide transport sector, in line with Qatar National Vision 2030 and Qatar National Master Plan. The updated transport master plan meets several national comprehensive and sustainable outcomes and provides safe, integrated and environmentally friendly transport systems, which ultimately serves the local communities' needs.

There are many important outcomes that are met through Package 1, such as modeling transport activities in Qatar and how those activities are related to several socioeconomic and demographic characteristics. The models are developed to be utilized by different governmental agencies, such as Public Work Authority (Ashghal), Qatar Rail and Ministry of Interior and others for their use.

Transport Data Management system is another major outcome of this package, that provides the possibility of storing and retrieving different traffic data, such as traffic volumes, vehicle classifications and field surveys using state-of-the-art tools, including Geographic Information Systems, that are easy to operate and update.

Moreover, the completion of Package 1 of Updating Qatar Transport Master Plan is important for future transport planning in Qatar, as it facilitates the process of evaluating potential impact and benefits of updating transport systems and policies that ultimately will improve the transport system efficiency in the State of Qatar.

APPENDIX A

LOCAL FACTOR

Appendix A Local Factors

A.1 Traffic Count Adjustment Factors

The estimation of Annual Average Daily Traffic from daily counts requires the application of Monthly and weekly factors as shown in **Equation 1**.

AADT=ADT*MF*WF ***(Equation 1)***

Where:

ADT = average daily traffic, the total traffic at a specific location over a given time interval (more than a day and less than a year) divided by the number of days surveyed.

MF = monthly adjustment factor for the data collection month, derived from the control count station by dividing the *AADT* by the *ADT* of the month for the control count location.

WF = a weekly factor, derived from control count location data by dividing the *ADT* of the month by the *ADT* for the week. In the case of Qatar, the *WF* factors for each month are all 1 as there is no distinct pattern in the observed weekly variations.

The monthly adjustment factors used are shown in **Table A-1.**

Table A-1: Monthly Traffic Adjustment Factors (MF)

Month	MF
January	1.02
February	0.91
March	0.93
April	0.99
May	1.04
June	0.99
July	1.12
August	1.14
September	0.95
October	0.95
November	0.95
December	1.00

Source: TMPQ 2008 study

In the case where one-day counts are being undertaken, there is also a need for a Day of Week Factor (DWF), calculated as shown in **Equation 2**.

DWF= (ADT/Volume of a Specific Day) ***(Equation 2)***

DWF values vary not only by day of week but also by road hierarchy, and possibly region/ area. *Automatic Traffic Count* data was allocated to road type and region and analyses of the *DWF* carried

out for each combination of road type and region for which adequate data exists. **Table A-2** shows the overall DWF factors for use in Qatar.

Table A-2: Overall 2017/18 DWFs

Day of Week	DWF
Sunday	0.952
Monday	0.945
Tuesday	0.945
Wednesday	0.938
Thursday	0.907
Friday	1.326
Saturday	1.099

Table A-3 shows the factors to convert Average Weekday Traffic (AWDT) flows to other time periods during the day by region and by vehicle type (Cars/Others). Similar factors have been derived for Average Daily Traffic and Average Weekend Day traffic.

Table A-3: AWDT Factors by Region

Period	Vehicle Type	DCCP	Inner Doha	Outer Doha	Al Khor	Rural - North	Mesaieed
12 Hours	Cars	0.665	0.668	0.667	0.657	0.714	0.747
	Others	0.690	0.688	0.687	0.683	0.736	0.655
14 Hours	Cars	0.767	0.775	0.776	0.784	0.809	0.810
	Others	0.781	0.780	0.774	0.794	0.822	0.748
16 Hours	Cars	0.853	0.867	0.867	0.884	0.888	0.872
	Others	0.843	0.856	0.837	0.867	0.878	0.835
18 Hours	Cars	0.919	0.929	0.937	0.951	0.942	0.931
	Others	0.926	0.928	0.922	0.942	0.925	0.890
AM (0600-0900)	Cars	0.172	0.168	0.172	0.171	0.164	0.236
	Others	0.180	0.175	0.174	0.174	0.149	0.142
MD (1200-1500)	Cars	0.168	0.176	0.169	0.161	0.169	0.193
	Others	0.162	0.178	0.167	0.161	0.181	0.164
PM (1700-2000)	Cars	0.157	0.164	0.168	0.196	0.168	0.123
	Others	0.155	0.149	0.144	0.175	0.158	0.156

Table A-4 and **Table A-5** show factors for the adjustment of traffic counts that are carried out in Ramadan or Summer months. The factors provided are used to convert a count in Ramadan, for example, to an average weekday by multiplying the Ramadan count by (1/Factor).

Table A-4: Ramadan Count Adjustment Factors – All Counts

Time Period	AWDT (Average Weekday)		AWkDT (Average Weekend)		ADT (Average Day)	
	Cars	Other Vehicles	Cars	Other Vehicles	Cars	Other Vehicles
24 hours	0.98	0.90	0.93	0.89	0.97	0.90
18 hours	0.88	0.81	0.82	0.80	0.87	0.81
16 hours	0.87	0.79	0.79	0.78	0.85	0.79
14 hours	0.84	0.78	0.73	0.76	0.82	0.77
12 hours	0.87	0.79	0.74	0.78	0.84	0.79
AM (0600-0900)	0.78	0.77	0.70	0.83	0.77	0.78
MD (1200-1500)	0.97	0.84	0.74	0.78	0.92	0.82
PM (1700-2000)	0.69	0.63	0.77	0.67	0.71	0.64

Table A-5: Summer Count Adjustment Factors – All Counts

Time Period	AWDT (Average Weekday)		AWkDT (Average Weekend)		ADT (Average Day)	
	Cars	Other Vehicles	Cars	Other Vehicles	Cars	Other Vehicles
24 hours	0.92	0.84	0.92	0.88	0.92	0.85
18 hours	0.90	0.79	0.90	0.85	0.90	0.80
16 hours	0.90	0.78	0.89	0.84	0.89	0.79
14 hours	0.88	0.78	0.87	0.84	0.88	0.79
12 hours	0.87	0.78	0.85	0.85	0.86	0.79
AM (0600-0900)	0.83	0.76	0.88	0.95	0.84	0.80
MD (1200-1500)	0.83	0.71	0.81	0.77	0.82	0.72
PM (1700-2000)	0.96	0.81	0.96	0.81	0.96	0.81

shows the factors that have to be applied to convert the peak period counts to average daily flows. For example, for the AM period on a weekday the daily car counts would be 5.8 times the AM period counts, but at weekends it would be 10.2 times the AM period counts.

Table A-6: Average Ratio of Peak Period to Daily Flow for Weekday and Weekend

Average Ratio of Peak Period to Daily Flow for Weekday and Weekend	Weekday					Weekend				
	Car	LGV	Bus	HGV	Total Average	Car	LGV	Bus	HGV	Total Average
AM 0600 - 0900	5.8	5.6	5.6	5.8	**5.8**	10.2	7.1	7.1	7.9	**9.4**
MD 1200 - 1500	5.8	5.7	6.0	6.0	**5.8**	6.3	6.3	6.7	6.6	**6.3**
PM 1700 - 2000	5.9	6.8	6.6	7.1	**6.1**	5.2	6.0	5.8	6.2	**5.3**

Note: Total averages are derived from background calculations based on the proportion of vehicles by category.

Table A-7 shows the proportion of the peak period traffic that takes place in each of the peak hours.

Table A-7: Peak Hour to Peak Period

Peak Hour to Peak Period	Weekday					Weekend				
	Car	LGV	Bus	HGV	Total Average	Car	LGV	Bus	HGV	Total Average
0700	36.0%	34.6%	36.5%	34.1%	**35.4%**	38.0%	35.1%	36.2%	40.0%	**37.0%**
1300	34.3%	33.6%	34.2%	35.4%	**34.1%**	34.1%	33.7%	34.9%	35.4%	**33.9%**
1700	35.1%	38.7%	39.4%	38.1%	**35.8%**	34.0%	37.4%	38.3%	36.2%	**34.7%**

Note: Total averages are derived from background calculations based on the proportion of vehicles by category.

A.2 Traffic Capacity

The capacity of the highway network is an important factor in determining the overall network performance and in developing a transport strategy. **Table A-8** shows the lane capacity in vehicles per hour for different road classes with the highest capacity being on expressway and rural freeways and the lowest on local urban and rural roads.

Table A-8: Lane Capacity by Road Class - 2018 QSTM

Road Class	Posted Capacity per Lane Range (veh/hr)	Average Capacity per Lane
Expressway	1,800 – 2,000	1,980
Major Arterial	1,800 – 2,000	1,913
Minor Arterial	1,800	1,816
Major Collector	1,000 – 1,800	1,342
Minor Collector	800 – 1,800	1,122
Collector/Distributor	1,300 – 1,800	1,527
Local Road Urban	500 -1,000	756
Rural Freeway	1,800 – 2,000	1,989
Rural Arterial	1,800 – 2,000	1,891
Rural Collector	1,300 – 1,800	1,537
Rural Local Road	500 – 1,000	822

Note: The average capacity per lane has been weighted using the proportion of links coded for each road class in the QSTM database.

Table A-9 shows the base saturation flows in passenger car equivalents for signalized junctions that were derived from the local survey data. These range from 2,260 for straight ahead lanes to 1,866 for a combined movement lane.

Table A-9: Saturation Flow Rates (PCU) by Lane Type

Lane Type	Average Headway (secs)	Saturation flow Rate (PCU)
Left	1.648	2,184
Left/U-turn	1.728	2,084
Left/U-turn/Through	1.930	1,866
Through	1.593	2,260
U-turn	1.875	1,920
U-turn/Through	1.766	2,039

The effect of the proportion of heavy vehicles in the traffic stream on the saturation flow is determine the saturation flow rate using equation six and the factors by lane type in **Table A-10**. In **Table A-10** the H_f factors for the combined lane movement types have been inferred from those for the individual lane type relationships.

*Saturation Flow Rate= So - Hf * Hp* ***(Equation 2)***

Where

S_o = base saturation flow rate for the lane type in PCU

H_f = heavy vehicle factor

H_p = heavy vehicle proportion (in percent terms)

Table A-10: Base Saturation Flow Rates and Heavy Vehicle Factors

Lane Type	Saturation flow Rate S_o (PCU)	H_f
Left	2,184	8.20 (8.89)
Left/U-turn	2,084	10.4 (8.98)
Left/U-turn/Through	1,866	10.4 (8.98)
Through	2,260	6.36 (6.22)
U-Turn	1,920	12.64 (9.07)
U-Turn/Through	2,039	9.50 (7.65)

Note: figures in brackets are based on the unconstrained regression relationships and provided for comparative purposes.

Example calculation:

Turn type: Left

Saturation flow Rate S_0 (PCU) = 2,184 v/h

H_f =8.2

HV proportion = 25 percent

*Saturation Flow Rate = S_o - H_f * H_p*

Saturation flow rate = 2,184 - 8.2*25 = 1,979 (v/h)

Another important factor in influencing travel patterns and managing travel demand is the time required to find a parking space. Surveys were carried out at four major car parks and **Figure A-1** shows, for each car park, the relationship between average parking search time and time of day. The highest search times were recorded at Hamad Hospital and the City Center Mall.

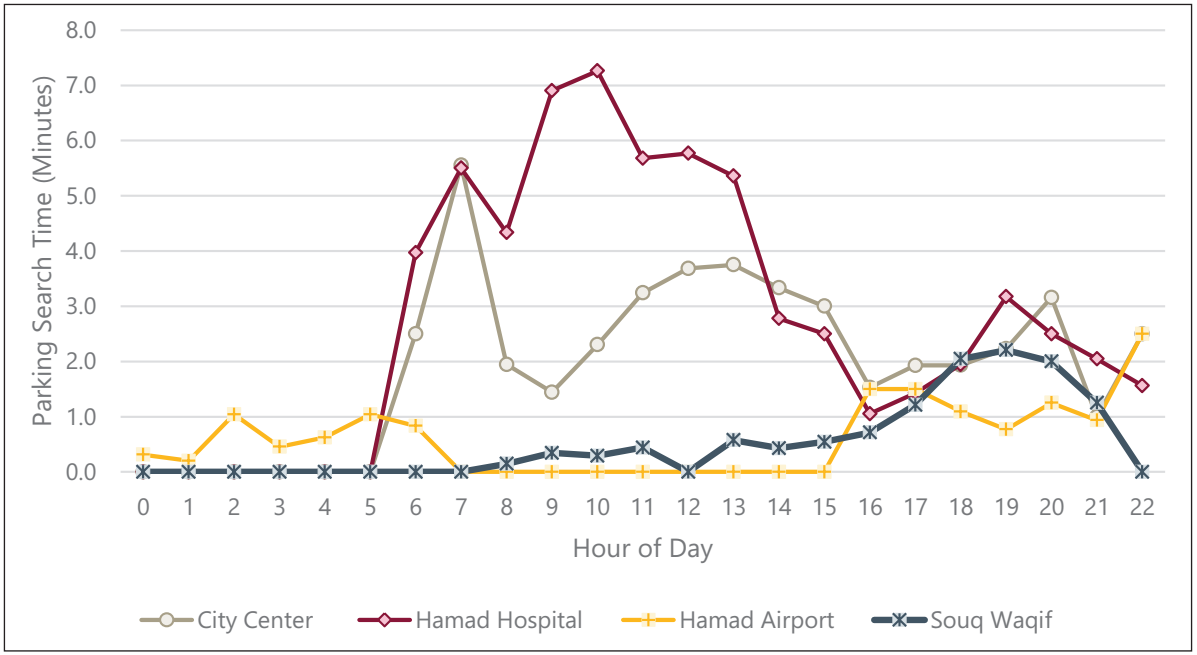


Figure A-1: Parking Search Time by Car Park and Time of Day

The observed parking search times were analyzed in conjunction with data on the car park occupancy at the time and a recommended parking search time relationship based on the analysis of the car parking survey data produced as given in **Equation 9**.

*Search Time= 0.7063 * e 2.3751 * (Occupancy Ratio)*	***(Equation 9)***

This should be applied with a maximum cut-off value of 30 minutes' search time.

A-3 Design Vehicles

In designing the highway network and associated facilities such as parking bays, car park structures and traffic signals it is necessary to have information on the physical dimensions of the vehicles that are most commonly encountered on the roads within Qatar. **Table A-11** to **Table A-13** show the design vehicle characteristics for small cars, large cars/SUV's and pick-up trucks.

Table A-11: Average Design Vehicle Characteristics – Small Private Cars

Category	Width (mm)	Length (mm)	Height (mm)	Turning radius (mm)
Small Private Car (85%)	1,850	4,925	1,495	5,700
Small Private Car (95%)	1,852	4,980	1,535	5,700
Small Private Car (99.8%)	1,968	5,435	1,720	6,300

Table A-12: Average Design Vehicle Characteristics – Large Private Cars/SUVs

Category	Width (mm)	Length (mm)	Height (mm)	Turning radius (mm)
Large Car/SUV (85%)	1,995	5,140	1,940	6,250
Large Car/SUV (95%)	2,045	5,278	1,958	6,550
Large Car/SUV (99.8%)	2,441	6,505	1,969	8,080

Table A-13: Average Design Vehicle Characteristics – Pick-ups

Category	Width (mm)	Length (mm)	Height (mm)	Turning radius (mm)
Pick-up (85%)	1,954	5,335	1,953	6,200
Pick-up (95%)	2,045	6,363	1,958	8,150
Pick-up (99.8%)	2,045	6,363	1,958	8,150

Table A-14 shows the results for the combined data and includes the turning radii. These are consistent with the existing QHDM values for width, length and turning circles but the vehicle height is significantly different. The QHDM value has therefore been increased to reflect the 95-percentile value given in **Table A-14**.

Table A-14: Proposed Design Vehicle Characteristics – All Private Cars

Category	Width (mm)	Length (mm)	Height (mm)	Turning Radius (mm)
All Private Car (85%)	1,970	4,999	1,890	6,100
All Private Car (95%)	2,030	5,179	1,940	6,250
All Private Car (99.8%)	2,441	6,505	1,970	8,080
QHDM	2,130	5,790	1,300	7,260

It is necessary to be able to express capacity and performance measures in such a way that the composition of the vehicles is taken into consideration. This is achieved by converting different vehicle types into passenger car equivalents using the values in **Table A-15**. For example, a 4-axle articulated vehicle has a factor of 3.0 passenger car equivalents indicating that it takes up three times as much road capacity as a car.

Table A-15: Recommended Passenger Car Unit Factors for Qatar

Vehicle Type	PCU Factor	
Bicycle	0.2	
Motorcycle	0.4	
Car	1.0	
Taxi	1.0	
Large Car/SUV	1.0	
LGV (2-axle)	1.0	1.5
LGV (2-axle 6 tires)	1.0	
HGV (3-axle)	1.9	
HGV (4-axle)	2.5	
HGV/Artic (4-axle)	3.0	
HGV/Artic (5-axle)	3.0	
HGV/Artic (6-axle)	3.0	
HGV/Multi-Artic (5-axle)	4.0	
HGV/Multi-Artic (6-axle)	4.0	
HGV/Multi-Artic (7-axle)	4.0	
Bus/Coach	2.0	
Mini-Bus	1.2	

A-4 Trip Rates

The number of trips typically made by different elements of the population is fundamental to the planning and modelling of the transport network and the extensive household interview

survey data was used to derive detailed trip rates by for different population groups taking into account nationality, gender, car availability, income, day of week, mode of travel and time of travel.

Table A-16 shows the average daily person trip rates by nationality, gender, car availability and day of week. These show that non-Qatari persons generally make more trips than Qatari persons, that males make more trips than females, and that weekday trips are higher than weekend trip rates.

Table A-16: Person Trip Rates (All Residents)

Nationality	Gender	Weekday		Weekend	
		Car Available	Non-Car Available	Car Available	Non-Car Available
Qatari	Male	2.496	1.896	2.196	1.200
	Female	1.698	1.476	1.080	0.924
Non-Qatari	Male	3.036	2.424	2.328	2.058
	Female	1.332	1.146	1.170	1.140

Note: All residents over 5 years of age. Source: Qatar 2017/18 Household Interview Survey

Table A-17: Average Household Trip Rates – Single Person Separately Identified

Household Size	Qatari Weekday	Qatari Weekend	Non-Qatari Weekday	Non-Qatari Weekend	No. of Records
1	2.485	2.208	2.846	2.475	2,859
2-3	3.899	3.778	5.152	4.382	3,859
4-6	7.382	6.682	8.633	7.012	4,147
7-9	13.866	9.389	14.248	12.405	942
10+	19.840	13.253	18.476	8.000	440
Average	**9.494**	**7.062**	**9.871**	**6.855**	**12,247**

Table A-18 and **Table A-19** show the differences in daily trip rates for households with children and those without. For household of the same size those with children make more trips than those without children.

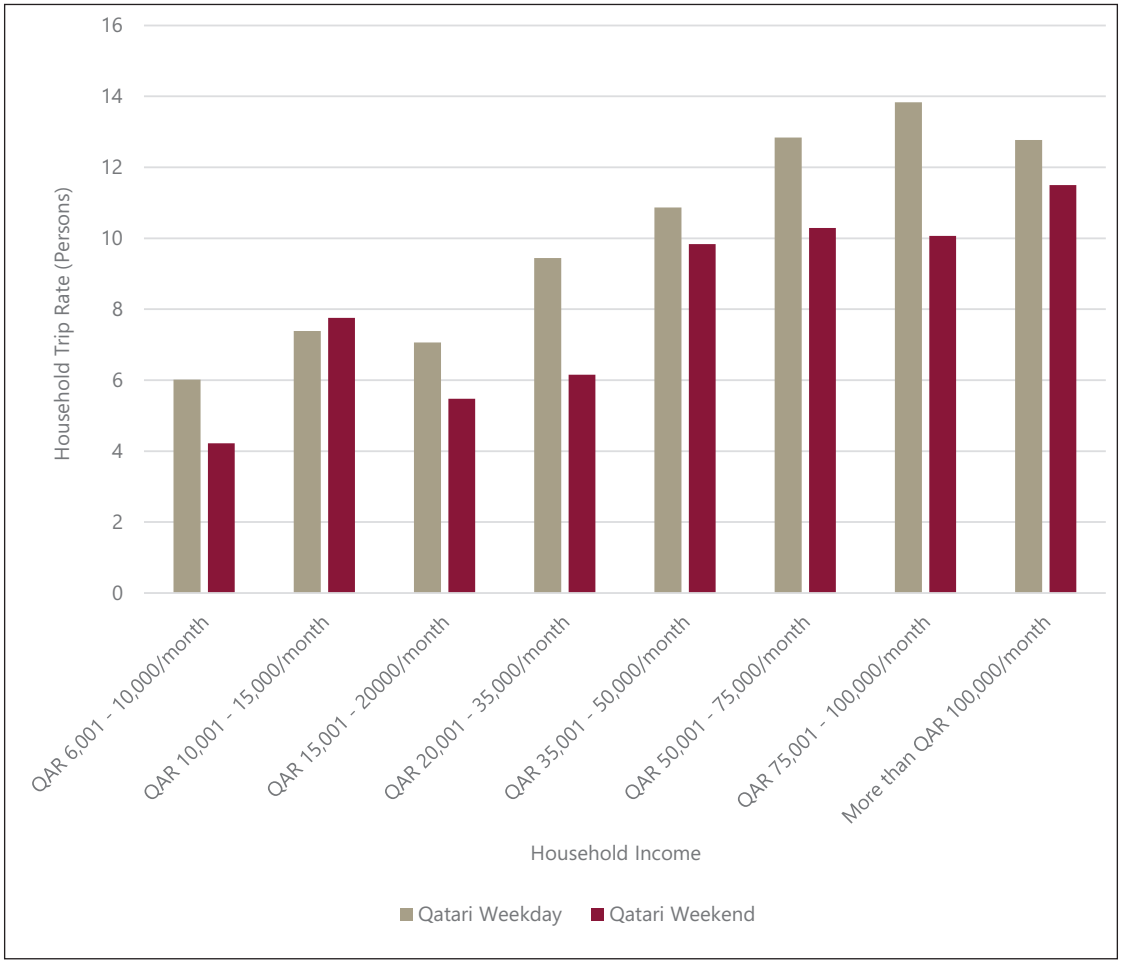
Table A-18: Average Household Trip Rates – Households with Children

Household Size	Qatari Weekday	Qatari Weekend	Non-Qatari Weekday	Non-Qatari Weekend	No. of Records
2-3	4.084	4.000	5.575	4.775	1.710
4-6	14.696	10.141	14.315	12.563	3.656
7-9	12.996	10.076	8.015	6.474	787
10+	20.246	14.062	18.476	8.000	410
Average	**13.006**	**9.570**	**11.595**	**7.953**	**6.563**

Table A-19: Average Household Trip Rates – Households without Children

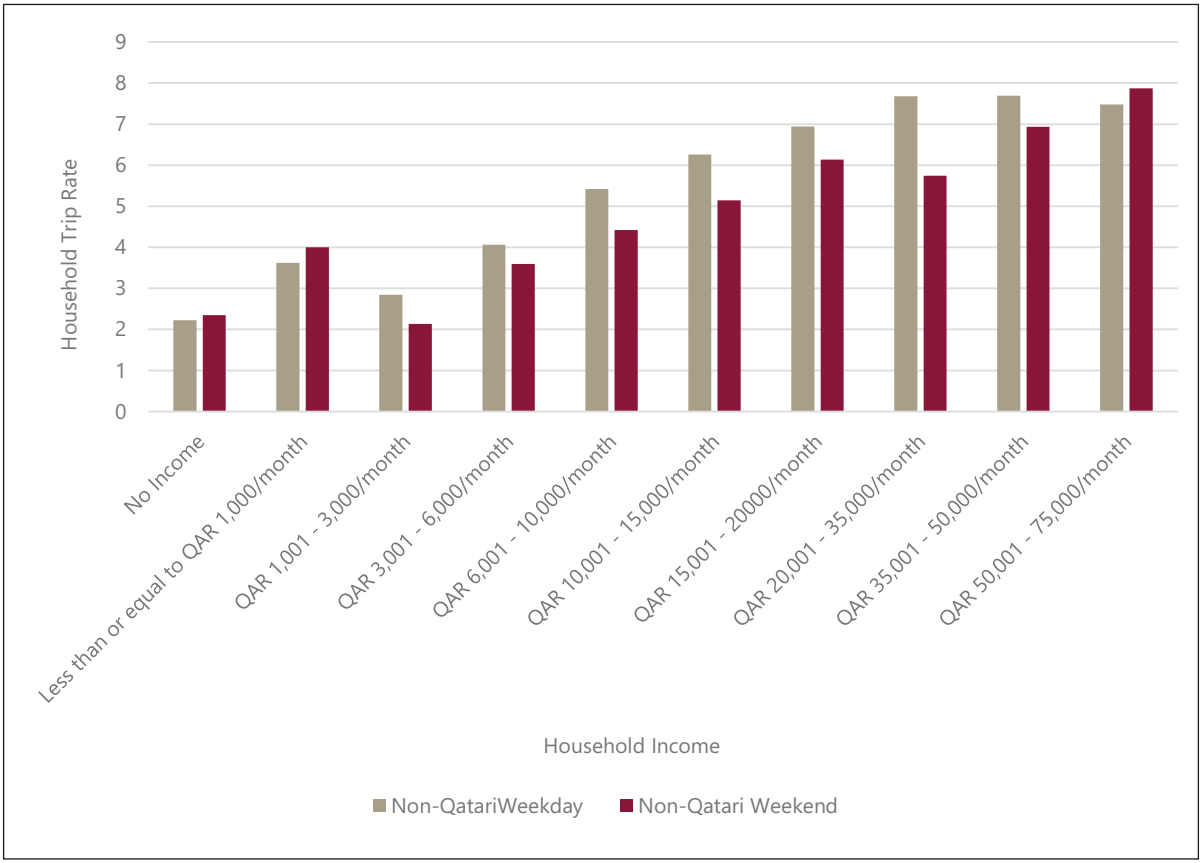
Household Size	Qatari Weekday	Qatari Weekend	Non-Qatari Weekday	Non-Qatari Weekend	No. of Records
1	2.485	2.208	2.846	2.475	2,859
2-3	3.841	3.714	4.786	4.018	2,149
4-6	6.640	6.348	8.015	6.269	491
7-9	10.645	6.609	12.000	11.400	155
10+	13.400	8.000	0.000	0.000	30
Average	**7.402**	**5.376**	**5.529**	**4.832**	**5,684**

Variations in household income are also shown to have an impact on trip making levels with increasing household income leading to higher trip rates, **Figure A-2** and **Figure A-3**.



Source: Qatar 2017/18 Household Interview Survey

Figure A-2: Qatari Household Trip Rates by Household Income and Day of Week



Source: Qatar 2017/18 Household Interview Survey

Figure A-3: Non-Qatari Household Trip Rates by Household Income and Day of Week

Table A-20 to **Table A-23** show trip rates by nationality, household size and mode of travel. The information shows that in Qatari households that car usage is dominant on both weekdays and weekends. Car is also the main mode used by non-Qataris but there is higher usage of school and company bus than for Qatari households.

Table A-20: Qatari Trip Rates by Household Size, and Mode of Travel - Weekdays

Household Size	Mode of Travel								
	Car Driver	Car Passenger	School Bus	Company Bus	Taxi	Public Bus	Walk	Other	Total
1-3	2.477	0.894	0.029	0.023	0.008	0.000	0.148	0.005	3.584
4-6	4.062	2.680	0.336	0.012	0.017	0.002	0.238	0.037	7.384
7-9	6.671	6.028	0.691	0.018	0.051	0.002	0.323	0.083	13.867
10+	8.605	9.573	1.000	0.031	0.000	0.002	0.561	0.067	19.839
Average	**5.196**	**4.360**	**0.478**	**0.019**	**0.022**	**0.001**	**0.295**	**0.048**	**10.419**
Household Size	**Mode of Travel**								
	Car Driver	**Car Passenger**	**School Bus**	**Company Bus**	**Taxi**	**Public Bus**	**Walk**	**Other**	**Total**
1-3	69.1%	25.0%	0.8%	0.7%	0.2%	0.0%	4.1%	0.1%	100.0%
4-6	55.0%	36.3%	4.6%	0.2%	0.2%	0.0%	3.2%	0.5%	100.0%
7-9	48.1%	43.5%	5.0%	0.1%	0.4%	0.0%	2.3%	0.6%	100.0%
10+	43.4%	48.3%	5.0%	0.2%	0.0%	0.0%	2.8%	0.3%	100.0%
Average	**49.9%**	**41.8%**	**4.6%**	**0.2%**	**0.2%**	**0.0%**	**2.8%**	**0.5%**	**100.0%**

Source: Qatar 2017/18 Household Interview Survey

Table A-21: Qatari Trip Rates by Household Size, and Mode of Travel – Weekend

Household Size	Mode of Travel								
	Car Driver	Car Passenger	School Bus	Company Bus	Taxi	Public Bus	Walk	Other	Total
1-3	2.123	0.731	0.000	0.000	0.029	0.000	0.413	0.000	3.296
4-6	3.719	2.553	0.011	0.004	0.011	0.000	0.347	0.037	6.682
7-9	3.822	4.876	0.026	0.000	0.000	0.000	0.638	0.027	9.389
10+	5.227	6.898	0.034	0.000	0.000	0.000	1.053	0.040	13.252
Average	**3.718**	**3.734**	**0.018**	**0.001**	**0.009**	**0.000**	**0.590**	**0.027**	**8.097**
Household Size	**Mode of Travel**								
	Car Driver	**Car Passenger**	**School Bus**	**Company Bus**	**Taxi**	**Public Bus**	**Walk**	**Other**	**Total**
1-3	64.4%	22.2%	0.0%	0.0%	0.9%	0.0%	12.5%	0.0%	100.0%
4-6	55.7%	38.2%	0.2%	0.1%	0.1%	0.0%	5.2%	0.5%	100.0%
7-9	40.7%	51.9%	0.3%	0.0%	0.0%	0.0%	6.8%	0.3%	100.0%
10+	39.4%	52.0%	0.3%	0.0%	0.0%	0.0%	8.0%	0.3%	100.0%
Average	**45.9%**	**46.1%**	**0.2%**	**0.0%**	**0.1%**	**0.0%**	**7.3%**	**0.3%**	**100.0%**

Source: Qatar 2017/18 Household Interview Survey

Table A-22: Non-Qatari Trip Rates by Household Size, and Mode of Travel – Weekdays

Household Size	Mode of Travel								
	Car Driver	Car Passenger	School Bus	Company Bus	Taxi	Public Bus	Walk	Other	Total
1-3	2.185	0.746	0.119	0.399	0.171	0.021	0.411	0.068	4.120
4-6	4.023	2.506	1.255	0.191	0.127	0.013	0.410	0.108	8.633
7-9	5.536	4.731	2.703	0.156	0.025	0.011	0.910	0.177	14.249
10+	7.391	4.832	5.519	0.210	0.000	0.000	0.464	0.061	18.477
Average	**2.910**	**1.458**	**0.586**	**0.321**	**0.151**	**0.018**	**0.424**	**0.084**	**5.953**
Household Size	**Mode of Travel**								
	Car Driver	**Car Passenger**	**School Bus**	**Company Bus**	**Taxi**	**Public Bus**	**Walk**	**Other**	**Total**
1-3	53.0%	18.1%	2.9%	9.7%	4.1%	0.5%	10.0%	1.7%	100.0%
4-6	46.6%	29.0%	14.5%	2.2%	1.5%	0.2%	4.7%	1.3%	100.0%
7-9	38.8%	33.2%	19.0%	1.1%	0.2%	0.1%	6.4%	1.2%	100.0%
10+	40.0%	26.2%	29.9%	1.1%	0.0%	0.0%	2.5%	0.3%	100.0%
Average	**48.9%**	**24.5%**	**9.9%**	**5.4%**	**2.5%**	**0.3%**	**7.1%**	**1.4%**	**100.0%**

Source: Qatar 2017/18 Household Interview Survey

Table A-23: Non-Qatari Trip Rates by Household Size, and Mode of Travel – Weekend

Household Size	Mode of Travel								
	Car Driver	Car Passenger	School Bus	Company Bus	Taxi	Public Bus	Walk	Other	Total
1-3	1.735	1.007	0.031	0.153	0.157	0.027	0.423	0.058	**3.591**
4-6	2.763	3.386	0.142	0.043	0.107	0.004	0.536	0.031	7.012
7-9	4.104	6.581	0.320	0.009	0.036	0.000	1.342	0.014	12.406
10+	3.992	2.932	0.000	0.000	0.029	0.000	1.048	0.000	8.001
Average	**2.141**	**1.935**	**0.074**	**0.112**	**0.137**	**0.019**	**0.483**	**0.047**	**4.948**
Household Size	**Mode of Travel**								
	Car Driver	**Car Passenger**	**School Bus**	**Company Bus**	**Taxi**	**Public Bus**	**Walk**	**Other**	**Total**
1-3	48.3%	28.0%	0.9%	4.3%	4.4%	0.7%	11.8%	1.6%	100.0%
4-6	39.4%	48.3%	2.0%	0.6%	1.5%	0.1%	7.6%	0.5%	100.0%
7-9	33.1%	53.0%	2.6%	0.1%	0.3%	0.0%	10.8%	0.1%	100.0%
10+	49.9%	36.6%	0.0%	0.0%	0.4%	0.0%	13.1%	0.0%	100.0%
Average	**43.3%**	**39.1%**	**1.5%**	**2.2%**	**2.8%**	**0.4%**	**9.8%**	**0.9%**	**100.0%**

Source: Qatar 2017/18 Household Interview Survey

A.5 Car Occupancy Factors

The conversion of person trips to vehicle trips relies on occupancy rates and local rates were derived from the household interview, hotel and laborer surveys and are shown in **Table A-24** and **Table A-25**

respectively. Car occupancy rates are lowest for commuting trips and highest at the weekend for shopping and leisure trips.

Table A-24: Car Occupancy Rates by Trip Purpose and Nationality and Day of Week (HHI Data)

Trip Purpose	All Nationalities		Qatari		Non-Qatari	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Home Based Work	1.14	1.15	1.03	1.03	1.17	1.17
Home Based Education	1.56	-	1.26	-	1.93	-
Home Based Shopping	2.01	2.32	1.66	2.13	2.08	2.35
Home Based Other	1.80	2.17	1.50	1.79	1.90	2.32
Non-Home Based	1.53	2.19	1.46	1.53	1.55	2.33

Note: Cells marked with - denote cells where there are less than 50 observations in the data.
Source: Qatar 2017/18 Household Interview Survey

Table A-25: Vehicle Occupancy for Hotel Guests and Laborers

Vehicle Type	Hotel Guests	Laborers
Car	2.41	1.32
Taxi	2.98	2.33
Private Shuttle	5.08	9.88
Company Bus	11.92	18.57

A.6 Journey Purpose Composition

The household interview data provided data on the purpose of travel by nationality, gender, time period and mode of travel and these are shown in **Table A-26** and **Table A-27** for

weekday and weekend respectively. On a weekday the majority of trips are made for HBO, 32.0%, followed by HBW, 31.1% with HBE being the other major trip purpose, 19.4%. There are significant differences in the composition of trips between weekday and weekend with HBW trips reducing from 31.1% to 11.5%, and HBE trips from 19.4% to 1.3% with HBO trips increasing to 60.5% of all trips

Table A-26: Weekday Journey Purpose Composition (HHI data)

Category	Description	Trip Purpose					
		HBW	HBE	HBS	HBO	EB	NHBO
Nationality	All	31.1%	19.4%	6.5%	32.0%	0.7%	10.3%
	Qatari	24.5%	29.3%	4.3%	32.9%	0.1%	8.9%
	Non-Qatari	33.3%	16.1%	7.2%	31.7%	0.9%	10.8%
Gender	Male	34.8%	14.3%	5.7%	32.7%	0.9%	11.6%
	Female	23.0%	30.6%	8.3%	30.5%	0.2%	7.4%
Time Period	AM	37.2%	24.5%	1.2%	23.6%	1.1%	12.4%
	MD	30.6%	28.0%	2.9%	25.4%	0.8%	12.3%
	PM	31.6%	1.7%	12.3%	45.1%	0.5%	8.8%
	Evening	8.8%	0.5%	23.3%	56.9%	0.3%	10.2%
	Nighttime	43.7%	29.4%	1.5%	22.7%	0.2%	2.5%
Qatari	Car	26.4%	25.5%	4.5%	33.9%	0.1%	9.6%
	Taxi	18.2%	25.0%	9.1%	43.2%	0.0%	4.5%

(Continued on the next page)

Table A-26: Weekday Journey Purpose Composition (HHI data) (Continued)

Qatari (Continued)	Other	0.0%	32.0%	4.0%	56.0%	0.0%	8.0%
	Walk	13.9%	14.2%	5.0%	62.5%	1.3%	3.1%
Non-Qatari	Car	35.0%	9.9%	7.7%	33.7%	1.0%	12.7%
	Taxi	48.5%	4.9%	10.8%	27.4%	0.7%	7.7%
	Bus	21.9%	63.2%	3.0%	10.3%	0.1%	1.5%
	Other	34.9%	6.3%	6.7%	42.3%	0.0%	9.8%
	Walk	28.5%	4.9%	9.3%	50.9%	0.5%	5.9%

Note: Cell Values denoted by - have less than 50 observations. Source: Qatar 2017/18 Household Interview Survey

Table A-27: Weekend Journey Purpose Composition (HHI data)

Category	Description	Trip Purpose					
		HBW	HBE	HBS	HBO	EB	NHBO
Nationality	All	11.5%	1.3%	15.3%	60.5%	0.4%	11.0%
	Qatari	5.5%	2.2%	11.5%	72.7%	0.1%	8.0%
	Non-Qatari	13.2%	1.1%	16.3%	57.2%	0.4%	11.8%
Gender	Male	14.1%	1.1%	13.1%	60.4%	0.5%	10.8%
	Female	6.0%	1.9%	20.1%	60.3%	0.1%	11.6%
Time Period	AM	27.6%	4.1%	8.9%	48.0%	0.8%	10.6%
	MD	9.0%	1.6%	13.2%	66.6%	0.5%	9.1%

(Continued on the next page)

Table A-27: Weekend Journey Purpose Composition (HHI data) (Continued)

Time Period (Continued)	MD	9.0%	1.6%	13.2%	66.6%	0.5%	9.1%
	PM	10.6%	0.2%	20.5%	54.0%	0.2%	14.5%
	Evening	4.0%	0.3%	19.7%	62.9%	0.0%	13.1%
	Night-time	27.0%	2.2%	6.4%	59.6%	0.1%	4.7%
Qatari	Car	6.0%	2.0%	12.2%	71.7%	0.1%	8.0%
	Taxi	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
	Bus	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
	Other	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
	Walk	0.0%	0.6%	1.2%	89.2%	0.0%	9.0%
Non-Qatari	Car	12.3%	0.7%	16.9%	56.6%	0.5%	13.0%
	Taxi	26.1%	0.0%	25.7%	40.7%	0.0%	7.5%
	Bus	35.0%	17.5%	11.6%	32.5%	0.0%	3.4%
	Other	8.6%	0.0%	11.4%	68.6%	0.0%	11.4%
	Walk	11.1%	0.4%	9.9%	73.2%	0.1%	5.3%

Note: Cell Values denoted by - have less than 50 observations. Source: Qatar 2017/18 Household Interview Survey

A.7 Population Projections and Car Ownership

Table A-28 shows the population projections by category for 2015 to 2050and gender. This shows an increase in population from 2.48 million in 2015 to 3.77 million by 2050.

Table A-28: Updated TMPQ Population Projections

Nationality Group	Forecast Year					
	2015	2020	2025	2030	2035	2050
Qatari Population	282,479	323,125	365,746	410,318	456,806	510,254
Skilled and Professional Expat Labor	571,563	671,339	1,065,103	1,203,722	1,297,555	1,517,700
Non-Working Expats	413,598	486,006	669,475	743,909	786,027	910,620
Unskilled Expat Labor	1,213,899	1,309,719	922,471	860,175	834,710	834,710
Total	**2,481,539**	**2,790,189**	**3,022,795**	**3,218,124**	**3,375,098**	**3,773,284**

Source: Population Report for Updating TMPQ (February 2019

Table A-29 shows the anticipated change in the ratio of Qatari to Skilled and Professional Expat, and unskilled expatriate Labor up to the study horizon year of 2050.

Table A-29: Population Category Proportions – 2015 to 2050

Nationality Group	Forecast Year					
	2015	2020	2025	2030	2035	2050
Qatari Population	11.4%	11.6%	12.1%	12.8%	13.5%	13.5%
Skilled/Professional Expatriate	39.7%	41.5%	57.4%	60.5%	61.8%	64.4%
Unskilled Expat Labor	48.9%	46.9%	30.5%	26.7%	24.7%	22.1%

Table A-30 shows the car ownership rate by nationality based on the household interview data. The car ownership rate for Qatari households is significantly higher, 470.5 per thousand persons, than that for non-Qatari household, 363.6 per thousand persons.

Table A-30: Car Ownership Rate Based on HHI

People	Cars/1000 person	Cars/1000 adult person
Other	363.6	556.9
Qatari	470.5	670.0
Total HHI	**384.6**	**580.4**

Table A-31 shows car ownership levels by income band as calculated from the HHI results. **Figure A-4** displays the same information in graphical form.

Table A-31: Car Ownership by Income (HHI)

Income	Non-Qatari		Qatari	
	Car/1000 people	Car/1000 adult	Car/1000 people	Car/1000 adult
Confidential	391	577	823	962
No Income	323	405	500	500
Less than or equal to QAR 1,000/ month	164	217	300	400
QAR 1,001 - 3,000/month	262	277	257	375
QAR 3,001 - 6,000/month	304	399	322	452
QAR 6,001 - 10,000/month	327	494	346	515
QAR 10,001 - 15,000/month	346	557	410	582
QAR 15,001 - 20000/month	368	595	417	635
QAR 20,001 - 35,000/month	400	652	453	667
QAR 35,001 - 50,000/month	464	715	478	689

(Continued on the next page)

Table A-31: Car Ownership by Income (HHI) (Continued)

Income	Non-Qatari		Qatari	
	Car/1000 people	Car/1000 adult	Car/1000 people	Car/1000 adult
QAR 50,001 - 75,000/month	521	776	547	745
QAR 75,001 - 100,000/month	517	687	621	793
More than QAR 100,000/month	549	700	385	580
Average household	**364**	**557**	**463**	**645**

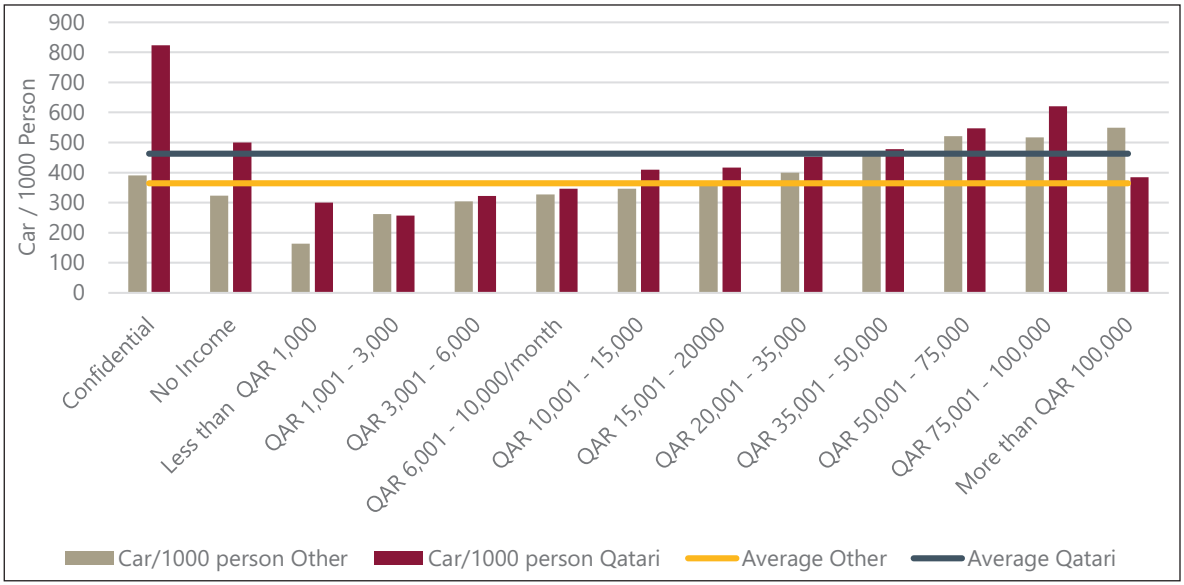


Figure A-4: Car Ownership by Income Group

وزارة المواصلات
MINISTRY OF TRANSPORT

ص.ب. 24455 P.O. Box
الدوحة، قطر Doha, Qatar
ت 1111 4045 974+ T
motc.gov.qa

نقل متكامل ومستدام للجميع
INTEGRATED & SUSTAINABLE TRANSPORT FOR ALL