QATAR قطر
دليل معدل الرحلات و المواقف
TRIP GENERATION & PARKING RATES MANUAL

وزارة المواصلات
MINISTRY OF TRANSPORT

دليل معدل الرحلات والمواقف في دولة قطر

QTGPRM

QATAR TRIP GENERATION & PARKING RATES MANUAL

USER MANUAL

2022

Volume 1

VOLUME 1
USER MANUAL

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تنويه

قامت وزارة المواصلات بإعداد هذا التقرير ضمن اختصاصتها وصلاحيتها وفقاً لأحدث الممارسات العالمية في هذا المجال وبناءً على المعلومات، والإحصائيات والبيانات المتوفرة عند إعداد هذا التقرير. لذا إن استخدام هذا التقرير لأي عمل، لا يعفي المستخدمين من استخدام أحدث الممارسات العالمية، وإتباع الأساليب الهندسية الصحيحة والمتبعة وفقاً لأحدث التقنيات العالمية المتبعة.

وعليه وجب التأكيد على أن وزارة المواصلات لا تتحمل أي مسؤولية مالية أو قانونية يمكن أن تُعزى إلى هذا الاستخدام، كما أنه لا يحق للمستخدمين المطالبة أو استلام أي نوع من التعويض عن أية أضرار أو خسائر.

وللحصول على نسخة من هذا التقرير، يجب التقدم بطلب رسمي إلى وزارة المواصلات في دولة قطر والذي يعد موافقة على ماورد في هذا التنويه. ويجوز للمستخدمين عرض محتويات التقرير ونسخها وطباعتها للاستخدام الخاص فقط، شريطة أن تحمل جميع النسخ والمطبوعات الخاصة بالمحتويات حقوق النشر وإشعارات الملكية وإخلاء المسؤولية الأخرى المعروضة على التقرير. كما لا يجوز للمستخدمين الإعلان أو النشر أو الإفصاح عن البيانات و / أو الكشف عن أي معلومات مدرجة في هذا التقرير على الإطلاق دون موافقة كتابية مسبقة من قبل وزارة المواصلات.

وفيما يخص التغييرات أو الإصدارات المستقبلية، ستقوم الوزارة بتوفيرها ويمكن الحصول عليها من خلال الاتصال بالإدارة المخولة في الوزارة، وعليه يتوجب على المستخدمين التحقق بشكل متواصل بأن لديهم أحدث إصدار من هذا التقرير.

ملاحظة: ستقوم وزارة المواصلات بمواصلة تحديث وتعديل هذا التقرير مع الأخذ بعين الاعتبار النظريات الجديدة وأحدث الأساليب التكنولوجية والمواضيع المُستجدة التي تتعلق بتخطيط وتحليل وتصميم أنظمة النقل والمرور. إن وزارة المواصلات تشجع المستخدمين على تقديم الملاحظات والاقتراحات والتعليقات وردود الأفعال وذلك من خلال قنوات الاتصال الخاصة بالوزارة. وسيتم مراجعة هذه الملاحظات والاقتراحات ومن ثم تقييمها للنظر في إمكانية إدراجها ضمن الإصدار القادم من التقرير.

Foreword

Land transportation is one of the key sectors that helps improve all aspects of life and ensures the delivery of goods and services to individuals and communities. It also underpins the growth of other sectors, such as energy, industry, mining, agriculture, and trade and drives the sustainable development of cities, societies, and the economy in step with the objectives of the Qatar National Vision 2030. It is with this understanding that the Ministry of Transport (MOT) issues this milestone, first edition Qatar Trip Generation and Parking Rates Manual (QTGPRM), Volumes 1–3.

The QTGPRM presents trip generation and parking demand rates derived from data collected in Qatar—a combined total of over 7,000 site and vehicle surveys, interviews, and traffic counts. Intended for government professionals, developers, private consultants, and researchers, the QTGPRM should be used in conjunction with the Guidelines and Procedures for Transportation Studies (GPTS), which outlines when and how the trip generation and parking demand rates published in QTGPRM should be used. Locally derived trip generation and parking demand rates, together with clear usage guidelines, will help decision makers, developers, and engineers plan and deliver a more sustainable transport system.

For each of 132 land use classes, QTGPRM documents the derived trip generation rates for persons and for vehicles, for each of four peak hours. The person-trip mode-split is estimated for car, taxi, public transit/bus, company/school bus, bicycle, walking, and other. The vehicle-trip mode-split is estimated for bus, car/taxi, light goods vehicle, and heavy goods vehicle. Peak parking space demand rates for cars, light goods vehicles, heavy goods vehicles, and buses are documented.

The QTGPRM also provides a mechanism for adjusting the estimated trip generation, in some cases, to account for trips made between different land uses on the same study site (internal capture) and to account for motorists accessing a study site en route to their primary destination (pass-by capture). A companion web-based software application has also been developed to allow the users to access QTGPRM online.

MOT encourages everyone to familiarize themself with the QTGPRM and stresses its commitment to continuously improving programs to deliver a land transportation system that satisfies the pillars of the Qatar National Vision 2030, which strives to place Qatar at the forefront of the most advanced nations, under the leadership of the Emir of Qatar, His Highness Sheikh Tamim Bin Hamad Al Thani.

مقدمة

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Abbreviations

AM	Morning
AR	Average Rate
BF	Best Fit
ATS	Areawide Transportation Study
CBD	Central Business District
CV	Coefficient of Variation
DTS	Detailed Transportation Study
FAR	Floor Area Ratio
FDOT	Florida Department of Transportation
GCC	Cooperation Council for the Arab States of the Gulf
GFA	Gross Floor Area
GPTS	Guidelines and Procedures for Transportation Studies
HGV	Heavy Goods Vehicle
ITE	Institute of Transportation Engineers (USA)
LGV	Light Goods Vehicle
ITS	Intelligent Transportation Systems
LOS	Level of Service
LTPD	Land Transport Planning Department
LTS	Limited Transportation Study
LUC	Land Use Class
MD	Midday
MS	Microsoft
MSDP	Municipal Spatial Development Plan
MM	Ministry of Municipality (Qatar)
MME	Ministry of Municipality and Environment (Qatar)
MOT	Ministry of Transport (Qatar)
NCHRP	National Cooperative Highway Research Program (USA)
PCU	Passenger Car Unit
PHF	Peak Hour Factor
PM	Afternoon
PT	Public Transit/Transport
PTAI	Public Transport Accessibility Index
QFMP	Qatar Freight Master Plan
QHDM	Qatar Highway Design Manual

(Continued on the next page)

Abbreviations (Continued)

QND95	Qatar National Datum 1995, EPSG:2932
QNDF	Qatar National Development Framework
QNV	Qatar National Vision 2030
QNMP	Qatar National Master Plan
QNRSS	Qatar National Road Safety Strategy
QPCM	Qatar Pedestrian Crossings Manual
QPMP	Qatar Parking Master Plan
QSTM	Qatar Strategic Transportation Model
QTCM	Qatar Traffic Control Manual
QTGPRM	Qatar Trip Generation and Parking Rates Manual
QUDC	Qatar Urban Design Compendium
TCRP	Transit Cooperative Research Program (USA)
TDMS	Transportation Data Management System
TfL	Transport for London (UK)
TMC	Turning Movement Count
TMIP	Travel Model Improvement Program (USA)
TMPQ	Transportation Master Plan for Qatar
TPTAPQ	Transportation Planning and Traffic Analysis Parameters for Qatar (part of TMPQ)
TRB	Transportation Research Board (USA)
STS	Special Transportation Study
TRICS	Trip Rate Information Computer System (UK)
TRL	Transport Research Laboratory (UK)
V/C	Volume-to-Capacity Ratio

UNITS OF MEASUREMENT

h	hour(s)
km	kilometer(s)
m	meter(s)
min	minute(s)
pce	passenger-car-equivalent
pce-vkt	passenger-car-equivalent vehicle-kilometers of travel
sec	second(s)
vkt	vehicle-kilometers of travel
vph	vehicles per hour

Terminology Used in QTGPRM

For the purposes of the Qatar Trip Generation and Parking Rates Manual:

- The term "MOT" shall mean Ministry of Transport. Throughout this document, and unless otherwise stated, MOT refers specifically to the Land Transport Planning Department.
- The term "Department" shall mean the Land Transport Planning Department of the Ministry of Transport.
- The term "Section" shall mean the Land Transport Studies Section of the Land Transport Planning Department.
- The terms "PWA" or "Ashghal" shall mean equivalently Public Works Authority.
- The term "Applicant" shall mean any developer (or their representative) applying for a development permit that is subject to the QTGPRM.
- The term "Consultant" shall refer to the specific consultant performing a transportation study.
- The term "transportation study" shall refer to any of the four categories of study defined in the Guidelines and Procedures for Transportation Studies (GPTS), namely Areawide Transportation Study, Detailed Transportation Study, Local Transportation Study, or Special Transportation Study.
- The term "trip" shall refer to the movement of a person or vehicle from an origin to a destination. While each trip necessarily includes both an origin "trip end" and a destination "trip end", the terms "trip generation" and "trips generated" shall refer only to the total of the trip ends associated with a given project site during a given time. Thus, 10 vehicles entering a project site and 20 vehicles exiting a project site during a one-hour period is equivalent to a trip generation of 30 trip ends per hour (10 inbound, 20 outbound). Practitioners should be aware that confusion may result from the more casual usage of the word "trips" where "trip ends" is more accurate.
- The terms "vehicle trip generation", "vehicle trip ends", and similar shall be construed in terms of the number of passenger car equivalent (pce) vehicles.
- The term "roadway segment" shall refer to a link and an adjacent intersection. A roadway segment is specific to a direction of travel and it is always the downstream intersection that is combined with the link.

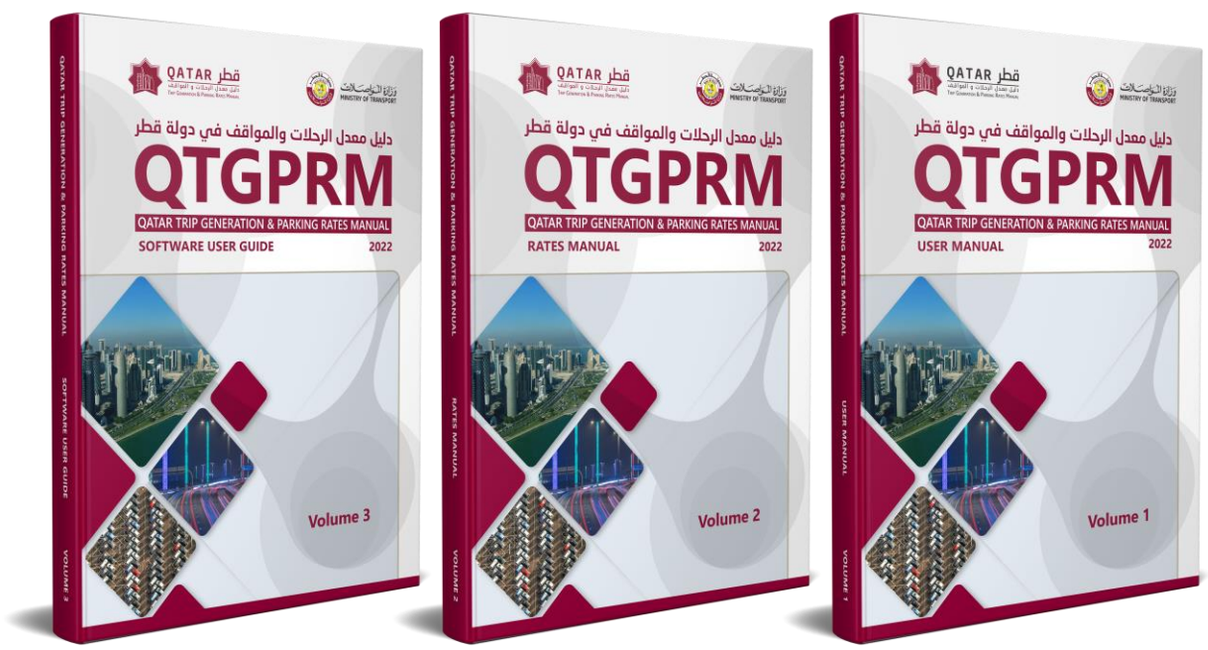
CHAPTER 1

Introduction

Chapter 1 Introduction

The Qatar Trip Generation and Parking Rates Manual (**QTGPRM**) presents trip generation and parking demand rates derived from local data collected in the State of Qatar. The intended audience includes government professionals, developers, private consultants needing to assess the likely transportation system impacts of planned developments, researchers and students of the built environment.

The QTGPRM comprises three volumes:



Volume 1: is the user manual for the table of rates contained within Volume 2
Volume 2: contains the trip generation and parking demand rates.
Volume 3: is a user guide for the QTGPRM web-based software.

VOLUME 1: USER MANUAL

Volume 1 comprises the following six chapters:
Chapter 1 defines key terms.
Chapter 2 provides a brief overview of the work undertaken to develop QTGPRM.

Chapter 3 explains how to estimate trip generation and parking demand using the appropriate rates provided in **Volume 2** of the QTGPRM and how adjustment factors can be used for given study site where applicable.

Chapter 4 provides a worked example to elaborate the estimation of trip generation and parking demand using the appropriate rates provided in **Volume 2** of the QTGPRM.

Chapter 5 explains the methods to adjust the trip generation estimates for study sites that meet specific MOT criteria.

Chapter 6 is intended solely for practitioners who might need to derive new rates to expand the existing data or to add new land use class, to support future updates to QTGPRM or for standalone transportation studies.

1.1 Key References

The QTGPRM is designed to be used in conjunction with the latest Guidelines and Procedures for Transportation Studies (GPTS), which outlines the processes to be carried out by consultants when conducting a transportation study for MOT. The GPTS identifies when and how person/vehicle trip generation and parking demand estimates derived from QTGPRM, should be used.

1.2 Definitions Adopted in this Manual

The following technical definitions apply throughout the three volumes of the QTGPRM.

Bicycle Trip: A trip that has been made primarily by bicycle or any other form of non-motorized wheeled vehicle.

Central Business District (CBD): The commercial core of a metropolitan region where major businesses, headquarters buildings, and financial services are usually concentrated. The Doha CBD is characterized by a large number of high-rise buildings, particularly office buildings and hotels, and some mixed-use developments.

Coefficient of Determination (R^2): A measure of the extent to which two variables are statistically correlated. It can take any value between 0 (no correlation) and 1 (perfect correlation). An R^2 of 0.75 implies that an incremental change in the independent variable (e.g., number of employees) accounts for 75 percent of the resulting change in the dependent variable (e.g., person-trips).

Coefficient of Variation (CV): The standard deviation of a trip generation or parking demand rate divided by the mean trip generation or parking demand rate, often expressed as a percentage. By scaling the standard deviation in this way, it is possible to compare the relative precision of regression models that have been derived using independent variables that have been measured in different units or on different scales.

Cordon Count: The number of persons or vehicles counted crossing a collection of survey points (e.g., all site access connections) which together define a notional boundary or cordon around the survey site.

Development Unit of Measurement: A defined quantity (e.g., employee, 100 m^2 GFA) used as the standard for determining the magnitude of an independent variable used to describe a land use listed in the QTGPRM.

Directional Count: A count of persons or vehicles, tallied by direction.

Directional Distribution: The relative proportion of person-trips or vehicle-trips entering a study site compared to those exiting it.

Door Count: A count of persons entering or leaving a building through a specific door or access point.

Diverted Trip: A vehicle trip that involves an intermediate stop *en route* to the location where the primary trip purpose will be satisfied and for which the distance from the primary trip route to the intermediate destination is less than half the distance from the primary trip origin to the primary trip destination.

Expansion Factor: A factor by which a sample measurement is multiplied to match the population total from which it was drawn.

GCC: Cooperation Council for the Arab States of the Gulf (known colloquially as the Gulf Cooperation Council), a political and economic alliance of six Middle East countries comprising: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates.

Guidelines and Procedures for Transportation Studies (GPTS): A guidebook to be used by consultants and practitioners when undertaking transportation studies in Qatar.

Gross Floor Area (GFA): The total floor area of a building, measured from the outside faces of the external walls and from the centerlines of any party walls shared with other developments or units.

Heavy Goods Vehicle (HGV): A commercial road vehicle as defined within classes 6-13 of the Qatar Highway Design Manual (QHDM).

Inbound Trip: A vehicle trip or person trip that arrives at a destination.

Independent Variable: A characteristic that is measurable, subject to random variation, and that can be demonstrated to have a measurable effect on another feature of interest (the dependent or response variable). In the context of trip generation study sites, a typical independent variable would be a measure of the study site size or scale (GFA, number of employees, etc.) and a typical dependent variable would be the number of person-trips or vehicle-trips generated.

Intercept Interview: A face-to-face survey (usually administered through a questionnaire) for which the subjects are chosen from among persons *en route* to or from the survey site.

Internally Captured Trip: A trip made between two distinct land uses within the same site, and which has been made entirely within the site boundary.

Land Use Class (LUC): A defined land use published in the QTGPRM and for which locally derived trip generation and parking demand rates are provided.

Light Goods Vehicle (LGV): A commercial road vehicle as defined within class 3 or 5 of the Qatar Highway Design Manual (QHDM).

Mixed-Use Development: An integrated development, usually master planned, consisting of at least two complementary and interactive land uses.

Mode Share: The relative share of total site trips made by a particular travel mode.

Off-Site: Land outside the site boundary.

Outbound Trip: A vehicle trip or person trip that departs from an origin.

Pass-By Trip: A vehicle trip that involves an intermediate stop *en route* to the location where the primary trip purpose will be satisfied and that will result in zero additional vehicle-kilometers of travel on the public roadway network.

Peak Hour of Adjacent Street Traffic: The four consecutive 15-minute intervals that exhibit the greatest traffic volume during a given peak period within the general vicinity of a study site (known colloquially as "rush hour").

Person Trip: A trip made by a person, regardless of mode. For example, four persons leaving a study site in a single vehicle are counted as four person-trips.

Primary Trip: A vehicle trip made for the specific purpose of visiting a given land use destination. Primary trips are thus distinct from diverted trips and pass-by trips, which involve intermediate stops *en route* to the primary destination.

PT: Known variously as public transport, public transportation, public transit, or transit. The term refers to any open access transportation service following a fixed route with pre-determined stops, and which is designed to carry multiple passengers. Examples include bus, metro, tram, and long-distance rail. taxi, paratransit, and vanpool (including airport shuttle) are not included in this category and are usually classified as cars.

Public Transport Accessibility Index (PTAI): A standardized measure of a study site's accessibility to public transport.

PT Trip: A trip that is made primarily using PT.

QA/QC: Comprises quality assurance (**QA**, the set of processes used to ensure the quality of a product as it is being developed) and quality control (**QC**, the set of processes used to identify and correct product defects).

Rural: Land outside an urban or suburban area that is either put to agricultural use or is largely undeveloped, although it might include scattered parcels of land developed at very low densities.

Site workbook: Is a set of spreadsheets used to document and analyze the site-specific data collected at a study site.

Standard Error: The standard error of a linear regression model. Standard error provides an indication of a model's precision, expressed in the same units as the dependent variable, and is used to help choose between candidate regression models.

Study Site: A parcel of land, plot, or block that has an assigned land use type (including land reserved for future development) and for which trip generation is to be estimated.

Survey Site: An existing developed site of a particular land use class that is used to derive trip generation or parking demand rates for QTGPRM.

Suburban: An area of low-density development located outside an urban area and generally dominated by residential land uses and neighborhood facilities such as schools and local shops.

Transportation Study: An investigation of the effects of a proposed development in terms of travel demand and impact on the transportation system, as defined in GPTS.

Trip Generation: The number of vehicle- or person-trips entering and exiting a site during a specified time interval.

Urban: An area of medium- to high-density development, located outside the CBD and with a mix of land uses (residential, commercial, institutional, educational, etc.) of a higher density than suburban areas.

Valid Interview: An interview survey record that has passed quality control checks.

Vehicle: Any motorized conveyance that is legally permitted for use on public roadways in Qatar (e.g., motorcycles, cars, trucks, taxis, buses, coaches).

Vehicle Count: The total number of vehicles counted entering/leaving a study/survey site during a pre-defined time interval.

Vehicle Occupancy: The total number of persons in a vehicle, including the driver.

Walk Trip: A trip that is made primarily on foot or using a mobility aid such as a wheelchair, walker, or crutches.

CHAPTER 2

Development of the Manual

Chapter 2 Development of the Manual

This is the first edition of QTGPRM. The publication of this manual is an accomplishment of another established milestone for the State of Qatar for its transitions toward the ambitious goals of the Qatar National Vision (QNV) 2030 and Qatar National Master Plan (QNMP).

The availability of robust, locally derived trip generation and parking demand rates, together with clear guidelines on how they should be applied, will allow the nation's decision makers, developers and engineering/transportation professionals to plan ahead with greater confidence to deliver a more, holistic, balanced and sustainable transport system.

The web-based application has also been developed to allow the users to access Qatar Trip Generation and Parking Rates online.

2.1 Land Use Classification

A three-level hierarchical system has been adopted comprising **Land Use Groups**, **Land Use Categories**, and **Land Use Classes.** This reflects common international best practices and accommodates the addition of new categories or classes. Placeholders have been provided for land use class that, although not yet present in Qatar, are expected to be developed in future. Overall, **2,538** site surveys (including weekday, weekends, and event days) were conducted on **1728** sites, and the final data have been used to derive rates for the **137** land use classes as shown in **Figure 2-1**.

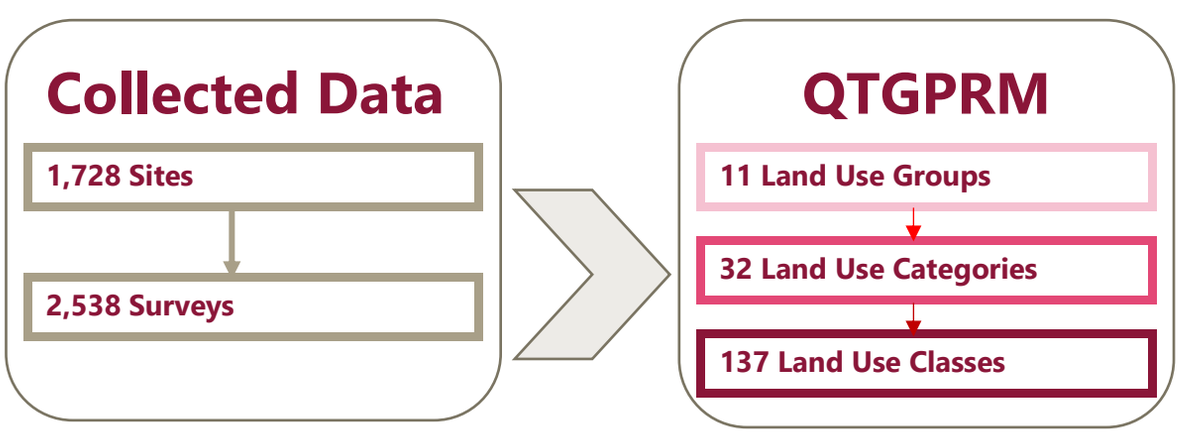


Figure 2-1: QTGPRM Statistics

To account for potential variation in trip making and travel behavior across Qatar, six geographical regions have been defined, as shown in

Figure 2-2. While region-specific trip generation and parking demand rates are not currently defined for all land use classes, such rates may become available as the survey database expands.

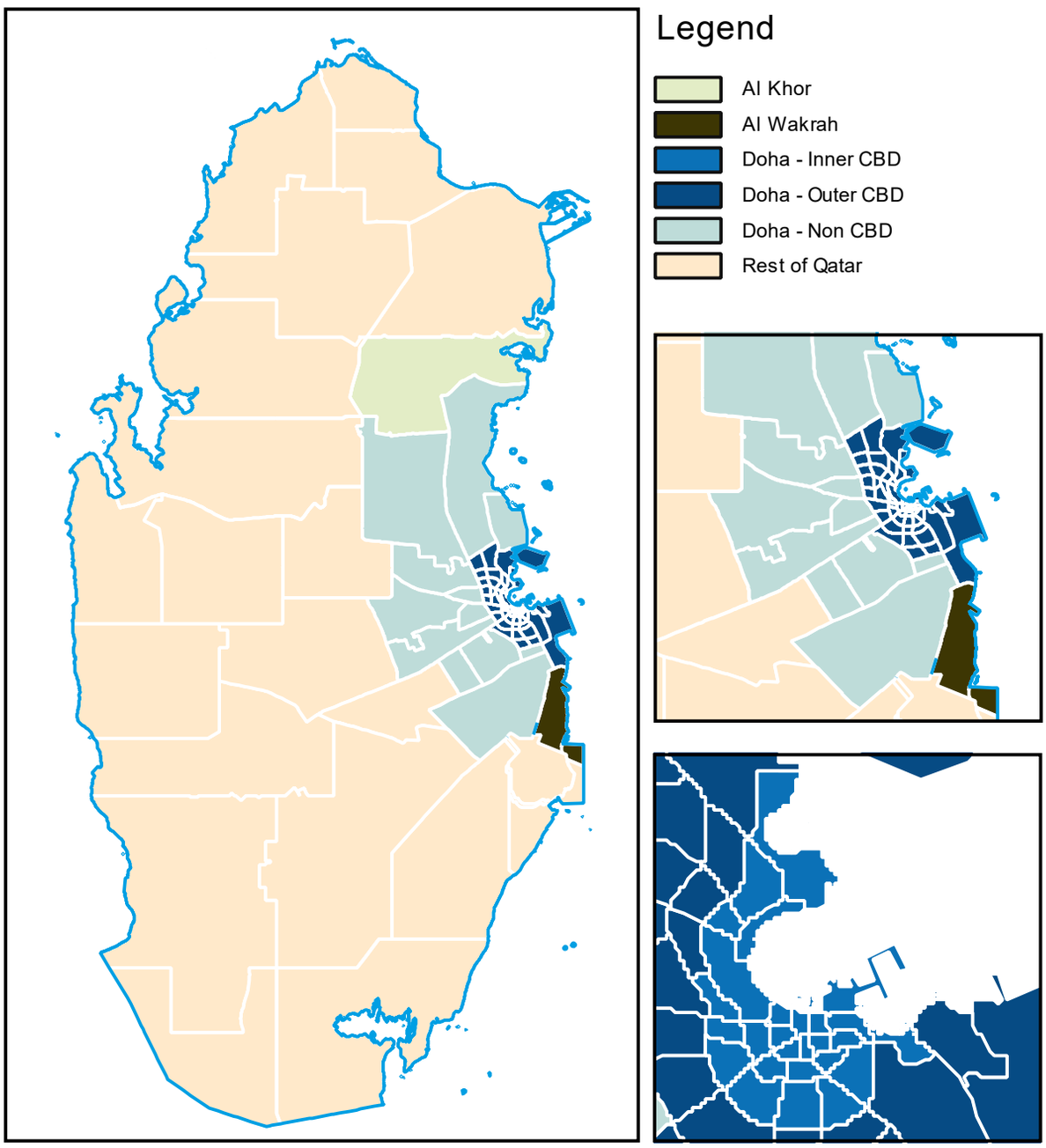


Figure 2-2: Used in QTGPRM

2.2 Site Selection

The site selection process used to identify candidate survey sites for the QTGPRM considered factors such as the need to achieve minimum sample sizes for each land use class, ensuring that only robust and valid data were collected. A representative sample of sites across the six geographic regions was a key factor in the selection of survey sites. The other key selection criteria and screening used in this process, are summarized in **Table 2-1**.

Table 2-1: Primary Selection Criteria for QTGPRM Survey Sites

Selection Criteria	Requirements
Land Use Type	There is strong agreement between the site and the defined land use.
Homogeneity	With exception of those needed to estimate rates for one of the mixed-use land use classes (Group 01000), the survey site contains a single land use class.
Size	Is representative of its land use class compared with similar sites elsewhere in Qatar.
Occupancy	Site has an occupancy (the extent to which a study site is fully occupied) level of at least 70 percent.
Maturity	Site has been operational for at least one year, preferably two.
Economic Viability	Site is economically viable.
Permission	Consent shall be obtainable and have been obtained prior to survey.
Parking	Parking is provided on-site parking, where required.
PT Accessibility	Sites with varying levels of PT access are selected to enable effects to be measured.
Access Connections	It is possible to distinguish between vehicles and persons entering and leaving the site. For sites with multiple access connections, it is possible to count all of them simultaneously.

2.3 QTGPRM Surveys

The QTGPRM development process is outlined in **Figure 2-3.**

Following four types of the survey were undertaken to collect the required data to estimate the trip generation and parking demand rates:

1. Land use surveys
2. Interviews (referred to as intercept surveys)
3. Vehicle occupancy surveys
4. Vehicle/person counts (see **Table 2-2**)

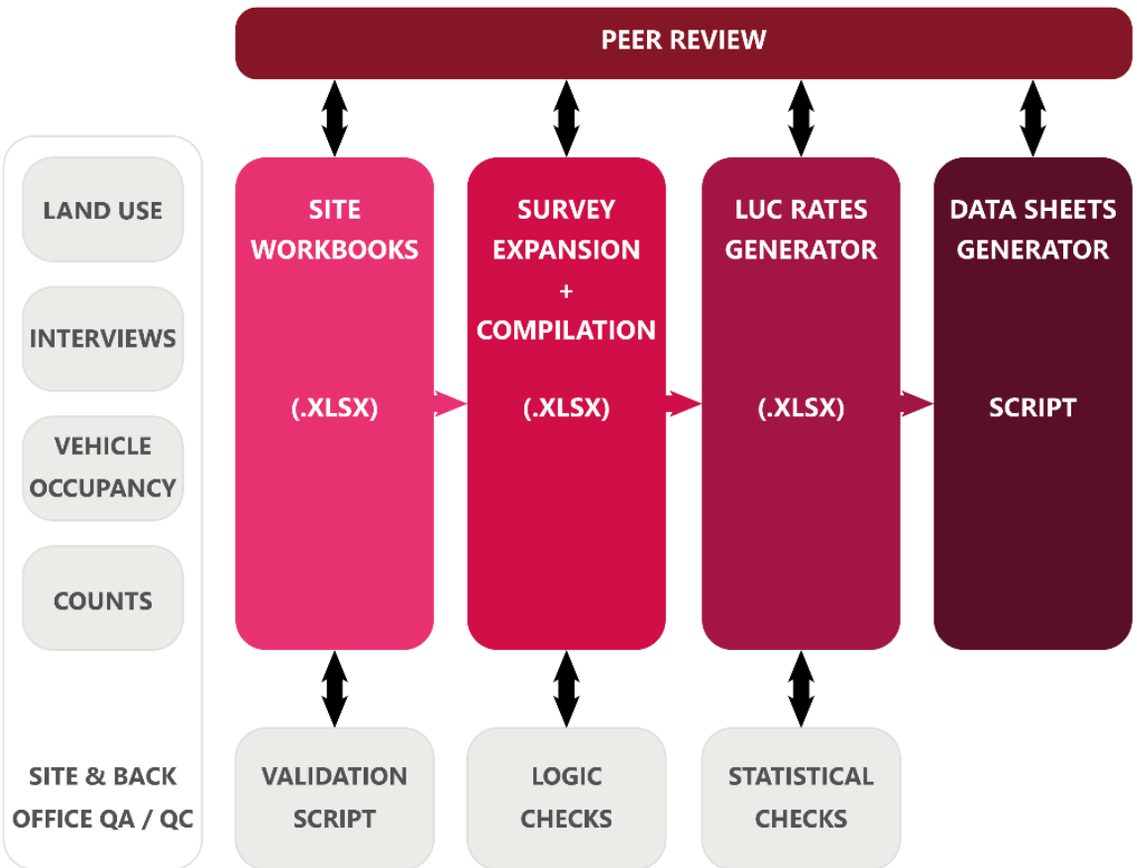


Figure 2-3: Key Steps in Developing QTGPRM

The site surveys were conducted over a two-year period to collect a representative data for both weekdays and weekends.

Table 2-2: Number of Surveys Conducted for QTGPRM

Type of Survey	No. Surveys	Description
Land Use Survey	1,728	Describes site characteristics, including existing development unit of measurement.
Interviews	2,482	Intercept surveys to determine mode of travel, identify any pass-by, diverted and internal trips, establish numbers parking off-site, and estimate vehicle occupancies.
Counts	2,538	Used to measure person and vehicle flows at all entry and exit points and to determine peak parking demand.
Vehicle Occupancy	288	Collected at access points for approximately 288 sites, to validate the estimation of vehicle occupancy data derived through interview surveys.

A summary of the main quality checks carried out is provided in **Table 2-3**. Issues that could not be reconciled during data processing were verified on site and the surveys were repeated where

needed. The last four quality control measures listed were applied to all stages of post-processing including count expansion and estimation of the preliminary and final rates.

Table 2-3: Quality Control Measures for QTGPRM

Procedure	Description
Survey Design	Design of the survey instrument(s) followed by extensive in-field testing.
Staff Training	All surveyors were given comprehensive and rigorous training by experienced surveyors and were tested both in the office and in the field. Interview based surveys were conducted using structured questionnaires delivered through a tablet-based application, which included in-built logic and validation checks.
Site Supervision and Monitoring	All surveys were supervised by highly experienced professionals. Multiple video cameras were installed at all survey sites to enable post-survey verification and scrutiny of site conditions.
Random Checks	Random quality checks were carried out on the surveyors when in the field, and on the data collected on site.
Cross-Validation	Independent data sources were used to validate one another. For example, expanded vehicle counts were compared with person counts.
Logic Checks	Standardized checks were used to ensure that reported measurements fell within expected ranges, and that assumed relationships between measurements were upheld (e.g., total vehicle-trips being less than total person-trips, AM peak inbound trips being higher than outbound trips for offices, total trips in and out of a site being roughly equal across the day).
Independent Audit	Peer review of survey results by experienced professionals not involved in the collection or processing of data. Multiple methods were used, ranging from auditing of completed survey workbooks to statistical tests on reported variables, and benchmarking against comparable international data.

2.4 Estimation of Rates

The trip generation and parking demand rates published in **Volume 2** of QTGPRM have been derived after using best practice statistical procedures to the validated site survey data.

For the trip generation rates, a set of decision rules derived from ITE (2017)[1] has been used to select between the following two calculation methods:

- weighted average of survey results for each land use class
- best-fit rate obtained by applying simple linear regression to survey results for each land use class

Where more than one independent variable was available for a defined land use class, each independent variable was tested (allowing for practical considerations such as the ease of measuring or forecasting the variable).

[1] ITE, 2017. Trip Generation Handbook, 3rd edition. Institute of Transportation Engineers, Washington DC, USA.

The estimation method and independent variable chosen for a given rate are reported in the land use class data sheets published in **Volume 2** of the QTGPRM.

Based on the preliminary results, further statistical tests were applied to confirm whether or not individual land use classes could be merged, or conversely whether they ought to be split. Independent tests were conducted to distinguish data outliers from potential measurement or data processing errors.

Parking demand rates have been derived using the observed peak hour parking accumulation as the dependent variable. The independent variable was matched to that recommended for the trip generation rate.

CHAPTER 3

Trip Generation and Parking Demand Estimation Using the QTGPRM

Chapter 3 Trip Generation and Parking Demand Estimation Using the QTGPRM

The eight main steps summarized in **Table 3-1,** and explained in detail in **Sections 3.1** to **3.8,** should be used to select from **Volume 2** of the QTGPRM the most suitable rates for estimating the trip generation and parking demand for a proposed development site.

Table 3-1: Steps to Estimate Trip Generation and Parking Demand

Steps	Description	Action
1.	**Selection of Land Use Class** (Section 3.1)	The proposed development site land use(s) should be matched to the most suitable land use class given in the QTGPRM. If a suitable match is not found, the user should consult with MOT for further guidance.
2.	**Regional Variation** (Section 3.2)	If regional rates are available, the user should select the most appropriate land use class from the QTGPRM to the region in which the proposed site is located. If the site is located to one of the regional boundaries, this should be consulted with MOT for further guidance.
3.	**Independent Variable** (Section 3.3)	Identify if the rates are available in the QTGPRM for the independent variable to be used for the proposed development. If the rates for the desired independent variable are not present or if an alternative independent variable is required, this should be consulted with MOT.
4.	**Size of the Proposed Development** (Section 3.4)	The size of the proposed development should be within the size range of the survey sites, that have used to estimate the trip generation and parking demand rates in the QTGPRM. If the size of the proposed development is outside to the size range given for the land use class in the QTGPRM, the user should consult with MOT for further guidance.
5.	**Analysis Periods** (Section 3.5)	The analysis periods (AM, MD, PM or PHG) required to be used for trip generation and parking demand estimation should be agreed with MOT in advance.
6.	**Trip Generation and Parking Demand** (Section 3.6)	The selected trip generation and parking demand rates from the QTGPRM should be applied to the study site size using appropriate development units of measurement (e.g., 100 m^2 GFA, number of employees, number of residential units, etc.).
7.	**Vehicle Class and Directional Splits** (Section 3.7)	The peak hour trip generation estimates should be disaggregated by vehicle class and directional split for the reporting, using the appropriate percentages provided in the QTGPRM.
8.	**MOT Review and Approval** (Section 3.8)	The trip generation (including person-trip, vehicle-trip, vehicle class, and directional split) and parking demand estimates should be submitted to MOT for the review and approval.

3.1 Step 1 – Selection of Land Use Class

The proposed development site land use(s) should be matched to the most suitable land use class documented in **Volume 2** of the QTGPRM. For development sites that include more than one land

use, this step should be repeated for each of the land uses within the development site. If an appropriate match is not present in the QTGPRM, the user should consult with MOT. It may be necessary to collect new data from comparable sites in Qatar, or, if there are no comparable sites, from alternative sources.

QTGPRM adopts a three-level classification system of Land Use Group, Land Use Category, and Land Use Class (LUC). Each land use class is identified by a five-digit number. The first two digits denote the Land Use Group, the third digit denotes the Land Use Category, and the final two digits denote the Land Use Class (see **Figure 3-1**).

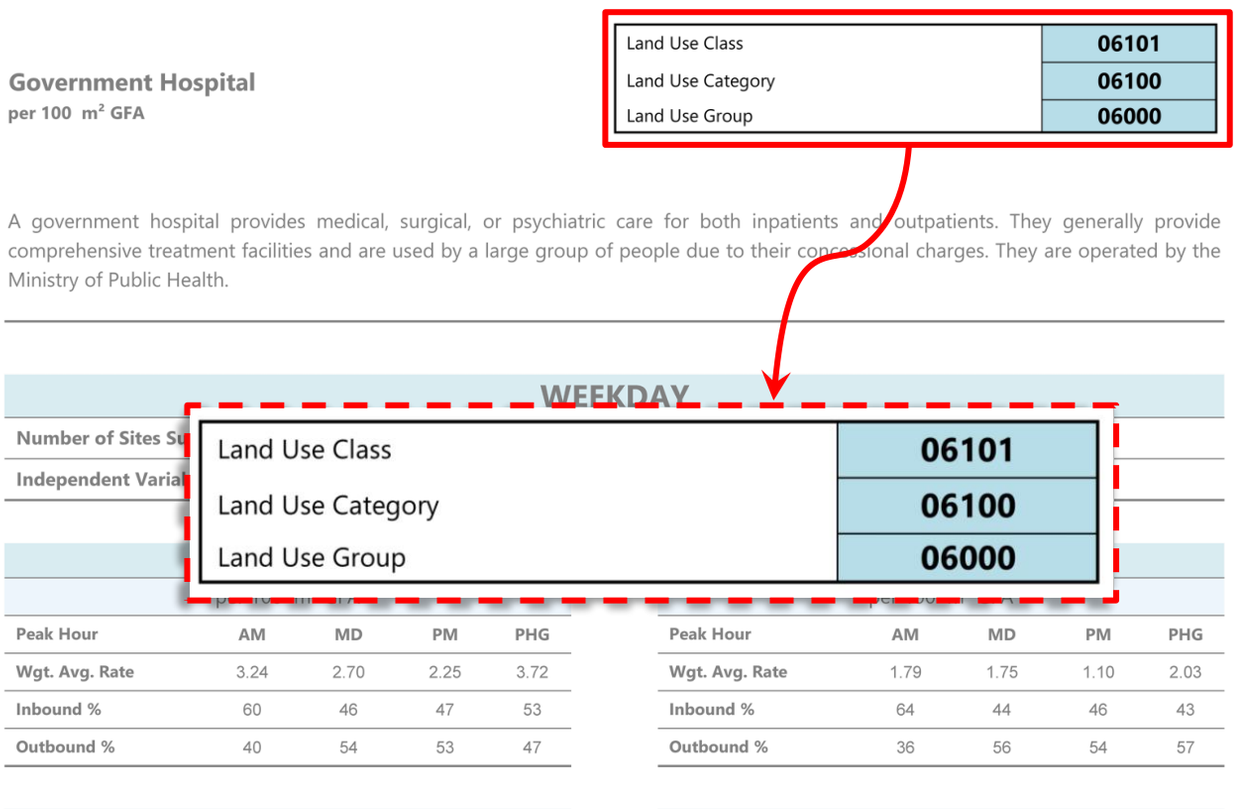


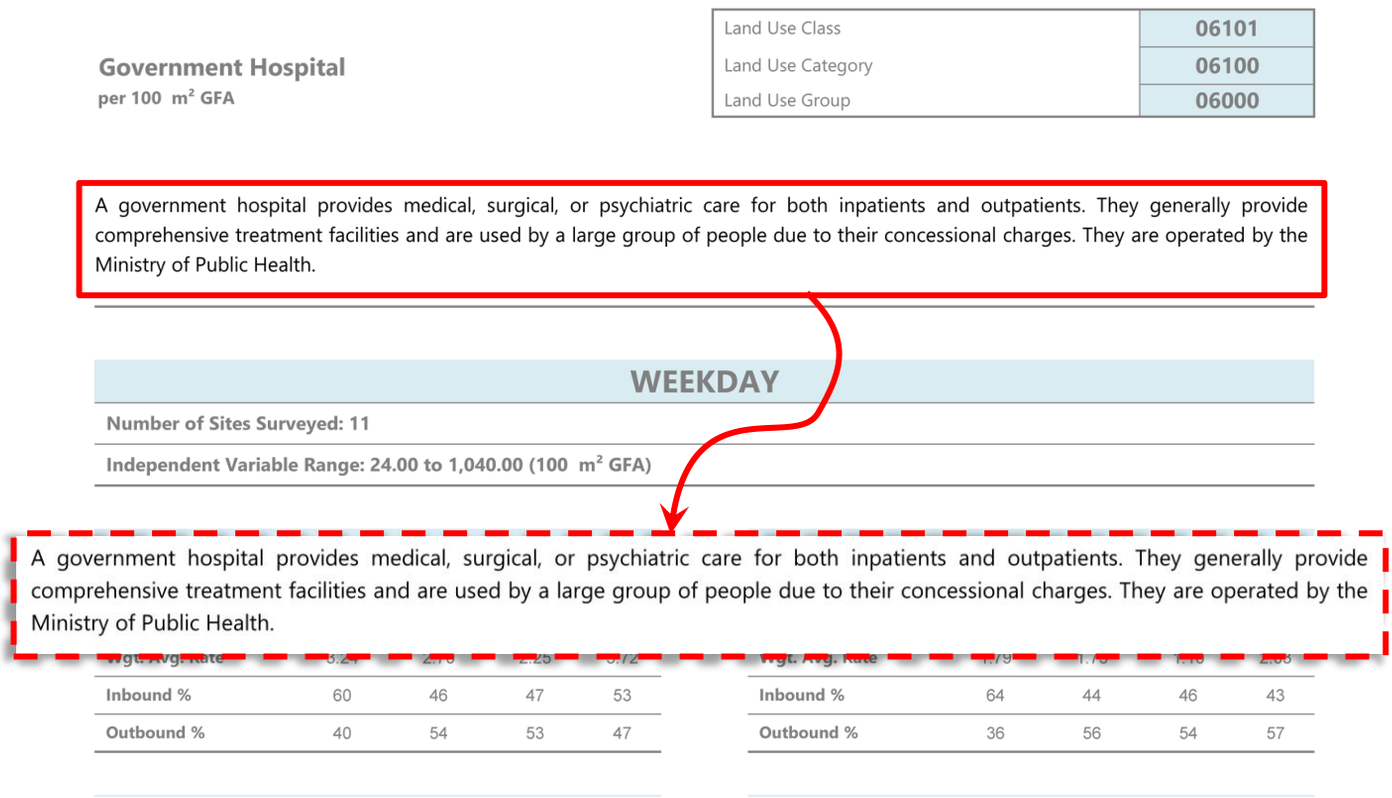
Figure 3-1: Location of Identification Number Within Table of Rates

The full list of land use classes is contained in Chapter 2 of QTGPRM **Volume 2**, which serves as an index to the corresponding rates data sheets. To locate the relevant land use class for a study site, identify the appropriate land use group, followed by the most suitable land use category, and finally the land use class. General descriptions of the land use groups are provided in **Table 3-2**.

The individual land use classes are described in the table of rates contained in **Volume 2** and in **Table 3-2**.

Table 3-2: QTGPRM Land Use Groups Descriptions

Land Use Group	Description
01000 Mixed-Use (Chapter 3, Volume 2)	The Mixed-Use land use group includes developments that combine residential, office, retail, restaurant, tourism, and/or entertainment land uses in a way that allows travel between the various site land uses without leaving the site. The Mixed-Use land use group includes four land use classes, three of which relate to specific combinations of land uses (e.g., retail and office). The fourth land use class is for land use combinations not included in the first three classes.
02000 Residential (Chapter 4, Volume 2)	Residential comprises housing types ranging from apartment buildings to compounds (freestanding, semi-attached, or attached) to freestanding single-family villas. The Residential land use group includes Arabic house, furnished apartment, labor accommodation, company accommodation, and elderly housing land uses classes, among others.
03000 Office (Chapter 5, Volume 2)	Office includes administrative and headquarters buildings used by government or private entities. Office buildings may include customer service facilities such as counters/desks.
04000 Commercial (Chapter 6, Volume 2)	Commercial includes buildings dedicated to personal services and the sale of goods, ranging from regional shopping centers to small shops. Commercial includes souqs, department stores, restaurants, and specialty stores (e.g., pharmacies, bookstores, hardware/paint stores, vehicle maintenance outlets, and petrol stations).
05000 Education (Chapter 7, Volume 2)	Education includes both government and private nursery schools and kindergartens; elementary, preparatory, and secondary schools; universities; and professional institutes, research and development facilities, libraries, and driving schools.
06000 Health (Chapter 8, Volume 2)	Health consists of buildings where medical services are provided, including hospitals, clinics, health centers, and dental surgeries.
07000 Religious Facilities (Chapter 9, Volume 2)	Religious Facilities include places of worship and prayer for followers of Islam and other religions. Religious Facilities includes wedding halls.
08000 Tourism (Chapter 10, Volume 2)	Tourism includes commercial lodging and accommodation developments that offer entertainment, recreation, and food (restaurants and cafes) services. Larger hotels may include meeting rooms and conference facilities.
09000 Recreational (Chapter 11, Volume 2)	Recreational consists of buildings and spaces available for sport, entertainment, and spectatorship including cinemas, theaters, gyms, museums, convention centers, theme parks, arenas, stadiums, parks, golf courses, racetracks, and marinas.
10000 Industrial (Chapter 12, Volume 2)	Industrial consists of sites dedicated to the production or transformation of goods, warehouses, distribution centers, and industrial parks.
11000 Transportation (Chapter 13, Volume 2)	Transportation includes facilities oriented toward the movement of persons or goods including bus stations and train stations associated parking.



Government Hospital
per 100 m^2 GFA

Land Use Class	06101
Land Use Category	06100
Land Use Group	06000

A government hospital provides medical, surgical, or psychiatric care for both inpatients and outpatients. They generally provide comprehensive treatment facilities and are used by a large group of people due to their concessional charges. They are operated by the Ministry of Public Health.

WEEKDAY

Number of Sites Surveyed: 11

Independent Variable Range: 24.00 to 1,040.00 (100 m^2 GFA)

A government hospital provides medical, surgical, or psychiatric care for both inpatients and outpatients. They generally provide comprehensive treatment facilities and are used by a large group of people due to their concessional charges. They are operated by the Ministry of Public Health.

Inbound %	60	46	47	53
Outbound %	40	54	53	47

Inbound %	64	44	46	43
Outbound %	36	56	54	57

Figure 3-2: LUC identifier and definition

3.2 Step 2 – Regional Variation

Six geographic regions are defined in the QTGPRM to allow for the possibility of statistically significant differences in trip generation or parking demand rates due to study site location. The geographic regions are listed in **Table 3-3** and shown in **Figure 3-3**.

Table 3-3: QTGPRM Study Site Regions

No.	Zone	Characteristics
1	**Inner CBD**	The Inner CBD (Central Business District) is the commercial focus of Doha city. Most public and private companies have their headquarters in this area. Currently, in comparison to the rest of Qatar, it has the highest population and/or employee densities, highest levels of transit accessibility, a mix of structured and shared parking, and many defined pedestrian sidewalks.
2	**Outer CBD**	The remainder of the CBD is defined as the Outer CBD. It is characterized by midrise multi-story buildings and, a broad mix of land uses. There are a range of pedestrian facilities, but fewer public transport options.
3	**Non-CBD**	The Non-CBD area of Doha is essentially suburban in nature. The majority of plots here comprise a single land use. Where mixed-use sites exist, they are generally located next to road intersections. Setbacks and landscaping are variable and streets typically define medium-sized blocks. Typical land uses include low and medium density residential and home-based occupations, limited commercial land uses and lodgings.
4	**Al Khor**	Al Khor is a coastal settlement located within the Al Khor municipality. It is located approximately 50 kilometers north of Qatar's capital city, Doha. It is a major regional settlement area
5	**Al Wakrah**	Qatar's second largest city, Al Wakrah is a coastal settlement located within the Al Wakrah municipality. It is located approximately 25 kilometers south of Qatar's capital city, Doha.
6	**Rest of Qatar**	Smaller settlements (Al Shamal, Dukhan, Mesaieed, Umm Bab, Al Jumayliyah) which are primarily residential in nature, and rural areas.

The application of the regional classification to each land use class, where applicable, is provided in Table 2-15 of **Volume 2**. For example, the trip generation and parking demand rates for Government Hospital (LUC 06101) apply to all six regions as shown in **Figure 3-3**.

Group	Category	Class & Description	Regional Application					
			Doha			Other		
			Inner CBD	Outer CBD	Non-CBD	Al Khor	Al Wakrah	Rest
		06101: Government Hospital	x	x	x	x	x	x
06000 Health	06100 Hospital / Health Centers	06102: Private Hospital	x	x	x	x	x	x
		06103: Primary Health Care Centre (PHCC)	x	x	x	x	x	x
		06104: Private Medical Clinic	x	x	x	x	x	x
		06105: Dental Surgery	x	x	x	x	x	x
		06106: Government Clinic	x	x	x	x	x	x
		06107: Veterinary Clinic	x	x	x	x	x	x

Figure 3-3: Regional Applicability by LUC

If regional rates are available, the user should select the land use class appropriate to the region in which the site is located. If the proposed development is located on the regional boundaries, this should be consulted with MOT for further instructions.

Once a region-specific land use class is identified to be an appropriate match, the corresponding trip generation and parking demand rates should be used.

3.3 Step 3 – Independent Variable

The user should identify if the rates are available in the QTGPRM for the independent variable to be used for the proposed development. If the rates for the desired independent variable are not present or if an alternative independent variable is required, this should be consulted with MOT for further instructions. The independent variable of the land use class can be found on the top left of the table of rates in the **Volume 2** of QTGPRM, as depicted in **Figure 3-4** overleaf.

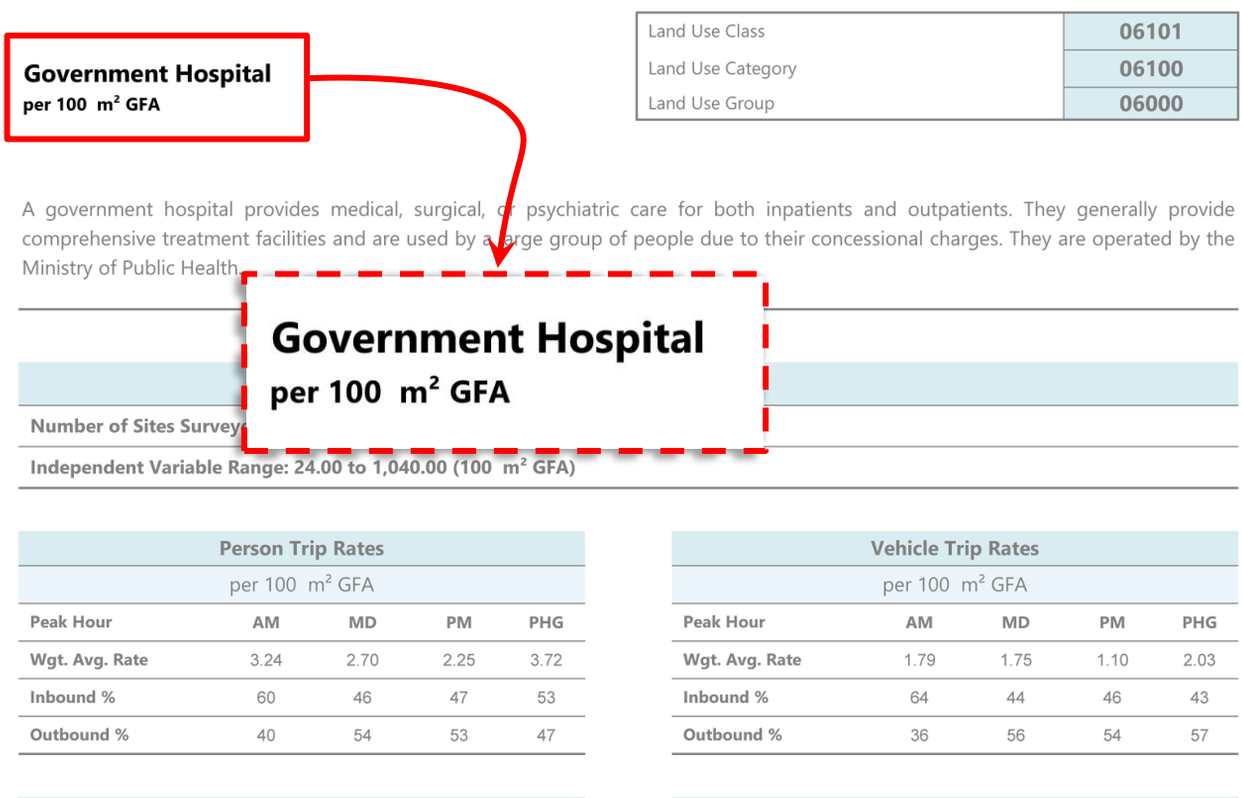


Figure 3-4: Finding the LUC Independent Variable

Where the size of the study site is available in the same unit of measurement, as used for the land use class as an independent variable, the land use class rates may be applied directly. Where the unit of measurement is different, the size of the study site in terms of the independent variable unit of measurement must be derived.

3.4 Step 4 – Size of the Proposed Development

The size of the proposed development should be within the size range of the survey sites, which have used to estimate the trip generation and parking demand rates in the QTGPRM.

The range can be found within the land use class data sheet, as shown in **Figure 3-5**. If the size of the proposed development is outside the size range of the sites surveyed, then the trip generation and parking demand rates for the selected land use class may not be applicable to the proposed development and an alternative method of estimating trip generation and parking demand may be needed following consultation with MOT.

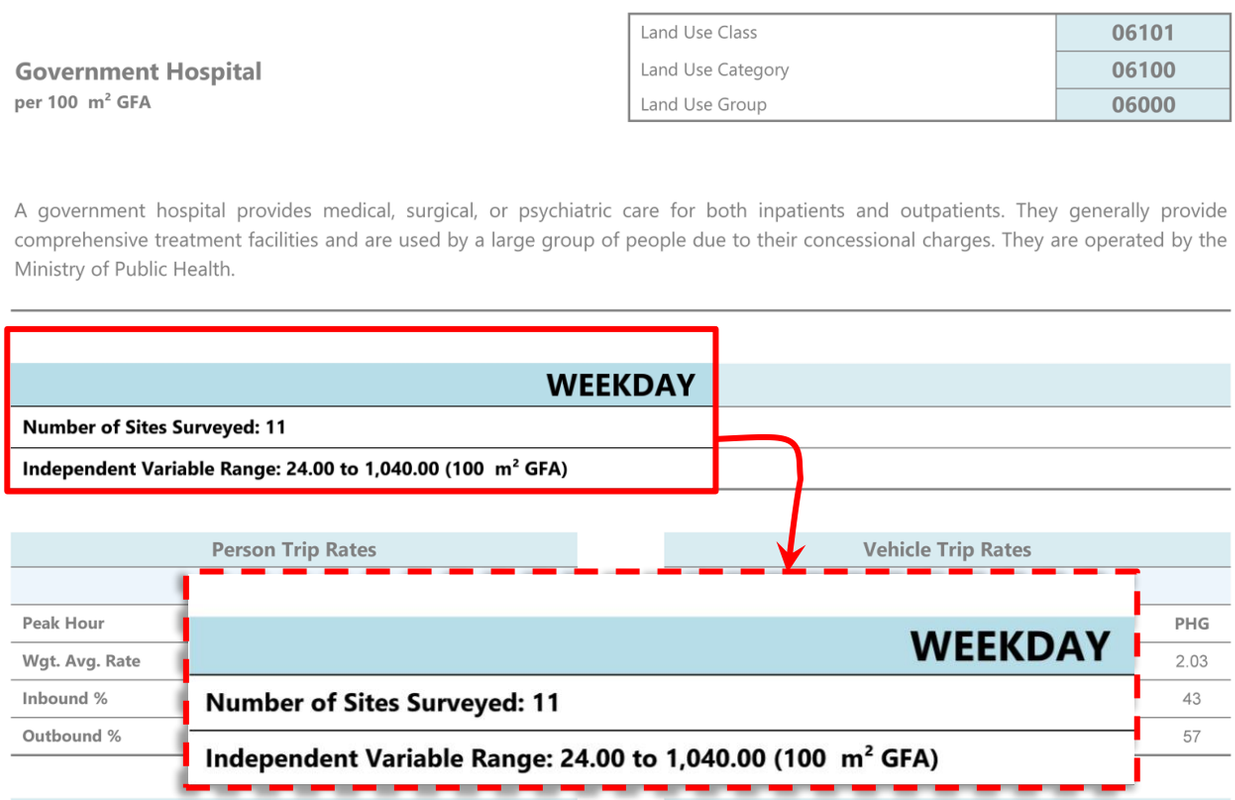


Figure 3-5: Sample observed range for a LUC trip rate

Extrapolating beyond the reported range is not recommended. However, the 95 percent confidence intervals presented in the corresponding data sheets in **Volume 2** do imply a degree of tolerance for the trip generation rates, provided the observed relationship between the dependent and independent variables can be reasonably approximated by a straight line, and that extrapolation below the minimum observed value would not result in a negative trip rate. For example, if the published rate is 2.5 and the upper and lower confidence limits are 1.2 and 3.8 respectively, then the implied tolerance would be ±52 percent.

By extension, if the observed range of the independent variable is 500 m^2 to 50,000 m^2, then the implied tolerance to be applied to candidate developments falling outside that range would be 240 m^2 to 76,000 m^2.

Nevertheless, if the proposed quantity falls outside the reported range for the matched land use class, the user should consult with MOT for further guidance.

3.5 Step 5 – Analysis Periods

The analysis periods (AM, MD, PM or PHG) to be used for the estimation of trip generation and parking demand, should be agreed with MOT in advance.

Consultants conducting a GPTS-compliant transportation study will have been alerted to this during the scoping meeting. The estimation of appropriate design hour traffic volumes will generally necessitate estimating project trip generation for the peak hours of the adjacent street (AM, MD, PM) and for the peak hour of the generator (PHG).

Both weekday and weekend rates are reported separately, where available, each on a single page. The reported weekend rates shall be interpreted as applying to both Friday and Saturday.

To estimate the parking demand for a study site, compare the published total weekday and weekend rates for the relevant land use class and select the higher of the two rates. A sample parking demand summary table from a land use class data sheet is shown in **Figure 3-6**.

Government Hospital
per 100 m² GFA

Land Use Class	06101
Land Use Category	06100
Land Use Group	06000

A government hospital provides medical, surgical, or psychiatric care for both inpatients and outpatients. They generally provide comprehensive treatment facilities and are used by a large group of people due to their concessional charges. They are operated by the Ministry of Public Health.

WEEKDAY

Number of Sites Surveyed: 11

Independent Variable Range: 24.00 to 1,040.00 (100 m² GFA)

Person Trip Rates
per 100 m² GFA

Peak Hour	AM	MD	PM	PHG
Wgt. Avg. Rate	3.24	2.70	2.25	3.72
Inbound %				
Outbound %				

Vehicle Trip Rates
per 100 m² GFA

Peak Hour	AM	MD	PM	PHG
Wgt. Avg. Rate	1.79	1.75	1.10	2.03
		44	46	43
		56	54	57

Peak Parking Space Demand
per 100 m² GFA

Cars	1.23
LGV	0.07
HGV	0.00
Buses	0.02

Pe … **icle Split**

Peak Hour			MD	PM	PHG
Car			4.0%	2.6%	3.2%
Taxi			87.9%	89.6%	91.6%
PT/Bus			8.1%	7.8%	5.2%
Company/School Bus			0.0%	0.0%	0.0%
Cycle	0.0%	0.0%	0.0%	0.0%	
Walk	0.5%	2.6%	0.3%	0.7%	
Other Vehicles	0.2%	0.1%	1.0%	0.3%	

Peak Parking Space Demand
per 100 m² GFA

Cars	1.23
LGV	0.07
HGV	0.00
Buses	0.02

Figure 3-6: Sample Parking Demand Extract from a LUC Data Sheet

3.6 Step 6 – Trip Generation and Parking Demand

3.6.1 Person and Vehicle-Trip Generation

The selected trip generation and parking demand rates from the QTGPRM **Volume 2**, should be applied to the study site size using appropriate development units of measurement (e.g., 100 m^2 GFA, number of employees, number of residential units, etc.). For study sites with more than one proposed land use, the trip generation should be estimated and reported for each individual proposed land use.

For many land use classes, both a weighted-average trip generation rate and a best-fit trip generation rate are reported, as shown in **Figure 3-7**.

For Stage 1 of a GPTS-compliant transportation study, the initial peak hour trip generation estimate for the study site is obtained by using the PHG person trip generation rate for the land use class.

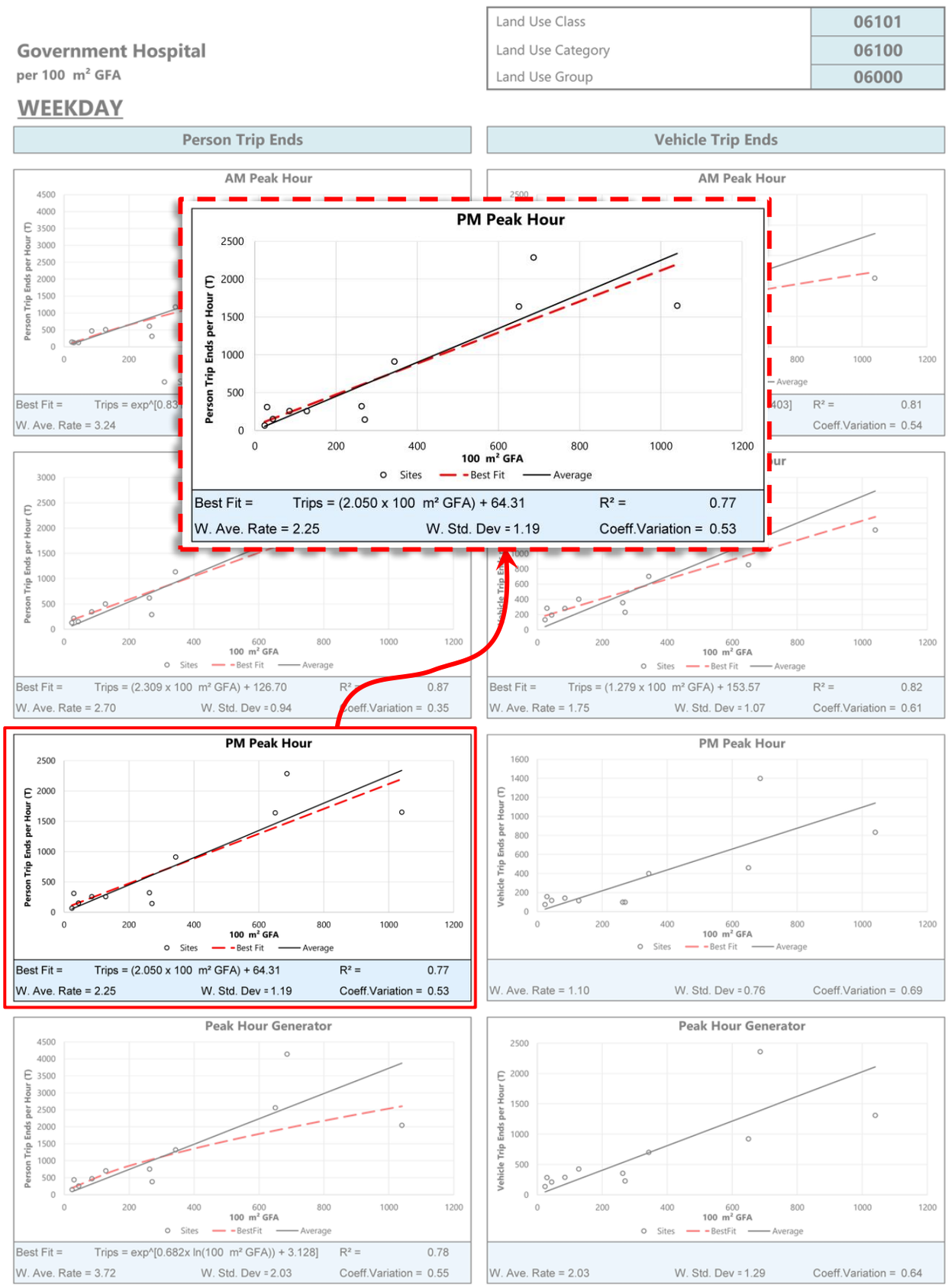


Figure 3-7: Locating the Best Fit and Weighted Average Rates on Scatter Plots

3.6.2 Parking Demand

To estimate study site parking demand, use the higher of the weekday or weekend parking demand rates for the relevant land use class (and region, if applicable).

For sites with multiple proposed land uses, estimate the parking demand for each land use separately, and then sum the individual estimates, rounding up to the nearest whole number.

3.7 Step 7 – Vehicle Class and Directional Splits

The peak hour trip generation estimates should be disaggregated by vehicle class and directional split, using the percentages appropriate to the reporting day and time period of the trip generation rates used. Ensure that the percentages used relate to the same reporting day as the trip generation rates identified in **Step 6**.

3.7.1 Vehicle Class Split

The vehicle class split of the vehicle trip generation estimate shall be based on the percentages listed in the vehicle class split table of the data sheet for the relevant land use class (as highlighted in **Figure 3-8**). The following vehicle classes are reported, although the vehicle class split of some of these classes may be zero percent:

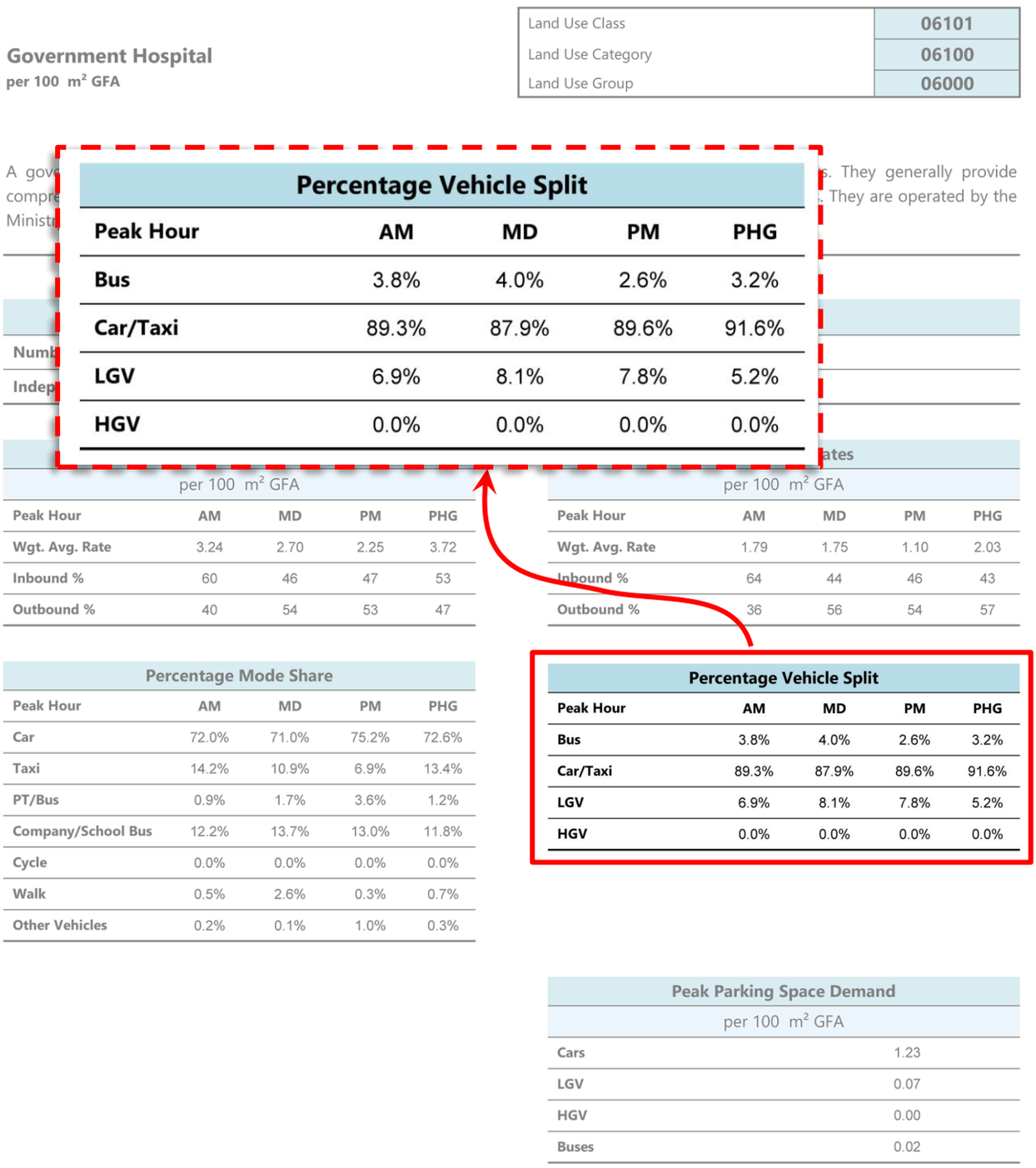
Note: *Estimated vehicle class splits are based on data collected at the survey sites at the time of the surveys.*

- Bus (i.e., PT bus, school bus, company bus, etc.)
- Car/Taxi
- Light Goods Vehicle
- Heavy Goods Vehicle

If a proposed development contains more than one land use, then the vehicle class split procedure should be repeated for each individual land use.

The mode share percentage figures provided in the user manual can be applied directly to the quoted person trip rates to show the number of people arriving/departing by each mode of travel (Car, Taxi, Public Transport, School/Company Bus, Cycle, or Walk). The mode share percentages have been derived from counts of people entering/leaving the specific survey sites and as such include all people whether they had parked on or off-site. The mode share percentages are useful as they provide the scale of Public Transport use and walking which can be used to determine the impact and requirement for facilities to meet the person based demand. The mode share

percentage figures cannot be directly compared to the vehicle split figures as the former relates to person trips and the latter to vehicle trips.



Government Hospital
per 100 m² GFA

Land Use Class	06101
Land Use Category	06100
Land Use Group	06000

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Percentage Vehicle Split

Peak Hour	AM	MD	PM	PHG
Bus	3.8%	4.0%	2.6%	3.2%
Car/Taxi	89.3%	87.9%	89.6%	91.6%
LGV	6.9%	8.1%	7.8%	5.2%
HGV	0.0%	0.0%	0.0%	0.0%

…ates

per 100 m² GFA

Peak Hour	AM	MD	PM	PHG
Wgt. Avg. Rate	3.24	2.70	2.25	3.72
Inbound %	60	46	47	53
Outbound %	40	54	53	47

per 100 m² GFA

Peak Hour	AM	MD	PM	PHG
Wgt. Avg. Rate	1.79	1.75	1.10	2.03
Inbound %	64	44	46	43
Outbound %	36	56	54	57

Percentage Mode Share

Peak Hour	AM	MD	PM	PHG
Car	72.0%	71.0%	75.2%	72.6%
Taxi	14.2%	10.9%	6.9%	13.4%
PT/Bus	0.9%	1.7%	3.6%	1.2%
Company/School Bus	12.2%	13.7%	13.0%	11.8%
Cycle	0.0%	0.0%	0.0%	0.0%
Walk	0.5%	2.6%	0.3%	0.7%
Other Vehicles	0.2%	0.1%	1.0%	0.3%

Percentage Vehicle Split

Peak Hour	AM	MD	PM	PHG
Bus	3.8%	4.0%	2.6%	3.2%
Car/Taxi	89.3%	87.9%	89.6%	91.6%
LGV	6.9%	8.1%	7.8%	5.2%
HGV	0.0%	0.0%	0.0%	0.0%

Peak Parking Space Demand

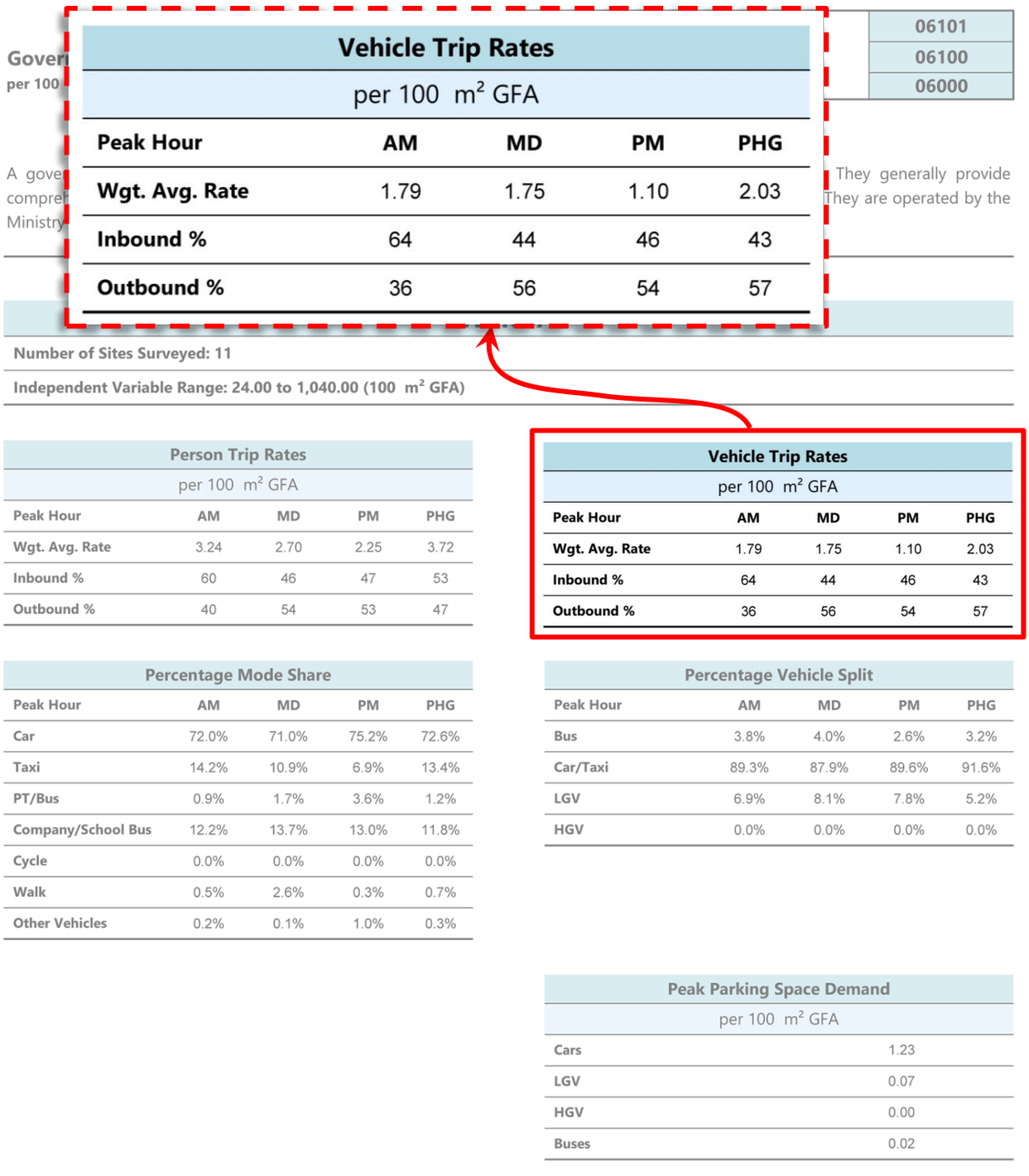
per 100 m² GFA

Cars	1.23
LGV	0.07
HGV	0.00
Buses	0.02

Figure 3-8: Sample Vehicle Class Split

3.7.2 Directional Split

The proportions of inbound and outbound travel provided in the data sheet for the relevant land use class (reported in the Vehicle Trip Generation Information table as highlighted in **Figure 3-9**) are applied to the vehicle class trip generation estimates, to obtain peak hour trip generation by direction of travel by vehicle class.



Gover
per 100

06101
06100
06000

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Ministry

They generally provide
They are operated by the

Vehicle Trip Rates				
per 100 m² GFA				
Peak Hour	**AM**	**MD**	**PM**	**PHG**
Wgt. Avg. Rate	1.79	1.75	1.10	2.03
Inbound %	64	44	46	43
Outbound %	36	56	54	57

Number of Sites Surveyed: 11

Independent Variable Range: 24.00 to 1,040.00 (100 m² GFA)

Person Trip Rates				
per 100 m² GFA				
Peak Hour	AM	MD	PM	PHG
Wgt. Avg. Rate	3.24	2.70	2.25	3.72
Inbound %	60	46	47	53
Outbound %	40	54	53	47

Vehicle Trip Rates				
per 100 m² GFA				
Peak Hour	**AM**	**MD**	**PM**	**PHG**
Wgt. Avg. Rate	1.79	1.75	1.10	2.03
Inbound %	64	44	46	43
Outbound %	36	56	54	57

Percentage Mode Share				
Peak Hour	AM	MD	PM	PHG
Car	72.0%	71.0%	75.2%	72.6%
Taxi	14.2%	10.9%	6.9%	13.4%
PT/Bus	0.9%	1.7%	3.6%	1.2%
Company/School Bus	12.2%	13.7%	13.0%	11.8%
Cycle	0.0%	0.0%	0.0%	0.0%
Walk	0.5%	2.6%	0.3%	0.7%
Other Vehicles	0.2%	0.1%	1.0%	0.3%

Percentage Vehicle Split				
Peak Hour	AM	MD	PM	PHG
Bus	3.8%	4.0%	2.6%	3.2%
Car/Taxi	89.3%	87.9%	89.6%	91.6%
LGV	6.9%	8.1%	7.8%	5.2%
HGV	0.0%	0.0%	0.0%	0.0%

Peak Parking Space Demand	
per 100 m² GFA	
Cars	1.23
LGV	0.07
HGV	0.00
Buses	0.02

Figure 3-9: Sample-Directional Splits for Vehicle-Trips

3.8 Step 8 – MOT Review and Approval

Finally, the selected rates and trip generation (including person-trip, vehicle-trip, vehicle class, and directional split) and parking demand estimates should be compiled and submitted to MOT for the review and approval. For a development proposal that includes more than one land use, both the individual parking demand and trip generation estimates (**Step 6** and **Step 7**) and the total parking demand and trip generation estimates should be reported.

Estimates related to discrete units (person-trips, vehicle-trips, etc.) should be rounded to the nearest whole number and estimates for individual demand components, when summed, should match the aggregate estimates (i.e., ignore minor rounding error to avoid the appearance of a math error).

CHAPTER 4

Trip Generation and Parking Demand Estimation – Worked Example

Chapter 4 Trip Generation and Parking Demand Estimation- Worked Example

4.1 Introduction

This chapter presents a worked example to explain the process of estimating the trip generation and parking demand, for a hypothetical proposed development using the rates documented in **Volume 2** of the QTGPRM.

4.2 Worked Example

This worked example illustrates the process of estimating peak hour trip generation and parking demand for a hypothetical proposed government hospital of 10,000 m^2 GFA.

4.2.1 Step 1 – Selection of Land Use Class

The hypothetical proposed government hospital is health facility. The user should refer to QTGPRM **Volume 2**, Chapter 2, to identify the most appropriate land use class. In this worked example, the proposed development falls under the Land Use Group 06000 - Health, Land Use Category 06100 – Medical, and LUC 06101 - Government Hospital. For further confirmation, the user should refer to the detailed definition provided within the table of rates for LUC 06101.

4.2.2 Step 2 – Regional Variation

To check whether the published rates for this LUC 06101 vary by region, the user should refer to QTGPRM **Volume 2**, Chapter 2, which confirms that LUC 006101 applies to all regions and that there is no regional variation in the reported rates.

4.2.3 Step 3 – Independent Variable

The independent variable reported in the table of rates for LUC 06101 is gross floor area (GFA) and the unit of measurement is one hundred square meters (100 m^2). Therefore, the reported size of the development (10,000 m^2) should be divided by 100 m^2 to obtain the development size expressed in the same units as the land use class independent variable, 10,000 m^2 ÷ 100 m^2 = 100.

4.2.4 Step 4 – Size of the Proposed Development

The size of the proposed development should be checked to be within the size range of the survey sites on which the trip generation and parking demand rates are based. For example, the size range for LUC 06101 is 24 [100 m^2] to 1,040 [100 m^2] GFA. The size of the proposed development (100 [100 m^2] GFA) is within this size range. If the size of the proposed development is outside the size range of the sites surveyed, then the trip generation and parking demand rates for the selected land use class may not be applicable to the proposed development and an alternative method of estimating trip generation and parking demand may be needed. In such situation, it is recommended to consult with MOT for further guidance.

4.2.5 Step 5 – Select Analysis Periods

Step 5 requires selecting analysis period during the project scoping meeting. For example, the analysis periods used in the example are the weekday PM peak hour of the adjacent street (PM) and the weekday peak hour of the generator (PHG).

4.2.6 Step 6 – Apply Rates

The reported trip generation and parking demand rates for LUC 06101 for the agreed analysis periods (PM and PHG) are shown in **Table 4-1**.

Table 4-1: Worked Example Person-Trip, Vehicle-Trip, and Parking Demand Rates

Rate Type	Per 100 m^2	Weekday	
		PM	PHG
Person-Trip	Weighted average	2.25	3.72
	Inbound %	47	53
	Outbound %	53	47
Vehicle-Trip	Weighted average	1.10	2.03
	Inbound %	46	43
	Outbound %	54	57
Parking Demand		Peak Parking Space Demand per 100 m^2 GFA	
		Cars	1.23
		LGV	0.07
		HGV	0.00
		Buses	0.02

Multiplying the size of the development (100 [100 m^2] GFA) by the reported rates, provides the peak hour trip generation and parking demand estimates as presented in **Table 4-2**.

Table 4-2: Worked Example Peak Hour Trip Generation and Parking Demand Estimates

Estimate	Weekday	
	PM	PHG
Person-Trips	(2.25 x 100) = **225**	(3.72 x 100) = **372**
Vehicle-Trips	(1.10 x 100) = **110**	(2.03 x 100) = **203**
Parking Demand	(1.32 x 100) = **132**	

4.2.7 Step 7 – Apply Vehicle Class and Directional Splits

In next step, the user requires to disaggregate the **Table 4-2** vehicle trip generation estimates by vehicle class and by direction of travel using the proportions provided in land use rates tables in the **Volume 2**, as elaborated in **Table 4-3** and **Figure 4-1**.

Percentage Vehicle Split				
Peak Hour	AM	MD	PM	PHG
Bus	3.8%	4.0%	2.6%	3.2%
Car/Taxi	89.3%	87.9%	89.6%	91.6%
LGV	6.9%	8.1%	7.8%	5.2%
HGV	0.0%	0.0%	0.0%	0.0%

Vehicle Trip Rates				
	per 100 m^2 GFA			
Peak Hour	AM	MD	PM	PHG
Wgt. Avg. Rate	1.79	1.75	1.10	2.03
Inbound %	64	44	46	43
Outbound %	36	56	54	57

Figure 4-1: Worked Example Vehicle Class and Directional Splits

Table 4-3: Worked Example Trip Generation Estimates by Vehicle Class

Vehicle Class	Weekday	
	PM	PHG
Bus	(2.6% x 110) = 2.86	(3.2% x 203) = 6.50
Car/Taxi	(89.6% x 110) = 98.56	(91.6% x 203) = 185.95
LGV	(7.8% x 110) = 8.58	(5.2% x 203) = 10.56
HGV	(0% x 110) = 0	(0% x 203) = 0

Table 4-4: Worked Example Trip Generation Estimates by Travel Direction

Vehicle Class	Weekday			
	PM		PHG	
	In	Out	In	Out
Bus	(46% x 2.86) = **1.32**	(54% x 2.86) = **1.54**	(43% x 6.5) = **2.79**	(57% x 6.5) = **3.70**
Car/Taxi	(46% x 98.56) =**45.34**	(54% x 94.55) = **53.22**	(43% x 185.95) =**79.96**	(57% x 185.95) = **105.99**
LGV	(46% x 8.58) = **3.95**	(54% x 8.59) = **4.63**	(43% x 10.56) = **4.54**	(57% x 10.56) = **6.02**
HGV	(46% x 0) = **0**	(54% x 0) = **0**	(43% x 0) = **0**	(57% x 0) = **0**

4.2.8 Step 8 – Report Rates and Estimates

A sample summary sheet showing all the required information for the worked example is given in **Table 4-5**. To derive the parking demand for each vehicle class, the parking rates given in **Table 4.1** are simply multiplied by size of the development **100** [100 m^2] GFA.

Table 4-5: Worked Example Summary Sheet

Estimate	WEEKDAY			
	PM		PHG	
	In	Out	In	Out
Person	225 x 47% = 106	225 x 53% =119	372 x 53% = 197	372 x 47% = 175
Vehicle				
Bus	1	2	3	4
Car/Taxi	45	53	80	106
LGV	4	5	5	6
HGV	0.00	0.00	0.00	0.00
Total	**110**		**203**	
Parking				
Car	100 x 1.23 = **123** spaces			
LGV	100 x 0.07 = **70** spaces			
HGV	100 x 0.00= **0** spaces			
Bus	100 x 0.02 = **2** spaces			

CHAPTER 5

Adjustments to Trip Generation Estimate

Chapter 5 Adjustments to Trip Generation Estimate

5.1 Permitted Adjustments

MOT will consider and may approve adjustments to the estimated trip generation due to internal capture and pass-by trips, where applicable and justified, such as;

- **Internal Capture** – to reflect internally-captured trips, comprising trips made between different land uses on the same study site.
- **Pass-by Capture** – for commercial sites adjacent to major travel routes that have the potential to attract significant numbers of trips made by motorists passing by the site en route to their primary destination (i.e., trips where the study site is not the primary destination).

These adjustments do not apply to the published parking demand rates.

5.2 Internal Capture

For development sites with a mix of complementary land uses, it is likely that some trips will be made entirely within the development boundaries (e.g., from office uses to commercial uses, or from commercial uses to residential uses).

To avoid overestimating the potential impact of such developments on the surrounding road network, it is important that any internally-captured trips be accounted for and removed from the peak hour estimates before they are used in a transportation study. The internal capture will be accounted by default where Qatar Strategic Transportation Model (QSTM) is being used. For a transportation study that does not require QSTM, internal capture can be estimated as outlined in the following sections.

5.2.1 Criteria for Internal Capture Adjustment

To be eligible for internal capture adjustment, a development shall meet the following criteria:

- Contains at least two or more of the following Land Use Categories; Office, Retail, Residential, Hotel, Restaurant and Recreational
- Travel between the individual site land uses can be accomplished without crossing the site boundaries.
- Development does not fall within mixed-use Category LUC 01101, LUC 01201, or LUC 01301.

5.2.2 Internal Capture Adjustment Factors

The internal capture adjustment factors have been estimated using the data collected for the development of the QTGPRM, and presented in **Table 5-1** through to **Table 5-6** for three time periods

Table 5-1: AM Peak Hour Internal Capture Factors for Outbound Person-Trips

From \ To	Office	Retail	Restaurant/ Entertainment	Residential	Hotel
Office		1%	0%	1%	0%
Retail	6%		5%	3%	0%
Restaurant/ Entertainment	5%	4%		1%	0%
Residential	2%	2%	1%		0%
Hotel	0%	0%	0%	0%	

Table 5-2: MD Peak Hour Internal Capture Factors for Outbound Person-Trips

From \ To	Office	Retail	Restaurant/ Entertainment	Residential	Hotel
Office		3%	2%	1%	0%
Retail	3%		4%	3%	0%
Restaurant/ Entertainment	2%	5%		0%	0%
Residential	1%	1%	6%		0%
Hotel	0%	0%	0%	0%	

Table 5-3: PM Peak Hour Internal Capture Factors for Outbound Person-Trips

From \ To	Office	Retail	Restaurant/ Entertainment	Residential	Hotel
Office		3%	2%	1%	1%
Retail	4%		6%	0%	0%
Restaurant/ Entertainment	2%	2%		0%	0%
Residential	1%	3%	2%		0%
Hotel	3%	3%	3%	0%	

Table 5-4: AM Peak Hour Internal Capture Factors for Inbound Person-Trips

From \ To	Office	Retail	Restaurant/ Entertainment	Residential	Hotel
Office		3%	2%	2%	0%
Retail	2%		6%	3%	0%
Restaurant/ Entertainment	0%	5%		3%	0%
Residential	1%	6%	1%		0%
Hotel	0%	0%	0%	0%	

Table 5-5: MD Peak Hour Internal Capture Factors for Inbound Person-Trips

From \ To	Office	Retail	Restaurant/ Entertainment	Residential	Hotel
Office		3%	1%	0%	0%
Retail	4%		5%	0%	0%
Restaurant/ Entertainment	5%	6%		1%	0%
Residential	2%	1%	0%		0%
Hotel	0%	0%	0%	0%	

Table 5-6: PM Peak Hour Internal Capture Factors for Inbound Person-Trips

From \ To	Office	Retail	Restaurant/ Entertainment	Residential	Hotel
Office		4%	2%	1%	3%
Retail	3%		8%	5%	0%
Restaurant/ Entertainment	2%	7%		2%	0%
Residential	1%	1%	0%		0%
Hotel	7%	0%	0%	0%	

5.2.3 Internal Capture - Worked Example

A hypothetical study site with a mix of office, retail, and restaurant land uses has been considered in the worked example below, to estimate the internal capture using the QTGPRM adjustment factors.

Assuming that, the PM is the agreed analysis period, the trip generation for person-trip should be estimated for the PM peak hour for each land use. The person-trips shown in **Table 5-7** are the

arbitrary number of trips used in this example to elaborate. The process to estimate the trip generation for a site, is explained in **Chapter 4.**

Table 5-7: Example -Trip Generation to Derive Internal Capture

Land Uses	Inbound PM Peak Hour Person-Trips	Outbound PM Peak Hour Person-Trips
Office	85	80
Retail	50	52
Restaurant	37	41

The percentage of internally-captured trips between each pair of land uses during the PM peak hour can be identified in **Table 5-3** and **Table 5-6**, as shown in **Figure 5-1**.

Table 5 3: PM Peak Hour Internal Capture Factors for Outbound Person-Trips

From \ To	Office	Retail	Restaurant/ Entertainment	Residential	Hotel
Office		3%	2%	1%	1%
Retail	4%		6%	0%	0%
Restaurant/ Entertainment	2%	2%		0%	0%
Residential	1%	3%	2%		0%
Hotel	3%	3%	3%	0%	

Table 5 6: PM Peak Hour Internal Capture Factors for Inbound Person-Trips

From \ To	Office	Retail	Restaurant/ Entertainment	Residential	Hotel
Office		4%	2%	1%	3%
Retail	3%		8%	5%	0%
Restaurant/ Entertainment	2%	7%		2%	0%
Residential	1%	1%	0%		0%
Hotel	7%	0%	0%	0%	

Figure 5-1: Worked Example – PM Internal Capture Rates

The percentages given in **Figure 5-1** represent the potential for internal capture, and it is possible that the 4 percent of inbound trips, to Retail from Office (**Table 5-6**) may be less than 3 percent of outbound trips, from Office to Retail (**Table 5-3**).

The potential for internal capture between each pair of land uses can be estimated based on the number of inbound trips (column-wise estimation) and the number of outbound trips (row-wise estimation). The results are shown in **Table 5-8** and **Table 5-9**.

Table 5-8: Internal Capture Worked Example – Column-wise (Inbound) Estimate

Land Use	Office	Retail	Restaurant/ Entertainment
Office		(4% x 50) = **2.0**	(2% x 37) = **0.7**
Retail	(3% x 85) = **2.6**		(8% x 37) = **3.0**
Restaurant/Entertainment	(2% x 85) = **1.7**	(7% x 50) = **3.5**	

Table 5-9: Internal Capture Worked Example – Row-wise (Outbound) Estimate

Land Use	Office	Retail	Restaurant/ Entertainment
Office		(3% x 80) = **2.4**	(2% x 80) = **1.6**
Retail	(4% x 52) = **2.1**		(6% x 52) = **3.1**
Restaurant/Entertainment	(2% x 41) = **0.8**	(2% x 41) = **0.8**	

Use the minimum of the two internal capture estimates for each pair of land uses, as shown in **Table 5-10**.

Table 5-10: Internal Capture Worked Example – Internal Trip Generation Estimate

Land Use	Office	Retail	Restaurant/ Entertainment	Total Outbound
Office		2.0	0.7	**2.7**
Retail	2.1		3.0	**5.1**
Restaurant/ Entertainment	0.8	0.8		**1.6**
Total Inbound	**2.9**	**2.8**	**3.7**	**9.4**

Subtract the estimated internal trips (**Table 5-10**) from the estimated gross trips (**Table 5-7**) to derive the external trip generation estimate, as shown in **Table 5-11**.

Table 5-11: Internal Capture Worked Example – PM Peak Hour External Person-Trips

Land Use	Inbound External Trips	Outbound External Trips
Office	82 = (85 – 2.9)	77 = (80 – 2.7)
Retail	47 = (50 – 2.8)	47 = (52 – 5.1)
Restaurant/Entertainment	33 = (37 – 3.7)	39 = (41 – 1.6)
Total	**163 = (172 – 9.4)**	**164 = (173 – 9.4)**

The results of the internal capture worked example are presented in in **Figure 5-2** to elaborate.

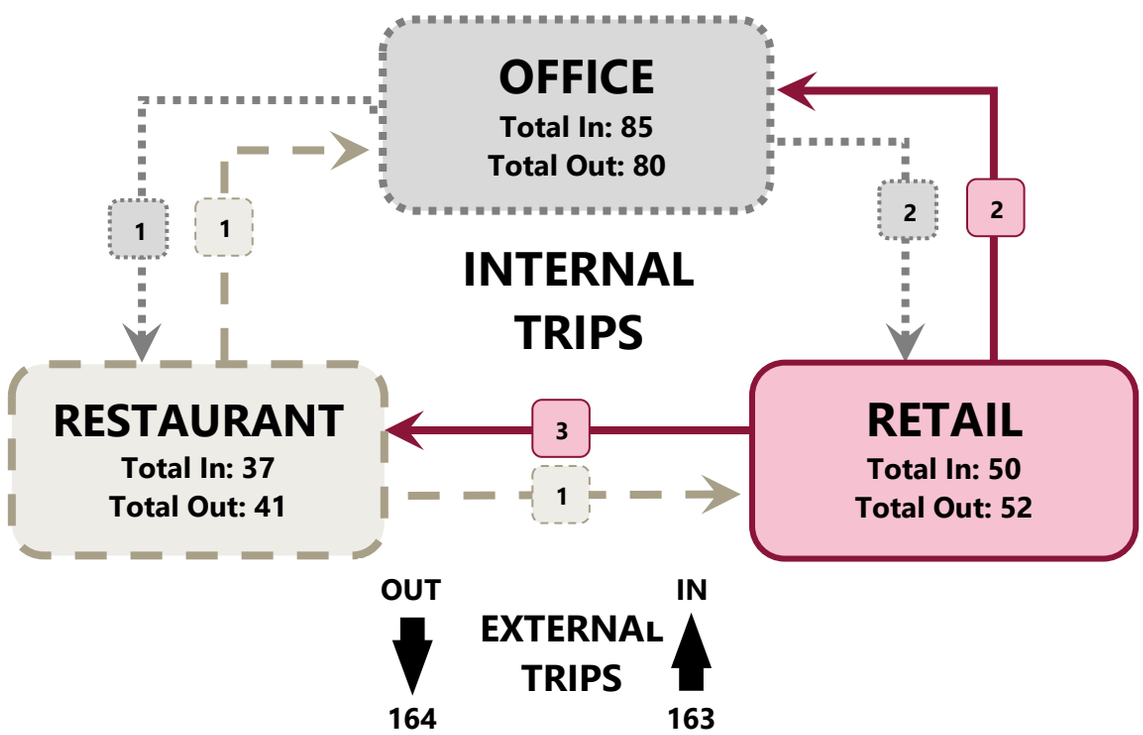

Figure 5-2: Internal Capture Worked Example – Internal Capture Diagram

The internal and external person-trip trip generation estimates can be converted to internal and external vehicle-trip trip generation estimates.

5.3 Pass-By Trips

While an estimate of all study site inbound and outbound vehicle-trips is required to assess the suitability of the proposed site access connections, not all traffic using the site access connections will necessarily be new traffic on the adjacent roadway network.

For some developments such as convenience stores, fast food outlets, drive-through restaurants, etc. the vehicle trips are likely to include the vehicles *en route* to another destination. Such businesses will typically be built to take advantage of such passing traffic. As such, some proportion of the vehicle trips to these businesses would still exist on the road network regardless of whether the study site existed. Therefore, such trips are not new to the surrounding roadway network.

For developments that meet the criteria outlined in **Section 5.3.1**, MOT may allow an adjustment to the estimated external vehicle-trip trip generation. Pass-by capture adjustments are not applicable to study site estimated parking demand and are not applicable when assessing the operational performance of proposed site access connections.

5.3.1 Criteria for Pass-by Capture Adjustment

In deciding whether a study site is likely to attract pass-by trips, the following criteria shall be met and shall continue to hold through the agreed horizon year:

- The land use class shall match one of those listed in **Table 5-12**.
- The study site shall include a direct vehicular access connection to a street classified higher than local street.
- The study site shall include dedicated off-street parking and/or a dedicated off-street pick-up/drop-off area.

5.3.2 Pass-by Capture Worked Example

The allowable percentages for pass-by capture reductions for land uses that meet the criteria are listed in **Table 5-12**.

Table 5-12: Pass-By Capture Reduction Percentages

Category	Land Use Description	Pass-By Percentage
01100	Mixed Use – Residential/Retail/Office	15%
01200	Mixed Use – Retail/Office	6%
01300	Mixed Use – Residential/Retail	3%
01400	Mixed Use – Multiple Land Uses	3%
02100	Apartments	1%
02200	Villas	2%
02300	Compounds	2%
02400 – 02500	Other Accommodations	1%
03100	Government Office	2%
03200	Non-Government Office	3%
03300	Finance and Banking Category	4%
03400	Service Oriented Offices	9%
04100	Shopping Malls/Centers	6%
04200	Food	8%
04300 – 04500	Specialty Store/Clusters/Showrooms	4%
04600	Petrol Station	16%
05100	Nursery/Schools	5%
05200	Higher Education	1%
05300	Education/Training/Research facility	2%
06100	Medical	2%
07100	Public Interests Facility	3%
08100	Hotel & Resort	2%
08200	Hotel/Serviced Apartment	1%
09100	Closed-Type Recreational Facility	3%
09200	Open-Type Recreational Facility	3%
10100	Light Industry	5%
10200	Medium Industry	2%
10300	Heavy Industry	1%
10400	Other Industry Facility	2%
10500	Agricultural land	0%
11100	Parking	1%

As an example, for a development matching Category 01100 (Mixed Use – Residential/Retail/Office), the weekday PM peak hour trip generation, estimated to be 301 vehicle-trips, of which 91.7 percent are car/taxi with an average occupancy of 1.2 persons, will result a total of **292** car trips (i.e., 301 vehicle-trips x 91.7% car).

The remaining (301 – 292 =) 9 vehicle-trips will be made by other motor-vehicle modes that are not subject to pass-by capture adjustment (i.e., bus, LGV, HGV).

Per **Table 5-12**, the allowable pass-by capture reduction of 15 percent of the applicable car trips results in an estimated total of 44 pass-by car trips (292 x 15%), while the remaining 248 trips will be considered as primary car trips.

CHAPTER 6

Deriving Rates for New Sites

Chapter 6 Deriving Rates for New Sites

6.1 How to Derive New Rates

This chapter is intended for practitioners who might have to undertake the surveys to derive trip generation and parking demand for new sites either to expand the existing database or to add new land use classes in the QTGPRM. It is recommended to liaise with MOT for further guidance before commencing any such work.

Advice on data collection, post-processing (data cleaning, transformation, expansion, etc.), and suitable statistical techniques for deriving robust rates is followed by an outline of the processes that should be adopted to update the rates, published in **Volume 2** and the formats to be used in uploading data to the QTGPRM database.

6.2 Data Acquisition

This section outlines the methods used to capture and process the survey data from which the QTGPRM rates have been derived. The survey types used include land use observations, traffic and pedestrian counts, and face-to-face interviews.

6.2.1 Land Use Classification

The main requirements for the land use classification system adopted for QTGPRM are as follows:

- Each land use classification should represent a distinct, broadly homogeneous group, that is, a group of land uses that exhibit similar characteristics to one another and that are materially different from all other groupings.
- Each land use classification should reflect both current and anticipated future land uses.
- Each land use classification should be capable of being modeled with a minimum number of independent variables (ideally one).

6.2.2 Site Selection

If a new (or candidate) land use class is to be defined, the analyst will first need to agree with MOT on a suitable land use class number (following the convention outlined in **Section 3.1**) and on the appropriate number of representative sample sites.

6.2.2.1 Minimum Number of Sites

All trip generation and parking demand rates are statistical estimates, derived from measurements of real-world features. In the absence of systematic bias or measurement error (which the survey design and sampling method are intended to eliminate), it is assumed that variations in the trip generation rates derived from each survey site in the same land use class may be modeled using the normal distribution.

According to the central limit theorem, the larger the sample size, the more precise any statistics derived from them will be. But beyond a certain sample size, the level of effort required to improve model precision may no longer be justified.

A further consideration for trip generation and parking demand rates is that a single independent variable is expected to explain all observed variation in trip generation and parking demand. Hence, there is a need to include sites that reflect the full range of independent variable values for each identified land use class in the State of Qatar.

ITE (2017)[2] advises that a minimum of three sites be used (and preferably no fewer than six) while TRICS (2018)[3] recommends a minimum sample of 20, which is consistent with the central limit theorem. Except for truly unique land uses, a sample size of at least four sites is advised.

6.2.2.2 Site Selection Criteria

Survey sites should be representative of the land use class to which they have been assigned and should be capable of being surveyed. To determine the latter, candidate survey sites should be screened using the criteria outlined in this section. This can be done in two stages. The first stage may be based on a desktop review, but the final selection can only be made following site visits.

Compliance with Land Use Definition. The site matches the defined land use class with respect to both the independent and dependent variables.

Homogeneity of Land Use. With exception of sites to be used for Land Use Group 01000, survey sites should contain a single land use.

Size. The site should reflect the range of sites that fall within the defined land use class throughout Qatar. This requires benchmarking against other sites considered to be of the same Class.

[2] ITE, 2017. Trip Generation Handbook, 3rd edition. Institute of Transportation Engineers, Washington DC, USA.
[3] TRICS, 2018. TRICS Good Practices 2018. TRICS Consortium, London, UK.

Occupancy. There are many reasons why a study site might not be fully occupied; it could be incomplete or newly completed, or it might be undergoing renovation. Occupancy levels of at least 70 percent are recommended. Study sites with lower occupancy should be used only when there are few alternative sites and only when the independent variable is first adjusted to match the proportion of the building or site that is occupied.

Maturity. Even study sites that are fully occupied may need time to become established. As a minimum, the survey site should have been fully operational for at least one year, preferably two or more, prior to conducting the survey.

Degree of Economic Success of the Site. The survey site should be an economically healthy representative of the land use class.

Permission. This is required both from the site owner or manager and from the Ministry of Interior (often through a Non-Objection Certificate). Restrictions may be imposed, particularly with respect to personal privacy.

Availability of Parking. Some land use classes typically provide on-site parking while other land use classes (especially in urban areas) typically do not. Where observed off-site parking provision is considered to be significant, the data collection plan should include sufficient intercept surveys to capture this component of site demand.

Public Transport Accessibility. Survey sites representing varying levels of public transport access should be selected. Where restrictions are applied to specific travel modes, or where public transport is not available within a reasonable walking distance of the site, this should be noted in the land use survey record.

Isolation. It should be possible to isolate the site for counting purposes. For example, there should be no shared parking or driveways. It should not be possible for pedestrians to enter the site from nearby plots/parcels. There should be no through traffic across the site.

Access Connections/Pedestrian Access Points. The survey site should have a limited number of access connections and pedestrian access points to limit the survey effort and minimize the chances of missed observations. Survey locations should be confirmed as part of the site reconnaissance to ensure that it is possible to distinguish persons and vehicles entering and leaving the site from persons and vehicles not related to the site. For sites with multiple survey locations, all surveys should be carried out simultaneously.

Roadworks. There should be no (or minimal) construction present either on-site or on adjacent roadways during the time that the surveys are conducted.

6.2.2.3 Study Regions

To account for potential variation in trip generation rates due to location, the following six study regions have been defined.

- Doha Inner-CBD.
- Doha Outer-CBD.
- Doha Non-CBD
- Al Wakrah
- Al Khor
- Other

Currently these regions have been applied to only selected land use classes as defined in **Volume 2**. If rates for a new land use class are to be derived, then it may be necessary to test for the presence of regional variation. Check with MOT.

6.2.2.4 Mixed-Use Sites

Survey sites for land use classes within Group 01000 (Mixed Use) require special consideration since they vary widely in size, layout, and constituent land uses. In general, site selection for this category should consider the factors listed below.

- The land uses should interact with each other.
- The mix of land uses should be representative of current or anticipated trends in this type of development.
- Efforts should be made to capture a representative range of developments.
- Individual land uses should all be internally connected, either by footways or by streets within the site boundary.
- The area in which the development is located should be mostly built-out, mature and with a representative pattern of development. Where possible, external factors that could impact the amount of internal capture (competing opportunities, available travel modes, economic strength, etc.) should be recorded.
- Parking should be shared between the land use components and the proportion of reserved spaces should be minor.
- The survey instrument should be able to distinguish between trips to, trips from, and trips within the site. Where intercept surveys are proposed (i.e., face-to-face surveys of a sample of trip makers), they should be conducted at locations that are representative of all such trips.
- There should be no through-traffic.

Within Land Use Group 01000 there are four mixed-use land use classes defined as follows and are treated separately in terms of developing and applying the trip rate estimates:

- 01101 Mixed Use – Residential/Retail/Office. A mixed-use development combining residential, retail, and office uses on the same site, and with at least 70 percent of the floorspace occupied by residential uses.
- 01201 Mixed Use – Retail/Office. A mixed-use development combining retail and office uses on the same site, and with at least 70 percent of the floorspace occupied by office and retail uses. This class of mixed land use has no residential units.
- 01301 Mixed Use – Residential/Retail. A mixed-use development combining residential and retail uses on the same site, and with at least 70 percent of the floorspace occupied by residential and retail units. This mixed-use land use class has no office space.
- 01401 Mixed Use – Multiple Land Uses. A mixed land use development that contains a mix of land uses not defined by any other land use class.

6.2.2.5 Special Generators

Special generators are land uses for which the minimum sample size condition cannot be met. These would be land uses for which, due to their unique nature there are normally very limited numbers of sites available for survey, and for which the outturn trip rates can vary considerably between sites. For example, a Camel Racetrack would fall into this category, Rates estimated for such sites will not be applicable to other sites.

6.2.3 Survey Types

The main survey types used to develop trip generation and parking demand rates are listed in **Table 6-1**, together with the variable they are intended to measure. Supplementary guidance is available in the "TMPQ Package 1, Book 3, Volume 2, Survey Methodology Binder".

Site observations are used to confirm the land use classification and to check compliance with site selection criteria. Characteristics such as GFA and number of employees should be confirmed with the property owner/manager. Vehicle occupancy surveys help establish the relationship between person-trips and vehicle-trips.

Table 6-1: Principal Surveys Used

Survey Instrument	Description
Land Use Data	To record site characteristics.
Automated Counts	To be located on the adjacent street(s), for land uses where passing traffic may influence the trip generation rate.
Intercept Surveys	To determine travel mode, to distinguish pass-by, diverted, and internal trips, and to determine the number of vehicles parking off-site.
Person Counts	Collected at all site access points to capture total person-trips by direction of travel and to derive expansion factors for intercept surveys.
Vehicle Occupancy	Estimated through interview data at all sites to help derive factors for converting between person-trips and vehicle-trips. Also, vehicle occupancy surveys were undertaken at approximately 300 sites to collect data to validate the estimated vehicle occupancy from the interview data.
Parking Counts	To determine parking accumulation profiles and peak parking demand.
Vehicle Counts	Collected at all site access connections to help determine total vehicle-trips (when combined with information from expanded intercept surveys).

Parking demand is typically measured using a combination of inventory and patrol surveys covering both on- and off-site locations. Where practical, a survey cordon should be defined around the site and the immediate area where parking for the development is observed. Where this is not possible, it will be necessary to conduct intercept surveys, either inside the survey site or at the site boundary, to determine the number of vehicles parked off-site.

Parking demand profiles are derived from parking accumulation observations at 15-minute intervals. The parking demand rate will be based on the highest observed accumulation.

Intercept surveys are used to capture information that cannot be observed or measured directly, such as the main mode of transportation used for drop-off trips, vehicle party size, the origin/destination of a trip, and journey purpose. Intercept surveys are particularly useful in identifying pass-by and diverted trips and, in the case of mixed-use developments, internally-captured trips.

Flow or volume counts are required to measure the total number of trips entering and leaving the survey site, to determine the study site peak hours, and to derive expansion factors for intercept surveys. **Figure 6-1** shows a flowchart for the different survey components.

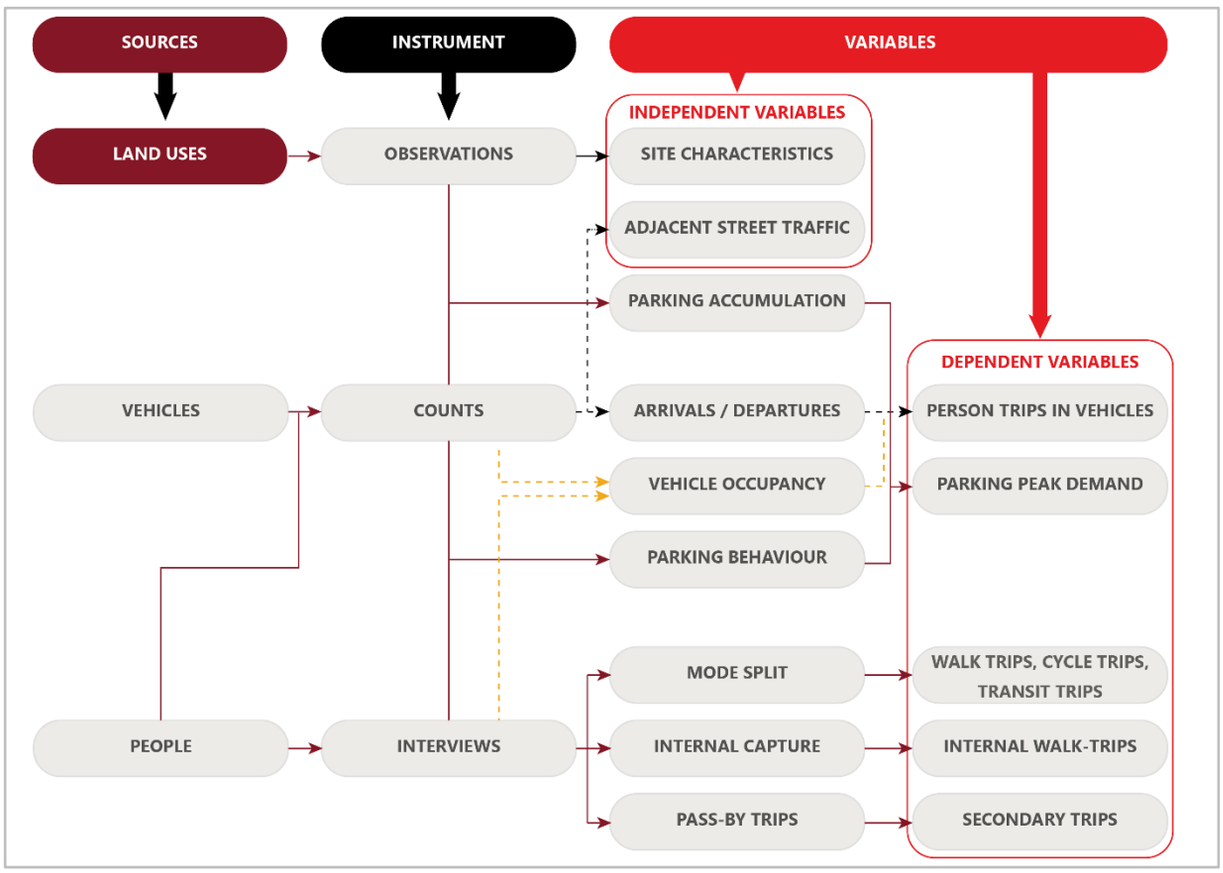

Figure 6-1: QTGPRM Data Sources, Survey Instruments, and Measured Variables

Table 6-2 summarizes the main characteristics of mixed-use sites that should be recorded. **Table 6-3** lists characteristics that should be noted for individual buildings within mixed use sites and **Table 6-4** identifies suitable contextual data.

Table 6-2: Characteristics to be Recorded for Mixed-Use Sites

Type	Information	Comments
General Characteristics of Site	Name	Name of the site
	Development type	Whether the site is contained within a single-block, multiple blocks, or a planning zone or administrative unit
	Site maturity	Year the site opened (if the site opened in stages, include the date of the latest phase)
	Primary tenant(s) or managing agent	Primary tenant (some sites may have more than one major tenant)
	Other land uses within the site	Other land uses within the site using the QTGPRM land use classes
	Building/Area Name/Address	Names or building addresses if the site is subdivided.
Physical Characteristics of Site	Site Plan	Site diagram, sketch, plan, or aerial image of the site, preferably to scale, showing the overall site layout, building footprint, building entrances from street systems, and parking areas
	Site Area and Density	Total site area and site density, in terms of floor area ratio (FAR)
	Site Access Locations and Types	Site access plan for passenger cars, service vehicles, pedestrians (including PT patrons), and bicyclists, including location of each access connection, type of traffic control, and existing or planned PT stops, station entrances, and services
	Internal Circulation Facilities	Internal circulation routes used by motorists/service vehicles, pedestrians, bicyclists, and whether they are enclosed, partly covered, or exposed
	Locations and Quantity of Parking	Location(s) of dedicated and shared parking facilities, type of parking facility (e.g., surface, garage), number of spaces (formal and informal), arrangements for sharing with other developments, and daily/hourly parking cost

Source: adapted from NCHRP 2011[4]

[4] NCHRP, 2011. Enhancing Internal Trip Capture Estimation for Mixed-Use Developments. Transportation Research Board of the National Academies. Washington DC, USA.

Table 6-3: Characteristics to be Recorded for Individual Buildings within Mixed-Use Sites

Information	Comments
Building Size	Record the measurements for the independent variable(s) as published in **Volume 2** for the matching land use classes.
Primary Land Use	Identify the primary land use within the building using the appropriate QTGPRM land use class. If more than 5 percent of the building area is occupied by a secondary use, it should be treated separately so that internal capture rates can be derived.
Building Occupancy	Quantify the occupancy for each building and for each separate land use inside each building. In a multi-tenant building, contact the property manager, leasing agent, or owner to obtain this information.
Building Primary Access Connection Point	Determine the main access point to the building. If multiple access points exist, use the following rules: • Record the point midway between two entrances on the same building face, if both have similar inbound/outbound volumes. • Record the center point of a block face having numerous entrances. • Record the center point of a block for a land use covering an entire block and with entrances on each side that are equally popular. • For an enclosed retail mall with more than one major store, record the internal entrances, not the external entrance. • For an open-air community shopping center or neighborhood shopping center, or for an enclosed mall with a single major store, record the main entrance of the primary/anchor tenant. • For an office building, record the entrance lobby. • For a hotel, record the entrance lobby or registration desk. • For a restaurant, record the main customer entrance. • For a residential site, record the ground floor dwelling unit entrance. • For an entertainment facility, record the main entrance lobby.
Building Proximity	Measure the walking distance between buildings in a mixed-use site. The desired level of precision is 10 percent of the approximate total distance or 30m, whichever is the shorter.
Connectivity between Buildings (optional)	Rate the connectivity between buildings: • *fully-integrated* – the pedestrian connection is direct and internal to the development. • *partly integrated* – connections via external sidewalks or dedicated crossing facilities. • *informal connectivity* – entails walking through parking aisles or along streets without sidewalks.
Parking Supply	Rate the parking provided for building tenants and visitors within 200m of the building entrance, and in particular, its convenience (ample or limited). Report total parking spaces and parking charges that apply. Indicate the number of spaces reserved for each land use class and time restrictions imposed on their use.

Source: adapted from NCHRP (2011)5

Table 6-4: Contextual Site Information

Information	Comments
Location within Urban Area	Classify using Qatar National Development Framework (QNDF) definitions (Urban, Non-Urban, Capital City Center, Metropolitan Center, District Center, Town Center, etc.).
External Competition	Consider the extent to which adjacent land use classes may compete with the chosen site and determine whether that is likely to affect suitability as a survey site (e.g., a large supermarket adjacent to the site may affect the trip generation).

[5] NCHRP, 2011. Enhancing Internal Trip Capture Estimation for Mixed-Use Developments. Transportation Research Board of the National Academies. Washington DC, USA.

For mixed-use sites, it is important to provide enough interviewers to cover all entrances to all site elements simultaneously. Where this is not feasible, interviews shall be conducted at a representative cross-section of locations within each land use class, deploying interviewers at the more popular entrances (as determined from a pre-survey visit).

According to ITE (2017)[6] a minimum of 30 valid interviews will be needed for each survey period. Interviews should be conducted with individuals both entering and leaving the survey site. Some land use classes tend to be inactive in the mornings; to achieve the minimum sample size for such sites, it may be necessary to conduct interviews over several days.

Where interviewee movements cannot be observed directly, the interview surveys will need to be designed to capture reported origins and destinations. The main travel mode used is particularly important.

The main land use pairings of interest for mixed-use site data collection are indicated with a 'X' in **Table 6-5**. The pairings are locally derived and are based on the common combinations of mixed land use sites surveyed in Qatar. Other combinations that may prove significant in some cases are shaded gray.

Table 6-5: Priority Land Use Pairs for Mixed Land Use Surveys

Land Use	Recreational	Retail	Restaurant	Office	Residential	Hotel
Recreational		X	X	X	X	X
Retail	X		X	X	X	X
Restaurant	X	X		X	X	X
Office	X	X	X			X
Residential	X	X	X			
Hotel	X	X	X	X		

Source: NCHRP (2011)[7]. Categories amended to match QTGPRM land use categories.

6.2.4 Data Collection Plan

A data collection plan should be prepared for each survey site prior to the survey being undertaken. The data collection plan should be prepared by an experienced surveyor who is able

[6] ITE, 2017. Trip Generation Handbook, 3rd edition. Institute of Transportation Engineers, Washington DC, USA.

[7] NCHRP, 2011. Enhancing Internal Trip Capture Estimation for Mixed-Use Developments. Transportation Research Board of the National Academies. Washington DC, USA.

to anticipate potential issues and devise suitable action plans. A site visit is required to determine the following:

- The suitability of the site (based on the criteria given in **Section 6.2.2.2**).
- Identify all site access connection, building access points, and on- and off-site parking areas.
- Assess how the site operates in practice.

The site survey workbooks are spreadsheets (template available from MOT) designed to be used in an automated analysis process to populate the required data for both land use inventories and count surveys. The template and format of the site survey workbook must remain unchanged. The following should also be prepared to include in the site survey workbooks:

- General site layout and building footprints
- Plan(s) indicating site access connections for motorists (including delivery and service vehicles) and bicyclists, and building access points for pedestrians (including transit patrons)
- Symbols denoting the type(s) of traffic control in place at each access connection

6.2.5 Permissions

Securing the necessary permissions to undertake surveys is often a difficult and lengthy task. Sufficient time should be allowed for this in the survey program. Consent should first be obtained from the site owner or manager and then from the relevant local authorities (who will need to know the planned survey dates). It is particularly important to reassure all parties that the information collected will remain confidential.

To initiate the process of securing permission, it is best to provide all decision makers with an official letter addressed to them personally. The letter should describe the nature of the data collection program, its main objectives, how it is to be conducted, and how the results will be used to benefit the State of Qatar. Partnering with public relations specialists who are willing to act as project champions may expedite the process.

6.2.6 Land Use Surveys

Land use surveys are used to confirm or measure the following:

- Site eligibility (in terms of the criteria given in **Section 6.2.2.2**)
- The independent variables that can be measured (GFA, number of employees, etc.)
- The availability of supplementary data (e.g., records of visitors to a stadium, records of ticketing at a bank or service counter, parking lot entry/exit records)

Surveyors should record:

- Site coordinates (QND95 / Qatar National Grid, EPSG:2932)
- Surrounding land use class
- Surrounding transport networks/facilities including the presence/absence of footways, street lighting, etc., and their condition
- The year the site became operational
- The site operating hours
- The number of on- and off-site parking spaces available
- The number of employees, per shift, at the site
- The building GFA
- The number of building stories
- The number of customers at full occupancy

6.2.7 Intercept Surveys

Intercept surveys are needed for several reasons:

- To determine a person's primary mode of travel (essential for deriving multimodal trip generation rates)
- To identify significant numbers of persons observed to be parking off-site at locations that are not visible from the survey points
- To identify whether on-site parking is shared with another building/site
- To determine whether some of the trips that cross the survey cordon may be passing through the site on their way to another destination
- To determine vehicle occupancy (if it is not practical to count occupants from outside vehicles)
- To confirm the need to measure pass-by trips, diverted trips, or internally-capture trips

Since intercept surveys can usually be conducted for only a sample of site visitors, person-counts and vehicle-counts should be collected at the same time as the intercept surveys so that expansion factors can be derived. For a survey site with multiple interview points, individual expansion factors will be required for each interview point.

6.2.7.1 Guidelines for Conducting Intercept Surveys.

- Intercept surveys should cover all site access connections and building access points to capture a representative sample of all persons entering and leaving the survey site.
- Each interview should record whether the individual was picked-up or dropped-off, mode of transportation, whether they parked on-site or off-site, and the number of persons they travelled with.
- It is often the case that potential interviewees are in a hurry and reluctant to be interviewed. To minimize the risk of sampling bias or underreporting, questionnaires should be kept short and the questionnaire should be filled out by the surveyor.
- An experienced field supervisor should be present to check all interview locations regularly throughout the survey period to ensure that necessary staffing levels and sampling rates are being achieved, that interviews are being conducted in a polite and professional manner, and to be at hand to resolve any unforeseen problems that may arise.

6.2.7.2 Guidelines for Supervising Intercept Surveys

A typical survey team requires the following roles to be filled:

- Fieldwork Manager – controls all survey teams on the field
- QA/QC Supervisor – supervises the implementation of QA/QC procedures
- QA/QC Team – implements QA/QC procedures for a given survey site
- Team Supervisor – supervises the assigned survey team
- Surveyors – interview persons at a specific location on or around the survey site

The team supervisor should check the work of the staff at the start of the survey and at random intervals throughout the program to ensure that data are being collected correctly and information recorded accurately. Any interviewer misinterpretation of the questions being asked or deficiencies in the recorded answers should be corrected as soon as possible so that they do not recur.

Interview forms should be checked as soon as possible after completion, noting the following in particular:

- Times of interview is recorded
- Responses fall within the range of permitted choices
- Any written responses are complete and understandable
- Trip origin/destination and travel mode appear logical

Where discrepancies are found, the fieldwork manager should determine if a recount is needed.

All surveyors should be trained, trustworthy, and well-briefed; surveyors who do not fully understand the purpose of the survey will have difficulty explaining it to interviewees. Training sessions should include role playing to ensure survey results are consistent and reliable. Where surveys are to be conducted at locations unfamiliar to the field staff, pre-survey orientation visits are advisable.

Surveyors should always be uniformed (preferably displaying official government logos on their uniforms). In addition, an MOT (or the relevant local authority) telephone number should be established to answer questions citizens may have about the survey program.

6.2.7.3 Sampling Rates for Capturing Off-Site Parking

Ideally, the selected site for the survey should have availability of the on-site parking so that vehicle counts can be recorded from the observed data, instead of an indirect estimation of from the interview sample data. However, if this is unavoidable, the intercept interview data sample should be large, reliable, and robust to be used to estimate and validate the percentage of persons who arrive by car, but who park off-site (in turn used to determine the total number of persons travelling to the site by car).

The following approach is recommended for deriving an initial estimate of total site visitors across the survey day and the required number of surveyors.

- Apply the QTGPRM trip generation rates for the matching land use class to the measured independent variable for the study site. This should be done for both weekday and weekend demand, where available, for each of the three reported hours, and for the PHG (where it falls outside of the three standard peaks).
- Use the resulting estimates to derive a theoretical population size for the full day (it will be an underestimate and therefore robust) and use that to derive the required sample size as explained above.
- Assume each interviewer can complete 12 interviews per hour.
- The estimates for each peak hour can then be used to allocate data collectors across the day.

Since the sample size is based on several assumptions, it is recommended that both the population from which it is to be drawn (e.g., total persons arriving at the site in the first hour) and the assumed proportion of persons parking off-site, be reviewed in the early phases of the survey. This will allow the sampling rate to be adjusted where necessary.

6.2.8 Person-Counts and Vehicle-Counts

Person-counts and vehicle-counts are used to measure the total number of persons and vehicles entering and leaving a study site. From these counts, expansion factors can be calculated for surveys based on samples. Standard practice is to count all site access connections and building access points of the study site, accumulating the observed flows at 15-minute intervals.

Except where expressly required (for example to derive trip generation rates for an arena on an event day, a Jumma mosque at Friday prayer time, or a conference center during an exhibition), QTGPRM surveys should be conducted during neutral periods, avoiding holidays, major events, and other abnormal traffic periods.

Count observation points should be located so that trips related to the survey site can be clearly distinguished from trips not related to the survey site. When dealing with a mixed-use site, all means of entering or leaving each building within the site should be captured.

It is important the surveys capture all peak demand periods, including the peak hour of the generator (PHG), which may fall outside the three defined peak periods. **Table 6-6** provides typical survey periods for the main land use groups. Weekend counts may be required for some sites. The assumptions should be confirmed during the pre-survey site visit.

Table 6-6: Typical Survey Periods by Land Use Group

Land Use Group		Survey Period	Possible Peaks	Weekend
01000	Mixed-Use	0600 – 2200	MD, PM	Yes
02000	Residential	0600 – 2200	AM	No
03000	Office	0600 – 2200	AM, MD, PM	No
04000	Commercial	0600 – 2200	PM	Yes
05000	Education	0600 – 1900 0600 – 2200[a]	AM, MD, PM	No Yes[a]
06000	Health	0600 – 2200	AM, MD, PM	Yes
07000	Religious Facilities	0600 – 2200 0300 – 0000[b]	MD, PM	Yes
08000	Tourism	0600 – 2200	AM, MD, PM	Yes
09000	Recreational	0600 – 2200 0300 – 0000[c]	AM, PM	Yes
10000	Industrial	0600 – 2200	AM, PM	No
11000	Transportation	0600 – 2200	AM, PM	Yes

[a] *Driving schools*
[b] *Wedding Halls*
[c] *Stadiums and racetracks*

Counts for each location and for all site cordon counts together should be verified by the field supervisor immediately after each data collection period to ensure the following:

- The count covers the full survey period.
- Inbound and outbound flows are consistent.
- Variations by 15-minute period are reasonable and logical.
- Modal shares are within expected ranges, based on previous experience in Qatar, and consistent with the land use class and site location.
- Vehicle occupancies are within expected ranges.

The sample weekday profile for processed visitor counts provided in **Figure 6-2** relates to the access connection point locations shown in **Figure 6-3**.

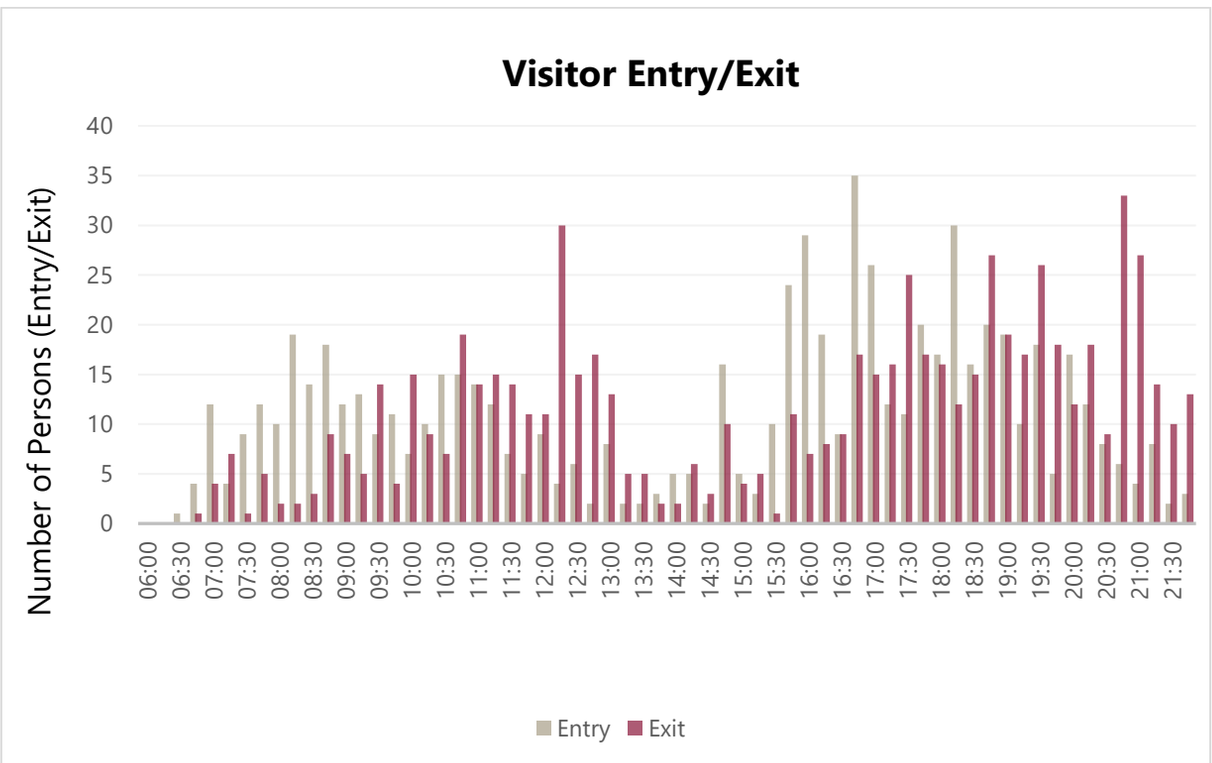

Figure 6-2: Sample Weekday Profile

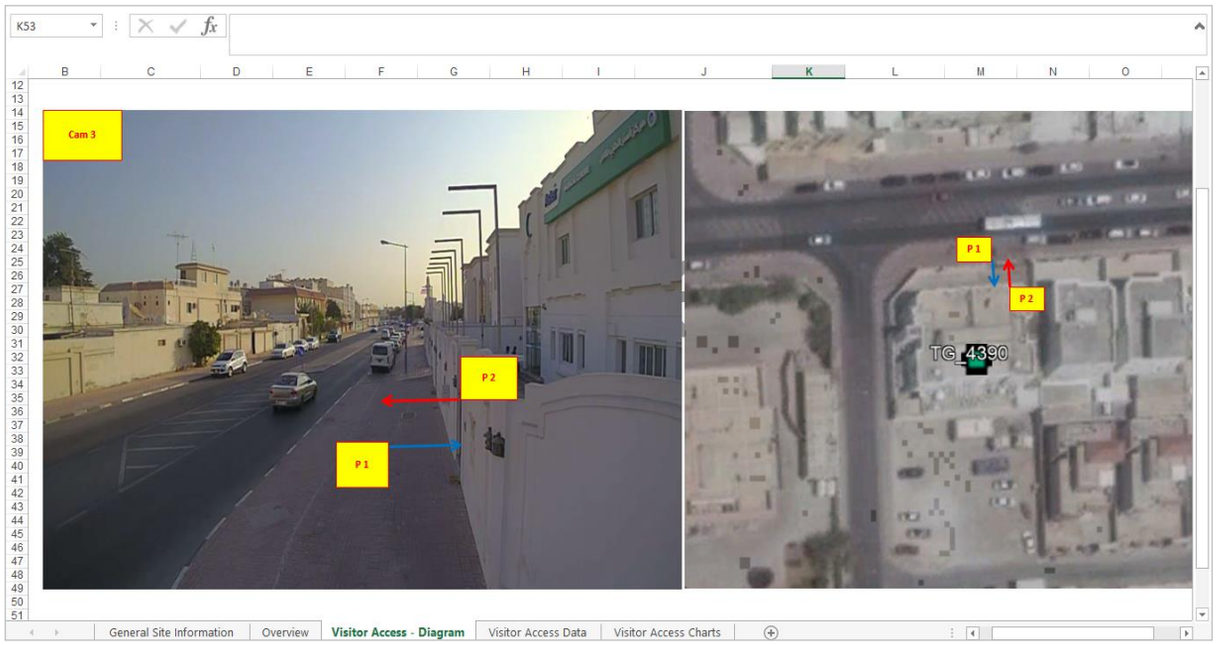

Figure 6-3: Sample Site Access Connection and Building Access Point Locations

6.2.9 Modal Classification Counts

QTGPRM provides multimodal trip generation rates for all land use classes. It is therefore necessary to classify all trips observed to and from the survey site, according to the main mode of travel used. This applies to vehicle-trips as well as to person-trips where the main mode of travel was not walking (e.g., the traveler was picked up or dropped off outside of the site boundary).

For QTGPRM, the following travel modes should be used for trip generation rates:

- Walk
- Bicycle
- Car
- Taxi (Karwa, Careem, Uber, etc.)
- Public Transport (including bus, Metro, and tram, etc., and private coach, school bus, and company bus, etc.)
- Other (including motorcycle)

The following vehicle classifications should be used for parking demand rates:

- Bicycle (optional)
- Car (including taxi, motorcycle, etc.)
- Light Goods Vehicles (LGV)
- Heavy Goods Vehicles (HGV)
- Bus (including private coach, school bus, etc.)

For both trip generation and parking demand, the vehicle classifications presented in **Figure 6-4** (reproduced from the Qatar Highway Design Manual) should be used. Vehicles classified as Car are indicated by a blue triangle in the diagram, LGV by a red star, HGV by a solid black circle, and Bus by a green square.

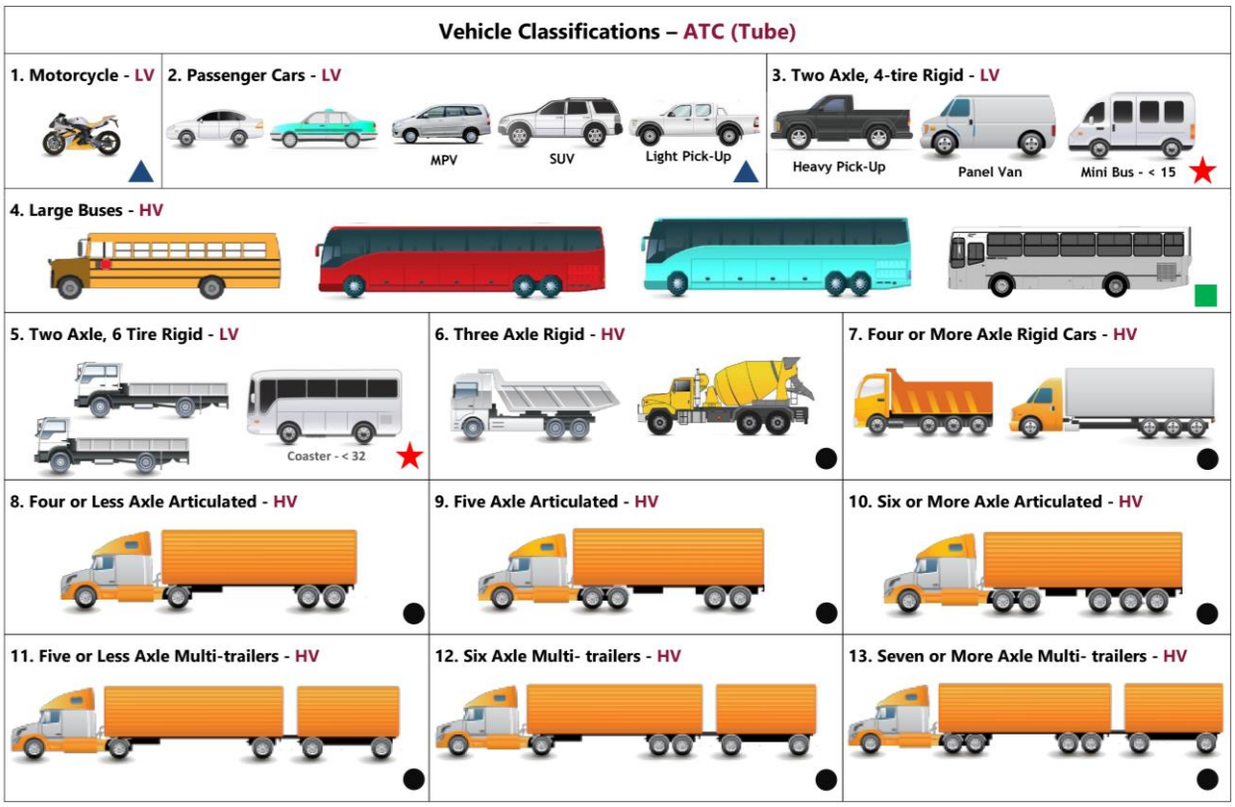

Figure 6-4: QTGPRM Vehicle Classification

6.2.10 Vehicle Occupancy

To derive the mode share for each of the main travel modes recorded, it is necessary to perform the calculation at the level of person-trips. This will often require conversion between person-trips and vehicle-trips, as derived in **Equation 3**.

$$person\text{-}trips = (O_m \times N_m) + walk\ trips \qquad \text{(Eq. 3)}$$

Where,

O_m = vehicle occupancy by mode m

N_m = number of vehicle-trips by mode m

While person-trips can usually be observed directly, some vehicle-trips may need to be estimated from intercept surveys, as described in **Section 6.2.9**. A similar approach may be applied for

establishing vehicle occupancy. In such cases, the interviews should include questions to determine primary travel mode and the size of the party with whom the respondent traveled.

6.2.11 Parking Surveys

Parking surveys are required to estimate peak daily parking demand for the survey site, which may not be the same as the number of parking spaces stated in the site planning permit.

Parking accumulation surveys begin with an initial count of all vehicles parked in the identified parking areas. Counts of vehicles entering and leaving the site survey area are then recorded at 15-minute intervals.

Where there is significant off-site parking (or extensive on-site parking), beat surveys, in which one or more surveyors patrol the survey area counting parked vehicles as they proceed, may be required.

A sample accumulation summary is provided in **Table 6-7**. From this summary, an accumulation graph can be plotted, such as the one illustrated in **Figure 6-5**.

Table 6-7: Parking Accumulation Example

Start Time	End Time	Arrivals	Departures	Net	Accumulation	Capacity	Capacity (%)
7:00 AM	7:15 AM	2	0	2	2	140	1.43%
7:15 AM	7:30 AM	5	0	5	7	140	5.00%
7:30 AM	7:45 AM	13	1	12	19	140	13.57%
7:45 AM	8:00 AM	25	1	24	43	140	30.71%
8:00 AM	8:15 AM	24	2	22	65	140	46.43%
8:15 AM	8:30 AM	26	1	25	90	140	64.29%
8:30 AM	8:45 AM	14	0	14	104	140	74.29%
8:45 AM	9:00 AM	8	0	8	112	140	80.00%
9:00 AM	9:15 AM	5	0	5	117	140	83.57%
9:15 AM	9:30 AM	4	0	4	121	140	86.43%
9:30 AM	9:45 AM	4	0	4	125	140	89.29%
9:45 AM	10:00 AM	1	1	0	125	140	89.29%
10:00 AM	10:15 AM	0	0	0	125	140	89.29%
10:15 AM	10:30 AM	0	0	0	125	140	89.29%

(Continued on the next page)

Table 6-7: Parking Accumulation Example (Continued)

Start Time	End Time	Arrivals	Departures	Net	Accumulation	Capacity	Capacity (%)
10:30 AM	10:45 AM	0	0	0	125	140	89.29%
10:45 AM	11:00 AM	0	0	0	125	140	89.29%
11:00 AM	11:15 AM	0	2	-2	123	140	87.86%
11:15 AM	11:30 AM	0	4	-4	119	140	85.00%
11:30 AM	11:45 AM	0	15	-15	104	140	74.29%
11:45 AM	12:00 AM	0	20	-20	84	140	60.00%
12:00 AM	12:15 PM	0	15	-15	69	140	49.29%
12:15 PM	12:30 PM	0	10	-10	59	140	42.14%
12:30 PM	12:45 PM	3	0	3	62	140	44.29%
12:45 PM	1:00 PM	3	1	2	64	140	45.71%
1:00 PM	1:15 PM	17	0	17	81	140	57.86%
1:15 PM	1:30 PM	17	0	17	98	140	70.00%
1:30 PM	1:45 PM	13	2	11	109	140	77.86%
1:45 PM	2:00 PM	10	1	9	118	140	84.29%
2:00 PM	2:15 PM	2	1	1	119	140	85.00%
2:15 PM	2:30 PM	1	1	0	119	140	85.00%
2:30 PM	2:45 PM	7	1	6	125	140	89.29%
2:45 PM	3:00 PM	0	3	-3	122	140	87.14%
3:00 PM	3:15 PM	1	10	-9	113	140	80.71%
3:15 PM	3:30 PM	0	15	-15	98	140	70.00%
3:30 PM	3:45 PM	0	20	-20	78	140	55.71%
3:45 PM	4:00 PM	0	25	-25	53	140	37.86%
4:00 PM	4:15 PM	0	25	-25	28	140	20.00%
4:15 PM	4:30 PM	0	9	-9	19	140	13.57%
4:30 PM	4:45 PM	0	7	-7	12	140	8.57%
4:45 PM	5:00 PM	0	4	-4	8	140	5.71%
5:00 PM	5:15 PM	0	2	-2	6	140	4.29%
5:15 PM	5:30 PM	0	1	-1	5	140	3.57%
5:30 PM	5:45 PM	0	1	-1	4	140	2.86%
5:45 PM	6:00 PM	0	1	-1	3	140	2.14%
6:00 PM	6:15 PM	0	1	-1	2	140	1.43%
6:15 PM	6:30 PM	0	1	-1	1	140	0.71%
6:30 PM	6:45 PM	0	1	-1	0	140	0.00%
6:45 PM	7:00 PM	0	0	0	0	140	0.00%

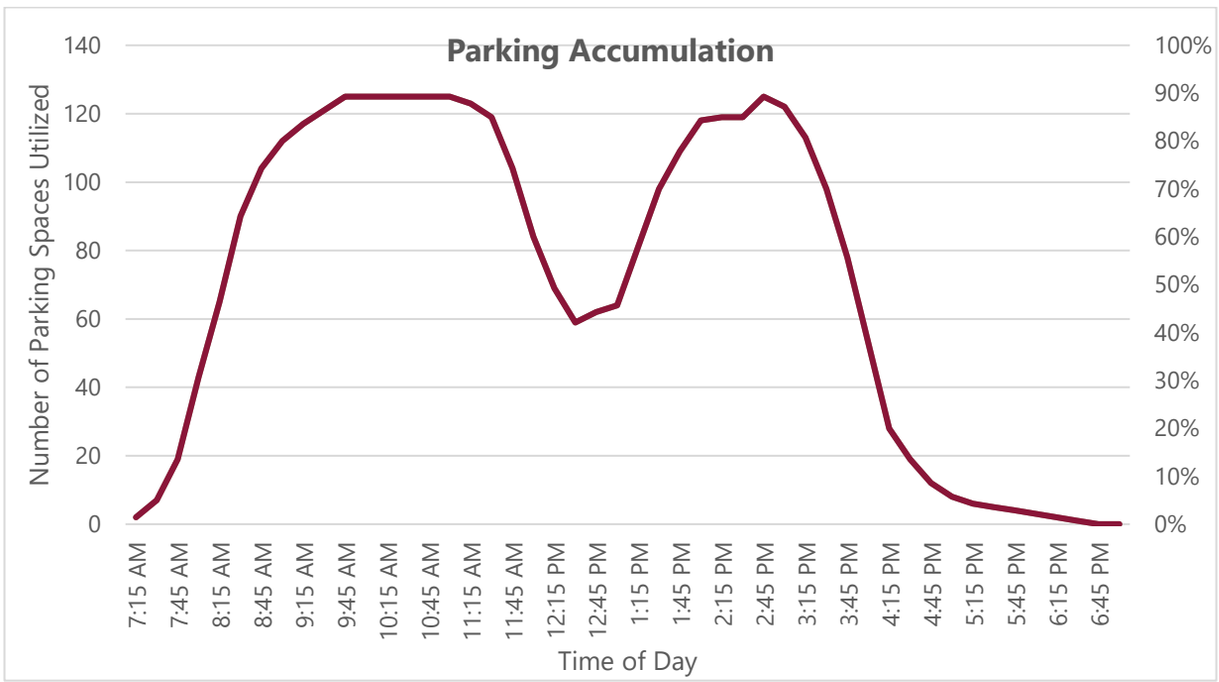

Figure 6-5: Parking Accumulation Graph

6.2.12 Pass-By Trips

For sites that are expected to attract a significant number of pass-by or diverted trips, it will be necessary to undertake interview surveys to quantify them. Minimum sample sizes for pass-by/diverted trip surveys are presented in **Table 6-8**. The expected proportion of such trips can be derived (e.g., from an observation over a 15-minute period) during the pre-survey site visit.) may be used. Assumptions should be checked during the survey and adjusted where necessary.

Table 6-8: Minimum Sample Size for Pass-By and Diverted Trips

Significance Level	Expected Pass-By + Diverted Trip (%)						
	20%	30%	40%	50%	60%	70%	Unknown
5%	246	323	369	385	369	323	385
10%	62	81	93	97	93	81	97
15%	28	36	41	43	41	36	43

Source: ITE (2017)[8]

[8] ITE, 2017. Trip Generation Handbook, 3rd edition. Institute of Transportation Engineers, Washington DC, USA.

6.3 Post-Processing

The recommended workflow for survey data post-processing is shown in **Figure 6-6**. First, the raw data received from site are reviewed, checked, and validated by the data analysts. Observations on the independent variables are then input to the applicable site workbook spreadsheet in strictly defined templates by MOT, along with the dependent variables (converted to 15-minute profiles). The results are audited and subjected to further logic checks before being expanded and combined. The summary data are input to the survey database from which the rates and factors are derived. In practice there is a degree of iteration between each stage of the process as the classifications are reviewed, anomalous results confirmed or replaced, and potential outliers identified and, where necessary, addressed. For the development of QTGPRM, the analysis process was set up using automated using spreadsheet macros.

The main steps are explained in more detail in **Figure 6-6** and illustrated through two worked examples.

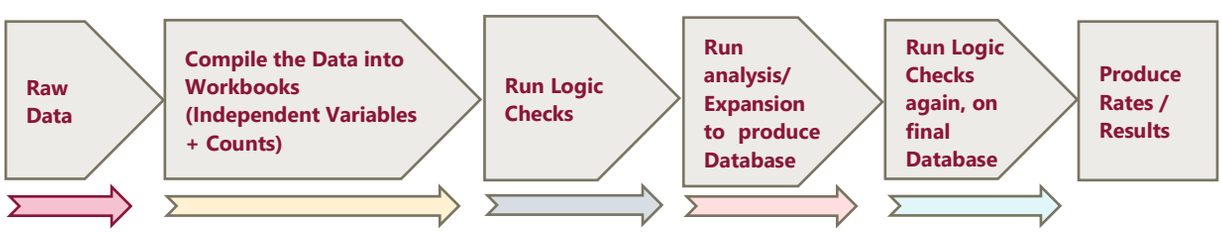

Figure 6-6: Survey Data Processing Workflow

6.3.1 Data Cleaning

No blank observations or records containing errors should be permitted to enter the database. Errors can be introduced either during data collection (e.g., through measurement error or survey bias) or while transferring the data from the survey forms into the database (transcription error). Standard logic checks should be applied during data entry. Data cleaning refers to the process of removing invalid records from the site survey database.

Quality Assurance (QA) and Quality Control (QC) procedures should be applied to a random sample (as large as practicable) on-site by the field supervisor to verify the completeness and accuracy of the recorded data. This process provides an opportunity to clarify with survey personnel regarding omissions, errors, or ambiguities.

After the survey results have been input to the workbook spreadsheet, random cross-checks for transcription errors should be conducted. This may be done by comparing a sample of survey sheets with the corresponding data records, correcting where necessary.

6.3.2 Data Expansion

6.3.2.1 Expansion of Sampled Counts

The most common reason for applying data expansion factors is that site observations are based on samples. To derive expansion factors, independent control counts are needed to measure the total population from which each sample has been drawn.

Care should be taken to ensure that expansion factors are calculated and applied correctly. This requires the correct population to be identified for each sample. For example, intercept surveys will typically need to be expanded by direction of travel because the sampling rates in each direction are likely to be different. Similarly, for surveys conducted on trips within mixed-use sites, separate factors will be needed for each building entrance.

The expansion of the interview data for a given intercept location can be explained in **Equation 4**.

$$X_e = (Y_o/X_v) \qquad \textbf{(Eq. 4)}$$

Where,

X_e = expansion factor

X_v = total number of valid surveys in the sample

Y_o = size of population from which the sample was drawn.

6.3.2.2 Stratified Samples

In some cases, weighted expansion factors may be needed, for example, where stratified sampling (e.g., samples by gender or age range) is used to correct for potential underreporting.

The worked example in **Section 6.3.3** covers the situation where interview responses need to be stratified by gender because fewer walk trips to/from the site are made by women than by men.

In this case, two classes have been added to the questionnaire, group 1 = men and group 2 = women. A total of 200 valid interviews were completed, 120 by men and 80 by women. There were two entrances to the building (A and B) and the recorded gender ratios varied both by entrance

and by direction of travel. The scenario is summarized in **Table 6-9**. Separate expansion factors have been derived for each stratum using **Equation 4**.

Table 6-9: Directional Counts and Expansion Factor

Access	Direction	Gender	Door Count	Interviews	Expansion Factor
A	Inbound	Men	117	33	3.5
A	Inbound	Women	134	20	6.7
A	Outbound	Men	88	32	2.8
A	Outbound	Women	103	15	6.9
B	Inbound	Men	121	25	4.8
B	Inbound	Women	97	19	5.1
B	Outbound	Men	119	30	4.0
B	Outbound	Women	91	26	3.5

6.3.3 Worked Examples

6.3.3.1 Single-Use Site

The first example is for a single-use site in an urban setting (**Figure 6-7**) during the PM peak hour.

The example site has one vehicular access to a surface parking lot. Vehicle movements (car, bicycle, and LGV) accessing the parking lot are captured by camera C_1.

There are two pick-up/drop-off bays and two pedestrian access points for the store, labelled A and B.

Camera C_2 is positioned to capture one of the pick-up/drop-off bays, as well as pedestrian access point A.

Camera C_3 is positioned to capture the second pick-up/drop-off bay and pedestrian access point B.

There is a bus interchange opposite the store, but the passenger movements between the bus interchange and the store are not visible from the camera locations.

In addition, the pre-survey site visit indicated that there is some off-site parking associated with the store. Therefore, intercept surveys (i_1 and i_2) are required inside the building near the pedestrian access points.

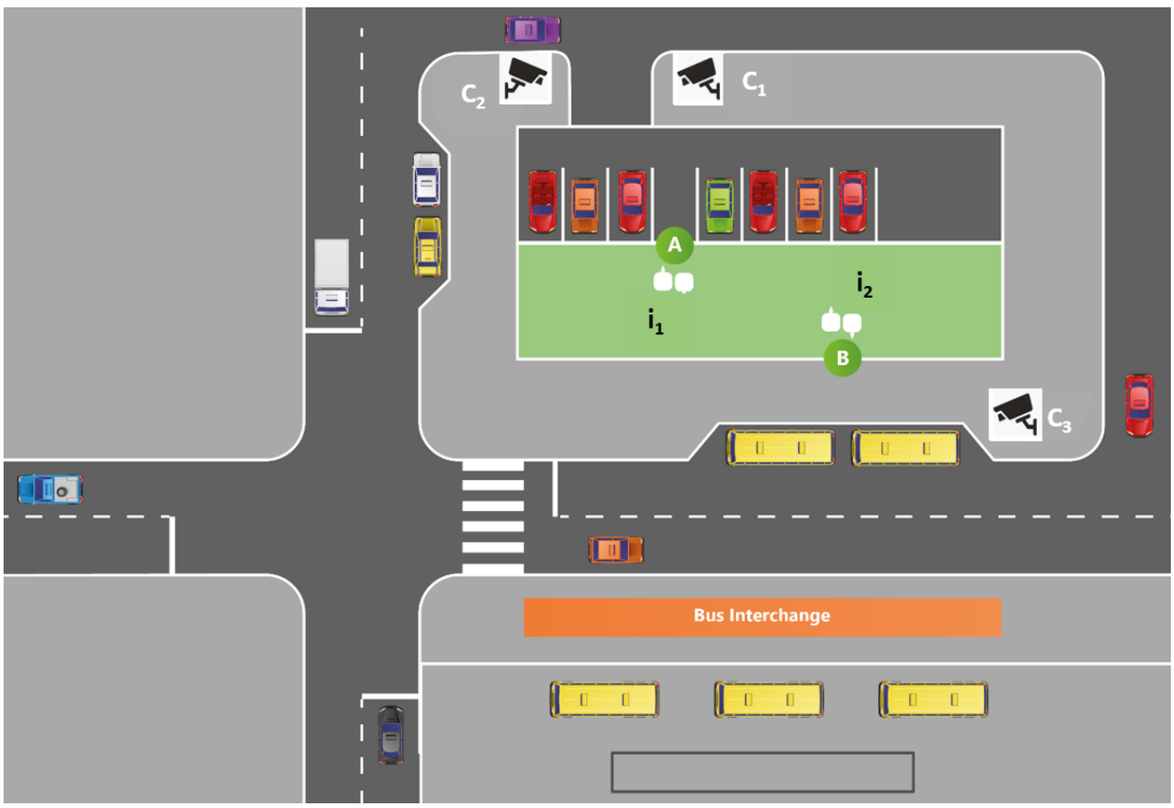

Figure 6-7: Data Processing: Non-Isolated Site

The counts recorded from the site at the end of the PM peak hour are summarized in **Table 6-10**.

Table 6-10: Person and Vehicle Counts from Camera Sites

Survey Location	Direction	Person-Trips	Vehicle-Trips
C_1	Inbound	n/a	174
	Outbound	n/a	172
	Total Counts	**n/a**	**346**
C_2	Inbound	357	8
	Outbound	340	9
	Total Counts	**697**	**17**
C_3	Inbound	81	11
	Outbound	74	11
	Total Counts	**155**	**22**

Many of the visitors at entrances A and B arrived on foot. However, from the camera surveys, it was not possible to determine whether those visitors had walked all the way to the store or travelled by another mode and had been dropped off nearby. To determine where visitors came from, intercept surveys were conducted.

Intercept Surveys

A total of 179 valid intercept surveys were completed, comprising 139 at location i_1 (53 entering and 86 leaving) and 40 at location i_2 (17 entering and 23 leaving). The distribution of person-trips by mode, based on the information provided by the survey respondents, is summarized in **Table 6-11**.

Table 6-11: Travel Mode Split Recorded from Intercept Surveys (Person-Trips)

Survey Location	Direction	Walk	Bicycle	Bus	Car			LGV	Sum
					PUDO*	Parking Lot	Off-site		
i_1	Inbound	1	1	0	2	43	5	1	**53**
	Outbound	3	1	0	3	70	7	2	**86**
i_2	Inbound	2	0	4	3	0	8	0	**17**
	Outbound	3	0	8	4	0	8	0	**23**
Sum		**9**	**2**	**12**	**12**	**113**	**28**	**3**	**179**
					153				

Expansion Factors for Intercept Surveys

From the observed person-counts entering and leaving the store through entrances A and B given in **Table 6-10**, obtained from camera locations C_2 and C_3, four expansion factors can be derived.

Expansion factors are based on direction of travel (inbound or outbound) at each of the two camera locations by using the total travel mode split for each direction of travel contained in **Table 6-11.**

Derived expansion factors are presented in **Table 6-12.**

Table 6-12: Expansion Factors for Intercept Surveys

Survey Pair	Direction	Expansion Factor (Table 6-10 ÷ Table 6-11)
$I_1 : C_2$	Inbound	357 ÷ 53 = 6.736
	Outbound	340 ÷ 86 = 3.953
$I_2 : C_3$	Inbound	81 ÷ 17 = 4.765
	Outbound	74 ÷ 23 = 3.217
Total	**Inbound**	**11.501**
	Outbound	**73.17**

Multiplying the **Table 6-12** expansion factors by the **Table 6-11** travel mode splits for locations i_1 and i_2, gives the total number of person-trips by main travel mode, as shown in **Table 6-13.**

> ***Note:*** *Since they are estimates they are not reported as integer values until the final calculation step.*

Table 6-13: Expanded Person-Trips by Mode (No. of Trips)

Survey Location	Direction	Walk	Bicycle	Bus	Car			LGV	Total
					PUDO	Parking Lot	Off-site		
i_1 (Table 6-16 x Table 6-15)	Inbound	6.7	6.7	0	13.5	289.6	33.7	6.7	**357.9**
	Outbound	11.9	4.0	0	11.9	276.7	27.7	7.9	**340.1**
i_2 (Table 6-16 x Table 6-15)	Inbound	9.5	0	19.1	14.3	0	38.1	0	**81**
	Outbound	9.7	0	25.7	12.9	0	25.7	0	**74**
Total $i_1 + i_2$	**Inbound**	**16.2**	**6.7**	**19.1**	**27.8**	**289.6**	**71.8**	**6.7**	**852**
	Outbound	**21.6**	**4.0**	**25.7**	**24.8**	**276.7**	**53.4**	**7.9**	

Mode Share

Multiplying the travel direction mode share totals by the expanded person-trips per mode (**Table 6-13)** gives the total mode share percentages by travel direction reported in **Table 6-14**.

Table 6-14: Person Mode Share (Percent)

Survey Location	Direction	Walk	Bicycle	Bus	Car			LGV	Total
					PUDO	On-Site	Off-Site		
i_1	Inbound (100 ÷ 336.7 = 0.28)	(6.7 x 0.28) 1.9%	(6.7 x 0.28) 1.9%	(0 x 0.28) 0.0%	(13.5 x 0.28) 3.8%	(289.6 x 0.28) 81.1%	(33.7 x 0.28) 9.4%	(6.7 x 0.28) 1.9%	100%
	Outbound (100 ÷ 340.1 = 0.29)	(11.9 x 0.29) 3.5%	(4.0 x 0.29) 1.2%	(0 x 0.29) 0.0%	(11.9 x 0.29) 3.5%	(276.7 x 0.29) 81.4%	(27.7 x 0.29) 8.1%	(7.9 x 0.29) 2.3%	100%
i_2	Inbound (100 ÷ 81 = 1.23)	(9.5 x 1.23) 11.8%	(0 x 1.23) 0.0%	(19.1 x 1.23) 23.5%	(14.3 x 1.23) 17.6%	(0 x 1.23) 0.0%	(38.1 x 1.23) 47.1%	(0 x 1.23) 0%	100%
	Outbound (100 ÷ 74 = 1.35)	(9.7 x 1.35) 13.0%	(0 x 1.35) 0.0%	(25.7 x 1.35) 34.8%	(12.9 x 1.35) 17.4%	(0 x 1.35) 0.0%	(25.7 x 1.35) 37.8%	(0 x 1.35) 0%	100%
Total		**4.4%**	**1.3%**	**5.3%**	**87.3%**			**1.7%**	**100%**

Deriving Vehicle Occupancy

Vehicle occupancy for the parking lot trips is derived by dividing total person-trips by total car trips.

However, when the site is accessed by car using alternative means of access, obtaining car occupancies can be complicated. For instance, pick-up/drop-off trips are more complicated, for several reasons.

First, without interviewing the driver of each car, an understanding of what their trip purpose is cannot be ascertained. The driver may be going to another location or may have made the trip purely to escort the passenger(s) to and from the store. A conservative approach is therefore recommended whereby both driver and passenger are considered as having made a primary trip to the survey site.

Second, pick-up/drop-off drivers will generate twice as many trips as those parking in the parking lot. Furthermore, their occupancy will fall after they have dropped off their passengers and, on the return trip, increase after they have collected their passengers.

Finally, there may be a time lag between the inbound and outbound leg of the trip (partly related to levels of congestion, partly to the wait time permitted at the pick-up/drop-off bays, and partly reflecting the fact that pick-up trips typically involve more waiting time than drop-off trips.

The pick-up/drop-off trips counted from camera locations C_2 and C_3 are summarized in **Table 6-15**. It was found during the PM peak hour, for one of the two pick-up/drop-off areas, 19 vehicles (and 19 drivers) entered and 20 vehicles (and 20 drivers) left, as a result of a time lag.

Based on the total expanded pick-up/drop-off counts from the intercept surveys (**Table 6-13**), a total of 52.6 trips results in 27.8 passengers being dropped off (i.e., outbound pick-up/drop-off,

i_1, = 13.5 + i_2 17.3) and 24.8 passengers being picked-up (i.e., inbound pick-up/drop-off, i_1, = 11.9 + i_2 12.9).

This results in a pick-up/drop-off bay total of 46.8 person-trips inbound (19 vehicle drivers + 27.8 passengers) and 44.8 person-trips outbound (i.e., 20 vehicle drivers + 24.8 passengers).

Table 6-15: Sample PUDO Trip Summary – Person-Trips

Trip Maker	Direction	Person-Trips
Driver	Inbound	19.0
	Outbound	20.0
Passenger	Inbound	27.8
	Outbound	24.8
Total	**Inbound**	**46.8**
	Outbound	**44.8**

The intercept surveys include a question relating to group size for respondents who arrived by car. From the answers received, vehicle occupancies for the cars parked off-site were obtained (ranging from 1.2 to 1.6 occupants per vehicle).

Dividing the corresponding person-trips from **Table 6-13** by the vehicle occupancy gives the number of cars parked off-site, as shown in **Table 6-16**.

Table 6-16: Off-Site Vehicle-Trips

Survey Location	Direction	Off Site Parking Lot Person-Trips	Vehicle Occupancy	Derived Cars Parked Off-Site
i_1	Inbound	33.7	1.2	(33.7÷1.2) = 28.1
	Outbound	27.7	1.3	(27.7÷1.3) = 21.3
i_2	Inbound	38.1	1.6	(38.1÷1.6) = 23.8
	Outbound	25.7	1.4	(25.7÷1.4) = 18.4

Adding the data in **Table 6-16** to data from the pick-up/drop-off trips (**Table 6-15**) and the car parking lot person trips (**Table 6-10**) gives the total number of car vehicle-trips and car person-trips. This is summarized in **Table 6-17**, from which an average vehicle occupancy has been calculated.

Table 6-17: Aggregate Car Occupancy Calculation

Vehicle Location	Direction	Total Car Person-Trips	Total Car Vehicle Trips	Total Car Occupancy
Parking Lot	Inbound	289.6	174	1.66 (289.6 ÷ 174)
	Outbound	276.7	172	1.61 (276.7 ÷ 172)
PUDO	Inbound	46.8	19	2.46 (46.8 ÷ 19)
	Outbound	44.8	20	2.24 (44.8 ÷ 20)
Off-Site	Inbound	71.8	51.9	1.38 (71.8 ÷ 51.9)
	Outbound	53.4	39.7	1.35 (53.4 ÷ 39.7)
Total	**Inbound**	**408.2**	**244.9**	**1.67**
	Outbound	**374.9**	**231.7**	**1.62**

The final calculation is the vehicle class split. For this, the vehicle-trips for the relevant vehicle classes are totaled across all survey locations as shown in **Table 6-18**.

> ***Note:*** *The total number of buses was derived from the intercept surveys.*
> *The total number of LGV was derived by using hypothetical average vehicle occupancy of 1.1, as determined by the intercept survey*.

Table 6-18: Vehicle Class Split (Trips)

Direction	Bus (Refer to Table 6-15)	Car (Refer to Table 6.21)	LGV	All Classes
Inbound	4	244.9	6.1 (6.7 ÷ 1.1)	**255**
Outbound	8	231.7	7.2 (7.9 ÷ 1.1)	**246.9**
Total	**12**	**476.6**	**13.3**	**501.9**

The vehicle class totals are then converted to percentages as shown in **Table 6-19**.

Table 6-19: Vehicle Class Split (Percent)

Bus	Car	LGV	All Classes
(100÷501.9) x 12 = 2.4%	(100÷501.9) x 476.6 = 94.9%	(100÷501.9) x 13.3 = 2.7%	100%

6.3.3.2 Mixed-Use Site

The derivation of trip generation rates for mixed-use sites requires quantification of both external trips (**Section 6.3.3.1**) and internal trips (trips with both the origin and destination trip ends within the project site and that do not use the site-external road network or transport systems).

Calculating the internal capture rate entails partitioning total site trips between internal and external trips, and then calculating the relative percentage of internal to external trips for each land use pairing. There are two different estimates for each pairing. One estimate is based on surveys of trip makers leaving a defined land use within the survey site and one estimate is based on surveys of trip makers entering a land use. The larger the sample sizes, the closer the two sets of estimates should be to one another.

Step 1. Count Internal Person-Trips.

Internal trip generation rates are derived from intercept interviews conducted at the main access points of the defined land uses within the survey site. Respondents interviewed leaving one of these land uses are asked about their next destination (see **Table 6-20**)

Table 6-20: Sample Intercept Survey Responses (Persons leaving the building)

1. Land use leaving from (origin)	2. Access Point No.	3. Interview Date	4. Interview Time (hh:mm)	5. Are you going to another building on this site?	6. Where are you going to?
Cinema	1	21-Mar-18	12:25	Yes	Retail
Cinema	1	21-Mar-18	12:29	Yes	Office
Cinema	1	21-Mar-18	12:31	Yes	Retail
Cinema	1	21-Mar-18	12:32	Yes	Restaurant
Cinema	1	21-Mar-18	12:35	Yes	Restaurant
Cinema	1	21-Mar-18	12:40	Yes	Retail
Cinema	1	21-Mar-18	12:44	Yes	Hotel
Cinema	2	21-Mar-18	12:51	No	Residential outside
Cinema	2	21-Mar-18	12:52	No	Residential outside
Cinema	2	21-Mar-18	12:57	No	Residential outside
….	….	….	….	….	….

After the survey results have been validated and expanded, the data can be recorded in a spreadsheet as shown in **Figure 6-8**. Applying a filter on the Question 5 responses (**Table 6-20**), allows the analyst to distinguish between internal and external trip totals.

5. Are you going to visit another building within this site?	Yes					
Count of Where are you going to?						
Row Labels	**Hotel**	**Office**	**Residential**	**Restaurant**	**Retail**	**Grand Total**
Restaurant/Entertainment	31	43	13	50	137	31
Grand Total	**31**	**43**	**13**	**50**	**137**	**31**

Figure 6-8: Internal Person-Trips from Cinema to other Land Uses.

The table is then expanded to derive the internally-captured trips between all pairs of site land uses. **Table 6-21** shows this information reformatted as a matrix. The rows provide the trip origins within the site and the columns provide the trip destinations. Adopting this format makes the tables easier to interpret and matches the results required for the final internal capture rates.

Table 6-21: Internal Person-Trips Derived from Outbound (Leaving) Surveys

From \ To	Hotel	Office	Residential	Restaurant /Entertainment	Retail
Hotel		12	0	12	5
Office	8		10	42	2
Residential	1	20		20	8
Restaurant/Entertainment	31	43	13		50
Retail	10	5	7	37	

The same procedure is followed for persons interviewed as they enter one of the defined land uses (**Table 6-22**). This time the respondents are asked their previous trip origin.

Table 6-22: Sample Intercept Survey Responses (Persons entering the building)

1. Land use arriving at (destination)	2. Access Point No.	3. Interview Date	4. Interview Time (hh:mm)	5. Are you coming from another building on this site?	6. Where have you come from?
Hotel	1	21-Mar-18	13:35	Yes	Restaurant
Hotel	1	21-Mar-18	13:44	Yes	Restaurant
Hotel	1	21-Mar-18	14:00	Yes	Retail
Hotel	1	21-Mar-18	14:06	Yes	Entertainment
Hotel	1	21-Mar-18	14:41	Yes	Retail
Hotel	1	21-Mar-18	14:52	Yes	Office
Hotel	2	21-Mar-18	15:21	No	Restaurant outside
Hotel	2	21-Mar-18	15:22	No	Office outside
Hotel	2	21-Mar-18	15:23	No	Office outside
Hotel	2	21-Mar-18	15:48	No	Restaurant outside
Hotel	2	21-Mar-18	16:58	No	Office outside

The corresponding trip matrix is shown as **Table 6-23**.

Table 6-23: Internal Person-Trips Derived from Inbound (Entering) Surveys

From \ To	Hotel	Office	Residential	Restaurant /Entertainment	Retail
Hotel		13	0	32	9
Office	5		10	1720	2
Residential	1	18		515	6
Restaurant/Entertainment	33	30	13		48
Retail	8	5	7	23	

Step 2. Count Total Person-Trips

Removing the filter used to exclude external trips displays the total person-trips. Again, there will be two sets of estimates, those derived from intercept surveys of persons leaving the buildings contained within the survey site, and those from surveys of persons arriving at buildings contained within the survey site. Sample results are provided in **Table 6-24** through **Table 6-27**.

Table 6-24: Person Trip Totals Derived from Outbound (Leaving) Surveys

Count results from Q. Where are you going to?	Includes: Internal and External Person-Trips				
	Hotel	Office	Residential	Restaurant /Entertainment	Retail
Hotel		37	2	90	15
Office	23		25	95	13
Residential	10	78		235	17
Restaurant/Entertainment	72	90	26		85
Retail	120	25	22	85	
Grand Total	**225**	**230**	**75**	**505**	**130**

Table 6-25: Person Trip Totals Derived from Inbound (Entering) Surveys

Count results from Q. Where are you coming from?	Includes: Internal and External Person-Trips				
	Hotel	Office	Residential	Restaurant /Entertainment	Retail
Hotel		45	5	80	20
Office	25		30	93	12
Residential	15	80		188	16
Restaurant/Entertainment	90	100	35		98
Retail	160	30	20	84	
Grand Total	**290**	**255**	**90**	**445**	**146**

The relative proportion of internal to external trips is calculated for each matrix cell. The person-trip totals derived from the inbound surveys (**Table 6-24**) are then matched to the total internal person-trips derived from inbound surveys (**Table 6-21**). The same process is followed for outbound trips, matching data contained in **Table 6-23** with **Table 6-25.** Data for the inbound internal capture rates are reported in the format shown in **Table 6-26**.

Table 6-26: Internal Capture Rates from Inbound Surveys

From \ To	Hotel	Office	Residential	Restaurant /Entertainment	Retail
Hotel		(100÷45)x13= 29%	(100÷5)x0= 0%	(100÷80)x32= 40%	(100÷20)x9= 45%
Office	(100÷25)x5= 20%		(100÷30)x10= 33%	(100÷93)x20= 22%	(100÷12)x2= 17%
Residential	(100÷15)x1= 7%	(100÷80)x18= 23%		(100÷188)x15= 8%	(100÷16)x6= 38%
Restaurant/Entertainment	(100÷90)x33= 37%	(100÷100)x30= 30%	(100÷35)x13= 37%		(100÷98)x48= 49%
Retail	(100÷160)x8= 5%	(100÷30)x5= 17%	(100÷20)x7= 35%	(100÷84)x23= 27%	

6.4 Analysis

This section provides an overview of the statistical techniques used to derive the rates reported in QTGPRM **Volume 2** and in the QTGPRM software. To ensure consistency, it is recommended these statistical techniques are used for any new trip generation and parking demand rate surveys used to support a GPTS-compliant transportation study or to update the QTGPRM database.

6.4.1 Estimation Models

Trip generation and parking demand rates used to support GPTS-compliant transportation studies should be based on robust analysis and accompanied by standard statistical measures that indicate their range of applicability.

QTGPRM adopts a procedure similar to that detailed in ITE (2017),[9] which recommends testing up to three independent variables per land use class. According to statistical best practice (e.g., Frost, 2019[10]), the preferred variable should be selected according to the reported standard error.

After a preferred independent variable has been selected, the choice of whether to report the weighted mean rate or a rate derived from simple linear regression should be based on the decision charts shown in **Figure 6-9** through **Figure 6-12,** which have been adapted from those presented in ITE (2017) for the purposes of this manual.

[9] ITE, 2017. Trip Generation Handbook, 3rd edition. Institute of Transportation Engineers, Washington DC, USA.

[10] Frost, 2019. Standard Error of the Regression, [online]. Available at : https://statisticsbyjim.com/glossary/standard-error-regression/ (Accessed 9 December 2019).

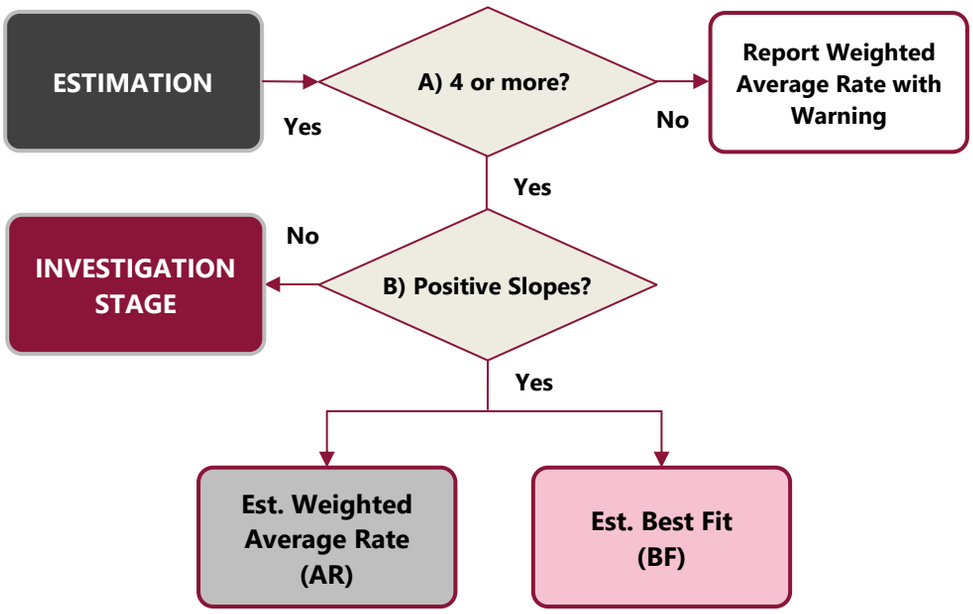

Figure 6-9: Decision Chart 1 for Selection of Reported Rate

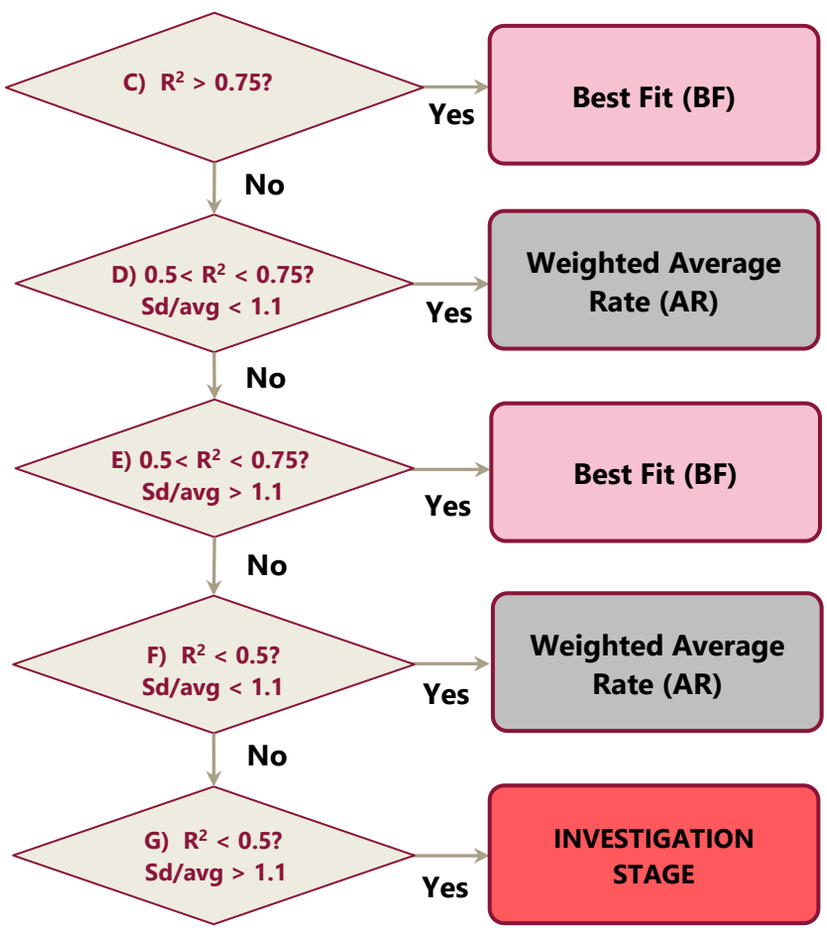

Figure 6-10: Decision Chart 2 for Selection of Reported Rate

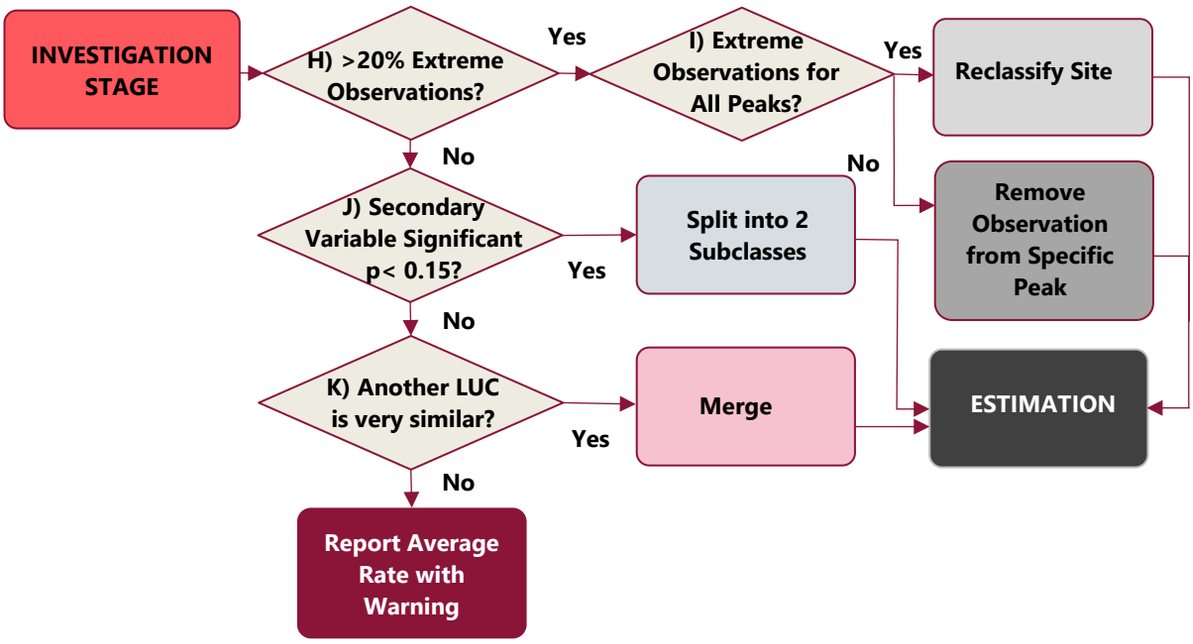

Figure 6-11: Decision Chart 3 for Selection of Reported Rate

6.4.1.1 Weighted Average Trip Generation Rates

The weighted average trip generation rate is calculated as shown in **Equation 5**.

$$\text{Rate} = \frac{\sum_{i=1}^{n} T_i}{\sum_{i=1}^{n} X_i} \qquad \textbf{(Eq. 5)}$$

Where,

T_i = the total trips observed at site ***i***

X_i = the value of the independent variable at site ***i***

and

n = the total number of sites.

The **standard deviation** for the weighted mean is given by **Equation 6**.

$$s = \sqrt{\frac{N}{N-1} \sum_{i=1}^{n} w_i \left(\left(\frac{T_i}{X_i} \right) - R \right)^2} \qquad \textbf{(Eq. 6)}$$

Where,

R = the overall weighted average trip generation rate

T_i = total trips observed at site ***i***

X_i = independent variable measured at site i

N = the number of sites

and

$$w_i = \frac{X_i}{\sum_{i=1}^{n} X_i} \qquad \textbf{(Eq. 7)}$$

6.4.1.2 Regression Models

The standard estimation model adopted for QTGPRM is a simple linear regression of the form **$y = \beta x + c$**. This should be the starting point, provided at least four valid site observations have been obtained and the following standard model conditions have been met:

- data are approximately normally distributed
- there are no extreme outliers
- there is little or no evidence of heteroscedasticity
- all data observations are independent of one another

This model is computationally straightforward and readily interpreted, with the slope of the fitted curve (**β**) being the average trip generation rate. Being a fixed value, the intercept reduces the power of the mode and should thus be close to zero.

A basic variant of this model involves the introduction of a secondary independent variable **$y=\beta_1 x_1 + \beta_2 x_2 + c$**. In such cases, the form is linear, no cross interactions are allowed, and the secondary independent variable is seen to be complementary and serves to reduce overall model error. Examples of such variables include PT accessibility[11] and parking supply. It is recommended that secondary variables only be applied where they are found to improve the model fit significantly and only where they can be applied to more than one land use class.

To meet assumptions of normality, it may be necessary to apply Box Cox transformations to either the independent or the dependent variable (typically a logarithmic transformation). In some circumstances, non-linear parametric models, such as the negative binomial or zero inflated negative binomial, may be appropriate.

[11] For more information refer to TfL, 2010. Measuring Public Transport Accessibility Levels: PTALs Summary. Transport for London, London, UK.

Table 6-27 provides a summary of recommended regression models to test.

Table 6-27: Recommended Regression Models

Method	Model	When to apply	Fitness Test
Ordinary Least Squares	Linear Regression with Intercept	• Observed trips or parking totals approximate to a normal distribution.	$R^2 > 0.50$
Maximum Likelihood	Negative Binomial Ln(y) = b1 ∗ x1 + b0	• Observations on dependent variables fail assumption of normality. • No zero-valued observations on the dependent variable.	p-value of dependent variable < 0.10
Maximum Likelihood	Zero Inflated Negative Binomial Ln(y) = b1 ∗ x1 + b0	• Observations on dependent variables fail assumption of normality. • Zero-valued observations included on the dependent variable.	p-value of dependent variable < 0.10

y *represents the dependent variable (e.g., number of trips or peak parking demand)*
b1 *represents the coefficient for the independent variable (**x1**)*
b0 *the intercept value.*

6.4.2 Outliers

An outlier is an observation that does not align with the majority of observations, the implication being that it reflects either a measurement error (on the independent or dependent variable) or a site that has been wrongly classified.

Methods to identify potential outliers include the following:

- The plot of residuals versus fitted model values (estimates) – a balanced number of observations is expected around the regression line.
- The histogram of residuals (where a normal trend is sought) or a normal line plot (where points are expected to lie close to the normal trend line).
- Exploratory data analysis (EDA) techniques, such as box plots.

The reported 95 percent confidence intervals for each derived rate can be used to establish suitable rejection thresholds.

Sample graphical aids are illustrated in **Figure 6-12**. These are available in most proprietary statistical software packages.

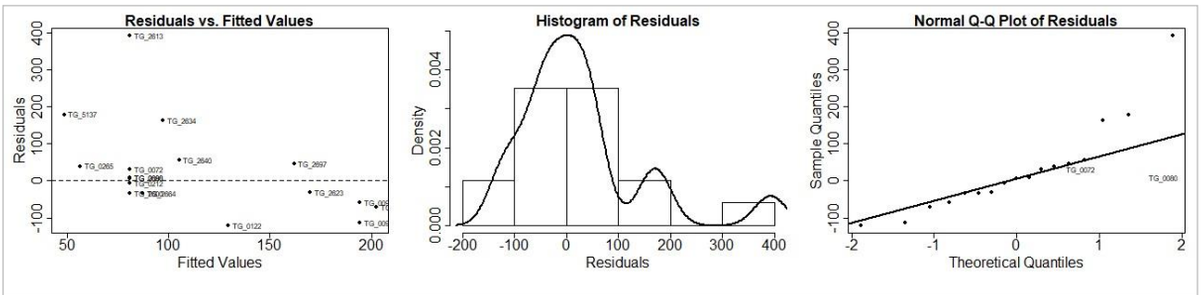

Figure 6-12: Graph Methods for Identifying Potential Outliers

Before removing suspected outliers, this should be checked for coding/transcription errors and, where necessary, adjusted and the estimation model re-run. Where no such errors are found, sites may be tested for potential inclusion with alternative land use classes. Valid observations should be removed only if sites have a statistically-significant impact on the derived rate and it can be demonstrated, from recourse to the site survey data, that site inclusion in a different land use class is warranted.

6.5 Updating QTGPRM

Updates to QTGPRM may be required for a variety of reasons.

- Transportation studies conducted on behalf of developers following the procedures specified in GPTS and this Volume.
- Specific studies commissioned by MOT to refresh QTGPRM.
- A rolling data collection program undertaken in collaboration with universities and local transportation engineering associations.

Newly derived rates may be incorporated into future updates of QTGPRM provided the data on which they are based has been collected, processed, and analyzed in accordance with the guidance in this Volume. In such cases, and where the land use class already exists, the results should be compared to the latest published QTGPRM rates. If it appears that an update is justified, MOT may supplement existing observations with new data and the rate derivation procedure rerun for the affected land use class(es).

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