Transit Capacity and Quality of Service Manual

TCRP report 100, the Transit Capacity and Quality of Service Manual, gives comprehensive definitions of capacity and quality of service for transit and specific methods to evaluate them. It deals with bus, rail ferry and transit stop and terminal capacity. Level of service id defined on scale of A-F similar for highways as given below[1]:

Exhibit 3-12. Fixed-Route Service Frequency LOS

LOS	Avg. Headway (min)	veh/h	Comments
A	<10	>6	Passengers do not need schedules
B	10-14	5-6	Frequent service, passengers consult schedules
C	15-20	3-4	Maximum desirable time to wait if bus/train missed
D	21-30	2	Service unattractive to choice riders
E	31-60	1	Service available during the hour
F	>60	<1	Service unattractive to all riders

Exhibit 3-13. Fixed-Route Hours of Service LOS

LOS	Hours of Service	Comments
A	19-24	Night or "owl" service provided
B	17-18	Late evening service provided
C	14-16	Early evening service provided
D	12-13	Daytime service provided
E	4-11	Peak hour service only or limited midday service
F	0-3	Very limited or no service

Exhibit 3-14. Fixed-Route Service Coverage LOS

LOS	% TSA Covered	Comments
A	90.0-100.0%	Virtually all major origins & destinations served
B	80.0-89.9%	Most major origins & destinations served
C	70.0-79.9%	About ¾ of higher-density areas served
D	60.0-69.9%	About two-thirds of higher-density areas served
E	50.0-59.9%	At least ½ of the higher-density areas served
F	<50.0%	Less than ½ of higher-density areas served

The manual can be obtained from the TCRP web site:
http://www.tcrponline.org/publications_home.html

The first chapter of the manual gives and overview and is included on the following pages

[1] Source: *Transit Capacity and Quality of Service Manual,* 2nd ed., Transportation Research Board, Washington, DC, 2003, pp. 3-30 – 3-34.

CHAPTER 1. INTRODUCTION

PURPOSE OF THE MANUAL

The *Transit Capacity and Quality of Service Manual* (TCQSM) provides transportation practitioners with a consistent set of techniques for evaluating the quality of service and capacity of transit services, facilities, and systems. The TCQSM does not set policies regarding a desirable or appropriate quality of service or capacity related to such transit elements. The manual's objectives include providing a logical set of methods for assessing transit services, facilities, and systems; assuring that practitioners have access to the latest research results; and presenting example problems illustrating the application of different procedures. The TCQSM is the primary source document incorporating research findings on transit capacity and quality of service. A companion document, the *Highway Capacity Manual 2000*, presents methods for evaluating the quality of service of roadway, pedestrian, and bicycle facilities.

SCOPE OF THE MANUAL

This manual is divided into nine parts:

- Part 1, *Introduction and Concepts,* summarizes the content and intended application of the manual and presents an overview of transit quality of service and capacity concepts.
- Part 2, *Transit in North America,* presents an overview of the various transit modes, services, and facilities provided in the United States and Canada.
- Part 3, *Quality of Service,* describes the factors that influence passengers' perceptions of their quality of travel on transit and provides quantitative methods for evaluating these factors.

Quality of service focuses on the passenger point of view.

- Part 4, *Bus Transit Capacity,* provides procedures for evaluating bus loading area (berth), stop, and facility (including busway, freeway high occupancy vehicle lane, arterial street bus lane, and mixed traffic lane) capacity.

Capacity addresses the number of people and/or transit vehicles that can be served consistently in a given amount of time.

- Part 5, *Rail Transit Capacity,* provides both generalized and more detailed procedures for evaluating the capacity of heavy rail (rapid) transit, light rail, commuter rail, automated guideway transit, and ropeways.
- Part 6, *Ferry Capacity,* addresses the capacity of passenger and auto ferries, focusing particularly on potential constraints at the dock.
- Part 7, *Stop, Station, and Terminal Capacity,* provides procedures to evaluate the capacity of and design passenger comfort level for various elements of bus stops, transit centers, transit stations, intermodal terminals, and similar facilities.
- Part 8, *Glossary,* presents a comprehensive glossary of terms used in the transit industry.
- Part 9, *Index,* provides an overall index to the TCQSM.

USE OF THE MANUAL

The TCQSM is intended for use by a range of practitioners, including transit planners, transportation planners, traffic engineers, transit operations personnel, design engineers, management personnel, teachers, and university students. To use the manual effectively and to apply its methodologies, some technical background is desirable, typically university-level training or technical work in a public agency or consulting firm.

The material from this document that is relevant to traffic engineers is also included in Chapter 14, "Transit Concepts," and Chapter 27, "Transit," of the *Highway Capacity Manual 2000,* which is available from TRB in printed and CD-ROM versions.

The quality of service section of the manual is intended to provide a comprehensive look at transit quality of service from a passenger's point-of-view, and a set of performance measures are provided. These measures can be applied to assess existing and projected quality of service as an aid in identifying transit service, facility, and system performance and improvement needs.

Level of service used to quantify quality of service.

The TCQSM uses the concept of *level of service* (LOS) to quantify quality of service. LOS is used for two main reasons: to ease the explanation of transit service quality concepts to laypeople and for consistency with how other modes already measure quality of service. Fixed-route transit LOS is based on an "A" (highest quality) through "F" (lowest quality) system similar to, but not exactly the same as, letter grades in school. Because of fundamental differences both between fixed-route and demand-responsive services, and among different types of demand-responsive service, a 1 through 8 scale is used to describe demand-responsive LOS.

The TCQSM provides guidance and not standards.

LOS standards are not identified in this manual, because individual agencies develop these related to their individual system and area characteristics. The TCQSM is not intended to set a national standard regarding the amount or level of service that should be provided for a given situation. In recognition of the fact that LOS may not be appropriate for all applications, the TCQSM also discusses alternative ways of measuring transit quality of service.

The capacity sections of the manual provide both planning and more detailed operations analysis procedures for assessing capacity for bus, rail, and ferry transit modes, and transit stops, stations, and terminals. A building-block approach to capacity analysis is presented, initially addressing the capacity characteristics of individual transit stops and station components, and then expansion of the concepts to address the capacity of broader transit services, facilities, and systems. The estimation of transit ridership in sizing transit services and facilities is not addressed in the manual.

The TCQSM does not address ridership estimation.

MEASUREMENT UNITS

This edition of the TCQSM has been published in dual units, U.S. customary and metric. U.S. customary units are presented as the primary units, with metric units as supplemental units.

NORTH AMERICAN AND INTERNATIONAL APPLICATIONS

In producing the TCQSM with metric units, TRB has taken a step toward making these methods and procedures more applicable to international work. However, the user of the manual is cautioned that the majority of the research base, the default values, and the typical applications are from North America, particularly the United States. Although there is considerable value in the general methods presented, their use outside of North America will likely require calibrating the procedures to local conditions, particularly in regard to user expectations of service quality. International

Unless otherwise specified, "North America" in the TCQSM refers to the United States and Canada.

users should also recognize major differences in the composition of traffic in on-street, mixed-traffic transit operations, and in typical geometrics and passenger processing measures.

TCQSM MEDIA

The TCQSM is provided in two forms: a printed document and an electronic version available on an accompanying CD-ROM or by downloading from the TCRP online publications website. The electronic version is hyperlinked, allowing users to jump immediately to related material within the manual. In addition, the references section of each part of the manual contains links to other related documents available on the Internet at the time the TCQSM was published.

Internet links are subject to change.

Calculation Software

The accompanying CD-ROM provides Microsoft® Excel spreadsheets that assist with the rail transit capacity procedures. In addition, spreadsheets have been provided that were used to develop the planning graphs presented in Part 4, Bus Transit Capacity. **Neither TRB nor the project team that developed the TCQSM provides support for these spreadsheets.**

For the other sections of the TCQSM, no software is provided to replicate the quality of service or capacity procedures; however, in most cases, the procedures can be worked out by hand or with the assistance of a spreadsheet. Over time, vendors may develop software packages to implement the TCQSM procedures, but TRB does not produce, review, or endorse any such software.

Other Reference Material on the CD-ROM

The accompanying CD-ROM also contains a library of related TCRP documents on transit capacity and quality of service. The introductory screen on the CD lists all of the documents that are included.

TYPOGRAPHIC CONVENTIONS

The following conventions are used in this manual:

Margin notes look like this.

- Margin notes are used to highlight certain points and to facilitate finding specific topics within a particular section.
- Blue underlined text indicates hyperlinks in the electronic version of the TCQSM.
- References are indicated by the letter "R" and a number, like this.[R1] Clicking on these numbers in the electronic version of the TCQSM takes the reader to the appropriate reference. Once there, clicking on the hyperlink provided below the reference (if available) opens a copy of that document, assuming that the document is still located on the Internet and in the same location as when the TCQSM was developed. Each part is treated as a separate document; therefore, the references cited in the text refer to the reference list at the end of each part. For example, [R1] in Part 2 refers to the references at the end of Part 2 and [R1] in Part 5 refers to the references at the end of Part 5.

Equation numbers, exhibit numbers, and appendices in text refer to the specific part they are used in (e.g., Exhibit 3-1). Clicking on an equation number or exhibit number reference in the electronic version of the TCQSM takes the reader to that equation or exhibit.

WHAT'S NEW IN THE SECOND EDITION

This Second Edition of the TCQSM represents a reorganization and expansion of material presented in the First Edition. A total of nine parts have been prepared, with a total of 43 chapters. The changes to the TCQSM are summarized below.

Part 1: Introduction and Concepts

Part 1 has been reorganized to include an overview of the content and application of the TCQSM. In addition, the overview of transit quality of service and capacity concepts has been expanded.

Part 2: Transit in North America

Part 2 has been formatted to focus on North American transit applications, with the quality of service and capacity concept discussions moved to Part 1. Transit mode statistics have been updated whenever data were available, including using the most recent National Transit Database information.

Part 3: Quality of Service

Quality of service has been moved in front of capacity in the Second Edition of the TCQSM to reflect user interest in this concept and the importance of quality of service related to all transit services. Part 3 includes an expanded quality of service discussion that provides a new framework for demand-responsive transit. This new framework—which describes quality of service on a "1" through "8" scale—was developed to better reflect the fundamental differences between the fixed-route and demand-responsive transit modes. The fixed-route quality of service framework presented in the First Edition has been retained, but enhancements and/or adjustments have been made to most of the measures.

Part 4: Bus Transit Capacity

Two significant additions to the Bus Transit Capacity part have been made. The first is a new "Planning Applications" chapter that, through the use of default values and graphs, allows users to quickly evaluate capacity issues related to broader planning applications. The second is the incorporation of research from TCRP Project A-7A that refines the arterial street bus lane speed estimation techniques.

Other enhancements to Part 4 include expanded sections on transit signal priority and bus rapid transit, given the increased application of these treatments to facilitate bus operations. The transit priority treatment discussion includes a presentation of the effects of different treatments on travel time and delay to both transit and general traffic.

Part 5: Rail Transit Capacity

Part 5 provides rail transit capacity analysis procedures. In addition to a new "Planning Applications" chapter, this entire part was rewritten to better flow with the rest of the TCQSM, as this part in the First Edition was developed by extracting material directly from the previous *TCRP Report 13*[R5] document on rail transit capacity.

Other enhancements in this part include a new section on ropeway capacity. Ropeways are defined as including aerial tramways, funiculars, and cable-hauled people movers. The commuter rail capacity section has also been expanded. Finally, the heavy rail, light rail, and commuter rail route statistics for lines in North America were updated to reflect the latest route development and ridership statistics, based on a survey of agencies providing these services.

Part 6: Ferry Capacity

For the first time, passenger and auto ferry capacity is addressed in the TCQSM. This part initially discusses different types of ferry services, vehicles, and docking/terminal facilities. This is followed by an assessment of how berth and dock capacity impact vessel capacity and how overall passenger and auto capacity on ferry routes may be calculated. As with other parts of the manual, example problems illustrating the ferry capacity analysis procedures are included.

Part 7: Stop, Station, and Terminal Capacity

Part 7 now focuses on an expanded discussion of stop, station, and terminal capacity, the title reflecting consideration of analysis procedures related to different types of transit facilities. Major enhancements to this part include a broader discussion of the relationship of different passenger processing elements in larger stations and terminals in impacting overall facility capacity, and discussions about sizing station facilities to address passenger demands, ADA requirements, and emergency evacuation requirements.

Part 8: Glossary

Part 8 includes an expanded glossary of terms from that presented in the First Edition, with more than 2,000 terms defined.

Part 9: Index

Part 9 includes a comprehensive alphabetical index of terms used in the manual.

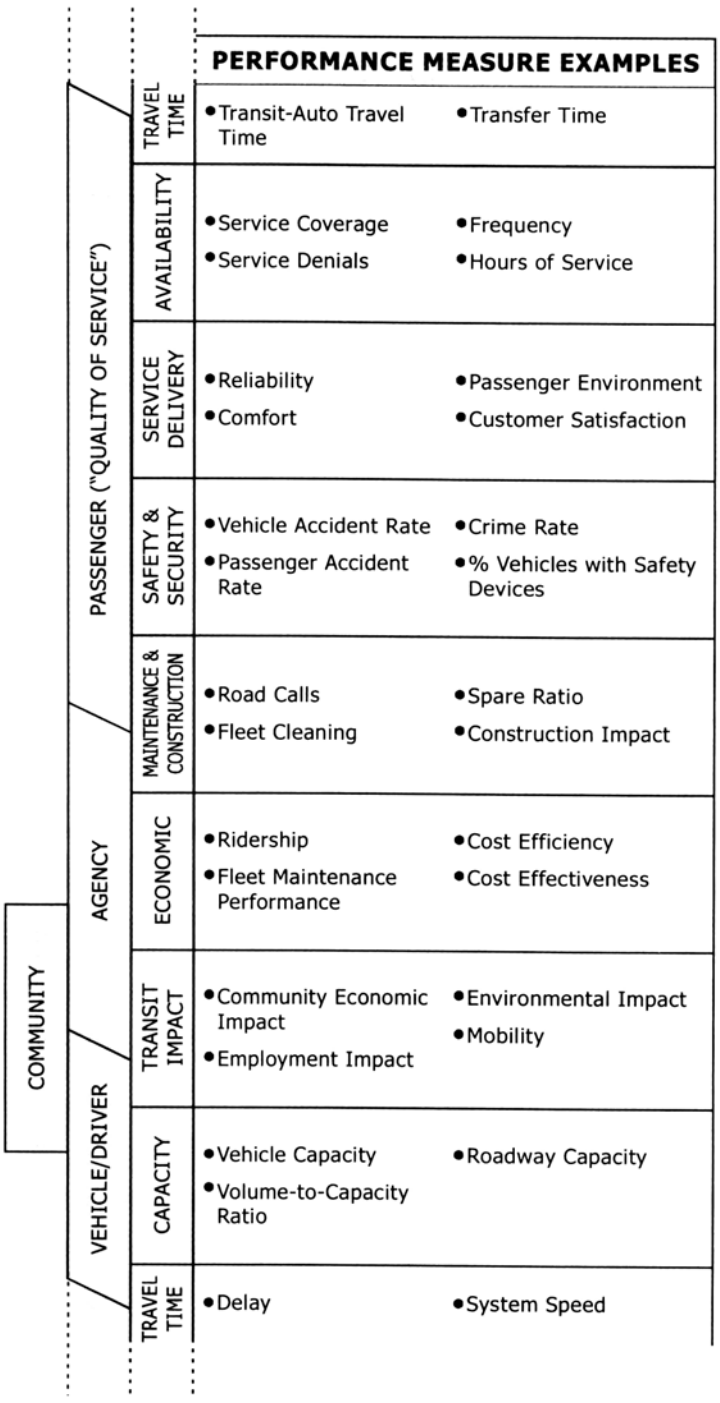
FUTURE UPDATES

In future years, other updates of the TCQSM will likely occur as research is conducted and new concepts and analytical procedures to assess transit capacity and quality of service are developed. The new TRB Committee on Transit Capacity and Quality of Service will take a leadership role in identifying research priorities and in helping shape further updates of the manual and the application of the document by the user community.

The committee welcomes user feedback on the TCQSM and has established a web site to solicit comments and suggestions that will be used to guide future editions of the manual.

http://webboard.trb.org/~tcqsm

Exhibit 3-3
Transit Performance Measure Categories and Examples[R17]



Transit performance measures can represent the passenger, agency, driver/vehicle, and/or community point of view.

Travel time overlaps the vehicle/driver and passenger points of view.