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Qatar's School Transportation System

Supporting Safety, Efficiency, and Service Quality

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Prepared for the Qatar Amiri Diwan

RAND RAND-QATAR POLICY INSTITUTE

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Preface

In 2007, at the request of the Supreme Education Council of Qatar, the RAND-Qatar Policy Institute (RQPI) conducted an exploratory scoping study of the school transportation system in Qatar (Pernin et al., 2008). That study reviewed the strategy, operations, and organization of the school transportation system of Qatar and recommended actions that the Supreme Education Council could take to improve its school transportation system. In 2009, as a follow-on effort, the Amiri Diwan asked RAND to conduct a new study to help fulfill the recommendations of the first study.[1] In response to that request, RQPI conducted this study to assess stakeholder perspectives on school transportation, identify a vision and goals for the school transportation system, and identify strategies to achieve that vision and better align Qatar's school transportation system with international norms. This monograph describes the results of that research.

This project was conducted under the auspices of RQPI and RAND Infrastructure, Safety, and Environment. RQPI is a partnership of the RAND Corporation and the Qatar Foundation for Education, Science, and Community Development. The aim of RQPI is to offer rigorous and objective analysis to clients in the greater Middle East. In serving clients in the Middle East, RQPI draws on the full professional resources of the RAND Corporation. RQPI is an integral part of Education City, which is being developed by Qatar Foundation under the leadership of Her Highness Sheikha Mozah Bint Nasser Al Missned. Education City is a community of institutions—from kindergarten through postgraduate university studies—contributing to education and research in both Qatar and the Gulf region.

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[1] The Amiri Diwan is the executive office of the Amir of Qatar.

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Summary

In recent years, Qatar has experienced dramatic development and population growth. Traffic has increased substantially, and student enrollments continue to grow. The State of Qatar has embarked on many educational reform efforts, the most significant of which is the implementation of Independent Schools in 2005 (Brewer et al., 2006). Among many educational reforms, one option being considered under the Independent School model is wider school choice, allowing parents to choose schools for their children regardless of where they live. This expansion of school choice is likely to increase the need for school transportation and adds complexity to school transportation operations.

In consideration of the many challenges associated with Qatar's continued growth and demographic changes, Qatar is interested in updating its school transportation system. Stakeholders, including school administrators and the Supreme Education Council, have expressed a variety of concerns about the current state of school transportation, ranging from safety and traffic congestion to efficiency and quality of the service.

Purpose

The purpose of this study is to (1) assess stakeholder perspectives on school transportation, (2) help identify a vision and goals for the school transportation system, (3) identify international norms for school transportation, (4) compare Qatar's current school transportation system with international norms, and (5) highlight strategies for Qatar to achieve the proposed vision and better align its school transportation system with international norms.[2] For the purposes of this study, we confine our definition of *international* to those practices employed by the United States, Canada, Western

[2] In addition to the above tasks, the project also included the development of an implementation plan as a sixth task. Building on the recommendations in this document, RQPI will provide to the government of Qatar a separate, companion document, titled "Qatar's School Transportation System: Implementation Manual," that highlights challenges, timelines, and organizational responsibilities associated with the recommended strategies.

Europe, and Gulf Cooperation Council (GCC) countries with recently modernized school transportation systems. We regard as *norms* those practices that are repeatedly referenced in the literature we reviewed and appear in case studies explored under this project.

Vision and Goals

An important part of this study was developing a vision and goals for the school transportation system. To develop the vision, we reviewed key planning documents[3] for Qatar and interviewed key stakeholders to glean from them what characteristics they thought the school transportation system should embody. From those interviews and documents, we distilled a four-element vision. The elements are as follows:

- Provide safe, efficient, and high-quality transportation for Qatar's students.
- Support educational options by enabling mobility and access.
- Provide a transportation experience that is supportive of Qatari values and culture.
- Minimize the impact on traffic congestion and the environment.

Once we had developed the elements of the vision, we next determined the goals that would be necessary to realize them. For example, to achieve the safety portion of the first vision element, we identified as a goal "Effective safety standards and measures are established and enforced." To achieve the vision element of minimizing the effect on traffic congestion, we identified as a goal "Transportation operations minimize delays and traffic around schools." Having defined visions and goals, we then worked to identify strategies that would support them.

Strategies to Support Vision and Goals

We identified a number of strategies that would bring Qatar's school transportation system into closer alignment with international norms. We also identified a few strategies that, while not commonly practiced, may be of interest to Qatar due to the stated preferences of administrators and parents. The strategies can be grouped into five major categories:

- school zone management
- bus design and operation
- fleet operations and management
- information, communication, and analysis
- student management.

[3] These included the Qatar National Vision 2030 (Qatar General Secretariat for Development Planning, 2008), the Qatar National Master Plan, and the Transportation Master Plan.

Each category contained several strategies, and these are listed in Table S.1. Of the strategies listed in Table S.1, 13 stood out in terms of being cost-effective and carrying little implementation risk. We list these in our recommendations at the end of this summary.

Evaluation of Select Strategies

In identifying possible strategies for Qatar's school transportation system, some options emerged that may offer significant benefits but raise important questions related to cul-

Table S.1
Candidate Strategies for Qatar's School Transportation System and the Vision Elements They Support

Strategy	Supported Vision Elements
School zone management	
School zones	Safety, Traffic
Traffic laws/education/enforcement	Safety, Traffic
Bus design and operation	
School bus standards	Safety, Quality
Bus driver standards/training/eval.	Safety, Quality, Values
Standard checklists and reporting	Safety, Quality, Efficiency
Technology tools (e.g., RFID)	Safety, Efficiency
Maintenance standards/monitoring	Safety, Quality
Fleet operations and management	
Bus route optimization	Efficiency
Pick-up/drop-off points	Efficiency
Staggered school start times	Efficiency, Traffic
Fleet size and composition	Quality
Information, communication, and analysis	
Policy manual	Safety, Quality, Efficiency
Awareness campaign	Safety, Access
Stakeholder feedback process	Safety, Quality, Efficiency, Values
Gather/assess safety data	Safety
Establish/monitor efficiency metrics	Efficiency, Quality
Student management	
Bus monitor enhancements	Values, Quality
Student loading and unloading procedures	Safety
Student behavior management	Values, Quality
Media on buses	Quality

tural concerns, uncertain cost-effectiveness, or inconsistency with international norms. Due to uncertainties about their costs and benefits, we provided a preliminary evaluation as a starting point for their consideration. Strategies that may warrant further consideration include the following:

- transitioning to smaller buses, to shorten route lengths and reduce student time spent on the bus
- decreasing the number of buses servicing schools, which would increase the number of students on each bus and reduce costs
- implementing bus stops to improve the efficiency of the school bus system
- staggering school start times, to reduce congestion and potentially enable buses to service multiple morning and afternoon bus routes
- integrating Radio Frequency Identification (RFID) tag devices into buses to enhance safety
- providing students access to media on buses, to enhance learning and increase bus ridership
- changing the requirements for bus monitors to enhance safety.

Figure S.1 summarizes the results of our preliminary evaluation of these strategies. If a strategy is assigned a green value for a particular criterion, this indicates that it enhances performance in that dimension. A red designation indicates that the strategy degrades performance in that dimension. In some cases, the effect of a strategy may be uncertain or produce mixed (both positive and negative) effects. We indicate this with a yellow value. In addition, we have added + and – symbols to indicate areas where strategies may have a particularly significant positive or negative effect.

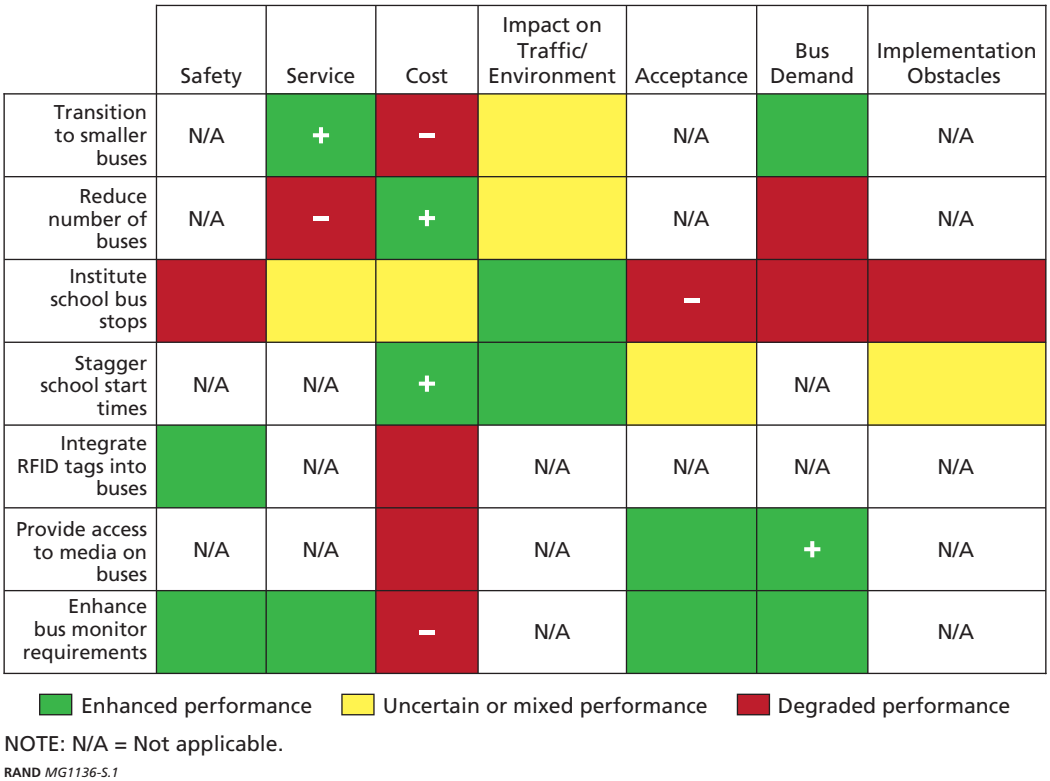
Concluding Observations and Recommendations

This monograph provides many options to implement in Qatar's school transportation system; these recommendations are summarized below. While all of these strategies are potentially viable, Qatar must decide which goals to prioritize for near-term implementation.[4]

Regardless of which strategies are implemented, decisionmakers should keep in mind that Qatar's school transportation system is indeed a *system*. As is the case with any system, its parts work together, not in isolation. So any change made in one part of the system must be weighed with effects on other parts of the system. Some of the recommendations listed below are complementary and reinforcing. Such recommenda-

[4] RQPI will provide to the government of Qatar a separate, companion document, titled "Qatar's School Transportation System: Implementation Manual," that will assist with these decisions and provide guidance on implementing each of the strategies.

Figure S.1
Expected Performance of Selected Other Strategies



NOTE: N/A = Not applicable.

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tions are best pursued as a set of coordinated initiatives. Other recommendations may be implemented as stand-alone initiatives. In choosing which strategies to implement, it will be important to consider which sets of initiatives will achieve the most efficient implementation and which sets of initiatives will achieve the greatest synergies after implementation. This consideration should include weighing the cost of implementing the system against the benefits that would accrue. Furthermore, Qatar's school system does not operate in isolation from other aspects of Qatari society, and thus changes made must mesh with Qatar's other concerns and priorities.

Implementation of the strategies mentioned here will require extensive coordination among the entities involved with school transportation in Qatar, including the Amiri Diwan, the Office of the Heir Apparent, the Supreme Education Council, school bus operators, schools in Qatar, the Urban Planning and Development Authority, the Public Works Authority, and the Traffic Police. Execution will certainly be a team effort requiring the active participation of all these stakeholders.

Recommended Strategies

We recommend that Qatar adopt the proposed vision and goals for the school transportation system. In the course of our study, we have identified a number of areas where Qatar's school transportation system does not conform to international norms. Should Qatar choose to conform to international norms, many of the strategies presented in Table S.1 may be viable in terms of implementation and cost. To bring the school transportation system in line with common international practices, Qatar should focus on the following 13 strategies:

- Establish clearly marked school zones with standardized safety features and traffic management around schools.
- Use traffic laws, education, and enforcement to control the behavior of private drivers near schools and school buses.
- Adopt international standards for school buses.
- Establish universal standards for licensing and training bus drivers.
- Make drivers responsible for completing daily, standardized checklists and reports to ensure adherence to standardized processes.
- Establish maintenance standards and a process for monitoring compliance.
- Publish a system-wide policy manual.
- Conduct awareness campaigns to reinforce practices, policies, and laws.
- Provide school administrators and parents a mechanism for giving transportation officials feedback about issues with school transportation.
- Maintain and track safety data to properly evaluate safety and formulate targeted responses to safety problems.
- Establish performance metrics and develop a system to gather data to measure system-wide performance.
- Ensure that trained school staff are available to supervise bus loading and unloading during peak hours.
- Enforce greater discipline on buses.

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- Dr. Houda Bouslama, Supreme Education Council
- Mr. Jassim Al Kuwari, Supreme Education Council
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Abbreviations

Ashghal	Public Works Authority (Qatar)
BRO	Bus Route Optimization model
DCE	discrete choice experiment
GCC	Gulf Cooperation Council
GPS	Global Positioning System
Karwa	Mowasalat Transportation Service Provider (Qatar)
NCST	National Congress on School Transportation (United States)
NHTSA	National Highway Traffic Safety Administration (United States)
NSTSP	National School Transportation Specifications and Procedures
OECD	Organisation for Economic Co-operation and Development
RFID	radio frequency identification
RQPI	RAND-Qatar Policy Institute
UAE	United Arab Emirates

CHAPTER ONE

Introduction

Motivation

In consideration of the challenges associated with Qatar's continued growth and demographic changes, Qatar is interested in updating its school transportation system. Stakeholders, including school administrators and the Supreme Education Council of Qatar, have expressed a variety of concerns about the current state of school transportation. For example, school administrators have expressed concerns about the general safety of children and the traffic congestion around schools; other concerns have been raised about efficiency and service quality. In support of efforts to update Qatar's school transportation system, RAND was asked to assess Qatar's school bus system and compare it to international norms for school bus transportation. In 2007, at the request of the Supreme Education Council (SEC) of Qatar, the RAND-Qatar Policy Institute (RQPI) conducted an exploratory study of Qatar's school transportation system (Pernin et al., 2008); this was followed by a second study in 2009 to help fulfill the recommendations of the first study. This monograph documents the results of this follow-on effort.

Purpose

The purposes of this study were to (1) assess stakeholder perspectives on school transportation, (2) help identify a vision and goals for the school transportation system, (3) identify international norms for school transportation, (4) compare Qatar's current school transportation system with international norms, and (5) highlight strategies for Qatar to achieve the proposed vision and better align its school transportation system with international norms.[1] For the purposes of this study, we confine our

[1] In addition to the above tasks, the project also included the development of an implementation plan as a sixth task. Based on the recommendations in this document, the implementation plan will be provided to the government of Qatar as a separate, companion document, titled "Qatar's School Transportation System: Implementation Manual," that highlights challenges, timelines, and organizational responsibilities associated with the recommended strategies.

definition of *international* to those practices employed by the United States, Canada, Western Europe, and recently modernized Gulf Cooperation Council (GCC) countries. We regard as *norms* those practices that are repeatedly referenced in the literature we reviewed and appear in case studies explored under this project.

This monograph describes results and recommendations emerging from this study and should assist senior personnel of institutions in Qatar who will be involved in school transportation.

Approach

Our approach included soliciting feedback regarding the school transportation system, drafting a vision and goals for the school transportation system, identifying international norms that support the goals, and identifying where Qatar departs from those norms. As Qatar's school transportation needs continue to grow, stakeholders—including school administrators, parents, and the Supreme Education Council—have expressed a variety of concerns about the current state of school transportation. To gain a better understanding of stakeholder perspectives, we conducted a series of interviews and surveys. The purpose of the surveys was to identify concerns and preferences regarding school transportation modes.

To guide future development of the school transportation system, we worked with Qatari stakeholders to establish an enduring vision and set of supporting goals, which are described in Chapter Three. The vision and goals consider Qatar's operational context and the national priorities as set forth in Qatar's strategic planning activities. The vision describes what the system should ultimately seek to become. The goals describe what should be achieved and provide guidance on where resources and strategies should be focused.

Next, we identified strategies that are commonly used by school transportation systems in the United States, Canada, Western Europe, and recently modernized Gulf GCC countries. Each strategy addresses at least one element of the vision set forth in Chapter Three, though most strategies address multiple vision elements. The strategies fall into five major categories:

- school zone management
- bus design and operation
- fleet operations and management
- information, communication, and analysis
- student management.

We compare Qatar's school transportation system with international norms to identify opportunities for updating Qatar's school transportation system. We highlight

the differences and offer recommendations that would bring Qatar's school transportation system in line with international norms.

Organization of This Monograph

This monograph has six chapters and four appendices. Chapter Two provides context for the following chapters by describing Qatar's school transportation system and stakeholder perceptions of school transportation in Qatar. Systemic change is best accomplished when driven by an overarching vision, and Chapter Three articulates such a vision for Qatar's school transportation system and sets forth goals that promote the vision. Subsequent chapters lay out strategies for fulfilling the goals that support the vision. Chapter Four presents strategies that are consistent with international norms. Chapter Five focuses on selected strategies outlined in Chapter Four and provides an evaluation for a subset of the strategies that may have significant implementation challenges. The final chapter provides concluding observations and outlines recommendations.

The report has four appendixes. Appendix A provides additional information about the survey of parents conducted in support of this research. Appendix B contains a short description of how other GCC countries approach school transportation to provide a sense of how comparable countries have dealt with problems similar to those faced by Qatar. Appendix C describes the bus routing model developed for this project. Finally, Appendix D contains documentary support for each of the strategies presented.

CHAPTER TWO

Key Observations About School Bus Transportation and the Perceptions of Parents and Administrators

This chapter provides an overview of Qatar's current school transportation system and describes how stakeholders view the school transportation system. The chapter begins with a discussion of the context of Qatar's school transportation system and a description of the bus fleet, operations, utilization, and costs. It then turns to the perspectives of school administrators, first providing the perspectives of the Independent and Semi-Independent administrators and then those of the private school administrators.[1] The chapter then discusses the perspectives of parents, drawing on the results of a prior study and new findings from a survey administered to parents. The chapter closes with a summary of observations about stakeholder preferences.

Context of Qatar's School Transportation System

The sections below describe the current school transportation system, its operations, and current preferences for school transportation modes.

Schools in Qatar

The State of Qatar has embarked on many educational reform efforts, the most significant of which is the implementation of the Independent Schools in 2005 (Brewer et al., 2006). One option being considered under the Independent School model is an increase in school choice, which would allow parents to choose schools for their children regardless of their home location. This increased school choice may add complexity to transportation demands, as students seek transportation to more schools and schools farther away from their own neighborhoods.

In 2009, about 120 Ministry (Semi-Independent) schools and about 70 Independent schools served a little more than half of the roughly 160,000 K–12 students in Qatar. The remaining student population, composed of Qatari nationals and expatri-

[1] Data collection for this study occurred in spring 2009. At that time, the Ministry of Education still had Semi-Independent schools. Currently, all schools overseen by the Supreme Education Council are Independent schools.

ates, attended the 84 private and community schools in Qatar. By the end of 2010, 77 additional Semi-Independent schools became Independent schools. Currently, all public schools in Qatar are Independent schools.

Organizational Responsibilities

Currently, the Supreme Education Council has a Shared Services Department that oversees the Transportation Department. The Transportation Department is responsible for facilitating school bus services to Independent and Semi-Independent schools. Schools request a certain number of buses annually depending on the students registered for transportation service, and buses are allocated according to the judgment of the Transportation Department. School transportation usually covers three or four zones representing service areas around a school; students who live outside these zones are not usually offered school transportation services.

The School Bus Fleet

At the start of each school year, Independent schools place a request to receive school buses with the Supreme Education Council, which either accepts, modifies, or denies the request. Karwa, a subsidiary company of Mowasalat, has been contracted to provide the buses and drivers for Independent schools in Qatar. Karwa currently operates approximately 1,300 buses, which service over 180 different schools.

The Supreme Education Council currently pays for school bus services for Independent schools through a series of overlapping contracts it holds with Karwa. The contracts typically span four years and specify the number of large, medium, and small buses that are to be provided by the company. The latest contract provides a larger percentage of medium- and small-sized buses, since more schools prefer smaller buses for their students.[2] Using the contracts, RAND estimated the average cost per large, medium, and small bus being provided by the company during the 2009–2010 school year. The costs per day are shown in Table 2.1 and cover vehicle, fuel, and driver costs.

The Transportation Office decides on an annual budget for buses based on the needs of schools. Children of Qatari citizens use the school transportation service free

Table 2.1
Characteristics of Bus Fleet

Bus Size	Share of Total Buses	Seats per Bus	Cost per Bus per Day
Large	70%	40–45	1,062 QR (292 USD)
Medium	27%	30–35	965 QR (265 USD)
Small	3%	20–29	926 QR (254 USD)

NOTES: QR = Qatari riyals; USD = U.S. dollars.

[2] Schools prefer the smaller buses since they are believed to be easier to maneuver in small neighborhoods, and the journey time for students is usually less because the bus has to pick up fewer students.

of charge. Children whose parents work for government or semigovernment entities also are provided school bus services free of charge. The remaining students must pay a fee of QR 600 per year (165 USD).

Karwa buses are more luxurious than school buses in most other countries (e.g., the United States, Canada). Typically, Karwa's vehicles are coach buses designed to transport tourists rather than children and therefore do not conform to international norms for school bus standards. However, the buses are new, have air conditioning, and are generally much better quality than the previous generation of buses used by the Supreme Education Council. Typically, the buses have comfortable, high-back seats with arm rests, and some buses contain DVD players.[3]

Bus Operations

Currently, school buses are assigned to specific schools and are not used for any other purpose. Drivers and school administrators have primary responsibility for bus routing and daily operations. Administrators at the Independent schools are responsible for assigning students to buses. Over the course of the first few weeks of school, the bus drivers are responsible for determining the bus route. This includes determining the order in which students are picked up and dropped off and the roads that are used. Maximum usage is about 1,000 km per week. Some buses are used as little as 100 km per week. The longest reported bus journeys take 1.5–2 hours each way.

Currently, on average, 40 percent of the students at Independent schools use the bus in Qatar. But ridership rates, as well as the number of students attending schools, vary significantly across schools. As a result, the total number of students using the bus at different schools varies significantly.

Boys and girls typically attend single-gender schools and travel on separate buses. In accordance with Qatari tradition, interactions between male and female students are discouraged and considered undesirable by parents and administrators. Currently, the buses typically pick up students directly from their houses. Formal bus stops are neither implemented nor generally considered an acceptable option due to cultural and environmental constraints—parents are uncomfortable with their children (especially girls) waiting outside on public streets, there is often no safe place to wait, and temperatures can often reach uncomfortably high levels.[4]

School bus drivers receive the same training as drivers of public and labor transport buses. Qatar's school bus drivers are not trained specifically to handle or transport schoolchildren. However, as is common in some GCC countries, Qatar employs bus

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[3] During our interviews, school administrators and Karwa officials suggested that the buses are too luxurious for student transport use and prone to damage and vandalism. Vandalism costs around 500,000–1 million QR annually (140,000–280,000 USD).

[4] In some instances, boys in secondary schools gather at informally designated spots for pick-up and drop-off. (Secondary schools serve grades 10–12, with students typically ranging from 16 to 18 years old.) This is more common among students living and going to schools outside Doha.

monitors to ride on many buses, in particular those transporting younger children and female students. Similar to bus drivers, monitors do not receive formalized training.

There are few, if any, universally employed measures for managing traffic near schools. However, schools can request signage, pedestrian crossings, digital speed display systems, and speed bumps or speed tables. A committee sets speed limits in school zones; committee members come from Ashghal (Qatar's Public Works Authority), the Urban Planning and Development Authority, the Traffic Police, and other relevant government entities.[5]

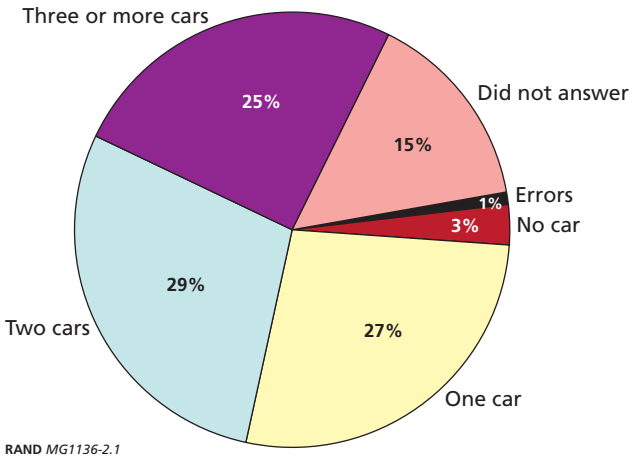
Modes of Transportation

Through a survey of parents at select schools, we identified the distribution of travel modes used in the school transportation system. (The survey is described in Appendix A.) Over 80 percent of respondents acknowledged owning at least one car, as shown in Figure 2.1. Approximately 34 percent of households employ a driver. Since the vast majority of households have access to personal vehicles, parents often have options other than school buses for transporting their children.

In the survey, we observed that 58 percent of pupils are driven to school, either by a parent or by a driver, while 38 percent of pupils travel to school by school bus (see Figure 2.2).

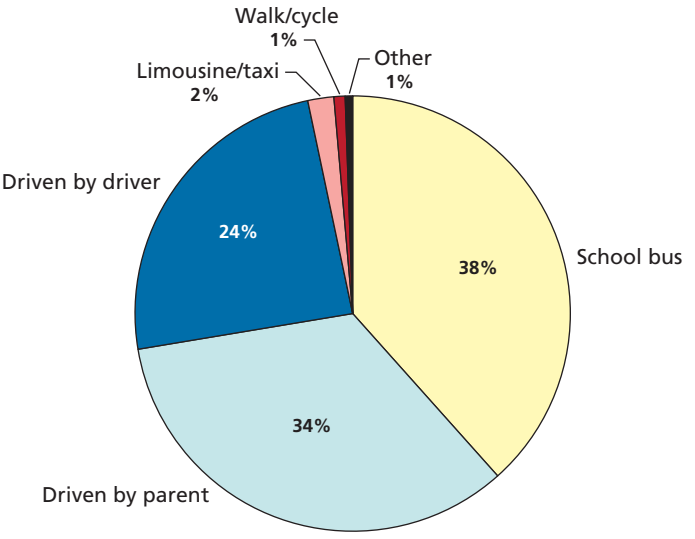
We also observed that pupils from households with drivers are much less likely to use the school bus—13 percent of pupils from households with drivers use the school bus, compared with 55 percent of pupils from households without drivers.

Figure 2.1
Car Ownership in the Survey Sample



[5] The committee has set the speed for school zones at 30–40 km per hour.

Figure 2.2
Observed Mode Usage to School



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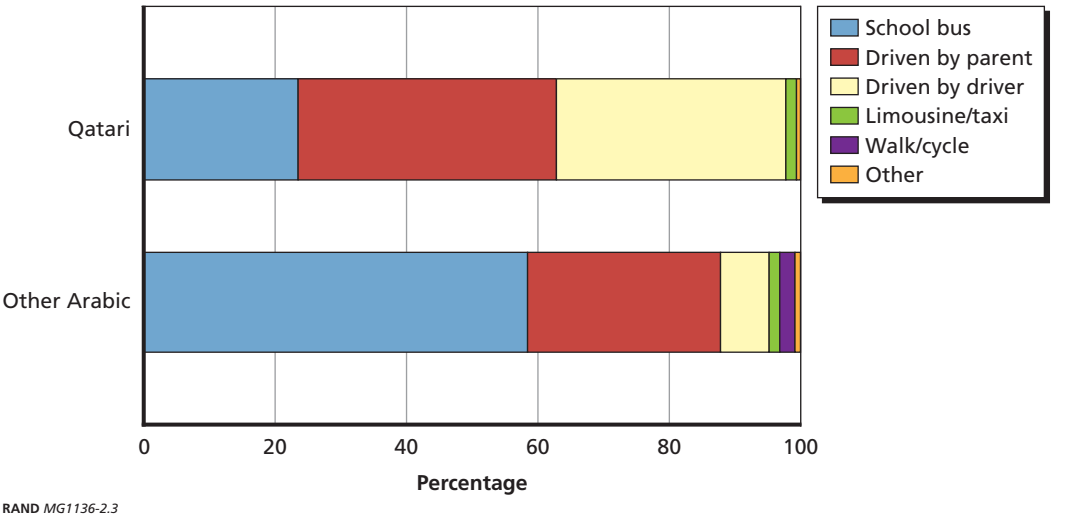
Qatari children are more likely to be driven to school by drivers and are less likely to use school buses compared with other Arabic children living in Qatar (Figure 2.3). This can be explained by the fact that Qataris are nine times more likely to employ a driver.

Figure 2.3
School Transportation for Qataris and Non-Qatari Arabs Residing in Qatar



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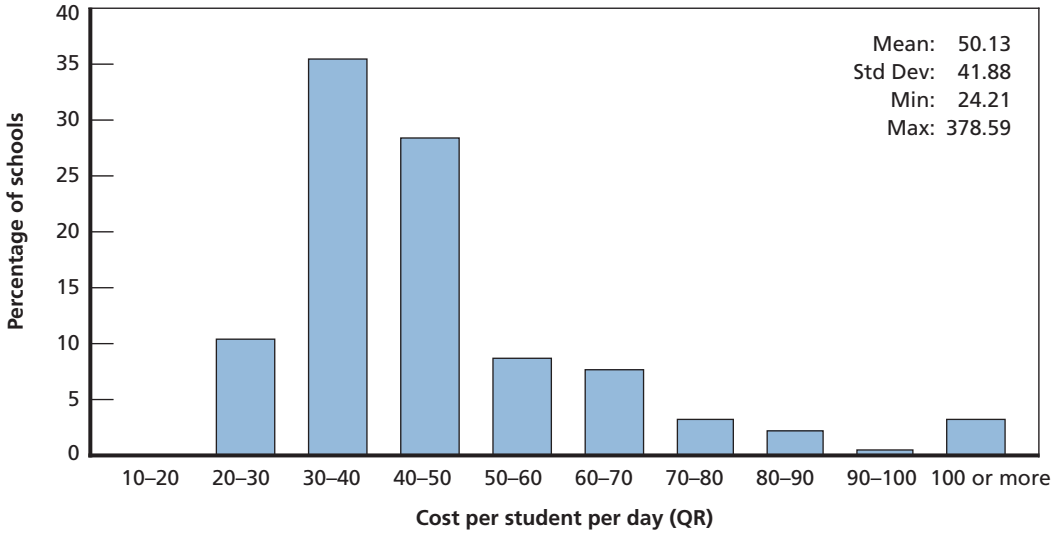
Cost of Bus Service

Using data on bus assignments and ridership at Independent schools, we are able to calculate the cost per day per student using the bus at 183 Independent schools. Figure 2.4 provides a histogram of the distribution of these costs. The average cost per student bused per day was approximately 50 QR (14 USD). It is interesting to note the dramatic variation in cost. This variation stems partially from variation in different buses assigned to schools, but more so from differences in the number of filled seats per bus at different schools.

Data from the United States suggest that the average cost of providing bus service per student served per day is about $4.50 (16.5 QR).[6] Thus, bus service per student per day in Qatar is about three times more expensive than average U.S. costs. The dramatically higher cost for service in Qatar is at least partially due to differences in the quality of bus used in the two countries, but may also stem from the fact that Karwa has market power and may be charging higher rates than a more competitive market would command. It could also be the case that school buses in Qatar are operated with fewer seats filled, which would increase the relative cost of providing school transportation services, but we have no data on school bus occupancy rates in the United States.

Figure 2.4
Cost per Day per Student Using the Bus



NOTE: Based on calculations developed by RAND using data from the 2008–2009 and 2009–2010 school year.

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[6] The cost of U.S. school bus service is taken from National Center for Education Statistics, 2009. To convert annual cost per student to daily cost per student, we used the national average number of school days per school year of 180 days.

Utilization of Bus Capacity

Figure 2.5 shows the distribution of the share of seats filled on buses across 183 Independent schools we obtained data for. On average, 67 percent of seats on buses operated by Karwa are occupied by students, although there is a lot of variation in the bus occupancy rate across schools.

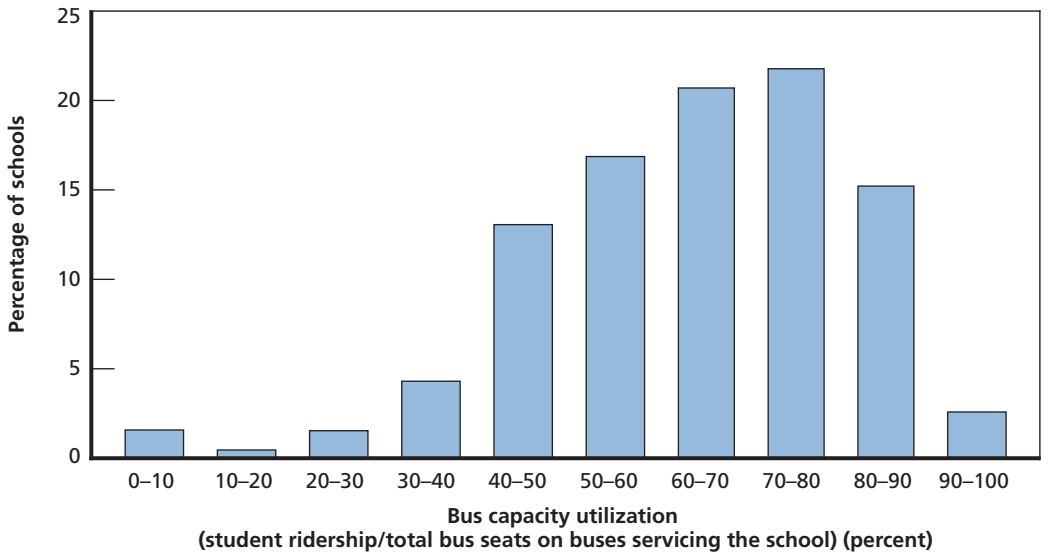
A Look into Demand

The current school transportation system faces a number of challenges with the introduction of additional school choice and the growing student population. Such challenges will increase demands on the school transportation system and influence transportation planning efforts. This section describes the demands on the current school transportation system and the implications of demographic changes that are occurring in Qatar.

The Introduction of the Independent Schools Model

With the introduction of Independent schools, parents may have the option of choosing schools for their children. Theoretically, parents will be able to register their children in any school, regardless of their home location. In practice, this is not currently the case. Currently, the Supreme Education Council has established geographic loca-

Figure 2.5
Share of Filled Seats on Buses Used by Independent Schools



NOTE: Based on calculations developed by RAND using data from the 2008–2009 and 2009–2010 school year.

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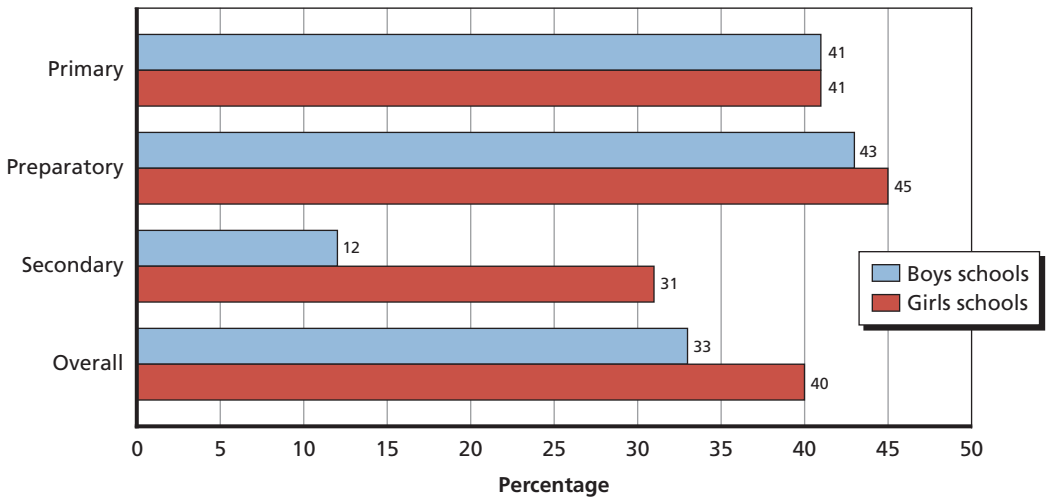
tion as the most important criterion for registration to make it logistically easier for schools and parents. Accordingly, parents must register their children in the schools closest to where they live ("Independent Schools Get New Admissions Policy," 2010). Students can register to take a particular school's bus only if they live in the school's surrounding area. Although no specific distance criterion is specified, every school covers four or five geographic zones (subdivisions of municipalities) for student registration and school transportation. It is not clear whether this decision will be temporary or long-term, but it has important implications for school transportation. Should the Supreme Education Council relax its geographic constraints, the increased school choices provided to students will translate to greater travel distances, increased congestion, and more complex routing for school buses.

Currently, as Figure 2.6 shows, 33–40 percent of school children attending Independent schools use the bus. Independent school students in primary and preparatory grades are more likely to use school bus services than students in secondary grades. The statistics further show that a higher proportion of girls, particularly at the secondary school level, use school buses. Primary schools service grades one through six, with students typically ranging from six to 11 years old. Preparatory schools service grades seven through nine, with students typically ranging from 12 to 15 years old. Secondary schools service grades 10 through 12, with students typically ranging from 16 to 18 years old.

Figure 2.6
Proportion of Students Using School Buses for Travel to Independent Schools



SOURCE: Data from Mowasalat statistics.

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Student Population Growth

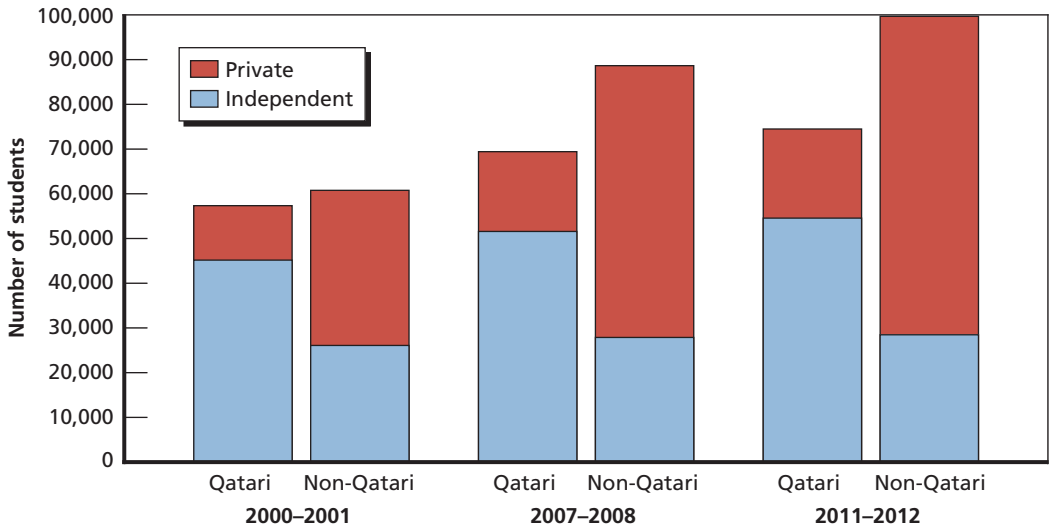
Qatar's population has more than doubled in the past few years. In 2003, Qatar had 700,000 residents. As of January 2011, Qatar's population reached 1.68 million residents (Qatar Statistics Authority, no date). This rapid population growth has resulted in a substantial increase in students. Population growth is expected to continue over the next few years.

In 2007–2008, more than 150,000 students enrolled in Ministry (Semi-Independent), Independent, and private schools. Over the past decade, the student population in Qatar has increased significantly, in accordance with overall population growth. The growth in student population is shown in Figure 2.7. In planning for improvements to the school transportation system, the significant growth in student population could affect school choice policies, bus utilization, and traffic congestion.

Assessing Perspectives on School Transportation

Perceptions of the school transportation system are important for promoting utilization. Improvements in safety, efficiency, and service quality can help address issues that parents and administrators have identified as making the school transportation system

Figure 2.7
Growth in Student Population



SOURCE: 2000–2001 data from Ministry of Education Educational Statistics; 2007–2008 data from Qatar National Educational Database System; 2011–2012 data project a 1.9 percent annual growth rate for Qatari students in government schools, a 1.02 percent annual growth rate for non-Qatari students in government schools, a 5.63 percent annual growth rate for Qatari students in private schools, and an 8.1 percent annual growth rate for non-Qataris in private schools.

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less desirable. To identify the most significant concerns of school transportation stakeholders in Qatar, we undertook a two-pronged approach:

1. interviews and survey of school administrators in Independent, Semi-Independent, and private schools
2. a survey of parents, using a basic questionnaire.

Administrator Perspectives on School Transportation

This section focuses on the results of the interviews and surveys with key administrators in the school transportation system.

Perspectives of Independent and Semi-Independent School Administrators

To understand the current status of the school transportation system and identify concerns about quality, efficiency, and safety, we interviewed administrators at four Independent schools and one Semi-Independent school.[7] The administrators interviewed typically included the principals, vice-principals, and "social workers."[8] These administrators have the primary responsibility for the welfare of students in their respective schools.

The schools were chosen to obtain diversity in geographical location, gender, grade level of students, and type of school. We visited the following schools:

- Al Shaqab Primary School for Girls (Independent school)
- Omar Bin Al Khattab Primary School for Boys (Independent school)
- Abu Bakr Al Siddiq Preparatory School for Boys (Independent school)
- Al Wakra Secondary School for Boys (Independent school)
- Arwa Bint Abdulmutalib Secondary School for Girls (Semi-Independent school).

Administrators were asked to describe their views of the transportation system and indicate whether it met the needs of the school and students. Sixty-eight percent of administrators felt that the Supreme Education Council adequately met their busing needs, while 96 percent of administrators rated the current school transportation system as either "good" or "excellent." While administrators were satisfied with the overall school transportation service, they raised specific concerns that appear to be common across schools. Officials at all five schools cited traffic congestion, long bus journey times, shortage of trained bus monitors, lack of training for drivers, and student misbehavior as the top concerns.

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[7] Data collection for this study occurred in spring 2009. At that time, the Ministry of Education still had Semi-Independent schools. Currently, all schools overseen by the Supreme Education Council are Independent schools.

[8] Social workers in Qatari schools are responsible for non-academic counseling. This duty can range from school transportation, to discipline issues, to guidance counseling.

Traffic Congestion. School administrators expressed general concerns about the traffic around their schools during drop-off and pick-up times. Due to the number of vehicles arriving at their schools and the different modes of transportation (e.g., cars, buses, pedestrians), management of student safety is often challenging. Schools do not have standardized, enforced safety zones. School zone markings vary from school to school. And, while common speed limits are established around schools, they are not rigorously enforced.

Long Journey Time. Administrators felt that reducing bus journey times was essential for encouraging parents to use school bus services. Administrators reported bus journey times as long as two hours. Schools tended to use large- or medium-sized buses that stop at every house to pick up the students. This door-to-door service consumes considerable time. Most administrators believed that smaller buses would reduce journey time because fewer student passengers would result in fewer stops.

When asked about the possibility of introducing communal pick-up points (i.e., bus stops) to reduce the number of stops and thereby reduce journey times, administrators felt that parents would be reluctant to use school bus services if some sort of pick-up point system was implemented; parents might be concerned about mixing children of different genders or ages, both of which are perceived to be bad influences on children. In addition, administrators voiced concerns about the physical environment in which children would have to wait. With many neighborhoods lacking sidewalks, there is often no safe place to wait. In addition, temperatures can reach uncomfortably high levels. In the late spring, summer, and fall, temperatures often exceed 35 degrees Celsius (100 degrees Fahrenheit).

Shortage of Effective Bus Monitors. Currently, bus monitors must be present on all girls' buses and buses transporting boys to primary school. Monitors are specifically responsible for managing student behavior and maintaining safe conditions. During interviews, some school administrators mentioned that bus monitors often lack the necessary experience, qualifications, and training required to manage children in the context of bus operations. Moreover, many bus monitors are from South Asian countries and lack the language skills to communicate with Arabic-speaking students. Many monitors also experience great difficulty in managing behavior on the bus, due to a lack of respect by some students and parents. However, there are some schools where teachers have successfully served as bus monitors and provided educational enrichment activities on the bus.[9]

Administrators were asked how bus monitors could become more effective. They felt that bus monitors needed proper training, in terms of both dealing with students and first aid. Administrators also believed monitors needed to be more engaged with students on the bus for parents to become comfortable with school bus services. They also felt that if bus monitors spoke Arabic, then students would respect them more.

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[9] Abu Bakr Al Siddiq Prepatory School for Boys praised this initiative, while Al Wakra Secondary Independent School for Boys rejected the idea.

Some administrators suggested that employing Qatari nationals, particularly Qatari women, as bus monitors might improve student respect for monitors. Some felt that Qatari women would be unwilling to take on a job as a bus monitor because of the negative perception of the job. Other administrators felt that with proper incentives, such as higher pay, more Qatari women would be willing to be bus monitors.

Lack of Bus Driver Training. The bus service provider, Karwa, trains all bus drivers at its driver training facilities. The training is virtually the same for both public transit bus drivers and school bus drivers. Other than some limited training in first aid, school bus drivers do not receive specialized training in how to manage children and the special safety issues involved in loading and unloading the bus. However, a busload of children poses different demands than adults who ride the bus along well-established public transit routes. Children must be supervised en route and need guidance during loading and unloading of buses. In addition, most school administrators felt that bus drivers did not know the geographic areas and all the possible routes surrounding the schools. In some cases, students direct the bus driver to their homes during the first few weeks of school. Of course, this approach becomes especially challenging with primary school students, who may lack the maturity to properly guide a driver.

Student Misbehavior and Vandalism Issues. School administrators were concerned about student vandalism and misbehavior on school buses. They reported that student misbehavior could be related to a number of factors. The first factor was a sense that students do not respect the authority of the bus monitor or bus drivers. Moreover, there were reported incidents of parents aggressively confronting bus monitors and drivers who have spoken to students about behavioral issues.

Perspectives of Private School Administrators

Interviews were conducted with administrators of nine private schools to investigate whether private schools had the same school transportation issues as the Independent and Semi-Independent schools. The schools included private community schools, private international schools, and private Arabic schools.

The private schools selected for interviews represented diverse student populations. Most schools had a student population between 1,000 and 2,000. A few schools had a student population of less than 1,000. One school had 4,800 non-Qatari students, 4,000 of whom take the bus. Four of the schools had 10 percent or less Qatari students in their student population. Three schools had from 85 to 100 percent Qatari students, and two schools had only about 30 percent of Qatari students.

The private school officials interviewed use various approaches to provide transportation. Some schools own their buses and outsource to private service providers. Some schools entirely outsource their student transportation. At two schools, the parents directly contract with a transportation company. In this case, the parents pay the company directly and coordinate routes with the transportation company. The school serves only as a link between the parents and the bus company.

Most of the buses used by private schools are small- and medium-sized buses. Monthly bus fees for round-trip service range from QR 360 to QR 660 (100 USD to 180 USD). The highest fees are for the schools that outsource service to a transportation company. The lowest fees observed were QR 200 per month for round-trip service. At the school with the lowest fees, there are no Qatari students enrolled, and 85 percent of its students use the school bus transportation system.

Examples of concerns highlighted by the private school administrators were traffic and road congestion, the need for supervised pick-up points, early pick-up and late drop-off of students, and inaction or late responses from governmental authorities on school and road safety issues.

Both private and Independent and Semi-Independent schools share concerns about traffic congestion, journey time, lack of clearly marked school zones, and parking. However, Independent and Semi-Independent Schools had additional concerns about shortage of effective bus monitors, lack of driver training, student misbehavior and vandalism, and lack of parental cooperation. Most of the unique problem areas associated with Independent and Semi-Independent schools are associated with how students and parents interact with the school transportation system. While better training for drivers and monitors will address some of these problem areas, these differences also signal potential opportunities to change perceptions by improving communication among administrators, parents, students, and drivers. Within these areas of concern, private schools provide a source of lessons for Independent schools.

Parental Perspectives and School Transportation Choices

Parents play a vital role as key decisionmakers for school transportation choices. To gain insights into the perspectives of parents, we reviewed the results of focus groups conducted under a prior RAND study (Pernin et al., 2008) and performed a new survey of parents at five schools. The new survey was conducted at the same five Independent and Semi-Independent schools where school administrators were interviewed.

The main objective of the parent surveys was to accomplish the following:

- Collect parents' views on factors affecting their decisions on which school they choose for their children.
- Quantify what modes of travel students used to travel to school (including school bus use)—by school type, age, gender, and nationality.
- Collect information on distances traveled to schools—by school type, age, gender, and nationality.
- Collect parents' views on school bus services.
- Quantify parent's preferences for school bus services.

In the survey, parents were asked to report how their children traveled to school, the importance of different school bus service characteristics in their decision of whether to use school bus services, and what they considered important in their school choice decision.

Data from Prior Study and Choice of Attributes

The prior RAND study (Pernin et al., 2008; Constant et al., 2008) conducted focus groups with parents, school administrators, and teachers to discuss bus utilization, reasons for not using the school bus system, rating of the current school bus system, desired features of a bus system, and implications for utilizing the bus system under a full implementation of parental school choice.

A number of the key findings from that study are summarized in Table 2.2. The check marks indicate cases where the most responses were obtained from individuals in the focus groups.

Parents, administrators, and teachers agreed that the length of travel time, the size of the school bus (i.e., large number of passengers needed to be picked up and dropped off), and the fact that for some students school bus transportation was not offered in their geographic area were the main reasons parents did not use school buses. Administrators and teachers also noted that students associated riding the school bus with a lack of prestige, and thus many preferred to be brought to school by their parent or a privately hired driver.

In the focus groups, detailed information was also collected through surveys with participants on their preferences for desirable features of a school bus transportation system (each respondent was asked to rate the importance of the feature: 3 = very important, 2 = important, 1 = not important).

The average ratings of the features are presented in Table 2.3. Parents indicated that the most important features were a trained driver, mandatory maintenance schedule, and air conditioning.

The previous RAND study (Constant et al., 2008) reported the following findings:

> The length of the commute, social status and social pressures felt by students, and the lingering reputation of the old bus system (despite the fact that new buses were rated as excellent) were the main reasons that parents cited for not using the bus. In some cases, students were not offered bus transportation because the route for that school did not cover their geographic area. The vast majority of people indicated that the new buses were excellent, but they also indicated that they were oversized for the population that they were serving and thus had long routes to complete. The amount of time considered by participants to be appropriate for a bus ride was 30–45 minutes, and some parents reported that the amount of time their child currently spends on the bus is closer to 1.5 hours each way. In terms of cost sharing, parents responded that competing private car options means that bus-use fees must be set at a very competitive level and must meet high standards of safety and reliability.

Table 2.2
Participant Responses in the Prior RAND Study

Item	Parents	Administrators	Teachers
Reason for not using bus			
Not offered for geographic area	√	√	√
Length of time on bus	√	√	
Size	√		√
Quality			
Cost			
Safety			
Lack of prestige		√	√
Rating of current bus system			
Excellent	√	√	√
Good			
Bad			
Very Bad			
Maximum goal for time on bus			
Up to 45 mins		√	√
Up to 30 mins	√		
Best improvements			
TV screens			
Video games			
Educational videos	√	√	√
Location information sent to parents	√	√	
Water or refreshments		√	√
Ability to do homework			√
Guides or farashas	√	√	√

SOURCE: Table 3.1 of Constant et al., 2008.

Findings from the Parent Survey

The parent survey was helpful in identifying the distribution of travel modes and user perspectives on the school transportation system. Below, we present findings from the questionnaire regarding distances traveled to school, drivers of school choice, and parent's views on school buses. As detailed further in Appendix A, we surveyed five schools and achieved a survey response rate of 52 percent.

Distance Traveled to School. In the survey, we observed that approximately 80 percent of students travel 15 km or less to school and about 95 percent travel 30 km

Table 2.3
Average Rating of Bus Features in the Prior RAND Study

	Administrator			Parents			Teachers		
Bus Feature	**Obs**	**Mean[a]**	**Rank**	**Obs**	**Mean[a]**	**Rank**	**Obs**	**Mean[a]**	**Rank**
Smaller buses	21	2.76	3	16	2.75	6	9	2.33	13
Trained driver	22	2.91	2	16	3.00	1	10	2.90	2
Separate lanes	22	2.59	8	16	2.69	8	10	2.50	7
Mandatory maintenance	22	2.73	4	16	2.88	2	10	2.50	7
Cleaner buses	21	2.14	17	16	2.38	14	10	2.30	14
Air conditioning	22	3.00	1	16	2.88	2	10	3.00	1
Education entertainment	22	2.32	15	16	2.56	10	10	2.50	7
Farashas	22	2.59	8	16	2.81	5	10	2.70	5
Gender specifications	21	2.24	16	15	1.80	19	10	1.30	19
Seat belts	21	2.62	5	15	2.60	9	10	2.40	11
Parent communications	21	2.62	5	16	2.38	14	10	2.60	6
Reduce cost	21	2.33	14	16	2.56	10	10	2.20	16
Inspections	22	2.59	8	16	2.88	2	10	2.80	4
Install cameras	21	2.38	12	16	2.50	12	10	2.40	11
Install equipment	21	2.38	12	16	2.31	16	10	2.50	7
Assign seats	22	2.14	19	15	1.93	18	10	2.10	17
Privately owned	21	2.14	17	14	2.14	17	10	2.10	17
Coordinating transport	22	2.55	11	16	2.50	12	9	2.22	15
Inform general public	21	2.62	5	16	2.75	6	10	2.90	2

SOURCE: Constant et al., 2008.

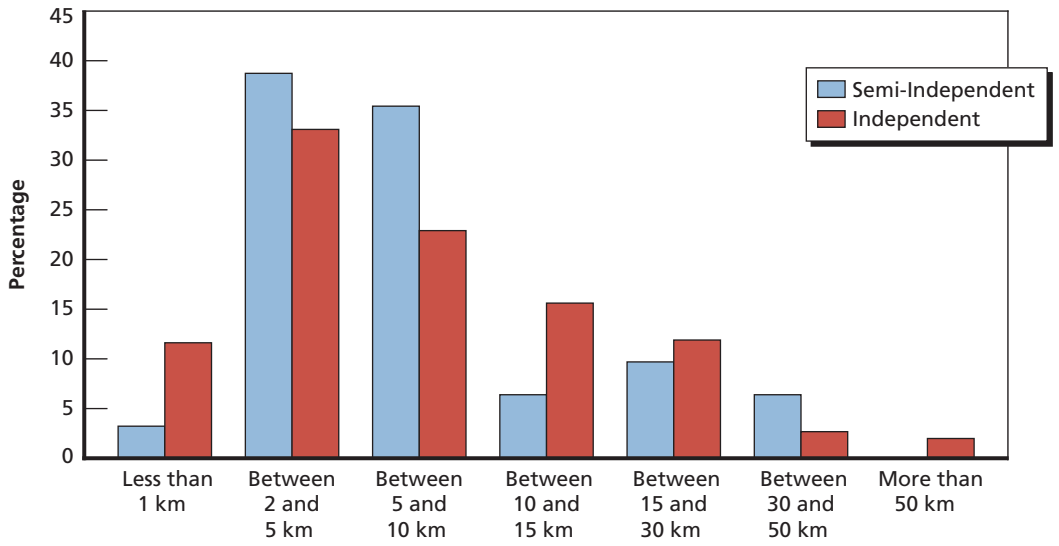
[a] 3 = very important, 2 = important, 1 = not important.

or less. (See Figure 2.8.) Given the transition to Independent schools, it is difficult to predict the impact on travel distances. However, experiences in other countries suggest that increased choice may result in increased travel distances.

Research in the UK has found that increased school choice has led to the increased distance between the home and school in the past two decades, resulting in increased car use—although for older children in the UK, longer trips tend to be by bus (Mackett, 2010). We note that attitudes in Qatar may be quite different from the attitudes in the UK, so further research is needed to understand the influence of school choice in the Qatar context.

Comparing Travel Times. Many parents surveyed for this study complained that the current school bus system takes an exorbitant amount of time to transport students relative to car travel. Using data from a survey of parents, we illustrate the time distri-

Figure 2.8
Travel Distances to School for Students at Semi-Independent and Independent Schools



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bution students spend on the bus in Figure 2.9. Roughly 30 percent of students spend 30 minutes or more riding the bus one way to or from school.

Factors Affecting School Choice. The emergence of more Independent schools presents new options to parents. When asked whether they would send their children to an Independent school outside of their neighborhood in the future, 41 percent of parents indicated that they would likely do so. Parents were also asked to rate the importance of specific factors in their decision of which Independent school they would send their children to. As indicated in Figure 2.10, parents rated quality of education most highly, followed by school proximity, quality of facilities, good school transportation to school, and recommendations by family or friends. Note that parents tend to focus on the characteristics of the school rather than the availability of good school transportation in selecting a school. While still ranked as important, good school transportation appears to be secondary to basic characteristics of a school—quality education, facilities, and location. With the introduction of greater school choice, parents will be selecting among more schools as they seek to achieve the best school experience for their child. Lack of good school-provided transportation may not prevent parents from choosing a particular school but will influence their preferred mode of transportation. If parents are not satisfied with transportation options of a chosen school, they may feel more comfortable using other modes of transportation (i.e., private cars) rather than school buses. To maximize participation in the school bus system, parents should feel that they will receive good school transportation options, regardless of their school choice.

Figure 2.9
Time Spent by Students on the Bus

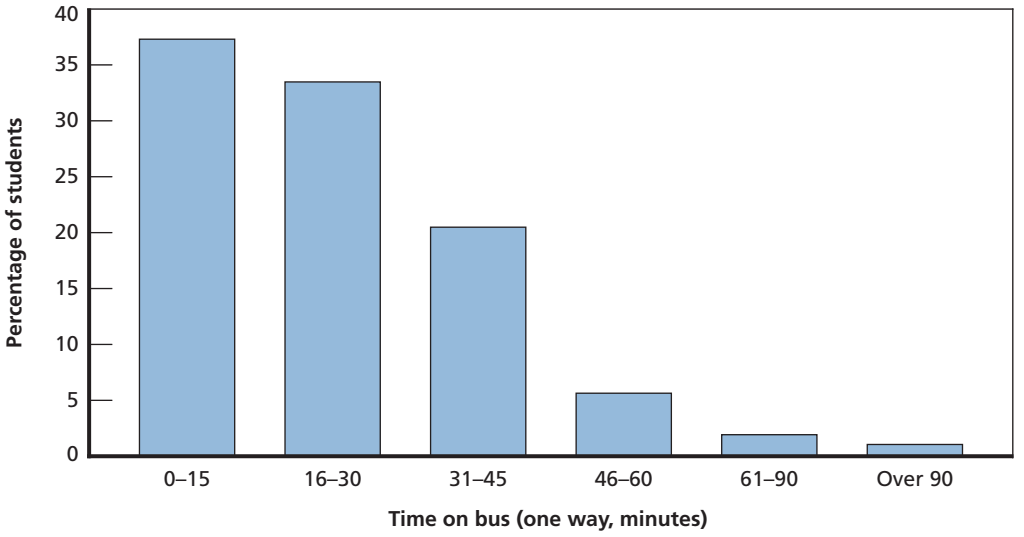

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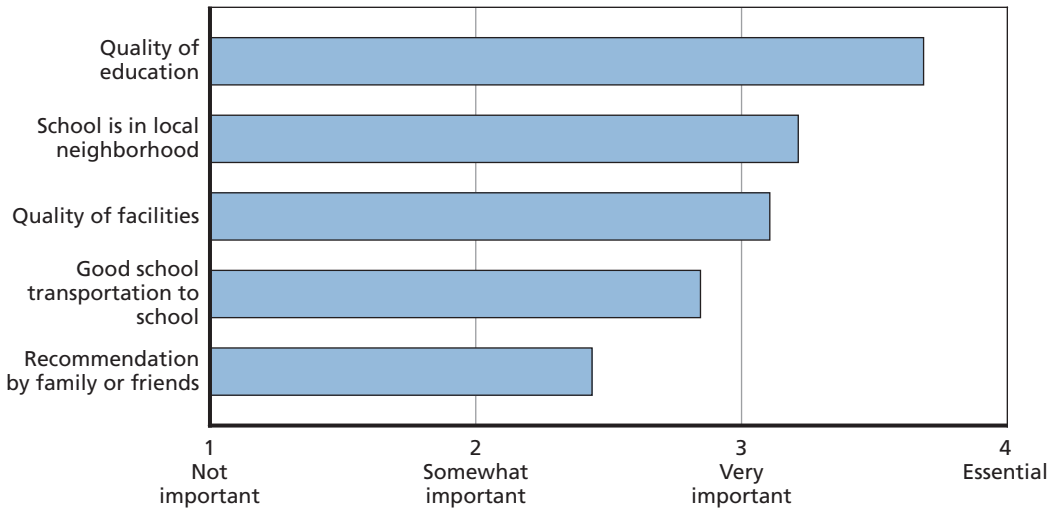
Figure 2.10
Importance of Factors in the Decision of Which School to Choose for Children



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Parents' Views on School Buses. About 75 percent of parents rated school bus services as "good" or "excellent" (See Figure 2.11). However, only 11 percent of parents indicated that they were completely satisfied with the bus experience. As Figure 2.12 shows, the top concern of parents who use the bus system was the behavior of other students on the bus, followed by journey length, and safety. To help improve the level

of satisfaction for bus users, Qatar could focus on strategies that improve student behavior, efficiency, and safety perceptions of parents.

For parents whose children did not use school buses, we asked about reasons why. Results appear in Figure 2.13. Parents cited children's preferences, the time children would spend on the bus, school bus safety, the convenience of driving children

Figure 2.11
Ratings of School Bus Services to School by Parents and Administrators

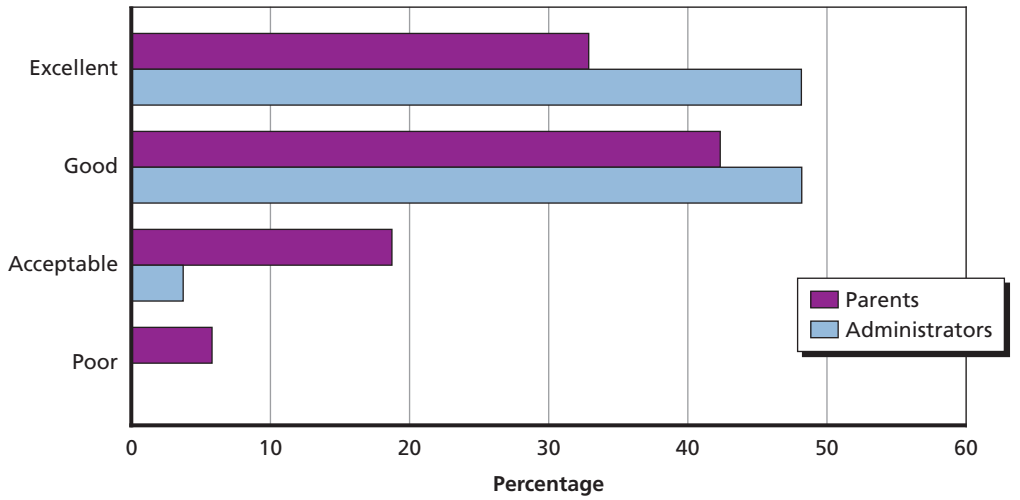

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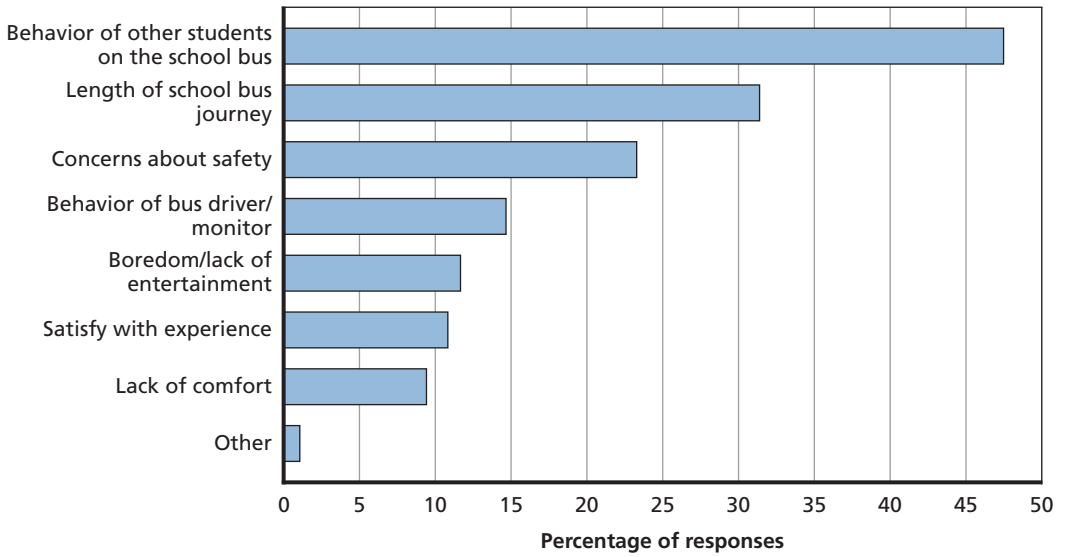
Figure 2.12
Key Parental Concerns from School Bus Users



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to school, and lack of school bus services to their neighborhood as the main reasons. Twenty percent of parents reported that no school bus service is provided to their neighborhood. As a result, Qatar may be able to expand ridership by simply offering more students transportation. In addition, to help promote increased ridership, Qatar could focus on strategies similar to those needed to improve satisfaction of current bus users—focusing on safety perceptions and journey time. However, significant resistance may remain due to children's preferences to be driven to school. Children's preferences present a unique challenge, since their impression of school buses may be tied to a number of exogenous factors, such as peer pressure and level of independence from parents.

Parents were also asked to rate a number of school bus attributes, indicating how important they were when considering school bus services. The ratings are shown in Figure 2.14. Among other highly rated attributes, parents highly value children being picked up from home (rather than the use of pick-up points) and use of bus monitors (farashas). Both of these strong preferences are inconsistent with the practices of other international school transportation systems. In contrast with practices of other countries, many Qatari parents may object to changes in pick-up arrangements and limiting use of bus monitors as Qatar seeks to increase efficiency or otherwise emulate common practices of other school transportation systems.

Figure 2.13
Reasons Why Parents Do Not Utilize School Buses

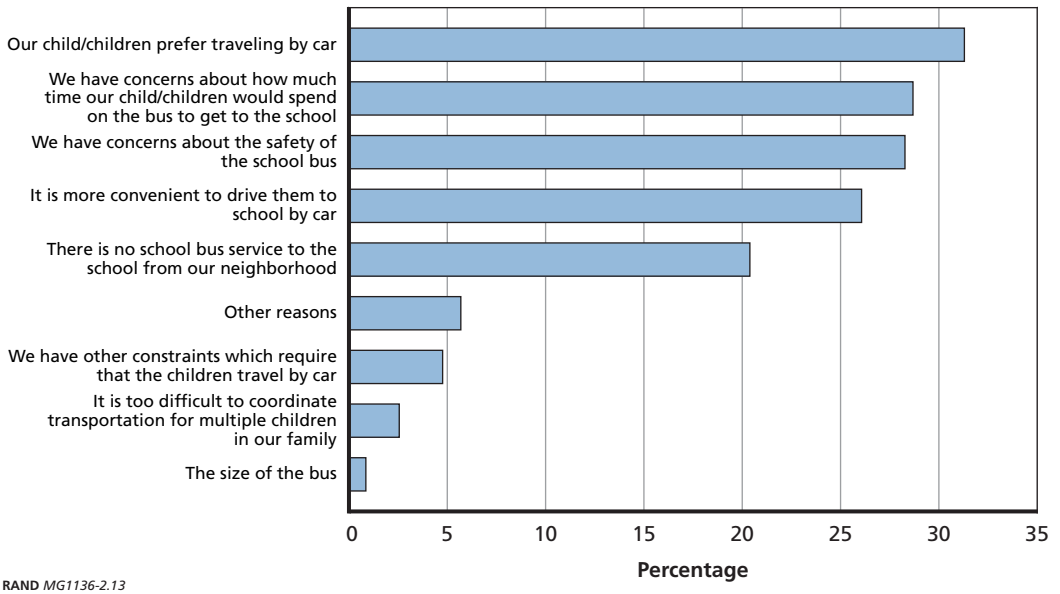

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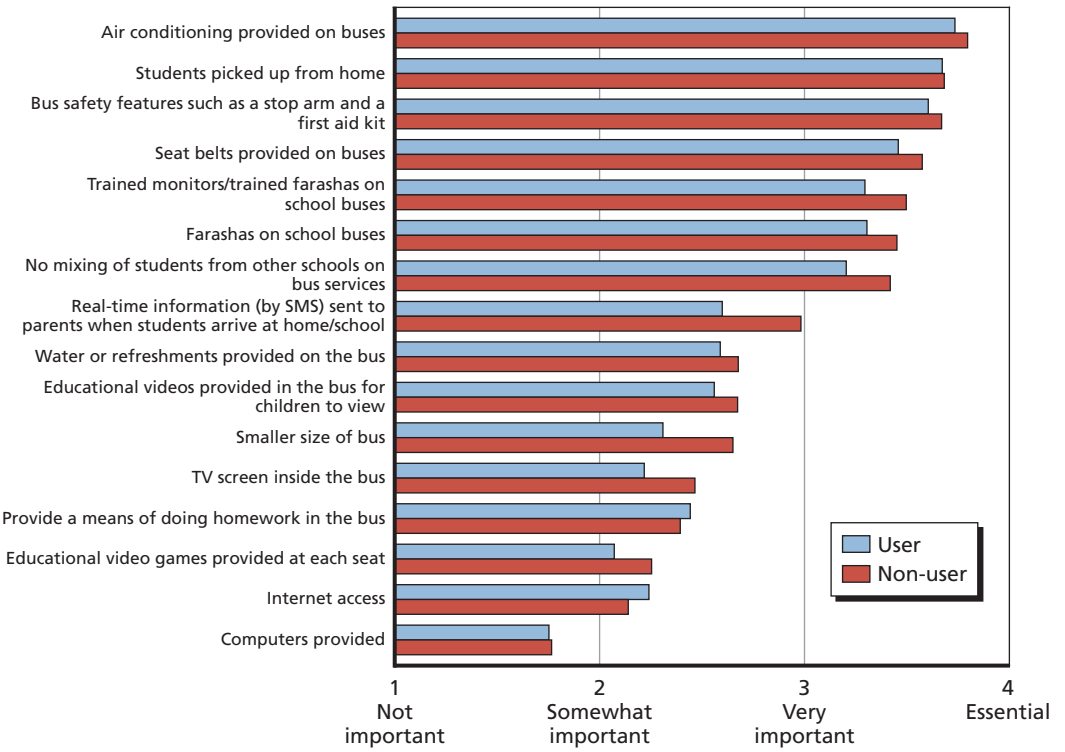
Figure 2.14
Parental Rating of School Bus Attributes



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Other findings from the survey questions are as follows:

- On average, 52 percent of parents would be willing to have their children picked up by a school bus from a safe point close to home, if it meant a faster bus journey for the child; however, there are substantial differences according to the gender of the child (58 percent of parents would be willing to have their male children picked up from a safe point, whereas only 39 percent of the parents would be willing to do the same for their female children; we observed no substantial differences by the child's grade).
- 55 percent of parents would support the idea of compulsory school bus transportation if the system were free, fast, comfortable and consistent with international quality standards.
- Given three hypothetical choices for bus sizes, 43 percent of parents prefer medium-sized buses (25–35 seats), 20.5 percent prefer vans or very small buses (10–20 seats), and 14 percent prefer large buses (35–49 seats); 22.5 percent have no preference.

Observations

Based on the interviews and surveys discussed above, we offer the following observations:

Parents and Administrators Have a Positive View of School Buses

Most parents and administrators view the school bus system positively, rating school bus services as either "good" or "excellent." Administrators appeared very positive, with none rating school buses as "poor." Parents were generally positive about school buses, with only 6 percent rating buses as "poor." Though both administrators and parents rated school buses highly, they both expressed concerns that should be considered.

Parents and School Administrators Have Common Concerns—Journey Time, Safety, and Student Behavior

Interviews with school administrators and surveys of parents revealed consistent themes related to journey time and safety. School administrators in Independent, Semi-Independent, and private schools cited concerns surrounding long journey times and traffic safety near schools. Parents' key concerns included journey time and safety of buses. There are several viable strategies that could be pursued to mitigate these concerns. Through efficient bus operations, journey times may be held to a minimum. Increased bus ridership will help minimize congestion around schools, thereby supporting both efficiency and safety. And improvements in school zone and bus features may help support safety and the perception of safety.

Parents and administrators of Independent and Semi-Independent schools reported high levels of concern about student behavior on school buses. Administrators in Independent schools cited lack of parental cooperation in handling discipline problems, a shortage of effective bus monitors, and a lack of trained drivers, all of which have the potential to enable misbehavior. Student behavior was cited most frequently as a concern of parents who use the bus system. Based on the concerns raised, strategies to help control and manage student behavior could help improve the experience of children and perceptions of parents.

While Good School Transportation Is Important, Parents Primarily Base Their School Choice on School Characteristics

In selecting schools, parents rated quality of education most highly, followed by school proximity, quality of facilities, good school transportation to school, and recommendations by family or friends. Not surprisingly, parents tend to prioritize the characteristics of the school over the availability of good school transportation in selecting a school. While still ranked as important, good school transportation appears to be secondary to the basic characteristics of a school. To help maximize participation in the school bus system, parents should feel that they will receive good school transportation options, regardless of their school choice.

Ridership May Be Increased by Broadening Service to More Neighborhoods

Twenty percent of parents reported that their current school does not provide service to their neighborhood. As a result, there is a substantial portion of the student population that cannot currently participate in the school transportation system. By simply expanding service to additional areas, Qatar may be able to increase ridership on school buses.

Children's Preference for Traveling by Car Is a Significant Factor That Limits Bus Ridership

Despite physical and operational improvements to the school transportation system, Qatar may experience resistance when attempting to increase bus ridership due to children's preferences to be driven to school. Children's preferences present a unique challenge, since their impression of school buses may be tied to a number of exogenous factors—peer pressure, status, level of independence from parents, etc. To address children's preferences for car travel, Qatar will need to consider strategies that clearly articulate the benefits of using the school transportation system and target the entrenched perceptions of parents and students.

Parents Prefer Home Pick-Up and Bus Monitors

In Qatar, school buses typically pick up children directly from their homes and bus monitors typically ride with children on the bus, two practices that are not commonly used outside of GCC countries. Consistent with international norms, the use of pick-up points, rather than direct home service, allows for greater efficiency and reduced travel times since buses do not have to make as many stops. In addition, many school transportation systems give bus drivers complete responsibility for children during transit rather than employing a bus monitor. Often, school bus drivers are trained on the handling and safety of children. Well-trained drivers are capable of supervising children in transit.

Parents in Qatar commonly rated home pick-up and bus monitors as "very important" or "essential" in rating features of the current school transportation system. Should Qatar seek to improve efficiency or reduce costs, the addition of pick-up points and the elimination of bus monitors could meet strong resistance from parents.

Changes related to pick-up points and bus monitors will need to balance operational improvements with cultural preferences. With home pick-up service in place, routing efficiency improvements will be limited. And with continued use of bus monitors, Qatar may be spending more than necessary on bus supervision.

Conclusion

Although one of the long-term goals of the Independent School model is to give parents more freedom to choose their preferred school, the system currently in place requires that parents register their children in the schools closest to where they live. As a result, students typically attend their neighborhood schools. This means, at least in the near future, average travel distances to school are likely to remain largely unchanged.

In the longer term, with the introduction of increased school choice, students will have greater transportation needs. About 40 percent of parents indicated that that they would send their children to an Independent school outside of their neighborhood in the future. The increasing school choice will likely result in longer travel distances and an increased need for school transportation. The observations from this chapter help identify some initial areas to consider when updating Qatar's school transportation system to satisfy emerging needs. As primary stakeholders, administrators' and parents' perspectives should be considered as vital to the planning process. Their concerns and ideas can provide valuable input into school transportation strategies that Qatar could pursue. In the following chapter, we expand upon the concerns raised here by articulating a structured vision and set of goals that can be used as enduring guidance for school transportation system development.

CHAPTER THREE

Vision and Goals for Qatar's School Transportation System

This chapter presents a proposal for the long-term vision and goals for Qatar's school transportation system. The vision presented here is consistent with other planning efforts in Qatar and serves as a foundation for formulating goals. The goals related to each part of the vision are presented as high-level statements describing the desired outcome across key dimensions of the school transportation system. The goals set forth general guidance about what the Qatar school transportation system should try to accomplish and provide a structure for motivating and organizing effective strategies.

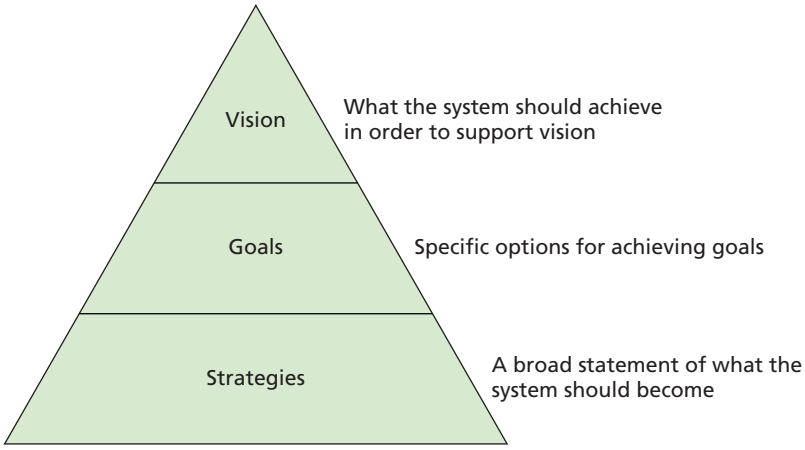
Systemic change requires guidance regarding what is important, where resources should be focused, and what should be accomplished. The overarching guidance in such situations can be described and communicated by establishing an enduring vision and a set of supporting goals. The vision describes what the system or organization should ultimately seek to become. While the vision may not represent the current state of the system, it reflects the ideal state that the system should seek to attain. The goals describe—at a high level—what should be achieved. The goals provide more targeted guidance on where resources and strategies should be focused. By prescribing the vision and goals, decisions can be made about which efforts should be pursued and the relative importance of different activities, programs, policies, and investments.

At the next lower level, specific strategies can be identified to achieve the goals. A strategy represents a specific approach that could be taken to achieve one or more goals. Strategies may be drawn from practices observed in other countries or created anew to address the specific needs of Qatar. Figure 3.1 shows the hierarchy of relationships among the vision, goals and strategies.

Vision

To develop a vision for the school transportation system, we reviewed key planning documents in Qatar, collected documentation from international school transportation systems, and received input from stakeholders to identify which elements are most important for Qatar's needs. In Qatar, national priorities are set forth in documents such as the Qatar National Vision 2030 (Qatar General Secretariat for Development

Figure 3.1
Relationships Among Vision, Goals, and Strategies



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Planning, 2008), which lays out a master vision for Qatar, highlights the major issues faced by the country, and sets priorities for addressing those issues. In addition to the Qatar National Vision 2030, we also relied on the Qatar National Master Plan and the Transportation Master Plan for guidance in drafting the vision.[1] We reviewed practices of international school transportation systems to identify priorities that other countries found important and that might also be relevant to Qatar. Our international review included materials describing school transportation in countries such as Dubai, Bahrain, the United Arab Emirates (UAE), the United Kingdom, Canada, and the United States. School administrators and parents provided input through one-on-one meetings, surveys, and focus groups. Interviews with key stakeholders and organizations in Qatar helped us confirm and adjust elements of the vision to best fit the needs of Qatar. On the basis of our findings, we propose a four-element vision for Qatar's school transportation system.

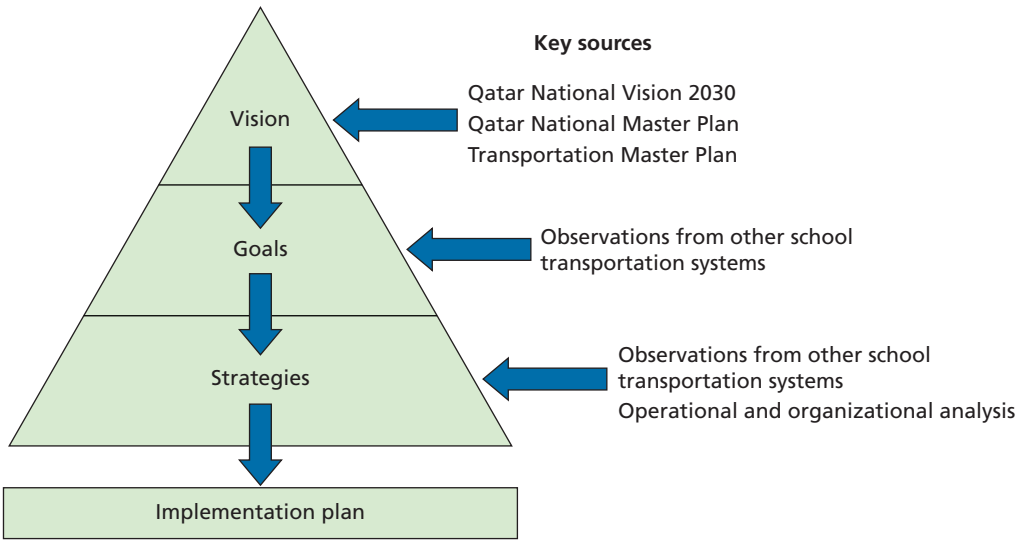
Figure 3.2 shows how key sources reviewed in the study relate to the proposed vision, goals, and strategies, together culminating in a plan for implementing the vision. The text boxes on the following pages highlight specific language in the key sources that support the vision elements. In the material quoted in the text boxes, the italics have been added by the authors.

Vision Element 1: Provide Safe, Efficient, and High-Quality Transportation for Qatar's Students

Safety, efficiency, and service quality form the cornerstones of many effective school transportation systems. In reviewing mission statements and manuals of school trans-

[1] The Qatar National Master Plan and the Transportation Master Plan are not available to the general public.

Figure 3.2
Relationships Among Vision, Goals, Strategies, and Key Sources



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portation systems, we commonly found references to these three components. Moreover, this vision element is consistent with Qatar's National Vision and feedback received during our interviews with stakeholders.

Safety is the highest priority in student transportation in Qatar (as well as for other transportation systems around the world). Vision statements for school transportation systems in Dubai and major counties in the United States (e.g., Fairfax County, Virginia, and Ventura County, California) all identify safety as a top priority. Efficiency is also highly valued in student transportation. In general, school transportation systems seek to transport children quickly and make the best use of system resources, including buses, time, and money. And finally, high-quality transportation is important based on parental preferences and Qatar's national vision for services. As noted in the Qatar National Vision 2030, Qatar seeks to provide high-quality services to its residents.

Vision Element 2: Support Educational Options by Enabling Mobility and Access

The second element of the vision reflects Qatar's commitment to supporting education access and options for all students. As part of its overall transportation master plan, Qatar identifies plans to develop into a country that provides good access and mobility for its citizens. Qatar seeks to provide educational and training opportunities to all students, including handicapped students and students with special needs. Good, flexible school transportation is an essential part of this effort.

Key Sources Supporting Vision Element 1

Qatar National Vision 2030
"Provide *high quality services* that respond to the needs and desires of individuals and businesses." (Qatar General Secretariat for Development Planning, 2008)

Dubai School Transport Manual
"Ensure a *safe and smooth* transport for all male and female students from all ages in Dubai Emirate through setting up international safety standards and measures over all the school buses." (Dubai Roads and Transport Authority, 2008a)

Fairfax County Pupil Transportation Manual
"The mission of the Office of Transportation Services is to provide *safe, efficient*, and economical pupil transportation to and from school and for extracurricular activities." (Fairfax County, Virginia, 2010)

Los Angeles Unified School District—Transportation Services Division
"The Transportation Services Division supports the District's academic programs by providing *safe, dependable, and cost-efficient* transportation services."
(Los Angeles Unified School District, Transportation Services Division, 2008)

Key Sources Supporting Vision Element 2

Qatar National Vision 2030
"*Accessible educational programs* for life-long learning"
"High quality *educational* and training *opportunities appropriate to each individual's aspirations and abilities*"
"*Increased opportunities* and vocational support for Qatari women"
(Dubai Roads and Transport Authority, 2008a)

Qatar Transportation Master Plan
"Development of Qatar into a country providing *good access and mobility* for business and personal use"
"*Provide access for all citizens* to locations of day-to-day activities, such as *schools*."

Dubai School Transportation Manual
"*Provide* or coordinate the school transport for handicapped students. It is prohibited to refuse transporting any handicapped student." (Dubai Roads and Transport Authority, 2008a)

Vision Element 3: Provide a Transportation Experience That Is Supportive of Qatari Values and Culture

The third element of the vision recognizes the importance of preserving Qatari values and culture throughout students' transportation experience. As acknowledged in the Qatar National Vision 2030, "the rapid economic and population growth creates strains between the old and new across many aspects of life." As the transportation system is improved and made more efficient, it will continue to be important to evaluate potential impacts on Qatari traditions and values. Choices that increase efficiency may present conflicts that need to be resolved—through either compromise or accommodation. In some cases, the cultural impact of some changes may be deemed unacceptable, while in other cases, reasonable compromises can be reached. Ultimately, this vision element provides for a necessary balance between highly valued traditions and new opportunities for improvements. This vision element was drawn from the Qatar National Vision and the Transportation Master Plan and is consistent with stakeholder interviews.

Key Sources Supporting Vision Element 3

Qatar National Vision 2030
"[The National Vision] promotes moral and religious *values and traditions*."
"Preserve Qatar's *national heritage* and enhance Arab and Islamic *values and identity*." (Qatar General Secretariat for Development Planning, 2008)

Qatar Transportation Master Plan
"Development of Qatar into a modern and attractive country, providing high quality of life for its citizens whilst *maintaining its traditions and heritage*"

Vision Element 4: Minimize the Impact on Traffic Congestion and the Environment

The fourth element of the vision addresses the importance of sustainability and environmental preservation. This includes the potential for efficient operations and scalable growth as the school system expands and students are offered additional educational opportunities. Efficient operations will ensure that resources are conserved and pollution is minimized. Scalable growth will ensure that future transportation needs can be met without leading to unmanageable traffic congestion and increased levels of inefficiency.

Both the Qatar National Vision 2030 and the Transportation Master Plan influence this element.

Key Sources Supporting Vision Element 4

Qatar National Vision 2030
"The State of Qatar seeks to *preserve and protect its unique environment* and nurture the abundance of nature granted by God."
"The State shall *preserve the environment* and its natural balance in order to achieve comprehensive and *sustainable development* for all generations [Permanent Constitution]." (Qatar General Secretariat for Development Planning, 2008)

Transportation Master Plan
"Development of Qatar into a *sustainable country*, allowing its economic and social development with *minimal impacts on its environmental assets* and with a reduced environmental footprint of human activities"

Goals to Support the Vision

Using the vision as guidance, we recommend a set of goals, each supporting one or more elements of the vision. The goals are informed by a literature review and interviews conducted with transportation officials in Abu Dhabi, Dubai, Bahrain, and the United States. We identified common themes that appeared across these transportation systems and formulated goals that fit into the vision for Qatar's school transportation system. On the basis of this effort, we offer the following goals for Qatar's school transportation system.

Safety

We identify three goals to motivate safety:

- Effective safety standards and measures are established and enforced.
- Stakeholders achieve a high level of awareness about school transportation safety.[2]
- Access to the transportation system is safe and secure.

Safety standards are essential for guiding school bus design, street markings around schools, and procedures for safely handling students. Moreover, safety standards establish expectations for school buses, bus drivers, schools, students, and motorists. Currently in Qatar, there is little or no formal guidance on bus design and no standard school transportation safety measures. For example, Qatar school buses lack standard identifiers, such as yellow paint, warning lights, and signage, which are common in the literature and in the school transport systems we reviewed.

[2] Parents, student, drivers, and school administrators are primary stakeholders.

The second safety goal focuses on increasing public awareness about school transportation safety. All stakeholders should be informed about school transportation safety to ensure that safety measures and procedures are effective. Students must understand their responsibility to follow procedures and look out for hazards. Parents must understand the importance of following proper drop-off procedures and must drive carefully when near other vehicles carrying children. And school representatives must understand how they can best contribute to a safe environment around their schools and how they can train students about safety.

The third safety goal is to ensure that access to the transportation system is safe and secure. The most hazardous portion of school transportation is where students are waiting, loading, and unloading from vehicles. Since most school transportation injuries and fatalities occur near pick-up and drop-off points, this segment of school transportation requires special attention. Physical barriers, clear school zone markings, and law enforcement can all promote safe access to school transportation.

Efficiency

Efficient service minimizes travel time for students and helps encourage ridership on school buses. In addition, efficient operations help to minimize costs and environmental impacts. We identify two goals to support efficiency:

- Routes and bus sizes are optimized and consistent with the needs of schools, families, and community.
- Schools, drivers, and bus officials are informed and responsive to factors affecting students' commutes.

The first efficiency goal is to ensure that routes and bus sizes are optimized and consistent with the needs of schools, families, and communities. However, efficiency must be pursued in the context of important requirements, such as safety and security. Any optimization effort should include safety and community concerns as possible constraints.

The second efficiency goal is to ensure that schools, drivers, and bus officials are updated regularly and responsive to factors affecting students. This goal may be achieved by employing technology or establishing driver communication procedures. A school transportation system can incorporate real-time communication between the driver and the school transportation officials—for example, by wireless communications such as cell phones. In addition, Qatar could consider using computerized route planning and the global positioning system (GPS) to monitor bus location. Information from such tracking systems could be provided to school administrators and possibly parents. By facilitating communication and tracking, school officials can know where students are and drivers can be alerted to new conditions.

Service Quality

The recommended goals for service quality will help ensure that students have a good experience with the school transportation system. The four service quality goals listed below will help ensure a high level of service quality:

- Commute times are reasonable.
- School transportation services are consistent and highly reliable.
- Transportation staff are competent and professional.
- The bus experience is comfortable and pleasant.

The first quality goal is to ensure that student commute times remain reasonable. Long commute times deter students from using the school transportation system and can be stressful for students that do choose to ride the bus. Establishing and maintaining reasonable commute times can help encourage school bus ridership. Our research found that the amount of time that a child had to spend on the bus was one of the most important factors for parents in choosing whether or not to use publicly provided school transportation. Interviews with schools in Qatar revealed that, on some bus routes, children can spend up to two hours each way on the bus. According to the survey conducted during this project, only 15 percent of parents were comfortable with commute times of 45 minutes or more. Our survey findings suggest that most parents would be satisfied with a commute of 30 minutes or less.[3]

The second quality goal is for school transportation services to be consistent and highly reliable. Consistent and reliable transportation service requires standards, measurement, and feedback mechanisms to be in place. The international school transportation systems we reviewed have formal processes in place to monitor and promote reliability through documented maintenance schedules and daily inspections. Such processes are often documented in policy manuals that detail expectations and requirements of the transportation system (Dubai Roads and Transport Authority, 2008a; Fairfax County, Virginia, 2010). We note, however, that general traffic congestion in Qatar, which is outside the control of the school transportation system, may pose additional challenges to achieving consistency and reliability.

The third quality goal focuses on ensuring that transportation staff are competent and professional. Bus drivers and guides play a major role in providing a high-quality experience on school buses. Drivers and guides transport students daily and are responsible for maintaining safe and secure travel. They must be properly trained and qualified to operate a school bus and to carry out appropriate procedures. They must have the self-discipline to respond calmly to challenging situations as they arise and must be physically and mentally prepared to lead the students safely out of dangerous situ-

[3] In Bahrain and Dubai, the average journey time is 45 minutes, and the maximum journey is approximately one hour.

ations. Prerequisites can be established and enforced to ensure the mental and physical fitness of drivers (Fairfax County, Virginia, 2010). Required driver qualifications may include criteria used in some school transportation systems outside of Qatar, such as background checks, specific school bus licensing requirements, training on how to interact with students, and the wearing of uniforms. For Qatar, additional requirements may be desirable, such as the ability to speak fluent Arabic.

The fourth quality goal is that the bus transportation experience is comfortable and pleasant for all students. Buses should be of high quality and contain reasonable amenities that are appealing to children and their parents. Common comfort standards should be enforced across school buses such as air conditioning, proper child seating, ventilation, and sun protection.

Access and Mobility

The second element of the school transportation system vision is to support educational options by enabling mobility. To support this vision element, we propose the following goal:

- Transportation options are available to all eligible students—including handicapped students.

The school transportation system should seek to support a broad student population. At the same time, there may be practical limits on who can be transported to which schools. Strategies for providing all eligible students with transportation should be preceded by defining the scope of services and populations that can be served. Eligibility may need to be constrained by such factors as the geographic distribution of demand. For example, if only a few students require transportation from distant regions, school bus transportation may not be justifiable. However, other transportation support may be provided to assist students in reaching their desired schools.

The school transportation system should also seek to accommodate handicapped students to whatever extent is possible. In some cases, existing buses can accommodate handicapped students. In other cases, the schools may need to arrange for special vehicles for student transport. And for handicapped students, there may be a need for transportation eligibility constraints that are tied to the severity of a child's disability.

Preserving Values and Culture

The third element of the vision is to provide a transportation experience that is supportive of Qatari values and culture. As Qatar continues on a trajectory of rapid progress, the school transportation system must be sensitive to prevailing Qatari values and culture. To preserve values and culture, we propose the following goals:

- Student interactions with other students are consistent with Qatari values and culture.
- Student interactions with drivers and monitors are consistent with Qatari values.
- The transportation infrastructure helps to preserve the character and sensibilities of Qatari communities.

First, the school transportation system should ensure that student interactions with other students are consistent with Qatari values and culture. This can be achieved by establishing guidelines for supervision of student interactions and by providing transportation options that limit interactions between male and female students. Some school transportation systems in the United States (e.g., Ventura County, California) require students and their parents to sign "contracts" prior to the school year detailing the rules of conduct and consequences for rule violations. If a student violates the rules of conduct, he or she is disciplined by the school in accordance with established criteria. Clear rules of conduct for students, similar to expectations in place in Dubai and U.S. school transportation systems, can help preserve Qatari values (Dubai Roads and Transport Authority, 2008a, p. 18, item 6).

Second, student interactions with drivers and monitors should be consistent with Qatari values. Bus drivers and monitors should demonstrate courteous, respectful, and proper behavior. To achieve this, all drivers should receive training on appearance, discipline, and handling of children. A neat, clean appearance helps to establish credibility and respect. In many international school transportation systems, bus drivers have uniforms or a specific dress code to project an aura of authority. Drivers must also be properly trained on how to handle children, including instruction on discipline and interactions that are appropriate for the age of students being transported. Bus drivers and monitors on buses should be specifically trained on handling children and maintaining discipline on school buses. The skills required to manage a busload of children are different than those needed for general public transportation. Drivers and monitors should be trained accordingly.

Third, the transportation infrastructure should help preserve the character and sensibilities of Qatari communities. The design of school zones should complement the surrounding neighborhoods and consider the concerns of residents and business owners. There should be mechanisms for receiving feedback from the community so that the school transportation system can grow and thrive harmoniously with the surrounding community. The school transportation system should consider the needs and desires of the community in planning for traffic control and aesthetics.

Minimizing Impact on Traffic and Environment

The fourth element of the vision is to minimize the impact on traffic congestion and the environment. Qatar seeks to preserve and protect its unique environment. According to the Qatar 2030 National Vision, development should be carried out with respon-

sibility and respect, balancing the needs of economic growth and social development with the conditions for environmental protection. To support this vision element, we propose the following goals:

- Transportation operations minimize delays and traffic around schools.
- The transportation system promotes clean energy use and sustainable transportation modes (including bus ridership).
- Government, businesses, and schools work together to minimize congestion.

First, transportation operations should seek to minimize delays. There are many areas where unnecessary delays may occur in the school transportation system: Routes may be inefficient, loading and unloading procedures may be disorganized, drivers may spend time waiting for students to emerge from their homes, or traffic may not be managed effectively around school zones. Some of these problems may be successfully addressed with effective policies and procedures, proper design of school zones, and attention to routing practices. For example, efficient routes may be achieved by using routing software or by enabling bus drivers to learn and collaborate with each other.

Second, the environmental impact of school transportation can be minimized by encouraging increased use of school buses and by transitioning the school bus fleet to clean energy sources. According to the survey conducted for this project, only 40 percent of students utilize the school bus system. If school bus utilization can be increased, the number of cars commuting to schools may be reduced, thereby reducing hydrocarbon emissions and easing congestion in the school zones. Environmental benefits can be even greater if buses transition to clean-burning fuel.

Third, congestion may be minimized through collaboration between business, government, and schools. In areas that are highly congested, there may be opportunities to minimize traffic congestion by staggering start times and changing traffic patterns. By staggering start times of schools, business, or government offices within a locale, traffic conflicts may be reduced, resulting in less severe traffic congestion.

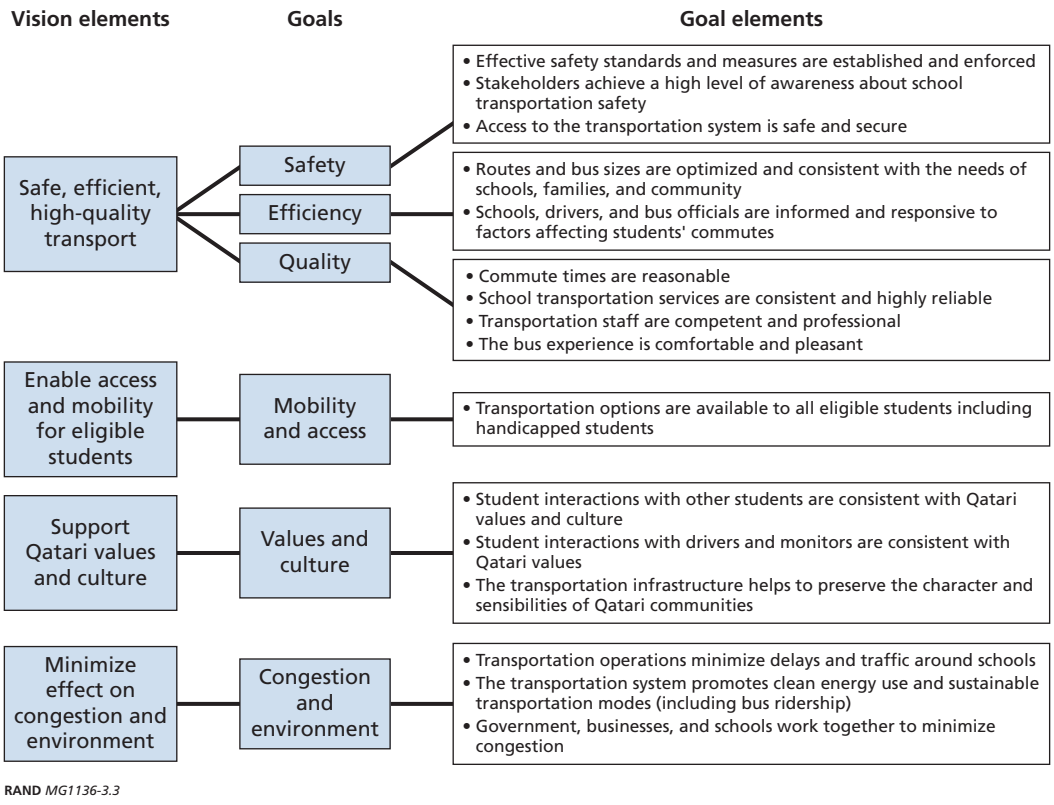
Summary of Linkages from Vision to Goals

The goals described above directly support elements of the vision. Figure 3.3 depicts the relationship among vision elements, goals, and goal elements.

Finding Strategies to Support the Goals and Vision

The proposed vision and goals presented in this chapter serve as a guide for both near-term and long-term development of Qatar's school transportation system. The vision provides a structure that covers a comprehensive set of concerns, as expressed in Qatar's

Figure 3.3
How Vision Elements Map to Goals and Goal Elements



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other strategic planning efforts. The goals provide focal points for choosing and prioritizing strategies for the transportation system.

To achieve some goals, viable strategies need to be identified and analyzed to determine which are most appropriate for Qatar. The next two chapters assist with the search for strategies. The following chapter identifies possible strategies that are consistent with international norms for Qatar's school transportation system, some of which have been mentioned briefly in this chapter.

CHAPTER FOUR

Candidate Strategies for Qatar's School Transportation System

In this chapter, we describe strategies for bringing Qatar's school transportation system into closer accord with international norms. The strategies are primarily derived from practices that commonly appeared in our review of selected international school transportation systems. We refer to these practices as *international norms* and use them for comparison with Qatar's school transportation system. Should Qatar choose to conform to international norms, many of the strategies presented in this chapter may be viable.

The strategies discussed in this chapter are shown in Table 4.1. They fall into the following five major categories:

- school zone management
- bus design and operation
- fleet operations and management
- information, communication, and analysis
- Student management.

"School zone management" strategies address the area surrounding a school, including the physical infrastructure, traffic controls, laws, and enforcement. "Bus design and operation" includes the characteristics and features of the bus, driver performance, and operation of individual buses. "Fleet operations and management" addresses system-wide performance as well as the size and mix of school buses. "Information, communication, and analysis" addresses the mechanisms for providing guidance and feedback. And "student management" addresses behavior and supervision of students using the school transportation system.

Identifying Strategies

The international strategies identified for Qatar are based on school bus systems of the United States, Canada, Western Europe, and select GCC countries. School transpor-

Table 4.1
Candidate Strategies for Qatar's School Transportation System and the Vision Elements They Support

Strategy	Supported Vision Elements
School zone management	
School zones	Safety, Traffic
Traffic laws/education/enforcement	Safety, Traffic
Bus design and operation	
School bus standards	Safety, Quality
Bus driver standards/training/eval.	Safety, Quality, Values
Standard checklists and reporting	Safety, Quality, Efficiency
Technology tools (e.g., RFID)	Safety, Efficiency
Maintenance standards/monitoring	Safety, Quality
Fleet operations and management	
Bus route optimization	Efficiency
Pick-up/drop-off points	Efficiency
Staggered school start times	Efficiency, Traffic
Fleet size and composition	Quality
Information, communication, and analysis	
Policy manual	Safety, Quality, Efficiency
Awareness campaign	Safety, Access
Stakeholder feedback process	Safety, Quality, Efficiency, Values
Gather/assess safety data	Safety
Establish/monitor efficiency metrics	Efficiency, Quality
Student management	
Bus monitor enhancements	Values, Quality
Student loading and unloading procedures	Safety
Student behavior management	Values, Quality
Media on buses	Quality

tation in the United States is often used as a model for other countries, partially due to the U.S. school transportation system's reputation for safety. For example, Canada and Dubai both looked to U.S. practices when updating their school transportation systems. Though the United States and Western Europe provide abundant sources of ideas, some strategies that may be appropriate in those regions may not be appropriate in the GCC. To ensure relevance to Qatar, we also used other GCC school transportation systems as a reference due to their similar cultural, geographic, environmental, and social characteristics.

In searching for strategies, we focused primarily on identifying common practices of the international school transportation systems cited above. For the purposes of this study, we regard as norms those practices that were repeatedly referenced in the literature review and cited during case studies. We also identified a few strategies that, while not commonly practiced, may be of interest to Qatar due to stated preferences of administrators and parents.

There were four components to our search for school transportation strategies. First, we reviewed GCC school transportation models using open-source literature and interviews with school officials.[1] Since several GCC countries have initiated transportation reform efforts in recent years, their experiences offer insight into lessons learned that are particularly relevant to Qatar. Second, we assessed Qatar's experiences with school transportation by interviewing school transportation officials, school administrators, and transport company (i.e., Karwa) administrators in Qatar. Third, we identified strategies used in the United States, based on guidance from national school transportation organizations, federal transportation guidelines, interviews with local school transportation officials, and reviews of county transportation policy manuals. Fourth, we reviewed literature on school transportation. The literature review revealed additional strategies and options from the United States and other countries around the world. Appendix D contains documentary support for each of the strategies presented.

Review of Gulf Cooperation Council School Transportation Models

We reviewed literature and news reports about school transportation in the UAE, Bahrain, Saudi Arabia, Kuwait, and Oman, in both English and Arabic. From this, we constructed an overview of school transportation in each country and assessed the availability of information. Appendix B summarizes our open source review of GCC school transportation systems. Based on the open source review, we selected countries to visit based on the following criteria:

- development efforts
- existence of public school transportation systems
- perceptions of quality in media reports
- innovation
- availability of data.

On the basis of these criteria, we selected the UAE and Bahrain for visits and interviews. As the UAE operates on a federal system, we chose to focus on two cities, Dubai and Abu Dhabi. Dubai seemed a particularly important emirate to study, since in 2007 it implemented a full school transportation reform based on practices in the United States and Europe. We chose Bahrain because it has an established, traditional

[1] The GCC members include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE.

school transportation system. We visited and conducted interviews in these countries to analyze how other countries similar to Qatar (in population, demographics, culture, and economics) deal with a variety of school transportation issues. We looked at qualitative and quantitative data on organization, operations, populations served, and policies. Interviews were conducted with staff from the following organizations:

- Roads and Transport Authority in Dubai (regulates public transportation in Dubai, including school transportation)
- Emirates Transport in Dubai (a quasi-government provider of public school transportation in Dubai)
- National Transportation Authority in Abu Dhabi (regulates public transportation in the UAE)
- Department of Transportation in Abu Dhabi (regulates public transportation in Abu Dhabi)
- Ministry of Education in Bahrain (oversees school transportation in Bahrain)
- National Transport in Bahrain (a private company that provides school transportation services to public schools in Bahrain).

Assessment of Qatar's Experiences with School Transportation

We met with officials from many organizations with responsibility for school transportation in Qatar to understand models and practices, policies, cultural considerations, and challenges. These organizations include the following:

- Supreme Education Council (responsible for overseeing schools)
- Public Works Authority, known as Ashghal (responsible for building roads and schools)
- Urban Planning and Development Authority (responsible for planning the layout of Doha and other cities in Qatar)
- Traffic Police at the Ministry of Interior (responsible for enforcing traffic safety laws around schools and educating school children on road safety)
- Amiri Diwan (the office of the Amir of Qatar)
- Office of the Heir Apparent of Qatar (responsible for overseeing our project and coordinating school transportation stakeholders)
- Karwa (provider of school transportation to government schools).

We conducted interviews and site visits at five schools in Qatar. The interviews included discussions of how the school transportation system has changed over time; challenges facing school transportation in Qatar; roles of various organizations; current policies; proposed goals for safety, efficiency, and service quality; and performance of the transportation system.

Identifying Strategies Used in the United States

The United States served as a source of strategies for Qatar, since it is highly regarded by many countries. Based on our literature review, Canada and some countries in Western Europe look to U.S. school transportation as a model. Many international school transportation systems benchmark themselves against U.S. practices because of the excellent safety record of the U.S. school transportation system. During interviews in the UAE and Bahrain, we also learned that some GCC school transportation systems benchmark themselves against practices in the United States. As exemplars for the United States, we reviewed two school transportation systems that follow commonly applied guidelines for U.S. school transportation.

In the United States, school transportation systems generally follow a common set of strategies that are consistent with national regulations and guidelines. While oversight of student transportation falls to a variety of intrastate agencies (e.g., departments of education, public safety, motor vehicles), guidance on laws and specifications are typically motivated at the national level by federal laws and regulations and national school transportation organizations. Federal agencies such as the National Highway Traffic Safety Administration (NHTSA) offer research, standards, and regulations that guide school transportation stakeholders at all levels. However, NHTSA does not address all aspects of school transportation.

One source that disseminates standards, regulations, and best practices for school transportation in the United States is the National Congress on School Transportation (NCST). Every five years, the NCST convenes a meeting with national school transportation experts and stakeholders to update and recommend standards and practices for school transportation. The NCST bases its guidance on federal transportation standards and regulations and the most current research findings. The NCST strives to issue guidance that represents best practices.

The NCST publishes the *National School Transportation Specifications and Procedures* (NSTSP) as a comprehensive guide to states and other potential users. The NSTSP recommendations cover a wide range of issues, from specific bus specifications to operations. As part of its content, the NSTSP includes references to Federal Motor Vehicle Safety Standards. The NSTSP goes beyond minimum federal requirements and offers guidance on operational issues, such as driver responsibilities and procedures. State and local entities responsible for school transportation may choose to adopt all or part of the specifications and procedures into laws, regulations, policies, and procedures.

Though local school transportation systems in the United States create their own manuals, the content of their manuals is often developed based on a common foundation such as that represented in the NSTSP documentation. For our review of U.S. strategies, we selected the school transportation systems in Fairfax County in Virginia and Ventura County in California. Both have well-established school transportation systems that service large, diverse, and widespread populations. As with many school

transportation systems in the United States, both Fairfax County and Ventura County follow guidelines represented in the NSTSP.

In addition to our interviews, we collected school transportation policy materials and manuals from other school transportation systems in the United States. Among the documents we reviewed were policy manuals from Fairfax County, Virginia; Ventura County, California; Wade County, North Carolina; and the National Association for Pupil Transportation.

Literature Review of International School Transportation Systems

Our literature review included studies of safety, operations, organizational approaches, and data in school transportation systems from various countries. Countries addressed in the review included the United States, Organisation for Economic Co-operation and Development (OECD) countries, Canada, and several European countries. The literature covered topics ranging from school bus standards, to safety practices, to methods to promote efficiency.

School Transportation Strategies

Below are candidate strategies for bringing school transportation in Qatar into closer alignment with international norms. The strategies are divided into five major categories: School zone management; bus design and operation; fleet operations and management; information, communication, and analysis; and student management. For each strategy, we provide a description and identify why the strategy should be of interest to Qatar.

School Zone Management

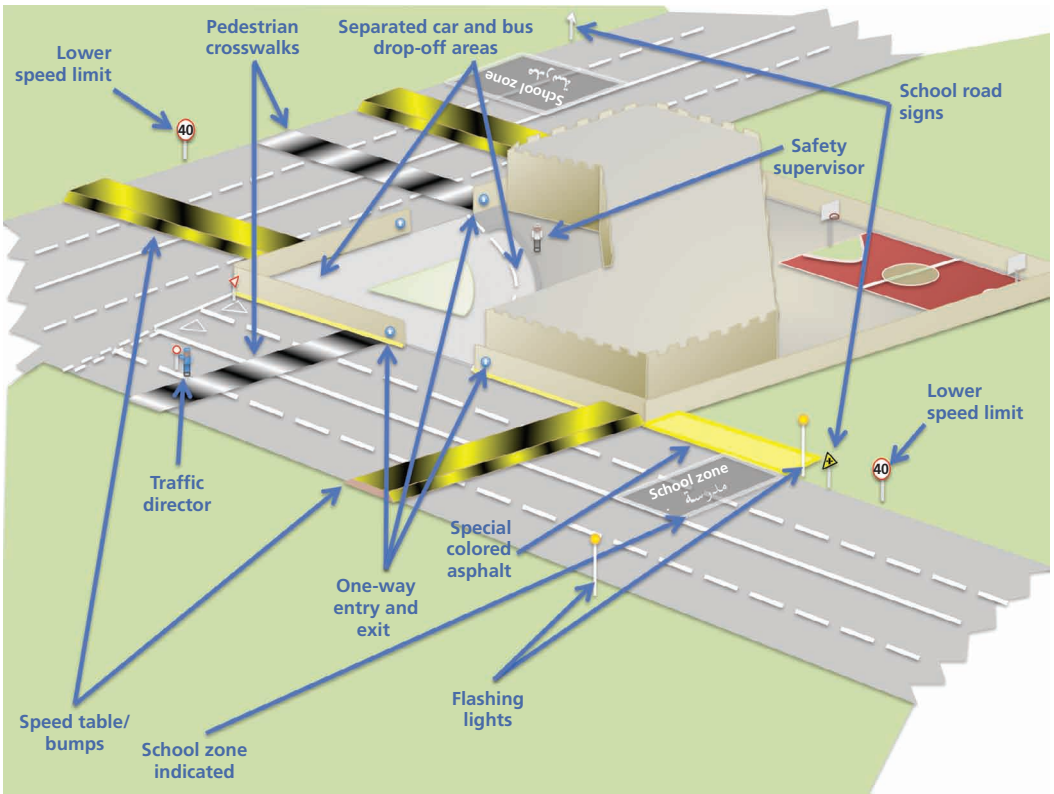
Many school systems (e.g., those of Dubai, Bahrain, the United States, Canada, New Zealand, and other countries in the OECD) have established strict standards for school design and road safety features near schools. Such features address safety and traffic management and are typically accompanied by laws that are routinely enforced. Qatar has not implemented uniform school zone standards to manage passenger vehicle and pedestrian behavior near schools. Well-defined and clearly marked school zones can accomplish the following when properly accompanied by public awareness, laws, and enforcement:

- Control and reduce traffic around schools.
- Separate vehicles from children.
- Promote safe driving.
- Manage loading and unloading of children.

School Zone Design. In Qatar, areas surrounding schools often lack features consistent with international norms for school transportation systems. Many common safety features are missing or implemented inconsistently. Figure 4.1 shows common features for safe and efficient traffic management in school zones. These often include the following:

Clear School Zone Markings. School zones can be marked so that drivers know to drive more carefully near schools (Organisation for Economic Co-operation and Development, 2004; National Highway Traffic Safety Administration, 2004). Markings can include signs painted on the road that say "School Zone," brightly painted asphalt, and flashing lights. When properly applied, these markings are checked and maintained to ensure that they are in good condition in all environmental conditions—daylight, darkness, and rain (Isebrands and Hallmark, 2007). Currently in Qatar, school zone markings are inconsistent from school to school and do not adequately caution drivers passing near schools.

Figure 4.1
Common Safety and Traffic Management Features



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Lower Speed Limits and Traffic-Calming Measures. In Qatar, speed limits, road signs, and safety features near schools are inconsistent and do not clearly caution drivers. School zones in the United States impose a speed limit of 25 miles per hour (about 40 km per hour), and similarly, school zones in Bahrain limit speed to 40 km per hour.[2] To raise driver awareness, real-time speed radar signs that flash vehicle speeds are becoming more popular in school zones, as are laws and signage warning that traffic fines are doubled within the school zone (Organisation for Economic Co-operation and Development, 2004).

To help enforce lower speeds, traffic-calming measures, such as speed bumps or speed tables, can also be added to school zones. Speed bumps and speed tables are elevated ridges built into the road to force vehicles to slow down. These measures remind drivers that they must maintain a low speed.

Pedestrian Crosswalks. In Qatar, there are rarely crosswalks for pedestrians at school sites. Many schools do not have sufficient space to support the volume of private cars that drop off children at school grounds. As a result, many families drop off their children outside the school grounds on the public street; children then cross the street and enter the school through the parking lot, often walking near cars and buses.[3] Interviews with school administrators revealed concerns that unguided pedestrian traffic may lead to accidents.

Traffic congestion around schools is a problem in U.S. and other school systems as well. However, designated pedestrian routes increase safety. Providing pedestrian routes at schools in Qatar can bring it closer to what is commonly practiced in other countries. A combination of crosswalks, stop signs, speed bumps, and speed tables can help reduce the likelihood of accidents. Pedestrian routes could be designed during the school site planning process for new schools. Schools that are already operational could be retrofitted to alter pedestrian traffic routes or create new routes to protect pedestrians and prevent them from mixing with school buses or cars (Laue, 2001).

Separation of Modes of Transportation. In Qatar, many schools have a one-way entry and exit, with no separate lanes for car and bus drop-offs. The latter is a recommendation commonly found in the literature (see, for example, Isebrands and Hallmark, 2007). Congestion on roads near schools in Qatar at the start and end of the school day is often a problem because of inadequate space for loading and unloading children from buses and private cars.

A common practice in the United States and other countries is the separation of modes of transportation—private car, bus, bicycle, and pedestrian. School buses and private passenger transport are separated to the extent possible, and schools set up separate pick-up and drop-off locations for each mode of transportation. School officials help maintain safety by supervising loading zones and crosswalks.

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[2] Although the traffic laws exist, interviewees in Bahrain indicated that the laws are often not enforced.

[3] In 2009, a girl was killed by a passing car while crossing the street to her school in Qatar, after being dropped off by her family car (Abano and Saeed, 2009).

Separation of modes of traffic can support efficiency as well. Problems of traffic access and congestion could be mitigated by the separation of modes of transport. Separation of modes may be achieved by providing access to the school site from at least two adjacent streets and by offering sufficient on-site space for cars and buses to stop and load or unload children. Such strategies prevent congestion and long lines of vehicles waiting on adjacent roadways. When separate loading and unloading zones are not feasible, some schools have staggered dismissal times by mode (for example, with different times for bus and private car pick-up).

Some of these school zone features may be challenging for Qatar to implement completely across all existing schools. Schools with an established infrastructure may lack the physical space or design characteristics to allow for every desired safety zone feature. However, some retrofitting may be possible for current schools, and these approaches could be useful in planning new schools.

Traffic Laws, Education, and Enforcement. School transportation systems in the United States and Canada have demonstrated that laws, education, and enforcement work together to control the behavior of private drivers near schools and school buses. Laws set the standards; education informs drivers about the behavior expected of them; and enforcement by traffic police ensures that there are penalties for not adhering to the laws. One lesson learned from Dubai's experience is the need for coordinating traffic laws, education, and enforcement with new school transportation practices. Dubai had implemented stop-arms and school zones without creating traffic laws to mandate driver behavior. Without supporting laws, drivers failed to heed the stop-arms on buses. Drawing on Dubai's experience, Abu Dhabi is now instituting traffic laws, education, and enforcement as a first phase of school transportation improvements.

Traffic Laws. As a way of better managing driver behavior, Qatar could pass laws that set substantial fines for speeding near schools or failing to heed safety laws. Many countries, including the United States and Canada, enforce large penalties for such violations.

Traffic Education. For laws to be obeyed, drivers need to know that the laws exist and that there are penalties for violating them. In Qatar, traffic education could take place through driver training, literature disseminated to those applying for a driver's license, or publicity campaigns in the newspapers, radio, or television. Publicity campaigns that raise safety awareness may be particularly important in Qatar, as most of the population consists of expatriates who received driver training in other countries. The United States' NHTSA also advises that laws, penalties, and safety consequences should be reliably and consistently communicated to all stakeholders, including drivers, school bus drivers, law enforcement officers, prosecutors, and the judiciary (National Highway Traffic Safety Administration, 2002).

Traffic Law Enforcement. Once established, laws governing traffic near schools should be enforced. Enforcement efforts can be implemented in a variety of ways. This can include employment of routine enforcement activities or selective enforcement activities. Routine enforcement means that law enforcement officers look for violations

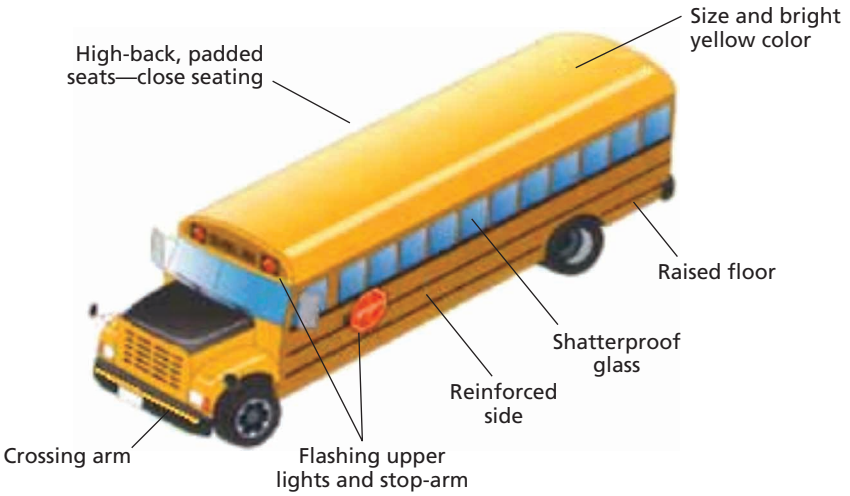
as part of their standard patrol duties. Selective enforcement activities include temporary officer assignments focused on eliminating specific safety problems. Such techniques include placing enforcement officers at specific intersections along bus routes, placing them on specific school buses, or requesting that they drive behind specific school buses for patrol duties (National Highway Traffic Safety Administration, 2002).

Bus Design and Operation

In Qatar, school bus operators are free to establish their own criteria for bus drivers and choose their own specifications for school buses. Major international school transportation systems usually establish and enforce common standards for buses and bus drivers. Such standards help to ensure consistent safety, efficiency, and service quality. Candidate approaches appear below.

School Bus Standards. Countries such as the United States, Canada, and the United Kingdom require that the buses that transport children to and from school meet specific standards and specifications. Some countries adopt the school bus standards of the United States because of its excellent safety record.[4] While standards vary somewhat across different school transportation systems, some common safety standards for buses are shown in Figure 4.2, which represents a typical Canadian or U.S. school bus and its safety features.

Figure 4.2
School Bus Standards



SOURCE: Ontario Ministry of Transportation, 2010.
RAND *MG1136-4.2*

[4] Dubai introduced school bus standards based on U.S. standards in 2007, and all previously operating school buses were given one year to retrofit to the new standards.

This section highlights a few commonly used standards that may be of particular relevance to Qatar. These include standardized identifiers for school buses, child restraint systems, stop-arms, and climate control. Though not explicitly described here, international norms also commonly include additional safety features such as emergency exits, flame retardant interior bus materials, shatter-proof windows, reinforced sides, and mirror and lighting systems.

Standard Identifiers for School Buses. Qatar's public school buses are not clearly distinguished from other buses in appearance. They are similar in size, design, and color (i.e., blue) to Qatar's other public transportation buses. In addition, some construction companies have purchased used yellow school buses from other countries to transport laborers. Buses dedicated to transporting laborers bear internationally recognized school bus markings including yellow paint, warning lights, and labeling of "School Bus." Because buses with school markings are allowed to transport laborers rather than students, motorists have not been conditioned to take care near properly marked school buses.

Distinguishing school buses from other vehicles (e.g., public transit buses, vans) by their appearance communicates to drivers that they should modify their driving behavior and use additional caution when a bus is stopped. Many international school systems use standard identifiers (e.g., signage, lights) and paint buses a bold, recognizable color so that they can be recognized easily (Gleave, 2003). Yellow is common (e.g., used in the United States, Europe, and Dubai) and is internationally recognized as the standard color for school buses. Dubai's buses have "School Bus" painted in black in both English and Arabic for additional recognition by both Arabic and English readers.

To improve recognition, Qatar could establish a requirement that all school buses be painted a designated color and be labeled as school buses in Arabic and English. In addition, Qatar could mandate that no other buses be painted the color of school buses.

Child Restraint Systems. There are two child restraint options for protecting children on buses in case of accidents—compartmentalization and seat belts. Compartmentalization is a safety system created specifically for school buses, protecting passengers by placing them between high-backed, well-padded seats that are designed to absorb crash forces (Virginia Commonwealth University, Transportation Safety Training Center, 2005). Compartmentalization works by using the seat backs to cushion the impact of students' bodies during a crash. According to the United States' National Transportation Safety Board, the NHTSA, and the Transportation Research Board of the National Research Council, compartmentalization can protect occupants and has demonstrated that passengers in severe accidents can escape serious injury in most accidents (National Highway Traffic Safety Administration, 2004).

The second child restraint option is the use of seat belts. Some school transportation systems (Ventura County, California, in the United States, some OECD countries, and Dubai in the UAE) require that school buses all have seat belts (Organisa-

tion for Economic Co-operation and Development, 2004). There are two kinds of seat belts: lap belts and the three-point lap/shoulder safety restraint system. The three-point lap/shoulder safety restraint system is the preferred and most appropriate seat belt for children (Virginia Commonwealth University, Transportation Safety Training Center, 2005; Connecticut School Transportation Association, 2010a).[5] Some research indicates that three-point safety belts offer better protection than compartmentalization, because the smallest children may not be adequately protected by compartmentalization or by lap belts.[6]

Three-point safety belts may also work well in combination with compartmentalization, but there is currently little evidence that the additional cost associated with a combined seat belt/compartmentalized system is justifiable. For example, the U.S. federal government has not mandated lap/shoulder belts because it concluded that the marginal safety benefits do not outweigh the high costs of implementation. Requiring children to wear safety belts can also be difficult to enforce; for example, while Ventura County places safety belts on buses, it does not mandate their use, because of difficulties in enforcement.

School bus standards in school transportation systems in the United States require that there be no hard or moving parts in the seats, such as arm rests, movable seat backs, or ash trays that could injure children in the event of an impact. In contrast, Qatar's public school buses (provided through Karwa) are coach buses with reclining, padded seats and lap safety belts. While these buses have seat belts, they are not ideally suited for transporting children. Due to Karwa's significant investment in coach buses, compartmentalization may not make sense in the near term since the benefits may not justify the costs. However, if Qatar is interested in cost-effective approaches to implementing new seat belt or compartmentalization standards, Qatar could require that new standards apply only to new buses purchased for school transportation.

Stop-Arms. Another safety option for Qatar is adding stop-arms to school buses. Stop-arms are red stop signs that extend from the side of the bus whenever the bus stops to load or unload children. Stop-arms are a common safety standard in many international school transportation systems (Ministry of Transportation, Government of Alberta, Canada, 2008; National Highway Traffic Safety Administration, 2002; Hirano, 2004).

In the United States and some other countries, the law requires drivers to stop behind a bus and not pass while the stop-arm is extended. This is designed to protect children from moving cars. Stop-arms are sometimes accompanied by flashing

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[5] Some argue that lap belts may result in a net loss of safety. Because a child's hips are secured, his head and trunk fly forward in the case of an impact, concentrating force on the child's head, neck, and undeveloped pelvis (Einstein, 2000). Three-point safety belts (that anchor a child's shoulders as well as pelvis) have replaced lap belts on some new buses.

[6] Lap belts may cause internal injuries or cause the child's head to absorb most of the impact (McMahon, 2005a).

lights or signs that read " STOP," " CAUTION," "STOPPING," or "DO NOT PASS" (Ministry of Transportation, Government of Alberta, 2008, pp. 4–6; Virginia Commonwealth University, Transportation Safety Training Center, 2005). When the law is properly enforced, drivers who fail to heed the stop-arm are subject to fines. Public awareness and supporting laws are required to ensure the effectiveness of stop-arms.

Climate Control. Since temperatures can reach over 50 degrees Celsius,[7] climate control on school buses is an important issue in school transportation for GCC countries. Managing the heat on the buses can also make the travel experience more comfortable for children. In recent years, Abu Dhabi and Dubai have required air conditioning on school buses. While Qatar already has air conditioning on all public school buses, tinted windows and white school bus roofs could enhance climate control. Currently, Dubai requires tinted windows for shade. And Fairfax County in Virginia has required that all school bus roofs be painted white to reflect heat, keep the buses cool, and reduce fuel costs associated with air conditioning. Simple measures, such as painting bus roofs white and tinting windows, can help keep Qatar's buses cool and reduce the burden on buses' air conditioning systems.

Bus Driver Standards and Training. Although some Qatari bus operators have established their own requirements, there are currently no universal requirements for licenses and training for bus drivers in either government or private schools. Standardized hiring criteria for school bus drivers can ensure good service and reliability. Based on international norms, the following prerequisites for school bus drivers could be required (Ministry of Transportation, Government of Alberta, 2008, p. 9):

- a national driver's license
- three years of bus driving experience
- language abilities
- criminal record, substance abuse, and health check
- training and exams.

In the United States, bus drivers often receive training on bus operations, routing, school transportation policies, and student management. School bus drivers receive specific training for school bus transport as opposed to general bus transit, including both pre-service and in-service driver training. School bus drivers in the United States are often required to have taken 40 hours of special training, while some school districts require considerably more (Ministry of Transportation, Government of Alberta, 2008, p. 9). Fairfax County, Virginia, for instance, requires 160 hours of training for school bus drivers. Ventura County, California, requires 50 hours of training, with monthly refresher training. Similarly, training and licensing standards were central components of Dubai's school transportation reform.

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7 50 degrees Celsius = 120 degrees Fahrenheit.

Developing specialized and ongoing training processes for school bus drivers is a viable strategy for supporting safety and could include the following elements:

- driving the bus
- student behavior management
- safety procedures for loading and unloading bus
- traffic laws
- first aid.

Standardized Checklists and Reporting. In accordance with international norms, drivers should be responsible for completing daily, standardized checklists and reports prior to pick-ups and after drop-offs for each route they complete. Standardized checklists not only help drivers adhere to standardized processes but also can increase transportation safety. Checklists can help ensure that all students have vacated the bus and can help identify problems with safety equipment on buses. As part of their checklist, Ventura County bus drivers are trained to inspect buses before and after every route. For confirmation, they are required to walk to the end of the bus after unloading children and flip a sign that indicates that they completed the check. In Fairfax, bus drivers are now required to walk to the end of the bus and press a button before parking the bus; this practice helps ensure that no children are left on the bus. In 2010, a four-year old girl in Qatar died because she was left sleeping on a hot bus after a route was completed (Pandit, 2010). By enforcing standard checklists, the likelihood of such tragedies can be reduced.

Technology Tools. Though RFID (radio frequency identification) technology is not commonly used in school transportation systems today, some schools are experimenting with RFID in an attempt to improve safety and efficiency. The Birla Public School in Qatar began an RFID pilot in 2010, issuing RFID cards to each student. Using RFID technology, children are tracked as they get on and off the bus, and bus drivers are alerted when they are missing a passenger and when all passengers have left the bus. The RFID system can also automatically send SMS text messages to parents as notification that the child's bus is approaching (Townson, 2010). RFID has also been used in Sweden (Green 2008, pp. 26–27). Qatar should closely monitor the experience of the Birla Public School and evaluate whether RFID can benefit the broader school transportation system.

Maintenance Standards and Monitoring. Maintenance standards define expectations for the schedule and types of services necessary to maintain reliable bus operations. All school transportation systems reviewed for this study have established protocols to ensure adherence to periodic maintenance and inspection schedules. For example, Dubai has established maintenance standards and regularly monitors maintenance metrics (Dubai Roads and Transport Authority, 2008a, p. 8). Enforcement of a formal maintenance program, including standards and monitoring, will help Qatar

ensure that vehicles are running reliably and safely at all times. Drivers may contribute to the monitoring of maintenance by performing daily visual inspections.

Fleet Operations and Management

The next set of strategies addresses overall school transportation system performance. These include strategies to help ensure efficient operations through the management of bus operations and composition of the bus fleet. While efficiency is the primary focus of these strategies, other factors are considered, such as compatibility with existing infrastructure, parental preferences, and public acceptance.

Bus Route Optimization. Currently in Qatar, school bus routes for government schools are planned manually by each bus driver and not by the bus companies, which may have better skills and knowledge of bus planning. Bus company officials report that this system does not allow them to minimize the time that children spend on the bus, since drivers are not properly trained in routing techniques. Possible routing strategies could include providing bus drivers with training on routing, revising roles and responsibilities so that the bus companies control route planning for government schools, or building analytical capacity within the Supreme Education Council. Routing strategies can be further supplemented with computerized bus route planning and GPS, if necessary.

Computerized route planning has the potential to ensure that routes are efficient. GPS may contribute to computerized route planning and is increasingly being used in school transportation systems. According to interviewees at school transportation companies in Dubai, route planning and bus tracking with GPS have the potential to accomplish the following:

- Coordinate routes so that routes do not need to be charted out manually.
- Perform real-time routing adjustments.
- Increase capacity on the buses and reduce the number of buses.
- Determine appropriate sizes of buses for routes.
- Cut emissions through more efficient routes.
- Reduce fuel consumption and costs through more efficient use of buses
- Reduce time on bus for children.
- Gather data about bus times and traffic patterns.
- Integrate services with the police for traffic management and accident monitoring.
- Help keep maintenance schedules.
- Reduce the amount of paper forms for monitoring timeliness.

Fairfax County installed GPS on its bus fleets. Interviewees in Fairfax said that they realized efficiency gains from the GPS that justified their initial startup cost. Operations staff can now review timing, locations, and routes and can also track when

buses need maintenance. GPS aids them in efficiently planning locations of pick-up and drop-off points.

Bus companies in the UAE and Bahrain are not using GPS on their fleets, although some are studying the issue. Bus companies, schools, and the Ministries of Education plan school routes manually, with officials mapping school bus routes without the use of computers or GPS. Emirates Transport in Dubai studied adding GPS onto buses, but funding was unavailable for retrofitting the bus fleet. In Bahrain, bus companies decide the size of the buses and the routes. National Transport in Bahrain has started a pilot to test GPS on a few buses, but they do not yet have data on the results. Abu Dhabi Department of Transportation is considering using Automated Vehicle Management (AVM) so that parents can track bus locations online or through SMS messages.

Pick-Up and Drop-Off Points. In Qatar, school buses generally stop at each house to pick up children. Picking up each child at home adds significant time to the total bus route. An alternative would be the use of "pick-up points" (i.e., bus stops). Pick-up points are places where several students aggregate to wait for the bus. While pick-up points may increase efficiency, they have distinct advantages and disadvantages in the Qatari context.

Advantages include significantly fewer stops, less time on buses for children, and improved timeliness to school. Most U.S. school systems, including Fairfax and Ventura, use pick-up and drop-off points. Bahrain also commonly uses pick-up and drop-off points.

For Qatar, there are several significant obstacles to implementing pick-up points. Interviews with schools and government officials in Qatar revealed a variety of reasons why pick-up points are not used very often. Many of the streets in Qatar do not have sidewalks or safe places for children to congregate. Also, high temperatures in the late spring, summer, and fall raise concerns about children waiting outside in heat that often exceeds 35 degrees Celsius. In addition, parents are concerned about small children standing in the street and about girls standing in the street where they can be seen by passers-by. In a focus group conducted by Emirates Transport, parents in the UAE had similar concerns to those in Qatar and rejected the idea of using pick-up and drop-off points. Reasons cited included concerns about girls standing in the street, parental protectiveness of small children, hesitance about mixing girls and boys outside, concern about mixing children of different ages, and the heat in the summer. In Dubai, only about 20 percent of students picked up by Emirates Transport used pick-up points. In addition, one study in the United States found that young children may not understand the dangers at bus stops, while older children are more likely to engage in reckless behavior (McMahon, 2005b, p. 3).

Bahrain, which has a climate and cultural norms similar to Qatar's, has used various methods to mitigate concerns about pick-up points. In Bahrain, there are 1,200 gender-segregated pick-up points that serve various age groups. They are clearly marked,

shaded, and have speed bumps nearby to ensure that passing cars slow down. The pick-up points are located within walking distance of children's homes (usually about 100–200 meters away). Parents are encouraged to escort their children to the points and wait for them until they are safely on board the bus. The Traffic Department, Ministry of Works, and the National Department of Transportation work together to choose appropriate locations for pick-up points and to improve comfort and safety of the pick-up points.

The use of pick-up points does not currently appear to be an attractive option for students in Qatar, due to the challenges cited above. However, pick-up points may become a viable strategy for new neighborhoods in Qatar if city planners incorporate design features that mitigate the disadvantages. To ensure safety, bus stops could be located to maximize the visibility of students to passing drivers (McMahon, 2005b, pp. 28–31). In addition, signage, stop-arms, traffic laws, and formalized boarding procedures could help protect children entering and exiting buses. To address concerns about high temperatures, bus stops could be shaded or enclosed to allow for air conditioning.

Staggering School Start Times. In Qatar, government schools for all age groups start at the same time. One option to increase the utility of Qatar's bus fleet could be staggering school start times, either for different age groups or for girls and boys. If one population of students starts school after another population of students, then one bus fleet may be able to run multiple routes per day.

In the United States' Fairfax and Ventura Counties, elementary, middle, and high school students start school at different times, enabling buses to support routes for multiple schools. In Dubai, the Ministry of Education staggers school times to increase utilization of Emirate Transport's bus fleet, with girls' schools starting an hour later than the boys' schools so that buses can run double shifts. Private schools stagger starting times by grade for the same purpose.

Managing Fleet Size and Composition. Currently in Qatar, each school requests buses based on student registrations, and the Transportation Department allocates buses based on the staff's judgment. While the allocation of buses is based on the aggregate needs of each school, the size of buses allocated and overall composition of the bus fleet are not optimized to ensure efficiency or timely transportation of students. Optimizing fleet size and composition would involve assigning the right size buses to school routes while trying to maximize filled seats and minimize ride times. Transitioning to smaller buses could reduce journey times and improve quality of service for students through shorter commute times, but it would also require the purchase of more buses and hiring of more monitors and drivers. Shifting to smaller buses may be more efficient for schools with fewer bus-riding students and in cases where the student population lives farther away from the school. Optimizing fleet size and composition may be a viable long-term strategy for managing commute times and supporting efficiency. This strategy is explored further in Chapter Five.

Information, Communication, and Analysis

The school transportation systems we reviewed have established processes for communicating with stakeholders, gathering data, and performing analysis of system performance. Documentation guides operations and clarifies stakeholders' understanding of their specific responsibilities. Such documentation often takes the form of manuals or policy documents and can be reinforced and more broadly disseminated through communications directed toward parents, students, and the public. To ensure that the transportation system achieves prescribed objectives, feedback mechanisms are implemented. Feedback comes not only from gathering and assessing data on safety and efficiency, but also from solicited input from parents and administrators. The key is to document standards for how the school transportation is supposed to function and measure whether the system is achieving its objectives. The following strategies focus on providing guidance, soliciting feedback, and analyzing performance of Qatar's school transportation system.

Policy Manuals. In Qatar, no single document currently describes the expectations for school transportation. Development of a policy manual is an important strategy for increasing coordination among the stakeholders.

Policy manuals for school transportation provide a common reference about roles, responsibilities, policies, procedures, rights, and services. Dubai's school transportation development effort culminated with the Dubai School Transport Manual, a document that describes school transport laws, school administration responsibilities, operating entity responsibilities, school bus driver responsibilities, student and parent responsibilities, school bus standards, fines and penalties, bus registration procedures, and bus driver training and licensing (Dubai Roads and Transport Authority, 2008a). Abu Dhabi's current effort to improve its school transport system will also culminate in a school transport manual. Both Fairfax County and Ventura County have produced and rely on school transportation manuals and supporting materials.

Awareness Campaigns. By educating stakeholders, awareness campaigns have the potential to support safety on the bus, encourage safe driving near schools, increase timeliness, and promote ridership. Awareness campaigns can target parents, students, drivers, and school officials with specific messages geared toward each group. Awareness campaigns have been shown to be effective in a variety of international settings. A study in Kuwait found that educating parents on procedures for safety and traffic control successfully reinforced safe behavior among children (Koushki and Al-Najjar, 2008, p. 23; Isebrands and Hallmark, 2007, pp. 2–4). Qatar has already taken some steps to raise awareness of school transportation safety. Beginning in the 2010 school year, Qatar introduced traffic safety lessons into the school curriculum ("Greenlight for Traffic Lessons in School Curriculum," 2010).

School transportation systems have taken various approaches to awareness campaigns. In Dubai, the Roads and Transport Authority provides seminars for parents, conducts awareness campaigns in schools for students, and publishes a magazine for

children and another publication directed at parents. The Roads and Transport Authority also sponsors ads on the radio and in the newspapers. Emirates Transport in Dubai does awareness campaigns that involve training school officials, providing pamphlets and posters, giving safety awards, and having a "Golden Rule" campaign modeled on a similar campaign by the National Authority for Pupil Transportation in the United States. In Bahrain, the Ministry of Education conducts public campaigns on the radio.

An awareness campaign in Qatar about school transportation could include any of the following:

- visits to schools by school transportation officials with organized activities
- offering training to children at schools as part of the school curriculum
- distributing safety information materials for parents
- meetings for parents with school officials, Traffic Police, and school transportation operators
- publicity on the radio, newspapers, and television
- books or coloring materials for children about safety in school transportation
- conferences about school transportation
- public demonstrations of buses—for example, placing a new bus that meets all standards and specifications in a local shopping mall for parents and children to tour.

Stakeholder Feedback Process. Schools and students' families should have a formal outlet for sharing feedback and ideas. This could be achieved by scheduling regular meetings with each stakeholder group or by providing instructions on how feedback may be submitted. By providing a formal feedback mechanism, stakeholders will become more vested in the school transportation system's success as their concerns are addressed (Dubai Roads and Transport Authority, 2008a, p. 8).

Gathering and Assessing Safety Data. Maintaining safety data can enable leaders and policy makers to properly evaluate safety and formulate targeted responses to safety problems, including identifying necessary changes in training, policies, and equipment. Even analysis of minor safety incidents can help Qatar better understand the causes of accidents and reduce them (Finlayson-Schueler, 2004). Based on international norms, a formalized data-gathering and evaluation process helps illuminate possible safety problems and guides development of appropriate solutions. Emirates Transport in Dubai collects extensive data on accident rates and causes and makes changes to its procedures accordingly.

If Qatar were to institute a data-gathering program, officials from school transportation institutions could work collaboratively to analyze data, identify problems,

and set goals for improvement.[8] The following are examples of data that would be useful for supporting safety in Qatar:

- accident rates of school buses and their causes
- accident rates of private cars transporting children to school
- accidents and injuries in school zones and their causes
- student discipline reports on buses
- bus inspection pass rates.

Establishing and Monitoring Efficiency Metrics. Establishing and monitoring efficiency metrics for the school transportation system helps to ensure that standards are reached and maintained. Through periodic reviews, performance metrics can be measured against objectives and monitored over time. Metrics can be used to hold bus operators accountable for performance and identify emerging problems that may require action. Metrics will also enable decisionmakers to conduct cost-benefit analysis for future policy decisions. Examples of viable efficiency metrics may include factors such as average travel time, percentage of on-time arrivals, and utilization rates.

Student Management

Effective management of students contributes to a safe, comfortable journey and can reinforce values that Qatar seeks to preserve. Student behavior on school buses was a common concern raised by parents and administrators surveyed for this study. Over 50 percent of parents with children who ride buses cited behavior of other students as a concern. Moreover, representatives from government organizations and school administrators have highlighted student discipline issues, including interpersonal conflicts and property damage. Students vandalize the bus, e.g., by breaking off chair handles and cutting seats with knives. Furthermore, there are few disciplinary consequences for students or monetary incentives for schools in place to deter bus damage. Behavioral problems and property damage occur on girls' buses as well as boys' buses. School bus vandalism costs Qatar approximately 500,000–1 million QR annually (140,000–280,000 USD). Strategies to manage student behavior on buses can help mitigate concerns and reduce incidents of vandalism and damage on buses.

Monitors. A common approach to managing students in GCC school transportation systems has been the use of bus monitors who ride on buses and supervise children. Karwa buses in Qatar and Emirates Transport in Dubai and Abu Dhabi employ monitors to supervise children. Though this approach is common in the GCC, monitors are not typically used in other countries. In most school transportation systems, bus drivers are responsible for the transportation and supervision of students in transit.

[8] Data on school transportation accidents in Qatar were not available during the research for this monograph. As a result, we could not definitively assess Qatar's current level of safety nor compare Qatar's safety performance with other countries.

For example, in the United States bus drivers supervise children without additional help from another adult. When given proper training and protocols for handling disciplinary issues, bus drivers may be capable of handling student supervision, though there may be cultural concerns that warrant the use of monitors in Qatar. For example, parents of female students may be uncomfortable with male drivers unless an adult female bus monitor is present on the bus.

Should Qatar continue to employ bus monitors, there are some key challenges in hiring monitors. First, interviews in Qatar revealed that monitors are often not respected by the students and have little authority with them to manage behavior; this may be because many monitors are low-skilled foreign nationals who may not speak Arabic. In Dubai, Emirates Transport has mitigated this challenge by, first, requiring monitors to be able to speak, read, and write Arabic and, second, by providing training in dealing with children and maintaining discipline. Abu Dhabi changed policies such that it now hires only Emirati nationals for the monitor jobs. As a result, interviewees in Abu Dhabi believed that monitors command more respect from the students. However, Emirati nationals also require much higher pay than do the foreigners who were previously hired.

The second challenge in hiring monitors for buses is cost. Cost concerns may be partially mitigated by providing monitors only on buses for which there is greater need. For example, at Emirates Transport in Dubai, monitors are placed only on buses for children under the age of 12.[9] On the other hand, the Bahrain Ministry of Education decided to not employ monitors on buses because officials believed that monitors were expensive but ineffective.

The following techniques may be useful in improving bus monitor performance:

- screening monitors during hiring
- training the monitors in student behavior management and safety
- offering the monitor positions to Qatari men or women at higher pay than currently offered, in order to increase their authority.

School Bus Loading and Unloading Procedures. The loading and unloading of students from buses is the most dangerous portion of school transportation. First, passing motorists present a risk to children getting on or off a bus. Second, the bus driver may not see children or pedestrians while stopping or starting the bus, putting them at risk for injury. Standardized operating procedures and student education can help mitigate some of these risks.

Supervised Loading and Unloading. School staff can help supervise loading and unloading and direct traffic around the school during peak hours. Assigned supervisors

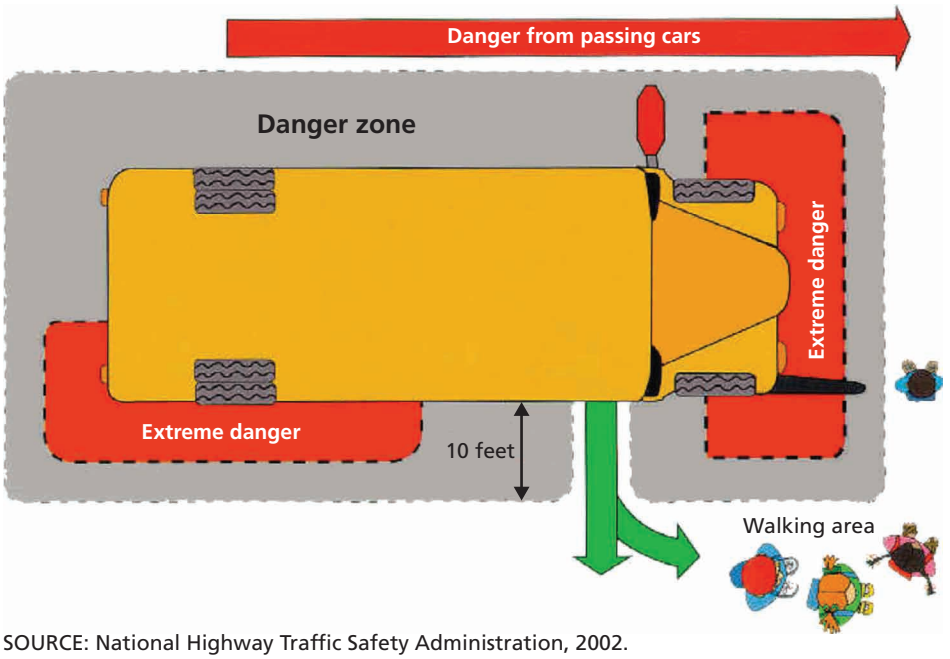
[9] In addition, the Emirates Transport monitors work as teaching assistants at the schools during the school day, providing greater value for their salaries.

can remind drivers of loading zone rules and keep traffic moving, focusing particularly on the high-volume traffic areas and crossings in the school zone. In the United States, school safety patrols and loading supervisors are trained and outfitted with reflective safety vests to maximize their visibility and effectiveness (Laue, 2001; Isebrands and Hallmark, 2007, pp. 1–3; Cooner, 2005, p. 96).

Educating Children About Safety When Loading or Unloading. Children are at greater risk in the area surrounding the school bus than on the school bus itself. Increasing their awareness about proper procedures can help minimize risks posed to children when near the school bus. In the United States, the NHTSA has identified a school bus "Danger Zone" of about 15 feet (or 4.5 meters) in all directions. The "Danger Zone" concept is used as a simple way to teach children about bus safety. Some training programs in the United States tell children to stand a minimum of three big steps (about 6 feet or 1.8 meters) away from the curb. Children who have to cross the street in front of the bus are advised to take five big steps (about 10 feet or 2.5 meters) ahead of the bus along the sidewalk before crossing in front of the bus so that the bus driver can see them (National Highway Traffic Safety Administration, 2002). Figure 4.3 illustrates the Danger Zone concept.

Student Behavior Management. Student behavioral management strategies can help to improve both the quality and safety of the school bus experience by reducing

Figure 4.3
NHTSA's Danger Zone Around School Bus



SOURCE: National Highway Traffic Safety Administration, 2002.
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bullying, vandalism, and other negative incidents during school bus transit. Interviewees in Qatar reported a variety of challenges with discipline on buses in Qatar, similar to student behavior challenges experienced in other countries. Viable student behavior management strategies for Qatar include training bus drivers to effectively supervise children, enforcing a code of conduct with penalties for misconduct, and possible use of onboard video cameras to monitor behavior. Bus driver training and codes of conduct are consistent with international norms and could be readily applied in Qatar. Although onboard video cameras may deter bad behavior, video cameras need to be explored further to evaluate cost and public acceptance.

Bus Driver Training. School transportation systems in the United States train bus drivers in student behavior management. Fairfax County and Ventura County each have a manual on student behavior management. In Ventura County, drivers can issue reports on students who misbehave on the bus; if the misbehavior continues, the school can deny a student bus services at the discretion of the principal. Bahrain also takes a proactive approach that resolves behavior problems while minimizing direct confrontation between students and drivers. National Transport in Bahrain trains drivers to ignore student behavior during the bus ride and report problems at the end of the bus ride to management for resolution. Qatar can establish similar procedures.

Enforcing a Code of Conduct. Another option to manage student behavior is coordination with parents to enforce a code of conduct. In response to problems with vandalism, the Ministry of Education in Bahrain launched a program in 2010–2011 that required parents to sign a contract at the beginning of the school year that establishes expectations about children's behavior and disciplinary actions. Bahrain alerts parents that they are responsible for their children's behavior on the bus, and the ministry developed penalties and consequences, holding parents accountable for their children's actions. Ventura County uses a similar approach: Parents sign a contract establishing behavioral expectations and consequences for violating bus rules.

Cameras on Buses. Another option to manage student behavior is to install video cameras on school buses. Cameras can record vandalism or bullying, deter poor behavior of drivers and students, and monitor whether bus drivers are performing their duties properly (Gleave, 2003). Cameras can also counteract false allegations against drivers. Fairfax County installed cameras on buses and experienced a dramatic improvement in student behavior on buses. Ventura County also has cameras on all of its buses and includes voice recorders for the more troublesome buses.

Installing cameras on buses may be controversial in Qatar. In interviews in Qatar, the UAE, and Bahrain, interviewees thought that families would object to having cameras on girls' buses because of cultural sensitivities related to photographing girls. In fact, Bahrain considered adding cameras on buses to monitor behavior, but the idea was rejected to prevent the filming of girls. Should Qatar choose to explore the use of cameras, testing the use of cameras on boys' buses might be a way of determining their effectiveness. If cameras were to be installed, a response process would be required to

handle violations. The response process would need to clearly define who has access to videos, how behavioral problems would be handled, and how communications with parents should be handled.

Media on Buses. Media on buses, such as educational programming, entertainment or wireless media, is not consistent with international norms. However, some Qatar buses already have video capabilities that could be used provide educational programs or support public awareness campaigns, such as encouraging seat belt use or promoting healthy eating and exercise. Many Karwa buses in Qatar already have video capabilities, but they have not been used extensively. Interviews revealed that occasionally students have brought videos, and sometimes buses have played verses from the Qur'an. Emirates Transport in Dubai piloted using videos on buses but did not continue the program because it was difficult to find daily high-quality programming. If funding were available, Qatar could address the programming issue by contracting with Al-Jazeera Children's Channel, for example, to provide age-appropriate educational content for bus rides during the year.

Summary of Recommended Strategies

In this chapter, we described 20 strategies for updating Qatar's school transportation system. Should Qatar choose to conform to international norms, many of the strategies presented in this chapter may be viable in terms of implementation and cost. We recommend that Qatar consider pursuing the 13 strategies that are highlighted in green in Table 4.2. These strategies appear to carry little implementation risk and most can be implemented with modest investments. Table 4.2 shows the primary criteria used as a basis for recommendations. Strategies are recommended based on international norms and viability. We identified strategies as consistent with international norms if they were supported by the literature review or case studies. We identified strategies as viable if (1) implementation obstacles appear to be modest and (2) anticipated costs appear to be modest. Implementation obstacles may include major infrastructure changes or community resistance. While we have not conducted detailed cost analyses on each of the recommended strategies, we assigned positive cost ratings to strategies if major infrastructure investments are not required. For example, establishing new driver standards and training will require the drafting of standards and design of training curricula but can be accommodated within the existing organizational structures and infrastructure. As a result, we anticipate that the investment level for driver training will be modest.

Some strategies contain multiple options, some of which are relatively easy to implement and some of which would face significant implementation challenges. In these cases, we marked an "O," indicating that only a subset of the strategy appears viable. For example, some new bus standards, such as markings or paint, should be

Table 4.2
Candidate Strategies for Qatar's School Transportation System: Viability and Correspondence to International Norms

	International Norms		Viability	
Strategy	**Literature Review**	**Case Studies**	**Implementation**	**Cost**
School zone management				
School zones	√	√	O	O
Traffic laws, education, and enforcement	√	√	√	√
Bus design and operation				
School bus standards	√	√	O	O
Bus driver standards, training, and evaluation	√	√	√	√
Standardized checklists and reporting	√	√	√	√
Technology tools (e.g., RFID)	√	√	–	–
Maintenance standards and monitoring	√	√	√	√
Fleet operations and management				
Bus route optimization	√	√	√	–
Pick-up/drop-off points	√	√	–	–
Staggered school start times	–	√	–	√
Fleet size and composition	–	√	√	–
Information, communication, and analysis				
Policy manual	√	√	√	√
Awareness campaign	√	√	√	√
Stakeholder feedback process	√	√	√	√
Gather and assess safety data	√	√	√	√
Establish and monitor efficiency metrics	√	√	√	√
Student management				
Bus monitor enhancements	–	√	√	–
Student loading and unloading procedures	√	√	√	√
Student behavior management	√	√	O	√
Media on buses	–	√	–	–

NOTES: √ = Supported as international norm or no significant feasbility concern.
O = No significant feasibility concern for some options within strategy.
– = Not supported as international norm or feasibility is highly uncertain.

achievable at modest cost, while others, such as changes to restraint systems, may require the costly replacement of buses. As a result, some of the new bus standards are viable and others may be cost-prohibitive.

Some strategies carry great uncertainties that cannot be fully addressed without further study. Strategies that were judged to have large implementation or cost uncertainties are marked with a – symbol. These strategies are highlighted in yellow and addressed further in the next chapter.

The 13 recommended strategies are as follows:

- **School zones:** Establish clearly marked school zones with standardized safety features and traffic management around schools. Support school zone markings with traffic laws and public education.
- **Traffic laws, education, and enforcement:** Use traffic laws, education, and enforcement to control the behavior of private drivers near schools and school buses. Traffic laws, public education, and enforcement help to fully capture the benefits of school zones.
- **School bus standards:** Adopt international standards for school buses. Comprehensive school bus standards could be expensive to implement immediately for the existing school bus fleet. However, standards can be phased in with the acquisition of new buses and retrofitted over time for existing buses. The addition of school bus labels and color schemes are examples of standards that could be readily retrofitted at modest cost and effort.
- **Bus driver training and evaluation:** Establish universal standards for licensing and training bus drivers. Train bus drivers in bus operations, routing, school transportation policies, and student management. Ensure that evaluation processes are in place to provide drivers feedback on their performance.
- **Standard checklists and reporting:** Drivers should be responsible for completing daily standardized checklists and reports prior to pick-ups and after drops for each route they complete. Checklists not only help drivers adhere to standardized processes but also can increase transportation safety.
- **Maintenance standards and monitoring:** Establish maintenance standards for buses and a process for monitoring adherence. To ensure that buses are safe and reliable, use checklists to help drivers systematically and routinely inspect for maintenance problems.
- **Policy manual:** Publish a system-wide policy manual as a shared reference for all stakeholders in school transportation. A policy manual can help promote standardized processes and procedures across the school transportation system.
- **Awareness campaigns:** Conduct awareness campaigns to reinforce practices, policies, and laws. By educating drivers, awareness campaigns reinforce the importance of safety around schools.

- **Stakeholder feedback process:** Provide the school administrators and parents a mechanism for giving transportation officials feedback about issues with school transportation. Stakeholder feedback can help to highlight emerging problems.
- **Gather and assess safety data:** Maintaining and tracking safety data will enable leaders and policy makers to properly evaluate safety and formulate targeted responses to safety problems, including identifying necessary changes in training, policies, and equipment.
- **Establish and monitor efficiency metrics:** Establish performance metrics and develop a system to gather data to measure system-wide performance. Metrics are essential for assessing how well the system is performing and for measuring improvements.
- **Loading and unloading procedures:** The most dangerous times of school transportation are during loading and unloading of buses. Have trained staff supervise bus loading and unloading during peak hours.
- **Student behavior management:** Improving discipline on buses can support safety and enhance the quality of students' experience on the bus. Some strategies for addressing behavioral problems may be inexpensive to implement such as improved driver training and coordination with parents.

These strategies all conform to international norms identified during the course of this study and appear to be feasible in Qatar's operational context. Other strategies discussed in this chapter may also be of interest but require further review due to uncertainties about costs, benefits, and feasibility of implementation. Such strategies are discussed in Chapter Five.

CHAPTER FIVE

Evaluation of Select Strategies

This chapter presents a discussion of operating strategies that may be beneficial but potentially carry significant challenges. In identifying possible strategies for Qatar's school transportation system, some options emerged as strategies that are consistent with international norms and appear feasible within Qatar's operational context. Other strategies may offer significant benefits but raise important questions related to cultural concerns, uncertain cost-effectiveness, or inconsistency with international norms. These strategies were introduced in Chapter Four but do not appear in our listing of strategies recommended for consideration by Qatar. Due to uncertainties about their costs and benefits, we provide an initial evaluation in this chapter as a starting point for their consideration.

Strategies Considered and the Evaluation Methodology

Strategies we selected for further evaluation present tradeoffs that need to be more fully explored before recommendations can be made. The selected strategies include the following:

- Bus fleet: Altering the fleet size and composition
  - Option 1: Transition to smaller buses, to shorten route lengths and reduce student time spent on the bus.
  - Option 2: Decrease the number of buses servicing schools, which would increase the number of students on each bus and reduce costs.
- Bus stops: Implementing pick-up/drop-off points
  - Use bus stops to improve the efficiency of the school bus system.
- Staggered school start times
  - Coordinate start times to reduce congestion and potentially enable buses to service multiple morning and afternoon bus routes.
- Using technology tools: RFID
  - Integrate RFID tag devices into buses to enhance safety.

- Media on buses
  - Provide students access to media on buses, to enhance learning and increase bus.
- Enhanced bus monitor requirements
  - Set standards for bus monitors to enhance service quality and safety.

Note that the first two options listed, moving to smaller buses and decreasing the total number of buses in the fleet, are both potential elements of the strategy of adjusting the size and composition of the bus fleet described in the prior chapter. Given that these two options will have the tendency to counteract one another (moving to smaller buses will reduce ride times but add to costs, while reducing the number of buses will reduce costs but increase ride times), we find it helpful to first evaluate each option separately. After examining their potential effects in isolation, we then consider how they might be combined in a strategic way.

Criteria Used to Characterize Strategy Performance

The criteria adopted for the analysis include seven key performance dimensions identified as important for implementation during interviews with stakeholders. They are

- safety
- service quality (travel time, reliability, orderly bus environment)
- cost
- impact on congestion and the environment
- acceptance (alignment with Qatari values and culture as well as public acceptance)
- impact on bus demand
- implementation obstacles.

For each of these criteria, we rate each strategy as having a positive effect, having a mixed or negligible effect, or having a negative effect. A summary of the ratings for each of the strategies and each of the criteria is presented at the end of the chapter. In general, our assessment indicates that there are policy tradeoffs associated with each strategy evaluated here. That is, while there are benefits to all of these strategies, there are also downsides to each.

Our Evaluation Approach

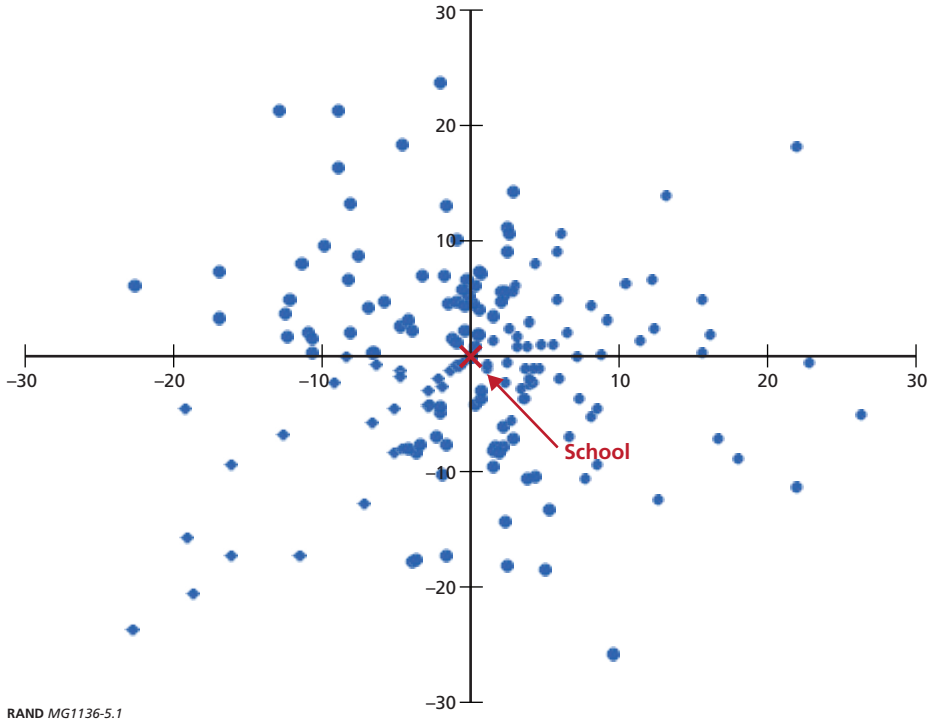
The evaluation builds on news articles, professional and academic literature, analysis of international norms, and interviews with schools, Karwa, and government officials. We also implemented a specialized modeling tool (the Bus Route Optimization model [BRO], detailed in Appendix C), which was developed as part of this project and enables us to simulate the effect on bus service of adopting a subset of the selected strategies. Below is a description of the BRO model and how it was tailored to represent Qatar's school transportation system.

The Bus Route Optimization Model. The BRO model evaluates how bus routes and student travel times would be affected by either changing the size and composition of the bus fleet (e.g., shifting to smaller buses or increasing bus occupancy rates) or including student pick-up and drop-off points rather than picking up students at their residences. The model requires relatively little input information and relies on a combination of simulation and optimization techniques.

For each school that the model considers, we note the number of students that ride the bus at the school and simulate how they are distributed around the school. The simulated distribution of households around the school is generated by randomly distributing points with a 60-minute driving distance radius from the school. Each household's location is drawn from a truncated exponential distribution. The parameters of this distribution were calibrated to survey data on the actual driving distance of bus-riding students from schools in Qatar. The survey data were collected as part of the demand analysis conducted on this project.

Figure 5.1 illustrates one simulated distribution for a school in Qatar. Travel time by car is assumed to be proportional to each household's distance from the school. That is, a household that is located twice as far from the school as another household is assumed to spend twice as long traveling to the school by car. Note that the density of households is greater at closer distances to the school. This is a characteristic of the truncated exponential distribution that was used in the simulation.

Figure 5.1
Bus Optimization Model

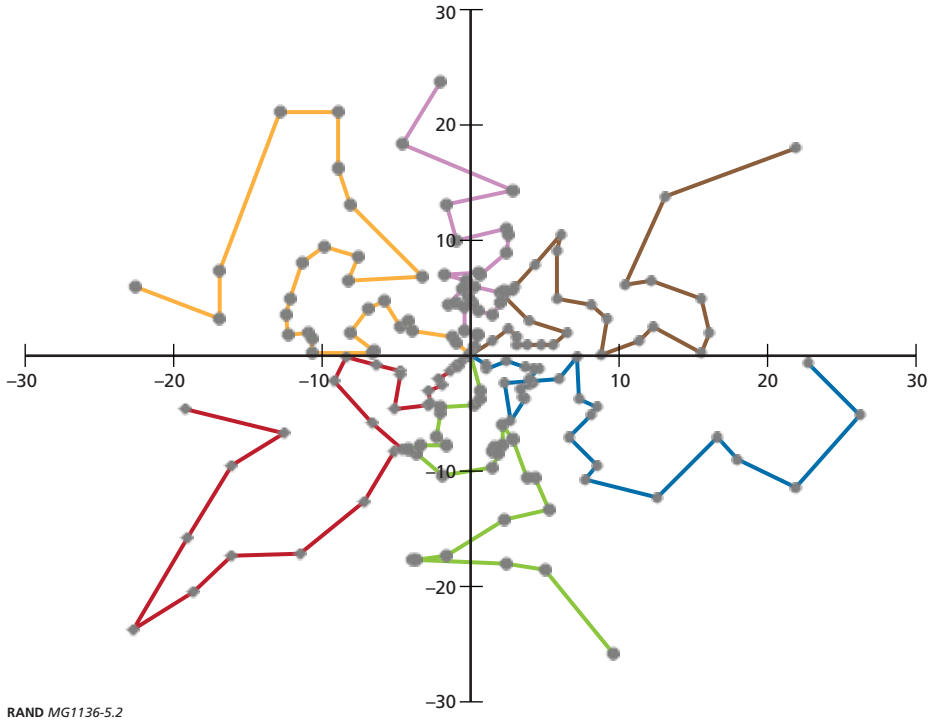


Assumptions about the number and size of buses servicing the school are input into the model to reflect fleet characteristics. The BRO model assigns each bus rider to a bus servicing the school and optimizes routes taken by the buses. The route is optimized to minimize total student travel time on the bus.

In Figure 5.2, six buses have been assigned to service the school. Each bus route is shown in a different color. Once the bus routes have been determined, the model calculates a variety of statistics, including the average student time on the bus, bus operating times and driving distances, and the cost of servicing students.

The model performs these steps for many simulated distributions of households around schools and then averages the key performance metrics. The data for each school are aggregated to characterize the overall average performance of different policies in Qatar. As a final step, we input the predicted effects into a demand-forecasting tool developed under this project for the purpose of quantifying effects on bus ridership.

Figure 5.2
Optimization Example



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As mentioned above, the model is designed to operate using data that were available to the RAND team for the analysis. These data include the following key inputs:

- Information on the driving distances from households to schools in Qatar. These data were developed from the survey discussed in Chapter Two.
- Information on the number of students who ride the bus, by school. These data were generated from a spreadsheet provided to RAND by the Supreme Education Council.
- For each school serviced by Karwa, RAND was provided with a description of the number and sizes of buses servicing each school.
- From ridership and bus size data, we were able to calculate the number of seats occupied on each bus at each school. The bus occupancy rate enters the model as an assumption that we can vary.

From these data, we applied the model to 20 representative schools in Qatar. The schools were stratified based on the number of students who ride the bus at the school.

The model was used to study three key strategies that involved

- changing the share of small, medium, and large buses
- changing the bus seat occupancy rate
- adding pick-up and drop-off points to the school bus route.

Evaluation of Select Strategies

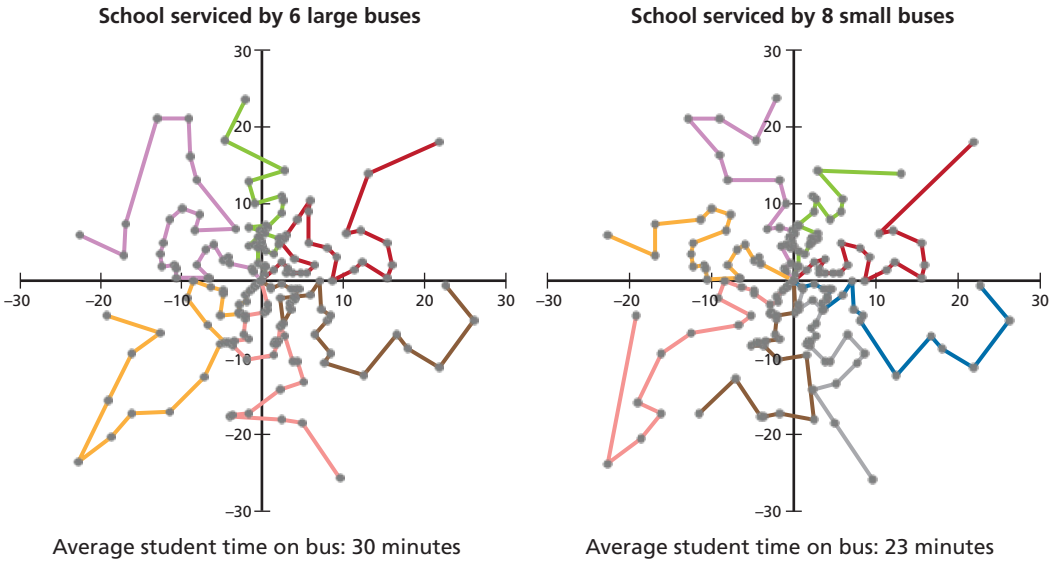
We now turn to our analysis of the seven strategies identified earlier. Our focus here is on characterizing their performance in Qatar. The findings provide an assessment of the direction and magnitude of the impacts of the strategy in Qatar. Inevitably, details of how each strategy is implemented could have important implications for the assessment.

Bus Fleet Option 1: Transitioning to Smaller Buses

The first strategy we look at is the effect of decreasing the number of students on each bus by moving toward smaller buses. This has the potential to reduce the amount of time that students spend traveling to and from school, because the number of stops that buses make will be reduced. Figure 5.3 illustrates this point. The left-hand example illustrates the bus routes for a school serviced by six large buses. In this case, the average student time on the bus is 30 minutes one-way. In the right-hand example, eight small buses are assumed to service the school. With eight small buses, the average amount of time that students spend on the bus decreases to 23 minutes.

It is important to emphasize that this is just a notional example, and actual effect will vary with the number of students using the bus at each school and where those

Figure 5.3
Comparison of Large and Small Buses



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students live in relation to the school. To get a better sense of this, we applied the BRO model to the representative set of 20 schools and then extrapolated the impacts to all Independent schools in Qatar.

To evaluate the effects of shifting to smaller buses, we considered two alternatives in terms of the share of large, medium, and small buses in the fleet. In the first case, we assume that an equal share of small, medium, and large buses are operated in Qatar. This would represent a large shift away from large buses to small buses, and a moderate increase in the number of medium buses used. In a second extreme case, we assume that all medium and large buses are replaced with small buses. The results are shown in Table 5.1

Table 5.1
Effects of Different Bus Sizes

Scenario	Bus Occupancy Rate (%)	Percentage Change in Number of Buses	Percentage Change in Cost	Percentage Change in Average Travel Time per Rider
Existing situation (70% large buses, 27% medium buses, 3% small buses)	67	–	–	–
Equal numbers of large, medium, and small buses	67	20	14	–12
All small buses	67	64	48	–34

In our modeling of these cases, we hold the bus occupancy rate constant. As a result, there is an increase in the number of buses that must be maintained and operated to service students. In the case where there is an equal share of small, medium, and large buses, the number of buses in service increases by 20 percent, and the cost of providing bus service increases by 14 percent. We see larger increases in the number of buses and bus costs when all small buses are required.

The potential average travel time reductions of these two cases range from 12 percent to 34 percent. Using the travel demand model developed for this project, we find that this would only slightly increase demand for school bus service.[1]

When we analyzed the effects of moving to smaller buses, it became apparent that the travel time benefits were greater at schools that have fewer bus-riding students and in cases where student populations being serviced by buses live farther away from the school. In these cases, smaller buses have a larger impact because, in general, the buses must travel longer distances between pick-ups. By transitioning to smaller buses, trips can be made more directly. As highlighted in Table 5.1, this has implications for where smaller school buses should be assigned when the Supreme Education Council allocates the contracted fleet to schools.

To summarize, moving to smaller buses would improve service quality (i.e., reduce travel time). At the same time, it would increase the cost of providing bus service. Because there are more buses on the road, but potentially fewer parents driving students to school, the policy would have an uncertain effect on traffic and emissions.

Bus Fleet Option 2: Reducing the Number of Buses

We also looked at the effect of maintaining the existing share of small, medium, and large buses and simply increasing the bus occupancy rate by 5 percent and 10 percent (see Table 5.2). In so doing, the Supreme Education Council would need to contract for fewer buses, which would reduce the costs of providing bus service. But this strategy would have negative effects on average student travel times, because buses would

Table 5.2
Effects of Reducing the Number of Buses/Increasing Bus Occupancy Rates

Scenario	Bus Occupancy Rate (%)	Percentage Change in Number of Buses	Percentage Change in Cost	Percentage Change in Average Travel Time per Rider
Existing situation	67	–	–	–
Increasing the bus occupancy rate by 5%	72	–7	–7	6
Increasing the bus occupancy rate by 10%	77	–13	–13	13

[1] The mode choice model implies that improvements in bus travel times (holding car times constant) will have only a small effect on bus demand.

effectively have longer routes and more stops. In effect, this strategy works exactly the opposite of the previous strategy. It may be an attractive strategy if decisionmakers are seeking to reduce their costs more than they are seeking to achieve other goals, such as improving service quality and promoting bus use.

It is important to note that this strategy could be combined with the previous strategy (moving to smaller buses). By combining these two seemingly opposing strategies, it may be possible to strike a better balance between costs and student travel times. To investigate this, we looked at a hybrid strategy in which the two smaller bus scenarios from the previous strategy were combined with a 5 percent increase in the bus occupancy rate. The results of this analysis are presented in Table 5.3. When an equal share of small, medium, and large buses are employed and when the bus seat occupancy rate is increased by 5 percent, we see that the cost increases by 6 percent while travel times improve by 7 percent.

Table 5.3
Effects of Combining Smaller Buses and Increased Occupancy Rates

Scenario	Bus Occupancy Rate (%)	Percentage Change in Number of Buses	Percentage Change in Cost	Percentage Change in Average Travel Time per Rider
Existing situation (70% large buses, 27% medium buses, 3% small buses)	67	–	–	–
Equal numbers of large, medium, and small buses, and 5% increase in bus occupancy rate	72	12	6	–7
All small buses, and 5% increase in bus occupancy rate	72	53	37	–31

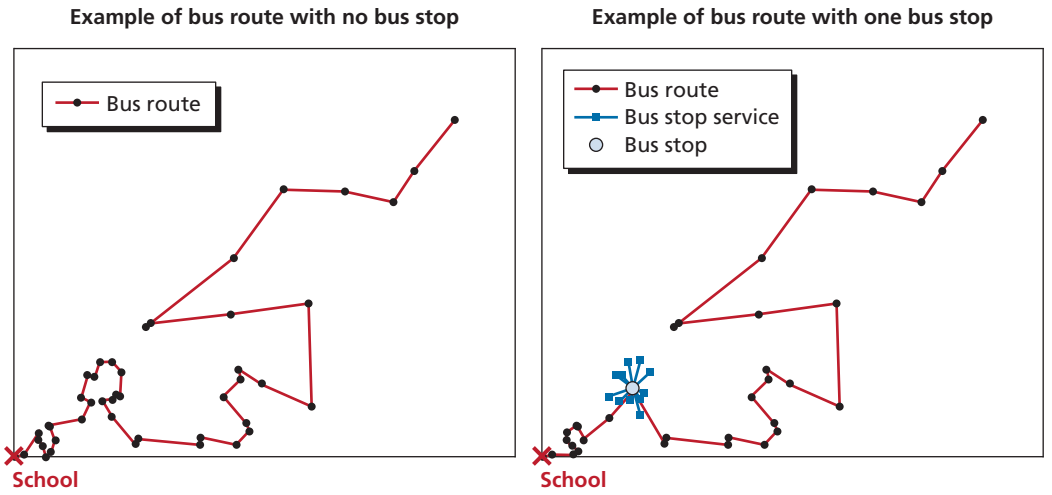
School Bus Stops: Adding Pick-Up/Drop-Off Points

In many other countries, school bus stops are standard and greatly improve the efficiency with which the bus transportation services can be provided. Within the GCC, Bahraini schools have incorporated pick-up/drop-off points into their school bus routes in an effort to reduce travel time.

By picking up and dropping off multiple students at a single location rather than at each student's residence, buses make fewer stops, which improves travel times for other students riding the bus. In addition, by reducing bus-running time, operating costs (e.g., expenditures on fuel, bus driver labor costs) can be reduced.

Figure 5.4 illustrates how school bus stops might work for a hypothetical route derived using the BRO model. In the left-hand example, a bus route is shown for which the average student time on the bus is approximately 40 minutes. In the right-hand case, 11 of the student stops are eliminated by requiring the use of a centrally located bus stop, which is shown in light blue. In this example, average student time on the bus

Figure 5.4
Effect of School Bus Stops on Journey Time



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is reduced by 7 minutes. Furthermore, the amount of time it takes the bus to pick up and drop off students is reduced, which can save the bus operator labor and fuel costs.

In our analysis, we considered two cases:

- In the first case, we add one bus stop to each bus route and require that all students within five minutes' walking distance use the bus stop.
- In the second case, we again add one bus stop to each bus route and require that all students within ten minutes' walking distance use the bus stop.

Table 5.4 shows the results.

Table 5.4
Effects of Introducing Bus Stops

Scenario	Average Number of Students Using a Bus Stop	Percentage Change in Average Travel Time per Rider
Existing situation (no bus stops)	–	–
One bus stop per route, small radius (students within five minutes' walking distance must use the bus stop)	5 (19% of riders)	–7
One bus stop per route, large radius (students within ten minutes' walking distance must use the bus stop)	8 (33% of riders)	–16

Note that in both of these cases the site of the bus stop was chosen to maximize the number of students who could use the bus stop within the specified walking distance. The bus route was then re-optimized to include the bus stop and omit the residences of students using the bus stop. Additionally, the shares of large, medium, and small buses in the system, as well as the average bus occupancy rate, were assumed to remain at current levels for the bus stop analysis.

In the first case, a typical bus stop accommodates about five students, or 19 percent of bus riders. Eighty-one percent of the bus users continue to be picked up and dropped off at their homes. In the second case, the radius of students who must use the stop is expanded and captures a larger number of bus travelers.

The average bus travel times derived by the BRO model are 7 percent and 16 percent less in the first and second case, respectively, than the status quo scenario that does not include any bus stops. Students who do not need to use the bus stop find their introduction attractive because they can now travel to and from school quicker in some instances. However, parents have raised significant opposition to school bus stops and say that they are less likely to allow their student to ride the bus if they are subject to having to use the stop. This will have a slightly negative effect on school demand.

Focus groups and parent surveys suggest that parents in Qatar are very much against requiring their students to use bus stops. Should they be widely adopted, they would likely have a negative effect on school bus use in the country. Despite such concerns, school bus stops may be applicable in certain instances in Qatar. For instance, if the school bus stop could be located within an existing building that offers appropriate supervision and access, it could be implemented with limited cost. There would still be public-acceptance issues that would need to be overcome, but the prominent and effective use of bus stops in other countries makes bus stops worthy of consideration if student safety can be ensured.

Given the issues associated with implementing bus stops in Qatar, this strategy does not perform well across many of the criteria we considered. Because sidewalks and crosswalks are not well established, we give it a negative score in terms of safety. For some students, it will improve bus travel times, while for others, it will require that they spend time waiting at the stop, which will reduce service quality. As a result, we give service quality a mixed performance rating. In terms of cost, school bus stops in other countries have been an important factor in enhancing the efficiency of the school transportation system. Qatar, however, would likely require significant investments in structures, which could be quite costly. Therefore, we give school bus stops a mixed rating in terms of cost. Because bus routes are shorter and take less time to complete with bus stops, impacts on traffic and environment are positive. Finally, for the reasons discussed above, acceptance, bus demand, and implementation obstacles are all negatively impacted should bus stops be pursued on a wide scale.

Staggered School Start Times

Staggered school start times have been adopted in other nations as a way of enabling individual school buses to make multiple morning and afternoon pick-up and drop-off trips. This strategy also has the potential to reduce congestion at schools when certain grades or groups of students start and end at different times or when neighboring schools have differing schedules. At the same time, they could aggravate some parents, making it more difficult to balance work and school schedules, while other parents may find staggered school start times attractive.

Most start times for government and private schools are between 7:00 a.m. and 7:30 a.m. With respect to Independent schools, the start time for all primary, preparatory, and secondary schools must begin sharply at 7:00 a.m. End timings also tend to vary for each school; however, the official end time for all Independent schools, regardless of grade level, is 1:30 p.m. There is more variation in the private school start and end times. For illustrative purposes, a sample of different private school start and end times is shown in Table 5.5.

Staggered school start times have the potential to reduce costs and traffic congestion near schools. Public acceptance would likely be mixed, however, since some parent schedules could benefit while others would be made more difficult. This may necessitate that work schedules be made more flexible so that parents can balance work and childcare responsibilities. Because of these issues, we acknowledge that there could be significant implementation obstacles.

Table 5.5
Start and End Times for Select Private Schools

	Pre-School		Secondary	
School	Start Time	End Time	Start Time	End Time
American School of Doha	8:00 a.m.	12:30 p.m.	7:55 a.m.	3:00 p.m.
Doha College	7:20 a.m.	12:30 p.m., AS: 2:30 p.m.	7:10 a.m.	1:20 p.m., AS: 2:30 p.m.
Doha English Speaking School	7:40 a.m.	12:55 p.m.	7:30 a.m.	1:00 p.m.
Middle East International School	7:15 a.m.	1:45 p.m.	7:15 a.m.	1:45 p.m.
Compass International School	7:30 a.m.	1:30 p.m.	7:30 a.m.	1:30 p.m.

NOTE: AS = after school extra curricular end times.

Technology Tools: Integrating RFID into School Buses

RFID is an innovative form of tracking technology that can follow the movements of students. The RFID system is composed of RFID tags and at least one RFID reader. RFID readers can be placed throughout the campus grounds and even on school trans-

portation vehicles. Tags are generally used as individual identification badges for students and faculty members to carry.

RFID tags can be active or passive. Passive tags carry limited data on the person being tracked and cannot transmit information over long distances. Students using this form of tag can only be tracked when they are in close contact with an RFID reader. By contrast, active tags are powered by self-contained batteries and can transmit information to access points hundreds of feet away.

With respect to student transportation, passive RFID tags are preferred over active tags. These tags can record the time, date, and location of students entering or exiting a bus. The card reader can then transmit the information to a secure database. Using software, school authorities can monitor student movements on and off buses as well as around campuses. If students are identified in places where they should not be (for example, on a bus after it has been shut down for the day), or if students are found not to be using the bus or attending school, school administrators and parents can be notified by an automated system.

RFID systems have various other uses. They can be installed in multiple locations on a bus to help ensure that drivers perform daily mandated safety inspections. Drivers can be directed to visit specific areas and check certain items, such as brake lights, rear tires, overhead interior lights, and emergency exits. Moreover, software can be installed on a handheld interrogator that can guide a driver through a series of questions about the bus's mechanical systems and RFID-tagged areas.

Additionally, RFID badges can be equipped with emergency call buttons that will automatically notify school authorities and parents if a student needs assistance. RFID readers placed in classrooms can record who enters and leaves the rooms, helping schools keep record of attendance and tardiness. Tags can also be affixed to high-value school property assets, such as laptop computers and overhead projectors, helping to secure and locate them efficiently if necessary.

Following the fatal incident of a student trapped in a school bus in 2010 (Pandit, 2010), Birla Public School in Qatar has already taken the lead in incorporating RFID technology to their bus transportation system. RFID tags are marked with student picture IDs and attached to a lanyard chain. Students using bus transportation are required to wear the tags around their necks before boarding buses in the morning and afternoon. Additionally, the school has equipped their fleet of buses with GPS devices.

There are many RFID service providers. Qatar-based iNet Middle East, for instance, uses a combination of RFID, GPS, and general packet radio service (GPRS) technologies to implement a student tracking system using both Qtel and Vodafone services. GPS systems that usually accompany RFID transportation technology can cost about 700–3,500 USD per bus for hardware and 10,000 USD for software to track the buses from a main location (Hurst, 2005).

It is important for schools to weigh the benefits and costs associated with implementing RFID into their transportation system. By monitoring students' travel to and from school grounds by means of RFID technology, schools can help assure parents

about their child's whereabouts, thereby creating greater appeal for the use of buses. On the other hand, broad application of RFID technology could entail significant costs, while many of the benefits achieved by RFID can be achieved through the implementation of manual processes.

Though RFID systems have been criticized as an invasion of privacy, information collected and transmitted can be securely processed and transmitted. Tags need not carry personal information about students. Instead, they can contain only ID codes to identify the networked device. A secure school database would then be needed to match ID codes specific to tags with student name, address, and affiliated contact numbers. Despite the fact that software can automate safety checks using RFID tag information, some schools may find maintaining and monitoring this information burdensome.

Examples of steps schools can take to better assess the benefits of RFID technologies include those listed below:

- Assess the tracking needs of schools and determine whether RFID tags could meet the needs better than other solutions.
- If RFID proves to be a cost-effective solution, design and distribute a parent and student survey to determine the acceptability for adding the RFID service.
- Consult with companies such as iNet about various options and costs associated with RFID technology integration at schools.
- Assess what kind of tag would reduce the probability of damage and misplacement (e.g., wallet tags, lanyard tags, backpack tags).

Providing Access to Media on School Buses

School buses can serve as more than just a mode of transportation. Time spent on the bus can be used to educate students. In an effort to embody the spirit of after-school programs, school buses could be outfitted with TV screens behind seats, which students could view and listen to using headsets. Educational content could be provided to students on a tailored basis. For example, TV screens could feature Al-Jazeera Children's' Channel, which recently entered into an agreement with Supreme Education Council to provide media services to all Independent schools. Installing such devices could also help maintain discipline among students by commanding their attention.

Educational media could be supplemented with directed educational exercises and activities. For instance, one school in Qatar, the Abu Bakr Al Siddiq Preparatory School for Boys, has integrated educational activities into its afternoon buses, which it calls the "Seventh Lesson." While monitoring students, a schoolteacher also provides students with mental exercises and educational games to occupy and benefit students. However, Tri-Logistics, a provider of school transport services to private schools in Qatar, does not incorporate such activities into its bus programs. The company asserts that interactive bus activities such as the "Seventh Lesson" can lead to potential outbursts and loud noises, which in turn can distract bus drivers and diminish the safety of students.

Internet access is another media option that could be considered. The Internet could be used to support homework assignments or provide entertainment while students are in transit. Providing Internet access could be less expensive than other media options since there may be little or no need to create specific content for the students. However, one drawback to Internet access may be the lack of control over content. There may be a need for content filters and attentive bus monitors to ensure that students do not access inappropriate Internet content.

Enabling students to view media on buses would require investments in screens and content. These investments could be substantial. At the same time, surveys of parents suggest that having media on buses is viewed positively and could increase school bus demand. Internet access may be a less expensive option but would require precautions to ensure that inappropriate content is not accessed.

Enhanced School Bus Monitor Requirements

Bus drivers and monitors carry different responsibilities. Bus monitors or attendants serve the important role of maintaining order and safety on the school bus. They can be hired from within the teaching faculty or separately. Bus monitors are usually required to have good communication skills, first aid training, and knowledge of the students who use the bus and their respective pick-up/drop-off points. Attracting qualified people with these skills requires sufficiently high wages. If qualified teaching faculty are hired to fill this role, they could potentially provide educational lectures to students on the bus.

School monitors are currently not used to a wide extent in Qatari Independent school systems due to obstacles of recruiting and training. However, buses carrying young students and female students have "farashas," who work as female maintenance employees during the school hours and accompany pupils on the bus to and from school. These employees do not have training in monitoring, disciplining, educating, or maintaining safety on the school bus. Several issues regarding farashas, including low salaries, lack of respect by the student body, and poor scheduling and substitution policies, need to be addressed.

Implementation of monitors in school transportation will require that schools recruit individuals who are fluent in either Arabic or English. Schools would also need to train monitors to perform cardiopulmonary resuscitation (CPR) and handle emergency situations. Moreover, schools should arm monitors with disciplinary power and capabilities to command the respect of students.

Though monitors generate additional staffing cost, they promote a safe environment within the school bus and among its riders. Furthermore, monitors improve school bus service by ensuring that student behavior is managed, order is maintained, cleanliness is monitored, air-conditioning/heaters are working, attendance is reported, etc. Monitors have high public acceptance and meet Qatari cultural values of ensuring increased supervision and comfort among students.

Comparing the Performance of Different Strategies

Our evaluation highlights the various tradeoffs between the seven strategies discussed above. To rank each strategy, we characterize how they will perform in Figure 5.5. Green indicates that the strategy enhances performance for a particular criterion. Red indicates that the strategy degrades performance in that dimension. In some cases, the effect of a strategy may be uncertain or produce mixed (both positive and negative) effects. We indicate this with a yellow value. In addition, we have added + and – symbols to indicate areas where strategies may have a particularly significant positive or negative effect. This would of course depend on how the strategy is actually implemented and is purely for illustrative purposes.

No single strategy performs well in terms of all criteria. Nevertheless, some strategies do look more attractive than others in terms of criteria that we know to be of great importance. For example, RFID and enhanced monitor requirements both perform well in terms of safety. Their chief downside is their cost. At the same time, these two strategies can partially substitute for one another. That is, RFID and monitors are duplicative in promoting some aspects of safety.

Figure 5.5
Expected Performance of Selected Strategies

	Safety	Service	Cost	Impact on Traffic/ Environment	Acceptance	Bus Demand	Implementation Obstacles
Transition to smaller buses	N/A	+	–		N/A		N/A
Reduce number of buses	N/A	–	+		N/A		N/A
Institute school bus stops					–		
Stagger school start times	N/A	N/A	+			N/A	
Integrate RFID tags into buses		N/A		N/A	N/A	N/A	N/A
Provide access to media on buses	N/A	N/A		N/A		+	N/A
Enhance bus monitor requirements			–	N/A			N/A

Enhanced performance Uncertain or mixed performance Degraded performance

NOTE: N/A = Not applicable.

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Conclusion

To conclude our analysis, we discuss sets of strategies that look promising, particularly when decisionmakers emphasize certain goals. In particular, we look at the case where policymakers put either (1) safety and service quality, (2) cost, or (3) sustainability, as captured by reduced traffic congestion and environmental impacts, ahead of other goals and objectives.

The proposed strategy sets are not intended to represent a comprehensive menu of options but rather were chosen from the limited set of strategies reviewed in this chapter. As discussed above, other strategies could enhance the school transportation system at little or no cost, and without harming other goals. These include the development of school zones, school bus standards, standardized operating procedures, adoption of new traffic laws affecting travel around schools (which should be coupled with public awareness and enforcement efforts to increase compliance), and the implementation of driver regulations and training.

If **safety and service quality** are deemed most important, shifting to smaller buses and adopting either RFID tags and/or enhancing monitor requirements look like appealing strategies. Smaller buses are already being used to a greater extent by the Supreme Education Council. As discussed in the previous chapter, smaller buses are most effective at reducing travel times at schools that attract students who tend to live further away and are more dispersed in where they live around the school.

To some extent, RFID tags and enhanced monitoring requirements accomplish similar safety goals and can be substituted for one another. It seems likely that, as RFID technology develops in the future, its cost will come down and opportunities to use it effectively both within the school transportation system and on campuses will increase.

The primary drawback to these strategies is that they are costly to implement. If implemented, however, all of these strategies could be first implemented at schools where they have the potential to provide the greatest benefits. As their effectiveness is better understood, decisions about expanding these strategies to other schools can then be made.

In contrast to the previous goals, if **reducing costs** is perceived as most important, then policymakers should consider reducing the number of buses, which will force schools to increase the bus occupancy rate. Our analysis showed that, on average, only about 67 percent of seats on buses were filled. If the bus occupancy rate was increased by 10 percent, the fleet of buses that the Supreme Education Council contracts for could be reduced by up to 13 percent, causing a comparable decrease in leasing costs.

Staggering school start times and having buses make multiple morning and afternoon trips is another effective way of reducing the number of buses that must be pro-

cured. This strategy has effectively been used in other countries where funding for school transportation services is more limited.

Finally, if **traffic congestion and emissions** are a key concern of decisionmakers, creating streets that better accommodate pedestrians and adopting bus stops could reduce bus route lengths, fuel use, and emissions. Staggering school start and end times by grade or class, so that students arrive and leave the school at different times, could help reduce traffic congestion around schools. In particular, when schools are located near one another, coordinating their start and end times to reduce the likelihood that parents are picking up and dropping off students at the same time could be useful. Finally, by increasing the bus occupancy rate, fewer buses would be required, which could reduce fuel consumption and bus emissions.

The strategies mentioned in this chapter may be of interest to Qatar since they represent additional options beyond the recommended strategies. Some of these may harness the benefits of technology, such as RFID and media access. Others may appeal to Qatari preferences, such as the use of smaller buses or monitors. Should Qatar find these concepts appealing, we recommend further research into their costs and benefits.

CHAPTER SIX

Recommendations and Concluding Observations

Demographic, developmental, and policy changes have coalesced to place increasing pressure on Qatar's school transportation system. The Government of Qatar recognizes this pressure and asked RQPI for an assessment of Qatar's school transportation system. This monograph addresses that request. It has surveyed the perspectives of those who administer the educational system and those who use it. It has provided a proposed vision and set of goals that are derived from and consistent with Qatar's national level policy documents. And the report offers strategies drawn from common practices of selected international school transportation systems.

We now summarize the recommendations presented in this monograph.

Adopt the Proposed Vision and Goals

We propose a vision comprising four elements, each with one or more supporting goals. The proposed vision and goals, summarized on the following page, are consistent with Qatar's national priorities and international norms of school transportation systems surveyed during this study. By adopting these statements of commitment, Qatar's decisionmakers will have a framework within which they can allocate resources and evaluate initiatives, policies, and programs aimed at improving school transportation for all Qatar students.

Vision Element 1: Provide Safe, Efficient, and High-Quality Transportation for Qatar's Students.

Goals:

- Effective safety standards and measures are established and enforced.
- Stakeholders achieve a high level of awareness about school transportation safety.[1]
- Access to the transportation system is safe and secure.
- Routes and bus sizes are optimized and consistent with the needs of schools, families, and community.
- Schools, drivers, and bus officials are informed and responsive to factors affecting students' commutes.
- Commute times are reasonable.
- School transportation services are consistent and highly reliable.
- Transportation staff are competent and professional.
- The bus experience is comfortable and pleasant.

Vision Element 2: Support Educational Options by Enabling Mobility and Access.

Goal:

- Transportation options are available to all eligible students—including handicapped students.

Vision Element 3: Provide a Transportation Experience That Is Supportive of Qatari Values and Culture.

Goals:

- Student interactions with other students are consistent with Qatari values and culture.
- Student interactions with drivers and monitors are consistent with Qatari values.
- The transportation infrastructure helps to preserve the character and sensibilities of Qatari communities.

Vision Element 4: Minimize the Impact on Traffic Congestion and the Environment.

Goals:

- Transportation operations minimize delays and traffic around schools.
- The transportation system promotes clean energy use and sustainable transportation modes (including bus ridership).
- Government, businesses, and schools work together to minimize congestion.

[1] Parents, student, drivers, and school administrators are primary stakeholders.

Recommended Strategies for Achieving the Vision and Goals

We have identified a number of areas where Qatar's school transportation system does not conform to international norms. To address these differences, we recommend that Qatar consider pursuing the 13 strategies that are highlighted in green in Table 6.1. These strategies carry little implementation risk, and most of them can be implemented with modest investments. We identified strategies as viable if (1) implementation obstacles appear to be modest and (2) anticipated costs appear to be modest. Some strategies contain multiple options, some of which are relatively easy to implement and some of which would face significant implementation challenges. In these cases, we marked an "O," indicating that a subset of the strategy appears viable. Some strategies carry great uncertainties that cannot be fully addressed without additional detailed data and analyses. Strategies that were judged to have large implementation or cost uncertainties are marked with a – symbol. These strategies are highlighted in yellow and are not recommended for near-term implementation.

Should Qatar seek to bring the school transportation system in line with common international practices, Qatar should focus on the following 13 strategies:

School Zones

Establish clearly marked school zones with standardized safety features and traffic management around schools. Standardized school zones would be consistent with international norms and support safety. Clear markings and other traffic management techniques help students remain safe near buses and protect students arriving by car and on foot. These measures would entail costs, but the Supreme Education Council could choose to implement the less expensive measures as an initial phase, e.g., signage, speed limits, and marked crosswalks. More expensive measures, such as speed bumps, flashing lights, and traffic directors, could be implemented later.

Traffic Laws, Education, and Enforcement

Use traffic laws, education, and enforcement to help control the behavior of private drivers near schools and school buses. Laws set the standards for driver behavior. Education informs drivers about the behavior expected of them. And enforcement by traffic police ensures that there are penalties for not adhering to the laws. Traffic laws, public education, and enforcement help to fully capture the benefits of school zones.

School Bus Standards

Adopt standards for school buses. School bus standards are consistent with international norms and would support both safety and quality elements of the vision. Comprehensive school bus standards could be expensive to implement immediately for the entire existing school bus fleet. However, standards can be phased in with the acquisition of new buses and retrofitted over time for existing buses. To reap the benefits of school bus standards, all standards do not need to be implemented in the near term.

Table 6.1
Candidate Strategies for Qatar's School Transportation System: Viability and Correspondence to International Norms

	International Norms		Viability	
Strategy	**Literature Review**	**Case Studies**	**Implementation**	**Cost**
School zone management				
School zones	√	√	O	O
Traffic laws, education, and enforcement	√	√	√	√
Bus design and operation				
School bus standards	√	√	O	O
Bus driver standards, training, and evaluation	√	√	√	√
Standardized checklists and reporting	√	√	√	√
Technology tools (e.g., RFID)	√	√	–	–
Maintenance standards and monitoring	√	√	√	√
Fleet operations and management				
Bus route optimization	√	√	√	–
Pick-up/drop-off points	√	√	–	–
Staggered school start times	–	√	–	√
Fleet size and composition	–	√	√	–
Information, communication, and analysis				
Policy manual	√	√	√	√
Awareness campaign	√	√	√	√
Stakeholder feedback process	√	√	√	√
Gather and assess safety data	√	√	√	√
Establish and monitor efficiency metrics	√	√	√	√
Student management				
Bus monitor enhancements	–	√	√	–
Student loading and unloading procedures	√	√	√	√
Student behavior management	√	√	O	√
Media on buses	–	√	–	–

NOTES: √ = Supported as international norm or no significant feasbility concern.
O = No significant feasibility concern for some options within strategy.
– = Not supported as international norm or feasibility is highly uncertain.

And some, such as unique paint schemes and proper signage, could offer immediate benefits at a relatively modest cost.

Bus Driver Training and Evaluation

Establish universal standards for licensing and training bus drivers. In international school transportation systems reviewed for this study, bus drivers received formalized training in school bus operations, routing, school transportation policies, and student management. Ensuring that evaluation processes are in place can provide drivers useful feedback on their performance.

Standard Checklists and Reporting

In accordance with international norms, drivers should be responsible for completing daily, standardized checklists and reports prior to pick-ups and after drop-offs for each route they complete. Checklists not only help drivers adhere to standardized processes but also can increase transportation safety. Checklists can help ensure all students have vacated the bus and can help identify problems with safety equipment on buses.

Maintenance Standards and Monitoring

Establish maintenance standards and a process for monitoring compliance. Maintenance standards would also aid efficiency and cost. Evaluation checklists would ensure that bus drivers comply with standards. And the establishment of maintenance standards and monitoring would help ensure that buses remain safe and reliable.

Policy Manual

Publish a system-wide policy manual as a shared reference for all stakeholders in school transportation. A policy manual can help promote standardized processes and procedures across the school transportation system. Policy manuals for school transportation can clarify roles, responsibilities, policies, procedures, rights, and expectations for service.

Awareness Campaigns

Conduct awareness campaigns to reinforce practices, policies, and laws. By educating stakeholders and motorists, awareness campaigns reinforce the importance of safety around schools. Such campaigns will be necessary if the traffic laws change to provide additional safety measures pertaining to school buses and school zones, e.g., adoption of stop-arms on buses, lowered speed limits.

Stakeholder Feedback Process

Provide the school administrators and parents a mechanism for giving transportation officials feedback about issues with school transportation. This could be achieved by scheduling regular meetings, conducting surveys, or providing instructions on how

written feedback may be submitted. By providing a formal feedback mechanism, stakeholders can become more vested in the school transportation system's success as their concerns are addressed.

Gather and Assess Safety Data

Maintaining and tracking safety data will enable leaders and policymakers to properly evaluate safety and formulate targeted responses to safety problems, including identifying necessary changes in training, policies, and equipment. Currently in Qatar, there are no well-maintained statistics on school transportation safety. Tracking and assessing even minor unsafe incidents can help Qatar better understand the causes of accidents.

Establish and Monitor Efficiency Metrics

Establish performance metrics and develop a system to gather data to measure system-wide performance. Metrics are essential for assessing how well the system is performing and for measuring improvements. Through periodic reviews, performance metrics can be measured against objectives and monitored over time. Metrics will also enable decisionmakers to conduct cost-benefit analysis for future policy decisions.

Loading and Unloading Procedures

Have trained staff supervise bus loading and unloading during peak hours. The most dangerous times of school transportation are during loading and unloading of buses. Standardized and supervised operating procedures, combined with proper supervision, can mitigate some of these risks with a modest investment in training for staff and children.

Student Behavior Management

Improving discipline on buses can support safety and enhance the quality of students' experience on the bus. School transportation systems have taken various approaches to managing student behavior on buses. Some strategies for addressing behavioral problems may be inexpensive to implement. For example, improved driver training and coordination with parents should not require large investments. Since the bus drivers already receive some form of training, adding new topics specific to transporting school children would only require modifying current programs of instruction rather than the creation of an entirely new training program.

Strategies That May Warrant Additional Research

In the course of researching strategies for this project, we have also identified additional strategies that require complex tradeoffs. Some of these strategies may be beneficial to Qatar's school transportation system, but each needs additional study to determine feasibility and evaluate whether the benefits justify the associated costs. Strategies that may warrant further investigation include the following:

- transitioning to smaller buses, to shorten route lengths and reduce student time spent on the bus
- decreasing the number of buses servicing schools, which would increase the number of students on each bus and reduce costs
- implementing bus stops to improve the efficiency of the school bus system
- staggering school start times, to reduce congestion and potentially enable buses to service multiple morning and afternoon bus routes
- integrating RFID tag devices into buses to enhance safety
- providing students access to media on buses, to enhance learning and increase bus ridership
- changing the requirements for bus monitors to enhance safety.

While some of these strategies have the potential to bring the school transportation system closer to international norms, they all bring special considerations that should be weighed before implementation. In particular, they would require cost-benefit analyses to determine whether the benefits of any given strategy will outweigh the costs of implementation.

Next Steps

This monograph makes many recommendations about how to align Qatar's school transportation system with international norms. Some of the recommendations are complementary or reinforcing. Such recommendations are best pursued as a set of coordinated initiatives. Other recommendations may be implemented as stand-alone initiatives. In choosing which strategies to implement, it will be important to consider which sets of initiatives to pursue to achieve the most efficient implementation and which sets of initiatives will achieve the greatest synergies after implementation. RQPI will provide to the government of Qatar a separate, companion document, titled "Qatar's School Transportation System: Implementation Manual," that will assist with these decisions and provide guidance on implementing each of the strategies.

APPENDIX A

Parent Survey: Supplemental Information

The survey was designed to reflect the diversity of Qatar's schools. The RQPI team visited selected schools and gave administrators surveys to distribute to students in a specific grade. The students then took the surveys home to be filled out by their parents and returned within a week. The RQPI team then received the completed surveys for analysis.

Data collection for this study occurred in spring 2009. At that time, the Ministry of Education still had Semi-Independent schools. Currently, all schools overseen by the Supreme Education Council are Independent schools.

Surveys were conducted at five schools, with differing status, gender of students, grades/stage, and location. Although the survey attempted to include a wide range of students, we recognize that it is not comprehensive and the sample size is limited. The results therefore provide indicative information only.

The surveys were distributed in the same week that the administrator focus group discussions were held. They were picked up one week later. Table A.1 describes the schools, the grade surveyed, and the number of surveys distributed and returned. The overall response rate was 52.8 percent.

The Achieved Sample

Although the survey response rate of 52.8 percent was high, there was substantial variation in response rates between schools (28 percent response rate from Al Wakra Independent Secondary School for Boys to 86.4 percent response rate from Al Shaqab Independent Primary School for Girls).

Some 97 percent of respondents came from car-owning households. Approximately 34 percent of households employ a driver.

As Figure A.1 shows, most of the respondents had a high school diploma, a bachelor's degree, or a higher degree. Fifty-six percent of the survey respondents were employed.

Nearly 50 percent of respondents were Qataris, as shown in Figure A.2. This proportion is broadly similar to the large-scale household survey carried out to support the Transportation Master plan, which indicated that 43 percent of the population were Qataris (Planung Transport Verkehr, 2008).

Table A.1
Summary of Parent Survey Responses by School and Grade

	Abu Bakr Al Siddiq Preparatory School for Boys	Arwa Bint Abdulmutalib Secondary School for Girls	Omar Bin Al Khattab Primary School for Boys	Al Shaqab Primary School for Girls	Al Wakra Secondary School for Boys
Independent	Yes	No	Yes	Yes	Yes
Gender	Boys	Girls	Boys	Girls	Boys
Grades surveyed	7th	11th	1st	5th	10th
Number of students	640	412	637	671	734
Location	Doha	Doha	Al Rayyan	Al Rayyan	Al Wakra
Distributed surveys	225	126	125	125	225
Returned surveys	139	48	78	108	63
Response rate	61.8%	38.1%	62.4%	86.4%	28.0%

Figure A.1
Educational Qualifications of the Survey Respondent

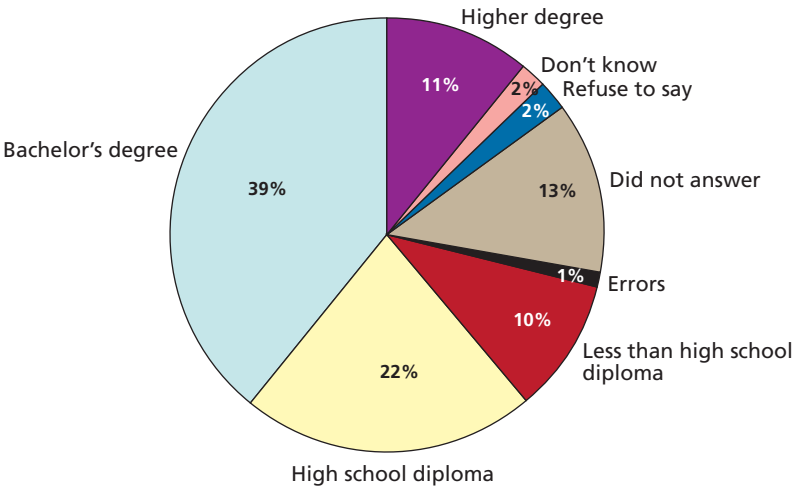

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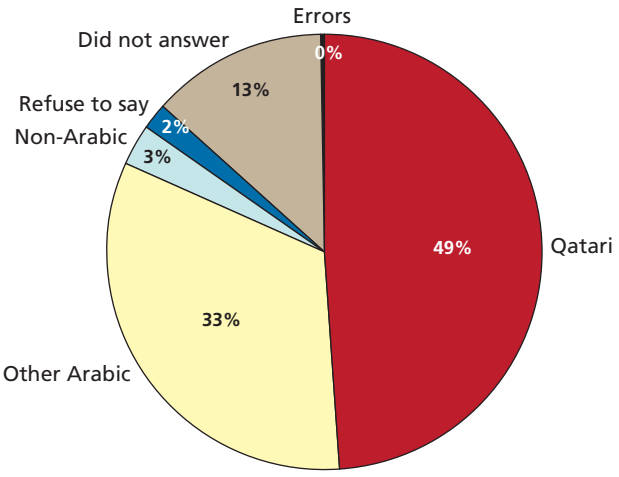
Figure A.2
Nationality of the Household in the Survey Sample



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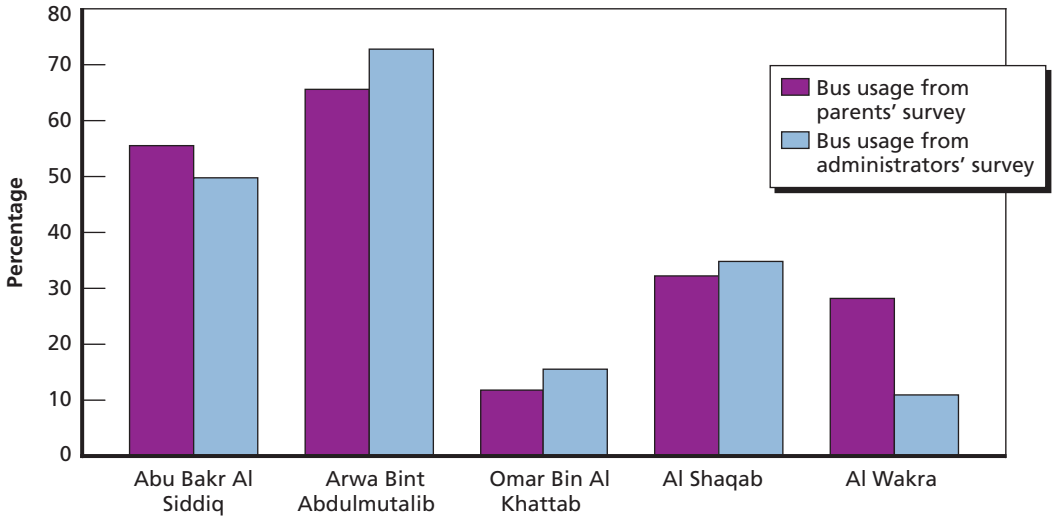
We also observe that the survey responses are broadly representative of actual school bus usage at each school except for Al Wakra school, where parents whose children travel to school by bus were more likely to respond to the survey (see Figure A.3).

Figure A.3
Bus Usage by School



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APPENDIX B

Overview of School Transportation in Other Gulf Cooperation Council Countries

Countries in the GCC near Qatar (namely, the UAE, Bahrain, Kuwait, Saudi Arabia, and Oman) provide a source of comparison for Qatar's school transportation system. This serves as a tool to ensure that options presented are culturally and logistically appropriate for Qatar. In this appendix, we provide a brief overview of the school transportation systems in other GCC countries, discussing their management structure, operations, services, student population, and reform or development efforts. The overview was created based on a review of open-source qualitative and quantitative data and interviews in the UAE and Bahrain. We used an initial version of this overview (with only the open-source materials) to select two GCC countries (the UAE and Bahrain) for further study, visits, and interviews. We then added further information about the UAE and Bahrain to this overview after our visits there. Descriptions of Kuwait, Saudi Arabia, and Oman are limited to what was found in the open sources.

United Arab Emirates

The UAE has seven individual emirates, each with significant self-governing authority. While the National Transport Authority, a national transportation regulatory body, does offer some overall transportation guidance to all emirates, in practice the authority for school transportation resides with each emirate. Here we discuss two emirates—Dubai and Abu Dhabi.

Dubai

The Emirate of Dubai has an organized public school transportation system, and the Dubai Roads and Transport Authority regulates and sets standards for the buses, school zones, and drivers (Dubai Roads and Transport Authority, 2011). Emirates Transport provides school transportation for all public school children, and private schools contract individually with companies for school transportation services. All school transportation operators must adhere to policies and regulations set by the Roads and Transport Authority. Emirates Transport provides service to about 18,000 pupils from

government schools; 84,000 students from private schools use private school transportation (Dubai Roads and Transport Authority, 2008a, p. 9).

In 2007, Dubai implemented a complete reform of its school transportation system. From 2006 to 2008, the Roads and Transport Authority studied school transportation approaches around the world (in particular the United States) and drafted complete reform plans ("RTA Unveils Rules Governing School Transport in Dubai," 2008). This resulted in a new regulatory framework and the publishing of a policy manual, the *Dubai School Transport Manual* (Government of Dubai, 2008) that describes policies, roles, and responsibilities for all parties involved in school transportation—the first system of its kind in the GCC. Objectives of the effort were to support industry and infrastructure in Dubai through efficient school transportation; to ensure safe and smooth transportation by adopting international safety standards; to prepare policies and procedures for school transportation system competency and reliability; to establish oversight of bus operations in efficiency, safety, licensing, and maintenance; to develop marketing campaigns for student awareness; and to create a system to process applications and complaints ("RTA Unveils Rules Governing School Transport in Dubai," 2008).

After the new standards were implemented, schools and operators were given a year to comply or otherwise face fines (Ahmed, 2009). Operators were required to retrofit buses, including painting all school buses yellow for recognition by other drivers, reducing the numbers of seats, and adding safety belts (Ahmed, 2009). School bus drivers are now required to have a special license to drive the school buses; the process includes completing training in driving safety and student management (Dubai Roads and Transport Authority, 2008b). In addition, the Roads and Transport Authority has conducted awareness campaigns for parents as well as students ("New Booklet Aims to Make School Bus Trips Safer in Dubai," 2009).

Dubai provides an important model for comparison to Qatar. Dubai, like Qatar, had a single bus operator providing transportation for public schools, with private operators providing transportation for private schools. Dubai's model of allowing all school transportation operators to continue operating, as long as they followed the new regulations, had the benefit of not requiring a new management model for school transportation while ensuring that both public and private school children would have the same access to safe school transportation. The system could continue using the same public and private operators, provided that all parties complied with new standards and policies. Dubai also adopted a variety of international practices, such as the requirement of special licenses for school bus drivers, awareness campaigns, school bus standards, and publication of a policy manual. The chapters of this monograph discuss specific examples of Dubai's practices. Table B.1 provides a summary of Dubai's school transportation system.

Table B.1
Overview of Dubai's School Transportation System

Organized public transportation system?	Yes
Provider	Dubai Roads and Transport Authority sets standards; schools contract individually with companies for services following these standards
Provided to	Public school students; standards apply to private school students as well
Students taking the bus	18,000 pupils from government schools and 84,000 from private schools
Availability of information	High
Reform or development efforts	2007 restructuring of entire school transportation system leading to Dubai Transportation Manual

Abu Dhabi

Abu Dhabi, the capital of the UAE, also has an organized public school transportation system. Emirates Transport provides 2,500 buses to transport students to and from public schools (Emirates Transport, 2008a, 2012). Approximately 205,000 students take the school bus, and the service is offered to all public school students (Emirates Transport, 2008a).

In 2009, Abu Dhabi began a study focused on improving its school transportation system, similar to Dubai's efforts. Previously, in 2007 and 2008, Abu Dhabi implemented several smaller changes to its school transportation system, including upgrading buses to include air conditioning and hiring Emirati nationals to serve as monitors on school buses (Emirates Transport, 2008b; Sroor, 2009).

Abu Dhabi also was a useful case to study because of its innovation in recent years in upgrading parts of its school transportation system, its current study to improve its school transportation system, and its approach to nationalizing school bus monitor positions. Table B.2 provides a summary of Abu Dhabi's school transportation system.

Bahrain

In Bahrain, the Ministry of Education is responsible for overseeing school transportation and setting policies. The Ministry of Education supervises transportation operators through contracting with one private company, National Transport, to provide school transportation services. National Transport then subcontracts operations with many small operators; the Ministry of Education only deals directly with National Transport.

In Bahrain, about 600 buses transport students to and from public schools (Saeed, 2008). The total number of students taking the bus is approximately 33,000,

Table B.2
Overview of Abu Dhabi's School Transportation System

Organized public transportation system?	Yes
Provider	Dubai Roads and Transport Authority sets standards; schools contract individually with companies for services following these standards
Provided to	Public school students
Students taking the bus	25,000 students
Availability of information	Medium
Reform or development efforts	2008 nationalization of bus attendants, upgrade of buses, provisions for students with special needs, undertaking a study to develop school transportation system

and public service is provided for those living far from schools and for those who do not have their own transportation. The government does not provide transportation for children in private schools. Unlike other countries in the GCC, Bahrain's Ministry of Education assigns pick-up and drop-off points for the students (Saeed, 2008).

School transportation in Bahrain has seen few major changes over the past several decades, with only minor developments in policies or operations. The Ministry of Education and National Transport have introduced gradual improvements to their services. In 2008, the Council of Ministers and the House of Representatives discussed having air conditioning on school buses. However, the project was not implemented because of its high cost (40 million Bahraini dinars) (Bahrain Ministry of Education, 2010; Saeed, 2008).

As discussed in the main body of this monograph, Bahrain provides a comparison in the use of pick-up and drop-off points, student behavior management, and awareness. Table B.3 provides a summary of Bahrain's school transportation system.

Table B.3
Overview of Bahrain's School Transportation System

Organized public transportation system?	Yes
Provider	Ministry of Education oversees; National Transport operates or oversees other small operators
Provided to	Public school students who live set distance from school
Students taking the bus	33,000 students
Availability of information	Medium
Reform or development efforts	Upgrade of buses in 2008 experimentation of parental involvement in student management, development of pick-up points

Kuwait

Kuwait has a publicly organized school transportation system, and the Kuwaiti Ministry of Education contracts with private transportation companies to provide school transportation services. About 1,100 buses transport students to and from schools (Radi, 2009). The Ministry of Education provides bus services to students who live further than 2 km from their school, students with special needs, and students in religious institutes. It is not clear from open sources how many students take the bus in Kuwait.

Kuwait has also experimented with development of its school transportation system. In 2007, Kuwait implemented a one-year pilot to put retired teachers on school buses to improve timeliness and behavior, but it did not adopt this as a program because of the prohibitive cost (Radi, 2009).

While Kuwait does have a public school transportation system and had made some efforts at developing it, other GCC countries had stronger school transportation systems and served as richer cases to study for Qatar. Table B.4 provides a summary of Kuwait's school transportation system.

Table B.4
Overview of Kuwait's School Transportation System

Organized public transportation system?	Yes
Provider	Ministry of Education oversees; private companies operate
Provided to	Student in religious institutes, special needs students, and students living more than 2 km from school
Students taking the bus	Unknown
Availability of information	Medium
Reform or development efforts	One-year pilot to put retired teachers on the bus as supervisors

Saudi Arabia

The Kingdom of Saudi Arabia does not have an organized public school transportation system; rather, parents and schools arrange for buses individually. Many families take their children to school with private transportation, and sometimes individual schools arrange with private companies for school transportation services. There are no universally applied standards for buses. Press coverage indicates a public perception that quality is a problem, with particular concern that some vehicles used may not be suitable for transporting students and that there are problems with student behavior. It is not clear how many students take the bus, or the number of vehicles used to transport them.

In 2008, Saudi Arabia implemented a pilot project to assess provision of school transportation services to girls. The Al-Ameen (Trustworthy) Project provided 4,200

public buses to transport 367,000 girls to schools in the Eastern Province, Riyadh, Mecca, and Qassim (Sambidge, 2008). The Ministry of Education led the effort, contracting with Hafil Transport Company in Riyadh for bus services. Saudi men were hired to drive the buses, with foreign drivers prohibited because of sensitivities about men driving girls. The goals of the pilot were to reduce transportation time and to transport students in a safe and culturally appropriate manner. The media reported complaints from parents about the quality of the service (Al-Sabir and Al-Adwani, 2008; Al-Nasir, 2008), saying that buses sometimes failed to arrive to pick up students, that there were not clear procedures on how to register students to take the bus, and that many drivers were poorly trained. While it is too early to know the results of the pilot, Saudi Arabia plans to extend school transportation services to other regions (Sambidge, 2008).

Given the lack of an established school transportation system, media complaints about quality, and only early stages of development efforts, Saudi Arabia did not seem a good model to study for Qatar. Table B.5 provides a summary of Saudi Arabia's school transportation system.

Table B.5
Overview of Saudi Arabia's School Transportation System

Organized public transportation system?	No. Parents and schools arrange for buses individually
Provider	Individuals or small transportation companies
Provided to	?
Students taking the bus	Parents and schools are responsible for providing school transportation
Availability of information	Low
Reform or development efforts	"Al-Ameen" (Trustworthy) project piloted in 2008 to provide school transportation to some girls with Saudi bus drivers

Oman

Very little information about school transportation in Oman was available. While the Omani Ministry of Education provides free transportation to students (International Bureau of Education, 2006), we found no other publicly available information about Oman's school transportation system, operations, or development efforts. RQPI contacted the Omani embassy in Qatar, but it did not have any readily available information about Oman's school transportation system. Table B.6 provides a summary of Oman's school transportation system.

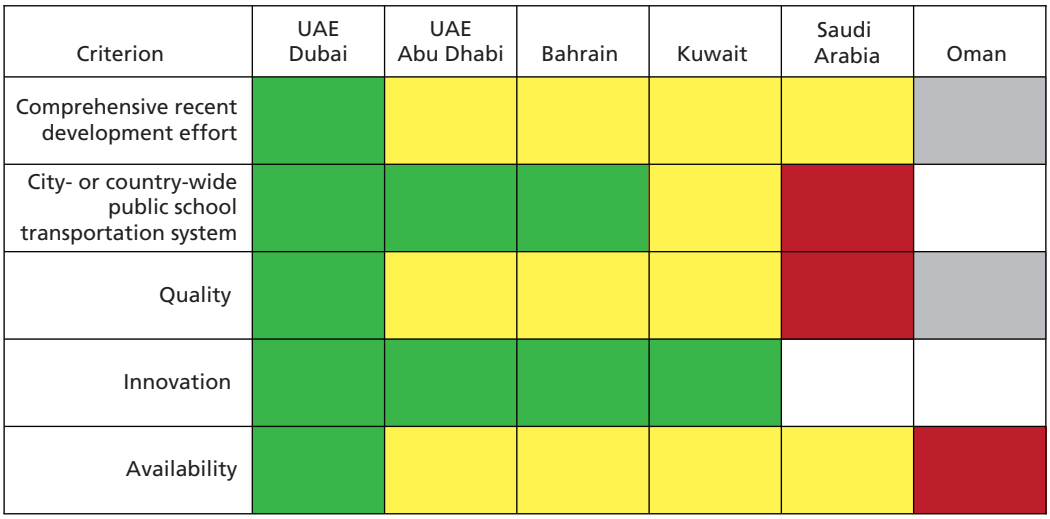
Table B.6
Overview of Oman's School Transportation System

Organized public transportation system?	Yes
Provider	Unknown
Provided to	Unknown
Students taking the bus	Unknown
Availability of information	Low
Reform or development efforts	Unknown

Selecting Two GCC Countries for Further Study

After comparing the GCC countries on their development efforts, the existence of a public school transportation system, reports of quality and innovation in the media, and availability of open-source information, we selected the UAE and Bahrain for further study for the following reasons. The UAE had at least two citywide public school transportation systems, with reputations for innovation and high quality. Dubai had implemented a recent overhaul of its school transportation system, and Abu Dhabi had experimented with several small development efforts. Bahrain had a long-standing public school transportation system, with a reputation for solid quality. Kuwait also might have been a good choice to study, but this research effort selected only two countries for visits and interviews. On the other hand, Saudi Arabia did not have a developed public school transportation system, and very little data were available about Oman's school transportation system. Figure B.1 is a stoplight chart that compares the GCC school transportation systems against the criteria for choosing countries to study.

Figure B.1
Criteria for Selecting GCC Transportation Systems to Study



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APPENDIX C

Bus Routing Model

The goal of the modeling analysis was to assess the likely effects of several potential strategies related to bus fleet composition and operations: specifically, transitioning to smaller buses, increasing bus occupancy levels, and incorporating bus stops to collect multiple students. The general approach within the study was to consider how such changes might affect the number of stops that a bus would need to make and then use bus route optimization to characterize the effects on student travel time.

In such an analysis, one would ideally examine actual student pick-up locations and optimize bus routes based on modeled travel times across the road network. Unfortunately, Qatar currently lacks the necessary information infrastructure to support such analysis: The Supreme Education Council does not maintain a database of student household locations, and a current serviceable electronic road network for Qatar does not exist. As a result, the study relied on the optimization of bus routes for simulated student locations and travel times, with the latter being estimated based on the Cartesian distance between locations. The approach was as follows.

Simulating Student Pick-up Locations

To simulate student pick-up locations, the first step was to consider potential variations in the number of bus riders at a school. The data collected at the beginning of the study included the number of bus riders at each of the 183 schools receiving government-provided school bus service, which ranged from 5 to 508 students per day. The distribution of bus riders at each of the schools was divided into 20 quantiles, and the median values from the 20 quantiles (i.e., the 2.5th percentile, the 7.5th percentile, etc.) were considered as possible values for the number of riders at a school.[1]

The analysis next considered different numbers of students that might be included on a bus route, ranging from 1 (the minimum possible occupancy) to 45 (full occupancy for the largest bus). For a given number of bus riders at a school and a given

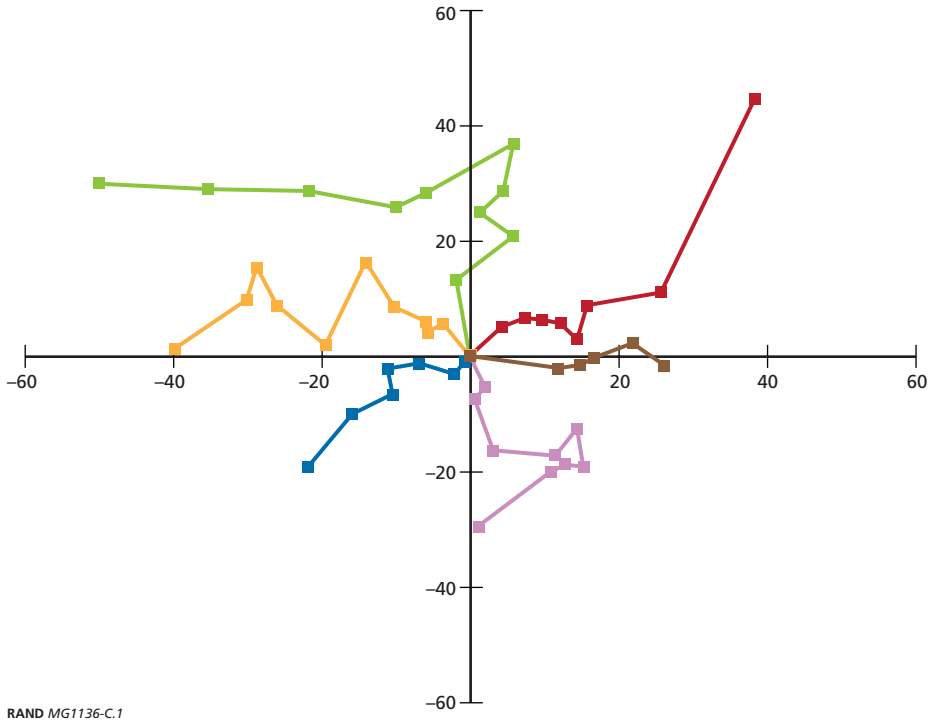
[1] The specific values used were 22, 32, 45, 57, 85, 101, 125, 149, 182, 200, 217, 234, 251, 264, 289, 316, 347, 378, and 436.

number of students on a particular bus route, we then assumed that the pick-up locations would tend to be clustered within a wedge (or "pie slice") of the area surrounding the school, with the angle of the wedge in radians calculated as

$$\frac{2\pi \times \text{number of riders on bus}}{\text{number of bus riders at school}}.$$

Such calculations are of course approximate and require some justification. To begin with, we assume that multiple bus routes serving a single school location will tend to be arranged as wedges around the school. To test this proposition, we set up and solved several moderate-sized multi–traveling salesman problems (using one of the mixed-integer formulations described by Bektas (2006) and relying on the CPLEX™ version 6.6 mathematical programming software) for pick-up locations distributed around a central origin/destination. Vehicles were assigned capacity limits to guarantee relatively even loads, and the first link in each tour—from the origin to the first pick-up point—was assigned a distance of 0 in order to generate linear rather than circular routes. Visual inspection of graphed results supported the expectation that optimal routes would in fact tend to cluster in wedges around the central destination. Figure C.1 illustrates an example for six buses routed to collect students at 50 pick-up

Figure C.1
Multi–Traveling Salesman Results for Six Buses and 50 Pick-Up Locations



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locations (in this and subsequent figures, units on the axes represent travel time in minutes; colored lines represent the bus routes).[2]

Calculating the size of a wedge based on the proportion of the number of students on a bus divided by the number of bus riders at a school also requires an assumption that bus riders are equally distributed in all directions around schools. This is not likely to be strictly accurate in real-world conditions, but it still should allow for a reasonable approximation.

After translating a given number of riders at the school and a given number of riders on a particular bus into a corresponding angular wedge, the next step was to simulate pick-up locations within that wedge. Each pick-up point was defined by an angle and a distance (in straight-line travel-time minutes) from the central school location. Angles were drawn from a uniform distribution within the wedge and distances were drawn according to a negative exponential distribution truncated at a radius of 60 minutes from a school. The parameters of this distribution were calibrated to survey data collected on the actual driving distance from home to schools, if traveled by car, for bus-riding students in Qatar. This reflects the fact that the spatial density of students who attend the school and make use of the bus system tends to decline with distance. To illustrate, Figure C.2 shows a set of 30 simulated pick-up locations at a school with 240 total bus riders.

For each distinct combination of total bus riders at a school and number of riders on a specific bus, with its corresponding angular wedge, we randomly generated 30 different sets of pick-up locations. In total, then, the experiment examined approximately 27,000 bus routing optimization problems: 20 values for total riders at school $\times$ 45 values for riders on a bus $\times$ 30 sets of pick-up locations for each combination.[3]

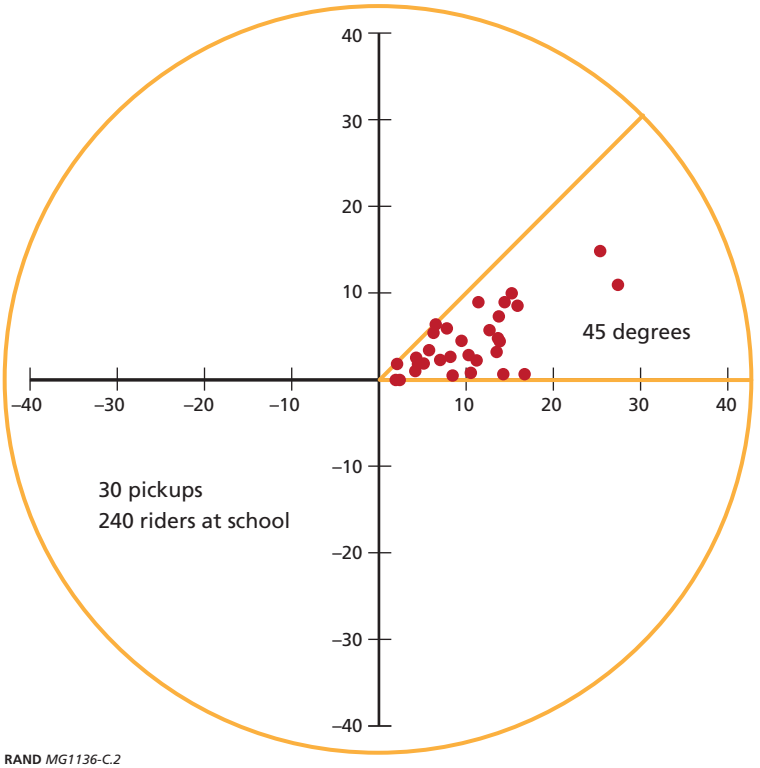
Optimization Overview

For each set of student pick-up locations considered—that is, for each distinct set of randomly generated pick-up locations within an angular wedge corresponding to a given number of riders at the school and riders on a particular bus—we began by optimizing a bus route to minimize total student time on the bus. Note that this goal differs from that of simply minimizing bus route distance. When minimizing total student travel time, early links in the route, with fewer students on board the bus, are inherently weighted less heavily than subsequent links when more students are on the bus. As a result, the optimized results will often include longer initial links so as to

[2] Unfortunately, computational time and memory limitations would not allow us to apply this approach to larger problems and the many cases we wished to explore here.

[3] In fact the actual number was 25,920; for the two cases in which total riders at school equaled 22 or 32, values for riders on a bus that would have exceeded total riders at the school were discarded.

Figure C.2
30 Simulated Pick-Up Locations at a School with 240 Bus Riders



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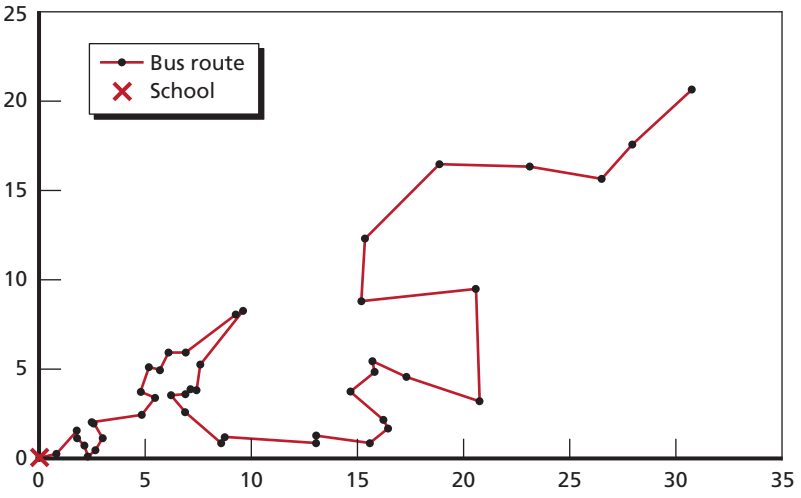
reduce the distance that must be traversed near the end of the route. This can be seen in Figures C.3 and C.4, which show the results for a set of 45 pick-up locations of optimizing the route to minimize total bus travel time (Figure C.3) and to minimize total student ride time (Figure C.4).

After optimizing the route to minimize student time on the bus, we then considered the addition of a single bus stop, located to maximize the number of students who could access the stop within a certain distance, and re-optimized the bus route to include that stop. This made it possible to evaluate what effect the addition of a bus stop would have on reducing route distance and in turn student travel time.

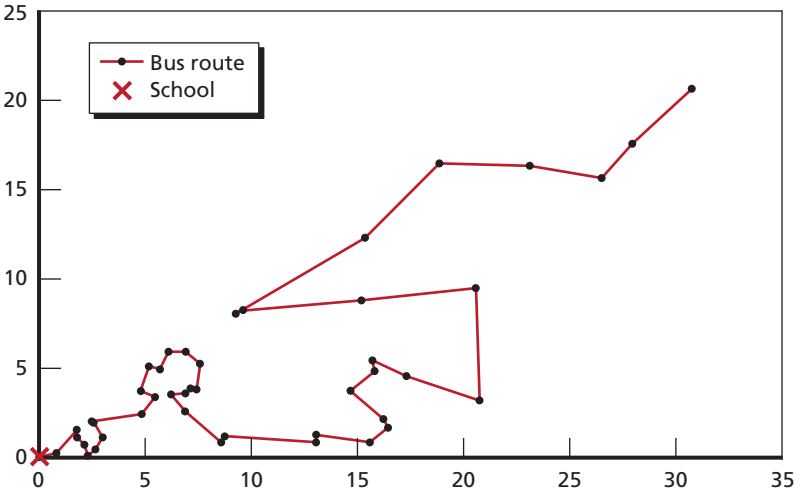
The rationale for examining just a single bus stop, rather than multiple bus stops, for a given route was as follows. Given the extreme temperatures, the common lack of sidewalks in Qatar, and the generally negative attitude toward the concept of bus stops expressed by parents in the initial survey work, a policy decision to implement bus stops was considered unlikely. Such a strategy would require significant investment in sidewalks around each stop as well as the development of enclosed, climate-controlled bus stop facilities. Given the remote prospects for adopting bus stops at this time, pur-

Figure C.3
Optimizing the Route to Minimize Bus Travel Distance



RAND *MG1136-C.3*

Figure C.4
Optimizing the Route to Minimize Total Student Time on Bus



RAND *MG1136-C.4*

suing a sophisticated modeling effort to examine placement of multiple bus stops along a route would likely have yielded little value for the client.

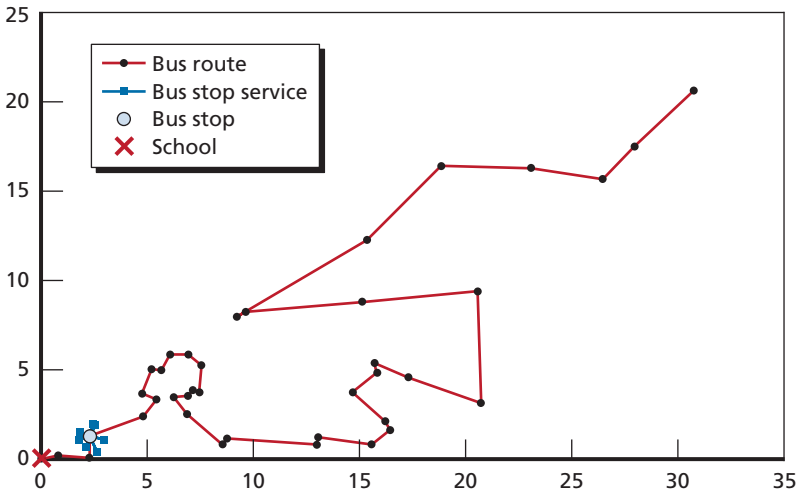
Examining the inclusion of just a single bus stop sited to maximize the number of students within a certain catchment radius, on the other hand, could be modeled with much less effort. And such analysis would at least provide an estimate of the maxi-

mum return—in terms of reduced student travel time—on the investment needed to add a bus stop to a route.[4] If decisionmakers then perceived that the student travel time improvements from adding a single bus stop merit the required investments, they could consider adding even more stops to the route. If, on the other hand, they perceived that the benefits of a single stop did not merit the costs of building sidewalks, developing a climate-controlled waiting area, and contradicting the expressed preferences of parents, then there would be no need to consider the addition of multiple stops along a route given the inevitably diminishing returns.

To allow for some variation, the bus stop analysis included two potential catchment radii: one and two minutes of vehicle travel time (corresponding roughly to five minutes and ten minutes of walking time). Figures C.5 and C.6 illustrate the results of optimizing the bus route to minimize student time on bus with the addition of a single bus stop with a catchment radius of five minutes' walking time and ten minutes' walking time, respectively.

Three observations from these sample results are worth noting. First, compared with the full route shown in Figure C.4, adding even a single bus stop can significantly reduce the complexity (and in turn travel time) of the route. Second, given that the spatial density of student locations decreases with distance from the school, bus stops tend to be located somewhat near the school. Third, depending on the specific spatial

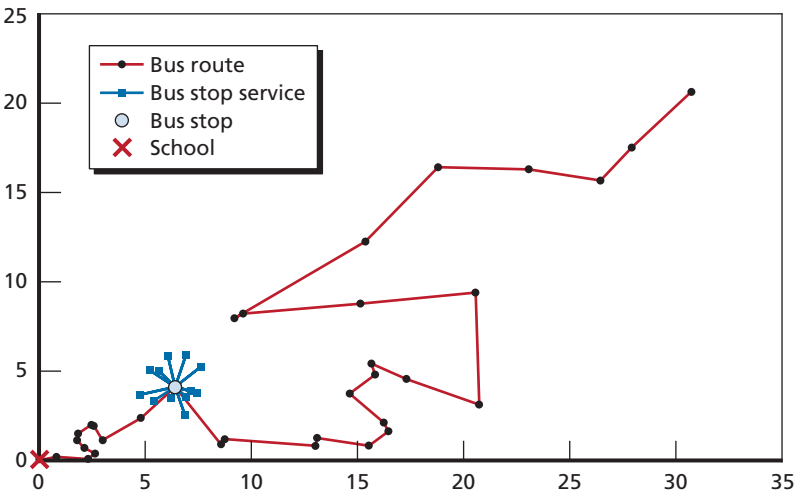
Figure C.5
Optimized Route with Single Bus Stop, Catchment Radius Five Minutes



RAND *MG1136-C.5*

[4] Adding multiple bus stops to a route would yield even greater reductions in time on bus, but each additional stop would collect progressively fewer students, resulting in diminishing reductions in student travel time at the margin.

Figure C.6
Optimized Route with Single Bus Stop, Catchment Radius Ten Minutes



RAND *MG1136-C.6*

distribution of pick-up points, changing the catchment radius can result in shifting the optimal location of a single bus stop.

For any given set of pick-up points, then, there were three distinct optimization problems considered: routing with no bus stops, routing with a single bus with a catchment radius of five minutes' walking time, and routing with a single bus stop with a catchment radius of ten minutes' walking time. As already discussed, our experimental design included 25,920 simulated sets of pick-up locations. This led us to solve roughly 75,000 total optimization problems.[5]

The results of these simulated optimization problems provided a helpful dataset for understanding how student travel times on the bus might be expected to vary based on the total number of bus riders at a school, the total number of riders on a bus, and whether or not the route included a bus stop. This data could then be sampled to estimate how changes in the bus fleet—that is, changes in the number of buses and their sizes, which in turn would affect the average number of riders on the bus routes—would affect student travel times by bus across the system as a whole, as well as how the inclusion of bus stops could affect student travel time. Using information from the Supreme Education Council's recent contracts with Karwa, we are also able to estimate the cost implications of such changes.

[5] For some of the sets with very few pick-up locations, it did not prove possible to locate a bus stop that could serve more than one student within a catchment radius of five or even ten minutes' walking distance; the total number of optimization problems was thus a bit less than 25,920 multiplied by 3.

Optimizing Bus Routes and Selecting Bus Stop Locations

The bus route optimization problem, as already described, was to design a route, traversing all pick-up locations en route to final arrival at the school, that would minimize aggregate student time on the bus. Representing a variation of the traveling salesman problem (Bektas, 2006), this can be formulated mathematically as follows.

First, let:

N = set of student pick-up locations

α = origin point for buses (school or elsewhere)

ω = final destination for buses (school)

O = set of route segment origins ($N \cup \alpha$)

D = set of route segment destinations ($N \cup \omega$)

p = number of route segment destinations, i.e., $|D|$

$t_{i,j}$ = travel time from $i \in O$ to $j \in D$

s_i = students to be picked up at location $i \in$ N

u_i = variable to indicate sequence of locations in route

$$X_{i,j} = \left\{ \begin{array}{l} 1 \text{ if bus travels from stop } i \in O \text{ to stop } j \in D \\ 0 \text{ otherwise} \end{array} \right\}$$

$$Y_{i,j} = \left\{ \begin{array}{l} \text{number of students on bus traveling from } i \text{ to } j \text{ (for } X_{i,j} = 1) \\ 0 \text{ otherwise} \end{array} \right\}.$$

Note that the s_i variables are intended to accommodate the inclusion of bus stops that collect multiple students. For designing routes that do not include bus stops—that is, when all students are picked up at their homes—the s_i values are all set to 1. When a single bus stop is added to the route, in contrast, the s_i value for the bus stop is set to the number of students to be picked up at the bus stop. Using the above notation, the bus route optimization problem can then be formulated as:

$$\text{Min } Z = \sum_{i \in N} \sum_{j=D} t_{i,j} Y_{i,j} \tag{1}$$

subject to:

$$\sum_{j \in D} X_{i,j} = 1 \qquad \forall i \in O \tag{2}$$

$$\sum_{i \in O} X_{i,j} = 1 \qquad \forall i \in D \tag{3}$$

$$Y_{i,j} = X_{i,j}\left(s_i + \sum_{k \in N} Y_{k,i}\right) \qquad \forall i \in N,\ j \in D \tag{4}$$

$$u_i - u_j + px_{i,j} \leq p - 1 \qquad \forall i \in N, j \in D, i \neq j \tag{5}$$

$$X_{i,j} = 0,1 \qquad \forall i \in 0, j \in D \tag{6}$$

$$Y_{i,j} = 0,1,2... \qquad \forall i \in N, j \in D\ . \tag{7}$$

The objective function (1) minimizes total student time on the bus, defined as the sum of travel times for each of the segments on the bus route multiplied by the number of students on the bus for each of the segments. Constraints (2) and (3) combine to ensure that the bus departs from its initial depot, arrives and departs from each pick-up location, and ultimately arrives at the school. Constraints (4) define the number of students on the bus for any given segment, which includes the number of students boarding at a given pick-up location plus the number of students already on the bus; if the segment in question is not included in the route, the number of students for the segment will be set to 0. Constraints (5), known as sub-tour elimination constraints (Miller et al., 1960), are intended to ensure that the solution represents a continuous linear route rather than including multiple discontinuous sub-tours. Finally, constraints (6) and (7) limit the decision variables to integer values.

In contrast to the standard traveling salesman problem, the formulation given above is nonlinear. This is because the objective of minimizing student time on the bus depends on the interaction of two variables: the $X_{i,j}$ variables, representing whether a given segment is included in the route, and the $Y_{i,j}$ variables, representing the number of students on the bus as it traverses that segment. It is possible to represent this interaction in several ways; in the formulation given above, the interaction is embedded in constraints (5). The nonlinearity in the formulation makes it more difficult to solve using exact procedures.

Given the complexity of the formulation, and the very large number of problems to be solved, our approach was to employ a relatively simple heuristic procedure: specifically, a variant of the λ-opt algorithm (Lin, 1965) that begins with an initial route and then iteratively seeks to improve that route by swapping the position of either one or two consecutive pick-up locations within the overall routing sequence (e.g., the fourth

and fifth pick-up locations might removed from their current ordering in the route and then reinserted between the seventh and eighth pick-up locations). The procedure continues until it is not possible to find any further shifts of one or two pick-up locations within the sequence that will improve the route.

The main strength of this approach is its speed, an important advantage when solving roughly 75,000 optimization problems. The drawback of the heuristic is that it may terminate in a solution that is far from optimal. This is a common challenge among heuristics that seek to improve a solution by evaluating a series of minor incremental changes to the current solution—they may become trapped in inferior "local optima" (suboptimal solutions that cannot be further improved through the heuristic's search strategy) rather than finding an optimum solution. One strategy for overcoming this limitation is to run a heuristic multiple times with different initial starting solutions, which may in turn lead to different final solutions, and then take the best final solution found in the series (see Church and Sorensen, 1996, for discussion of this approach in the context of location optimization modeling). Though this does not guarantee an optimal solution, it increases the odds that the final solution is either optimal or near-optimal.

Following this logic, our approach was to generate three initial starting solutions for each optimization problem considered, employ λ-opt to improve each of the solutions, and then adopt the best final result from the three runs. The procedures for developing the three initial starting routes can be described as follows:

- *Distance sort.* Pick-up locations are added to the route based on their distance from the school, with the farthest added first and the closest added last.
- *Nearest-neighbor.* The route begins with the farthest pick-up location from the school and then is constructed sequentially by adding the next nearest pick-up location that is not yet in the route, continuing until all pick-up locations have been included and then terminating at the school.
- *Reverse nearest-neighbor.* The route is built in reverse order, beginning with a segment from the school to the closest pick-up location and then sequentially adding the nearest pick-up location that is not yet in the route, continuing until all pick-up locations have been included.

The approach of generating three initial starting configurations, using λ-opt to improve each of the three routes, and then adopting the best final solution was employed three times for each set of simulated pick-up locations: once to optimize the route without the inclusion of bus stops to collect multiple students, once to optimize the route with the inclusion of a bus stop with a catchment radius of roughly five minutes' walking time, and once to optimize the route with the inclusion of a bus with a catchment radius of roughly ten minutes' walking time.

For routing problems involving the inclusion of a bus stop to collect multiple students, the location of the bus stop was determined in advance of the routing optimization. Ideally, one would optimize the bus route and bus stop location in parallel, though this would require a more complex solution procedure. The procedure for selecting bus stop locations can be described as follows.

The first step was to construct a grid of points, spaced at 0.1-minute vehicle travel time increments, to consider as potential bus stop locations.[6] The next step was to examine each of the candidate bus stop locations and determine (a) the number of student locations that could be served by the bus stop within the desired catchment radius and (b) the average distance that those students would need to walk to reach the bus stop. Note that this computation included only student locations that were closer to the bus stop than to school. The logic for this was that if a student lived closer to the school than to the bus stop, they would rationally choose to travel directly to school rather than using the bus stop.

In selecting the bus stop to be included in the route, the principal goal was to maximize the number of students that could be served by the bus stop within the desired radius. If multiple candidate bus stop locations could serve the same maximum number of students, as often proved to be the case, then the average student walking distance to reach the bus stop was employed as a secondary objective. That is, the candidate location that could serve the maximum number of students with the minimum walking distance was selected for the bus stop.

After selecting a bus stop location, students within the desired catchment radius were assigned to the bus stop, and the route was then optimized to include that stop. To facilitate a more equitable comparison between bus routes with and without bus stops to collect multiple students, the analysis also considered the time that it would take for a bus to stop and pick up students. Lacking empirical data upon which to calibrate such effects, we assumed that it would take the bus 30 seconds to stop and load a single student, and that it would take 10 more seconds to load each additional student when collecting multiple students at a single stop.

Aggregating Optimization Runs

The aim of this research was to inform decisionmakers about the expected costs and benefits of variations on the strategies we considered as they might be applied in Qatar. To illustrate the results, we constructed and analyzed a small number of strategy scenarios to reflect potential changes in the mix of bus sizes within the fleet, potential changes in bus occupancy rates, and the omission or inclusion of bus stops, as follows:

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[6] If conducting an analysis to develop actual bus routes and bus stop locations for a particular school, one might instead rely on a road network map to develop a set of candidate bus stop locations.

- *Bus sizes.* The scenarios included the current mix (70 percent large, 27 percent medium, and 3 percent small), a moderate shift to smaller buses (33 percent large, 33 percent medium, and 33 percent small), and an aggressive shift to smaller buses (all small). Large buses were assumed to have 43 seats, medium buses to have 32 seats, and small buses to have 24 seats.
- *Occupancy rate.* The scenarios included the current rate (67 percent) as well as a modest increase in occupancy (72 percent and 77 percent), which would be achieved by reducing the overall number of buses and in turn aggregate seat capacity.
- *Bus stops.* The scenarios included the current case of no bus stops, as well as the addition of a single bus stop with a catchment radius of either five or ten minutes' walking time.

Note that the inclusion of a base case within the scenarios—current mix of bus sizes, current 67 percent occupancy rate, and current lack of bus stops—made it possible for us to consider how shifting to any of the other scenarios would likely affect cost and student ride times, in percentage terms, using common metrics.

Estimates for each scenario were produced based on the following steps. First, we conducted some preliminary analysis of the simulation and optimization runs. For each wedge of the same size and with the same number of bus riders, we averaged the results across the 30 different randomly drawn student residential locations. This reduced the likelihood that our findings might be skewed by an unusual set of randomly drawn residential location within any of the optimization simulations.

Second, for each of the 20 different values for the number of bus riders at a school considered within the analysis (drawn to approximate the actual distribution of bus ridership at the more than 180 public schools in Qatar), we assigned a certain (potentially non-integer[7]) number of large buses, medium buses, and small buses. The specific number of buses in each of these categories was based on (a) the number of bus riders at the school, (b) the percentage mix of large, medium, and small buses for the scenario, and (c) the occupancy rate for the scenario in question. We then determined the number of students that would be on each bus as well as the size of the wedge that each bus would serve, which in turn made it possible to estimate student travel time on each bus based on the preceding simulation and optimization runs.

To illustrate the second step, consider a school with 200 bus-riding students under a scenario with equal percentages of large, medium, and small buses and an occupancy rate of 67 percent. This would result in an assignment of approximately 3 small buses, 3 medium buses, and 3 large buses to the school. Each small bus would carry 16 students (24 seats × 67 percent occupancy), each medium bus would carry 21 students (32 seats × 67 percent occupancy), and each large bus would carry 29 students (43 seats ×

[7] While non-integer values for the number of buses are not realistic, they greatly simplified the analysis and are not expected to bias the finds in any particular direction.

67 percent occupancy). The size of the wedge served by the small buses would be about 8 percent of the area around the school (16 riders on the bus divided by 200 total bus riders at the school), or roughly 39 degrees or 0.505 radians; for medium buses, the wedge would be about 10.5 percent of the area around the school (21 riders out of 200 total); and for large buses, the wedge would be about 14.4 percent of the area around the school (29 riders out of 200 total). These values capture both the total number of bus riders at the school and the total area around the school: $3 \times (16 + 21 + 29)$ rounds to about 200 riders, and $3 \times (8 \text{ percent} + 10.5 \text{ percent} + 14.4 \text{ percent})$ rounds to about 100 percent of the area around the school.

Third, to estimate the effects of the strategies embedded within a scenario across the Qatar school system, we applied the calculations just discussed to the 20 sampled values for the number of bus riders at a school and then summed and averaged the results, weighted for the number of students at each school. The metrics for comparing the performance of the alternate strategy scenarios included average student travel time on bus, the total number of buses in operation, the cost of procuring bus services, and the share of students that use the bus stops. For comparison purposes, the metrics for each scenario were presented in terms of percentage change from the base-case scenario (i.e., changes from the system as it currently stands).

APPENDIX D

Documentary Support for Strategies

The table below illustrates the relationship between the strategies developed for the Qatar school transportation system and the literature reviewed for the study. The left column shows the five areas of the strategy and their subcomponents, the middle column shows the literature source relevant to a given subcomponent, and the third column shows the finding from the particular strategy that is relevant to the subcomponents. The five major components of the strategy are school zone management; bus design and operation; fleet operations and management; information, communication, and analyses; and student management. If a given literature source is relevant to more than one element of the strategy, it is repeated in the rows of the table for that strategy.

Table D.1
Documentary Support for School Transportation System Strategies

Strategy	Source	Findings of Source
School zone management		
School zones	Laue, 2001	Physically control students to ensure safety (e.g., fences) Separate exits for students who do not ride the bus Design functional sites for buses at schools (separate loading zones for cars and buses) Reduce car traffic Supervise loading
	Organisation for Economic Co-operation and Development, 2004	Traffic calming measure warrant consideration (speed limits, signs, speed bumps) Recognition zones around bus stops, detection and warning systems, and improved mirrors for buses are all recommended

Table D.1—Continued

Strategy	Source	Findings of Source
	Isebrands and Hallmark, 2007	High volume of private vehicles attempting to access school properties causes severe congestion and queuing Establish a school transportation committee Organize a structured arrival and dismissal procedure Separate the different modes of transportation Have separate loading and unloading zones if possible Real-time speed radar signs that flash vehicle speeds are becoming more prevalent in school zones, as are "Fines Double in School Zones" signs. Another sign to consider would be the pedestrian countdown timers and signalized intersections and mid-block crossings because they offer students the opportunity to know if they have enough time to safely cross the street
	Koushki and Al-Najjar, 2008	High level of non-compliance and lack of traffic law enforcement lead to high number of accidents
	Cooner, 2005	Separate modes of transportation, cars, buses, pedestrians should have separate routes Stage school buses single file, not in multiple lanes
	Gleave, 2003	Reduced public congestion through modal shift from private car to bus Reduced traffic congestion at school and school gate through modal shift from private car to bus Improved behavior on existing transport
Traffic laws, education, enforcement	Matke, 2002	Failures to stop caused by ignorance, lax or light penalties, indifference or lax enforcement Campaigns against stop-arm running should be local Set standards and ensure enforcement
	National Highway Traffic Safety Administration, 2002	Violations from ignorance, indifference, or lax enforcement Enforce laws consistently Establish and disseminate enforcement standards Develop partnership with law enforcement, government Educate students about rules, dangers
	Laue, 2001	Educate and enforce traffic safety laws
	National Highway Traffic Safety Administration, 2012	Establish a system for drivers to report violations
	National Highway Traffic Safety Administration, 2004	Focus child safety education on the areas outside the schools bus Dangling drawstrings can get caught in bus doors resulting in dragging a child Need system for drivers to report violations
	Organisation for Economic Co-operation and Development, 2004	The most effective programs have a comprehensive and holistic approach Education needs to be targeted at the child's stage of development and part of standard education curriculum

Table D.1—Continued

Strategy	Source	Findings of Source
	Koushki and Al-Najjar, 2008	Strict enforcement of the enacted laws is crucial to the process of improving child safety in transportation in Kuwait
Bus design and operation		
School bus standards	Parker, 2002	Buses safer than cars Danger most during off- and on-boarding Lights, distinctive bus color, stopping arms all help, but accident data show more needs to be done Should: o Establish standards o Review safety of stop points o Get ideas from police, fire vehicles o Modify, amplify current alert devices
	Ministry of Transportation of Alberta, Canada, 2008	Consider U.S. standards in bus design Focus on emergency exit capability Put crossing arms on all buses Pedestrian alert signals (optional) Compartmentalization better than seat belts Require amber flashing lights on all 8-light systems Introduce 6-mirror system Retrofit buses with reflective tape
	Green, 2008	Fit buses with external loudspeakers so driver can direct children
	Hirano, 2004	16 years of data on front-end of bus accidents show that 115 fatalities involved buses without crossing arms compared with 11 for buses with crossing arms Improved visibility of buses important. Flashing strobe lights can help. LED message lights (STOP, DO NOT PASS) effective in stopping drivers from passing school buses
	National Highway Traffic Safety Administration, 2012	Federal manufacturing standards for school transport require stop-arms for school transport vehicles Should protect students without need to buckle up School buses are safer than cars as a way to get to school
	Organisation for Economic Co-operation and Development, 2004	Vehicle standards and safety equipment important in the comprehensive approach to children's road safety Vehicle design should incorporate passive safety systems like crumple zones, airbags, safety windows, and window locks
	McMahon, 2005a	Compartmentalization time tested but not always effective for younger children too small to be protected by seats
	Einstein, 2000	U.S. buses in study have distinctive color, flashing lights, stop-arms, compartmentalized seating School bus manufacturers held to higher standard than just bus manufacturers (e.g., side impact, roll-over, flame retardant)

Table D.1—Continued

Strategy	Source	Findings of Source
Bus driver standards, training, evaluation	Ministry of Transportation of Alberta, Canada, 2008	Amplify driver vetting process in place Offer driver training updates and enhanced training (bad weather) Reward safe drivers Develop standardized hiring criteria
	National Highway Traffic Safety Administration, 2002	Ensure drivers know rules so they can report safety violations
	Laue, 2001	Train and monitor school bus drivers (deviating from routes, violating policies) Pay drivers for delays beyond their control
	Finlayson-Schueler, 2004	Establish a goal and reward system for drivers Require accountability
	Organisation for Economic Co-operation and Development, 2004	Training and education of those who transport children to school is a major imperative
	Koushki and Al-Najjar, 2008	Bus drivers in study received special training, including passenger management , specifically for ages of children they transport
	Einstein, 2000	Have consistent bus drivers on routes; train them
	Connecticut Department of Transportation, 2012	Before becoming a school bus driver, a person must undergo extensive training and testing, including bus operator and school district training to learn routes, policies and additional student management training
	Georgia Department of Education, 2005	Drivers require 12 hours of classroom instruction and 12 hours of actual driving (6 hours with students; 6 hours without) Training includes vehicle inspection, basic first aid, and techniques for student management
Standardized checklists and reporting	McMahon, 2005b	Establish system for drivers to report "Bus Stop Hazard"
Technology tools (CCTV, RFID)	Green, 2008	Consider technologies to assist in seeing children and tracking their locations (camera, RFID tags)
	Finlayson-Schueler, 2004	Cameras on buses enable analysis of student behavior that may contribute to accidents
	Hirano, 2004	Motion activated sensors in blind spots can alert drivers to potential problems
	Einstein, 2000	Continually running video surveillance tapes were retained in the event of an incident, forwarded directly to the Sheriff's Department, which then coordinated review and enforcement actions
Maintenance standards and monitoring		

Table D.1—Continued

Strategy	Source	Findings of Source
Fleet operation and management		
Optimize bus routes	Ministry of Transportation of Alberta, Canada, 2008	Assess and monitor routes for safety
	Green, 2008	Create as much routine as possible, and have procedures in place for when a departure from the routine may be necessary
	Hirano, 2004	Assess and evaluate routes constantly (3X per year)
	Rashidi, Zokaei-Aashtiani, and Mohammadian, 2009	Complicated problems but algorithms exist to simplify the calculations; demonstrated on a system in Tehran
	Rhoulac, 2005	K-8 more likely to ride school bus morning and afternoon, especially if sibling can wait at bus stop. Higher grades more likely in afternoon. Higher income families more likely to ride school bus
Pick-up/ drop-off points	Green, 2008	Mark school transport stops Automate school transport process
	Hirano, 2004	Increase the visibility of stops as much as possible so motorists can clearly see bus
	National Highway Traffic Safety Administration, 2012	All school zones should be marked
	Isebrands and Hallmark, 2007	Structure drop-off and pick-up zones should be to minimize the number of times that children would have to cross paths with buses and private vehicles
Staggered start/stop times	Isebrands and Hallmark, 2007	If separate loading/unloading zones not possible, consider staggered start-stop times
Fleet size and composition		
Information, communications, and analysis		
Policy manual		
Awareness campaign	Matke, 2002	Campaigns of all lengths have increased attention on problem Develop and deploy media tools to heighten awareness Increase attention of local officials
	National Highway Traffic Safety Administration, 2002	Disseminate information widely Establish data analysis process
	Isebrands and Hallmark, 2007	Communicate with parents and students regularly to keep informed about safety issues
Stakeholder feedback process	Isebrands and Hallmark, 2007	Of the schools that were under observation, those that had a school transport committee were better prepared to address complaints and concerns and had procedures in place to resolve issues

Table D.1—Continued

Strategy	Source	Findings of Source
	Finlayson-Schueler, 2004	Create a Safety Committee or School Transportation Committee that will offer a forum for safety issues to be identified and repaired
Gather, assess safety data	National Highway Traffic Safety Administration, 2002	Gather data
	Matke, 2002	Track data on violations
	Finlayson-Schueler, 2004	Gather information by analyzing all data sets available; fatalities too infrequent so look at all data for trends
Establish and monitor efficiency metrics	U.S. Department of Transportation: Federal Transit Administration, Office of Safety and Security, 2011, p. 67, pp. 80–83	Cannot improve safety reliably and effectively without performance metrics Most transit systems do not effectively use the data they collect Three most common forms of metrics are a number (e.g., total number of accidents), a rate (e.g., accidents per X miles driven), or a ratio or percentage (e.g., ratio of preventable to non-preventable accidents or percentage of accidents that occur at stops)
	Iverson, 2005	Performance metrics can help managers tell if organizational goals and objectives are being met Metrics can help make the case for investing in capital equipment, infrastructure, or adjustments in personnel staffing
Student management		
Bus monitor enhancements	Gleave, 2003	Certain buses had escorts on board to assist the driver
Student loading and unloading procedures	Cooner, 2005	Load or unload on the right side of the car, directly onto the curb or sidewalk in bus and parent loading zones
Student behavior management	Baltes, 2001	On-board cameras and spot checks performed by contracted security officers were used to discipline disruptive students and to deter misbehavior
	Gleave, 2003	Have a guaranteed seat for each student (not a specific seat) Equip vehicles with CCTV cameras Certain buses had escorts on board to assist the driver
Media on buses		

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