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Improving Mobility Through Enhanced Transit Services: Review of the Literature for Transit Taxis

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ABSTRACT

This report, an interim deliverable for Task Order 5408: "Improving Mobility through Enhanced Transit Services", reviews the literature on the background and current potential for transit-taxi services in the United States and abroad. It documents the early tasks of a project aimed at improving the mobility of people during off-peak, low demand times of the day through innovative and alternative public transport services. To identify optimal transit-taxi concepts, we have designed a classification system defined by combinations of three service design options – fixed route, fixed-route with deviation, or hybrid/feeder service – and three operational strategies – using in-house vehicles and labor, contracting out services, or relying on the private market to meet demand. We also conducted case studies investigating these various possibilities. The research shows that most combinations of these three transit-taxi service concepts and operational strategies have been implemented in actual nighttime transit-taxi service and are currently still in use. The literature clarifies that there is no "one size fits all" approach to planning or operating transit taxi service. The service design and operating strategy will depend greatly on the respective financial and regulatory environments, as well as, demographic and land-use characteristics. The research conducted thus far, in concert with forthcoming institutional interviews and modeling, will help determine a specific transit-taxi pilot project implementation in California.

Key Words: transit taxi, night owl service, public transportation

EXECUTIVE SUMMARY

This report is an interim deliverable for Task Order 5408: "Improving Mobility through Enhanced Transit Services".

For many years, transit agencies and transportation departments have been experimenting with different options to reduce costs while providing enhanced mobility to their riders in response to the transit industry's loss of ridership share relative to other modes, as seen most notably with alternative-transit demonstration programs in the 1970s and 1980s. The goal was to explore innovative, cost-effective services and structures that were beyond traditional fixed-route and fixed-schedule transit and to use technology and real-time information to dispatch smaller vehicles to replace fixed-route regular size buses. However, because of technology limitations during the 1970s and early 1980s, these ambitious concepts were the right ideas that were a little ahead of their time. Now, technology is far more advanced and fairly inexpensive to implement, as many solutions to vehicle dispatching problems are available "off-the-shelf."

From our review of the literature, we have classified transit-taxi alternatives into the following three service design groupings: 1) Fixed-route skeletal, 2) Fixed-route with limited deviation, and 3) Feeder/Hybrid. Fixed-route skeletal service simply provides public transit services in a stop-to-stop style, but to a more limited extent than regular daytime bus service in terms of the number of stops the driver makes or diminished frequency or both. This typically happens during lower-demand hours when ridership levels do not necessitate full fixed-route service. Many transit systems operate networks whereby several daytime routes are combined into a single night route. Frequently, the routes are consolidated at major boarding points, thereby facilitating transfers between buses or from trains to buses at times. Fixed-route service with limited deviation, sometimes referred to as "flexible routing," is slightly more complex than skeletal transit service. The vehicle typically has the flexibility of a shared-taxi type service and can deviate a certain distance from designated fixed route stops based on rider request. We find a good deal of variation of this service type – both legal and illegal ad-hoc – in developing countries where informal transit markets flourish. Flexible routing is also prevalent in many U.S. and Canadian cities. Flexible routing is an especially useful service type for late-night – a time when safety concerns may prevent riders from using a normal bus service that does not deviate to

bring passengers closer to their final destinations. Feeder/Hybrid service is the most complex and has the most structural variety of the three service types. Broadly defined, this is a combination service whereby fixed-route transit vehicles interface with typically smaller shared-ride or dial-a-ride services that can provide door-to-door service (or at least closer point-to-point than a fixed-route service can provide) resulting in a hybrid bus-taxi service. This hybrid option can take on both a many-to-one (origins-to-bus) and a one-to-many form (bus-to-destinations). In both cases, it adds capacity and mainline mass transit usage by transporting people to/from the main corridors. Normally, this service type relies on more advanced technologies such as real-time information systems than the other two service types since it requires communication between two different vehicles, and at times, between different agencies. In the majority of the cases where we find this service, agencies rely on taxi companies to provide feeder services (typically in the form of shared-ride taxis).

The literature focuses primarily on three operational strategies for the three transit-taxi concepts: 1) use of in-house vehicles (regular full-size buses or smaller vehicles) coupled with extended service hours and/or days and operators to provide owl and/or weekend service; 2) contracting out services to other transit agencies or taxi operators to provide owl and/or weekend service, and 3) completely relying on outside private services as determined by market demand for owl/weekend services (if the municipality authorizes outside services).

Once a transit agency decides to implement a weekend type service (assuming a private option is either unavailable or not sufficient), it must determine which transit-taxi service concept is most viable and logistically feasible and whether or not that service will be in-house or contracted out. These decisions will be based on a number of interrelated factors which can be very specific to a country, region or municipality, including: demographic characteristics of the region, agencies' financing sources (operational and capital budgets and resources), political and institutional environments, technological capabilities, as well as availability of external operators (in the case of contracting) and vehicles. These factors also help to determine fare structures and service levels.

To better understand attributes of successful transit taxi solutions, we examined several case studies based on these three transit-taxi concepts. Several examples of agencies that operate fixed-route skeletal transit-taxi night services, including: 1) The Greater Vancouver Transportation Authority (TransLink), 2) Massachusetts Bay Transportation Authority (MBTA), 3) Bay Area Rapid Transit District (BART) / Alameda-Contra Costa Transit District (AC Transit), 4) Singapore Bus Service (SBS), 5) Orange County (California) Transportation Authority (OCTA), 6) Los Angeles Metropolitan Transportation Authority (LA Metro), and 7) various cities in Germany. Several cases appear, especially in cities abroad, whereby fixed-route services can provide some flexibility in their routing by deviating off the direct route in one form or another. The deviation tends to provide enhanced passenger safety and convenience; moreover, most agencies utilizing these types of services rely on smaller vehicles to provide the service. We examined two agencies that provide this kind of flexible-route night service: 1) King County (Seattle) Metro Transit (Metro) and 2) Ontario, Canada (Go Transit). There are many examples of hybrid feeder services in the literature. Highlighted here are those in Rimouski, Quebec, Canada and in the City of Madison in Wisconsin.

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1.0 INTRODUCTION

Due to low ridership and high operation costs, transit agencies in many cities curtail their service after-dark and on weekends. Consequently, riders needing to travel during these times have less mobility. They have to endure longer walking distances, longer wait times, more transfers, and face greater personal inconvenience and safety risks. There is a clear need for improvement in after-hour public transport service and this need calls for innovative solutions.

This project explores the concept of *transit-taxi* as a means to fill the need for improvement in off-peak public transport service. Transit taxis, for the purposes of this study, are defined as publicly available vehicles that use existing transit stop/station infrastructure as "origins" and "destinations," offer services when regular buses are not operational (e.g. nights or weekends), and provide a shared-ride experience. We perform three primary tasks: 1) development of a transit-taxi concept as a means to improve nighttime and weekend public transit service, 2) identify a site in California to conduct a pilot test of transit-taxi service, and 3) design of a program to implement the pilot test. The research team is using an integrated systems approach to investigate the transit-taxi concept from both operational and policy/institutional points-of-view. Each of these perspectives is critical in understanding the issues that are likely to arise as the concept advances from initial development to implementation.

For the development of a transit-taxi concept, we review the international literature on such services and solicit information from institutional stakeholders in this field. In this report, we present the findings of our review of the literature.

1.1 Literature Review Objectives

Drawing from an international body of literature, we seek to understand the context in which transit-taxi services have been implemented and examine at a more detailed level different operational and financing strategies for, and existing examples of these services to determine the conditions that have contributed to successful as well as not so successful implementations of such nighttime services. More specifically, our objective in conducting this research is to identify, to the extent possible, those combinations of characteristics that have contributed to successful nighttime and weekend transit-taxi services, including: the physical and socio-

demographic characteristics of communities and riders, the organizational and institutional characteristics facilitating or hindering implementation, and any intelligent transportation systems (ITS) technologies that have been used.

1.2 Overview

To narrow the scope of our study, we reviewed literature from the 1970s – a decade in which many innovative transit projects occurred – through the present year, 2005. We based our review on a wide range of materials including: professional and academic journals/books, periodicals, transit agency and Departments of Transportation (statewide and federal) evaluation data/reports as well as web-based searches using key words such as "night bus" and "transit taxi." The overwhelming majority of the relevant literature was anecdotal and descriptive rather than theoretical or analytical. We also found that literature specifically discussing transit-taxi service at night was very limited, leading us to also draw from literature related to transit-taxi, including studies on contracting, paratransit, taxi service innovation and informal transportation. Moreover, while we focused on the United States in this study, we also drew from literature dealing with transit-taxi concepts in other countries. International examples may not have direct transferability or application in the U.S. because of distinct political, institutional, demographic and cultural parameters; however, gaining an understanding of the international experience has been valuable nonetheless.

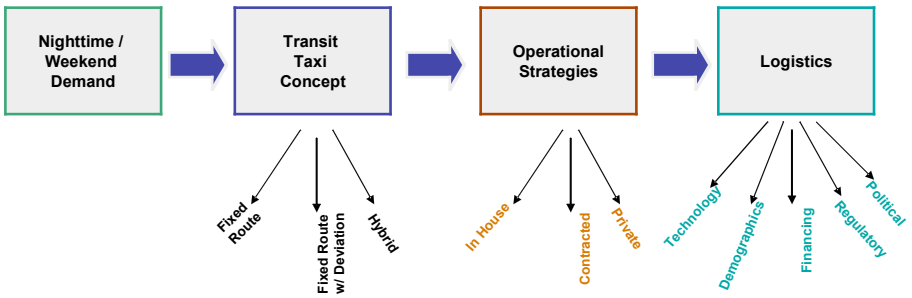

FIGURE 1 Review of Literature Flow Chart

The report is divided into two sections. In Section 2, we present the conceptual framework underlying transit-taxi service through a discussion of the historical and current developments of fixed-route public transit service alternatives. We discuss three different transit-taxi service types

and their associated operational strategies and logistics. This framework is diagrammed in Figure 1. Section 3 elaborates on findings from case studies of existing or considered transit-taxi services (based on the three transit-taxi models) in different cities around the world and highlights some of the necessary criteria and possible obstacles (i.e., institutional, political, technical, demographic, financial, etc.) in the implementation or continuation of these services. Finally, next steps for our study are discussed.

2.0 CONCEPTUAL FRAMEWORK

2.1 The Transit-Taxi Concept

For many years, transit agencies and transportation departments have been experimenting with different options to reduce costs while providing enhanced mobility to their riders, as seen most notably with alternative-transit demonstration programs in the 1970s and 1980s sponsored by the Urban Mass Transportation Administration (UMTA), the Federal Transit Administration's (FTA) predecessor. UMTA funded these demonstration projects in response to the transit industry's loss of ridership share relative to other modes. The goal was to explore innovative, cost-effective services and structures that were beyond traditional fixed-route and fixed-schedule transit, such as demand-responsive transit (DRT) [1] and privatization plans, (Love 1991; Teal 1993). This time of experimentation with DRT services was really the precursor to taxi bus or "transit-taxi." The goal of the projects, in many cases, was to use technology and real-time information to dispatch smaller vehicles to replace fixed-route regular size buses. But, because of technology limitations during the 1970s and early 1980s, these ambitious concepts were the right ideas that were a little ahead of their time, and may in part explain the present day delays of innovation and implementation in this area (Teal 1993). Now, technology is far more advanced and fairly inexpensive to implement, as many solutions to vehicle dispatching problems are available "off-the-shelf."

[1] Roger F. Teal explains in "Implications of Technological Developments for Demand Responsive Transit" that "DRT was designed to access users and deliver them to the desired destination. This was to be accomplished by accepting trip requests – consisting of origin point, destination point and desired pick up or arrival time – from users over the telephone and then dynamically scheduling and routing vehicles to service many of these trip requests simultaneously. The objective was to establish a shared-ride service of moderate productivity providing a level of service substantially better than conventional fixed-route transit, offering the promise that it could compete for some trips being made by automobile."

Beyond the push for technological enhancements, UMTA also encouraged privatization schemes during the 1970s, and many of the studies (both UMTA and otherwise) examined such options as privatization or contracting out of transit services to reduce costs and provide greater mobility and accessibility (Baxter 1992; Faber 1994; TCRP 1997; Cervero 1999; Cervero 2001). More recently, other researchers, including Robert Cervero (Cervero 1992; Teal 1993; Webber 1994; Cervero 1999; Cervero 2000; Cervero 2001) and Mel Webber (Webber 1994) have looked more closely at alternative transit concepts formed by market demand. Mainly, they discuss jitney services, primarily observed in developing countries, but which may have practical application in developed nations. Others' research focuses on the deregulation of the transit and taxi markets to open up additional entrepreneurial possibilities and potential competition (Baxter 1992; Cervero 1992).

Rather than broaden our research scope to include all alternative transit possibilities to serve nighttime riders, we have focused specifically on an alternative service concept referred to as transit taxi. Thus, our focus eliminates any concept of many-to-many transit services, such as, regular private taxi and dial-a-ride services, as well as any airport shuttle services (e.g. Super Shuttle) where existing station infrastructure is not a consideration in passenger delivery. Finally, for this initial review we have focused on a nighttime owl or weekend service since many transit agencies face an underutilization of fixed-route service during late evening hours (Multisystems 1979). Typically, during these times few or no existing transit services are available. Yet, in many places, high ridership potential exists due to the presence of different types of activity centers used during late night hours such as, universities, hospitals, commercial centers and other facilities that attract nighttime users. Focusing on nighttime and weekend service narrows our discussion to areas with lower temporal demands in more dense areas rather than lower spatial demands in outlying areas. It also provides an appropriate research scope as recent studies have shown that conditions available for implementing flexible transit-taxi services are better in urbanized cities than in rural areas (Remak 1975; Rode 2003).

2.1.1 Transit-Taxi Service Descriptions

From our review of the literature, we have classified the transit-taxi alternatives into the following three service design groupings: 1) Fixed-route skeletal, 2) Fixed-route with limited

deviation, and 3) Feeder/Hybrid. The literature uses many terms to describe these options; however, to simplify our explanations, we rely on one title for each concept. Furthermore, to tighten our scope, we focus on nighttime and weekend service.

Table 1 provides examples, though not a complete listing of, the prevalent use of nighttime transit-taxi services in the United States and abroad. The table breaks down the services by service design (columns) and operational strategies (rows), which will be discussed in this section.

TABLE 1 Service Design and Operational Strategies for Nighttime Service

	Fixed-Route	Fixed-route Service with Limited Deviation	Feeder / Hybrid
In-House	MBTA (Massachusetts Bay Transportation Authority) Vancouver's Translink OCTA (Orange County Transportation Authority) Nachtbus, Germany Barcelona's TMB Los Angeles Metro	King County Metro Go Transit Ontario, Canada OmniLink, Prince William County, Virginia Rouen, France	King County Metro
Contracted	BART Valley Metro, Arizona Germany Sammel Taxi	Germany Sammel Taxi	Rimouski TAXIBUS Ann Arbor AATA City of Madison, Wisconsin Germany Sammel Taxi
Privatized	Singapore Bus Service	Houston METRO (Fas Trak service)	Dollar Van (NYC)

Sources: (Englisher 1984; Gomez-Ibanez 1996; TCRP 1997; Garnett 2001; Massachusetts Institute of Technology (MIT) 2001; Gilbert et al. 2002; Bay Area Transit Information 2003; TransLink 2003; OCTA 2004; Go Transit 2005; Houston Transit 2005; King County Metro 2005; Los Angeles Metro 2005; SBS Transit Singapore 2005; TMB Barcelona 2005; University of Washington 2005?)

Fixed-route skeletal service

Fixed-route skeletal service is the most straight-forward of the three transit-taxi concepts and is used in many places around the world including: Southern California (Los Angeles, Orange County); (Englisher 1984; TCRP 1997; OCTA 2004; Los Angeles Metro 2005); Barcelona, Spain and Singapore (SBS Transit Singapore 2005; TMB Barcelona 2005). It simply provides public transit services in a stop-to-stop style, but to a more limited extent than regular daytime bus service in terms of the number of stops the driver makes or diminished frequency or both

(TCRP 1997). This typically happens during lower-demand hours, such as late-night hours (owl service) or weekends – times when the ridership levels do not necessitate full fixed-route service. Many transit systems operate networks whereby several daytime routes are combined into a single night route (TCRP 2001). Frequently, the routes are consolidated at major boarding points, thereby facilitating transfers between buses or from trains to buses at times (TCRP 2001). In several cases, we have also found a skeletal bus service taking over for metro or train service after the system's closing hours as seen in the San Francisco Bay Area where Alameda-Contra Costa Transit District (AC Transit), among other transit agencies, makes stops at the Bay Area Rapid Transit (BART) metro system stations after BART services end for the day.

Fixed-route service with limited deviation

Fixed-route service with limited deviation, sometimes referred to as "flexible routing" (Cervero 1999), is slightly more complex than skeletal transit service. The vehicle typically has the flexibility of a shared-taxi (sometimes referred to as paratransit) type service and can deviate a certain distance from designated fixed route stops based on rider request. For example, in Prince William County, Virginia, the flex-route feeder service, Omnilink, allows buses to deviate as much as 1.5 miles en route to the Virginia Railway Express (VRE) commuter services (Cervero 1999). We find a good deal of variation of this service type – both legal and illegal ad-hoc – in developing countries where informal transit markets flourish (Cervero 1992; Webber 1994; Cervero 1999; Cervero 2000; Cervero 2001). Flexible routing is also prevalent in many U.S. and Canadian cities In Montreal for example, the late night bus service appropriately called "Montreal Between Stops Program" drops passengers off at any point along the fixed-bus route (TCRP 1997).

Flexible routing is an especially useful service type for late-night – a time when safety concerns may prevent riders from using a normal bus service that does not deviate to bring passengers closer to their final destinations. In fact, because of safety concerns, we find flexible owl service on many college campuses across the country, including the University of Michigan in Ann Arbor and the University of Washington in Seattle, among many others. (Englisher 1984; University of Washington 2005?)

Feeder/Hybrid service

Feeder/Hybrid service is the most complex and has the most structural variety of the three service types. Broadly defined, this is a combination service whereby fixed-route transit vehicles interface with typically smaller shared-ride or dial-a-ride services that can provide door-to-door service (or at least closer point-to-point than a fixed-route service can provide) resulting in a hybrid bus-taxi service. This hybrid option can take on both a many-to-one (origins-to-bus) and a one-to-many form (bus-to-destinations). In both cases, it adds capacity and mainline mass transit usage by transporting people to/from the main corridors. Normally, this service type relies on more advanced technologies such as real-time information systems than the other two service types since it requires communication between two different vehicles, and at times, between different agencies. We find many examples of this service type in Western Europe, especially in German and Dutch cities (Cervero 1992; TCRP 2001) as well as in the United States (Cervero 1999) as proposed in Madison, Wisconsin (Multisystems 1979). In the majority of the cases, agencies rely on taxi companies to provide feeder services (typically in the form of shared-ride taxis) (Rosenbloom 1985).

2.2 Operational Strategies

The literature focuses primarily on three operational strategies for the three transit-taxi concepts:

1. Use of in-house vehicles (regular full-size buses or smaller vehicles) coupled with extended service hours and/or days and operators to provide owl and/or weekend service.
2. Contracting out services to other transit agencies or taxi operators to provide owl and/or weekend service.
3. Completely relying on outside private services as determined by market demand for owl/weekend services (if the municipality authorizes outside services).

In the first two options, transit agency decision makers creating the additional nighttime and/or weekend service typically integrate the new service into the entire transit schedule regardless of whether the service is in-house or contracted out to another operator. Institutional issues, regulatory conditions and financial structuring help determine how the service is provided.

2.2.1 In-House Operations

Many transit agency decision makers throughout North America and Western Europe extend service hours or supplement train service during hours of non-operation by operating agencies' in-house vehicles additional hours beyond existing bus service (TCRP 1997). From a review of agencies currently offering nighttime service via in-house fleet deployment, we found that several agencies rely on their full-size buses regardless of ridership levels[2] as found in Boston, Massachusetts where the Massachusetts Bay Transit Authority (MBTA) operates its forty-foot buses late into the night (Massachusetts Bay Transportation Authority (MBTA) 2005). However, operating in-house buses can be very cost ineffective because of high union wages and benefits and low passenger loads (Cervero 1992), leading several agencies to attempt to discontinue such services. In fact, we found that in the last two years two agencies that use in-house labor to provide night service, Boston's MBTA and Vancouver's TransLink, both attempted to shut down night service because of the financial losses each agency incurred. (Luba 2004; Mac 2005). Whereas Boston's MBTA succeeded in eliminating night owl service, TransLink maintained its nighttime service. Rescuing the service was a result of both Vancouver's Bus Riders Union (BRU) and the economic growth of the agency.

From the literature, it is not clear whether agencies necessarily operate different size in-house buses other than the standard 40-foot vehicles to provide the nighttime services. There are many discussions about agencies using smaller mini-van or shared-taxi vehicles to provide these services as seen in Rouen, France where the Metrobus network consists of two light rail lines, 36 bus routes, five shared-taxi circuits and 24 school routes (San Francisco Planning and Urban Research Association (SPUR) 2001), however the literature does not always specify whether these alternative vehicles are in-house or otherwise.[3]

[2] Many studies and agency web pages discussing Night Owl service do not specify the actual vehicle sizes. Today we have found little definitive evidence of bus sizes; however we assume that agencies use in-house vehicles of 40-foot buses unless other vehicle sizes and types are mentioned. We will determine this further in the interviews.
[3] Information obtained during the next phase of the project, administering the institutional survey, will be used to fill gaps remaining at the end of the review of the literature.

2.2.2 Contracted Services[4]

The high costs of operating an in-house service during low-demand hours (as explained in Section 2.2.1), lack of agency resources (i.e., vehicles and/or drivers), as well as other political and institutional factors have led many agencies that provide night-owl or other special services to contract out these portions of their service (Englisher 1984; TCRP 1997; Massachusetts Institute of Technology (MIT) 2001; Gilbert et al. 2002). The ability of agencies to contract out services and to determine specific route and vehicle options will depend on the stipulations of the labor contract. For example, a contract may limit an agency to only contract out lower-demand, lower-revenue earning routes, or to only contract with operators using smaller vehicles to prevent competition since labor may be paid less to operate smaller vehicles. Therefore, adding clauses to the contract enabling agencies to operate all services using full-size buses in house makes it more likely that labor is paid higher wages.

Agencies use a variety of contracting strategies – ranging from rail mass transit contracting out with local bus companies to replace rail service that is not cost effective (e.g. BART's contracts with AC Transit and other transit agencies) (Cervero 1999) to bus companies contracting with taxi companies offering shared-ride[5] services as seen with the Ann Arbor Transit Authority's (AATA) use of Yellow Cab to provide night service (Gilbert et al. 2002). Many agency officials view contracting as a cost-effective and cost-efficient alternative since the system infrastructure and operations in many cases would be established and therefore not necessitate heavy capital investments. Riders can benefit because contracted service operators would ideally react to the more competitive environment and therefore be motivated to provide better quality service. This could result in greater mobility options. The contractor, especially in the shared-taxi situation, can also benefit from a more secure and steady stream of business, and can allow the owner to expand operations (Gilbert et al. 2002).

[4] Contracting out services is referred to as "competitive tendering" in Europe TCRP (2001). Special Report 257 - Making Transit Work: Insight from Western Europe, Canada and the United States. Transportation Research Board. 257.

[5] Shared-ride taxi services are called "routed taxis," in continental Europe. They act as buses, and the system is set up and funded by the transit operator as explained in San Francisco Planning and Urban Research Association (SPUR) (2001). "Making Taxi Service Work in San Francisco." SPUR Newsletter 383.

In general, U.S. experiences with substituting shared-ride taxis for fixed route bus services on a contract basis have been encouraging (Cervero 1992) and seen as more innovative than operating full-size fixed-route buses (TCRP 1997). In Phoenix, AZ, for example, the local transit authority ─ Valley Metro ─ contracted with a taxi company to replace minimum level Sunday fixed route bus services – an arrangement that has saved over $700,000 per year (Guensler 2000). In the Norfolk Virginia Beach area, shared ride taxis that replaced poorly patronized bus runs in low-density areas led to a $16 per hour cost savings. Cost savings in these and other shared ride cases have generally been attributable to the use of lower paid, non-unionized drivers (Cervero 1992).

Research shows that in Western Europe, transit agencies and cities often rely on contractual relationships with taxis to help provide public transportation services. In Western Europe, taxis are more typically viewed as complementary to regularly scheduled transit service as in the U.S., even though the concept of shared-ride taxis is increasingly becoming more popular and prevalent in both Western Europe and the U.S. The literature shows that the concept of shared-ride taxis is increasingly becoming more popular and prevalent in both Western Europe and the U.S. (TCRP 2001). In fact, the French *Union des Transports Publics* signed a partnership agreement with the French National Federation of Taxicab Owners (FNAT) that affirms that both industries share a common goal of providing public transportation service in a non-competitive manner. FNAT has even publicized case studies of effective cooperation and has developed a model agreement to be used by their 15,000 members when entering into partnership agreements with public transportation authorities (Massachusetts Institute of Technology (MIT) 2001).

More specifically, we find that a method that transit agencies heavily rely on contracting with or subsidizing taxi companies for shared-ride taxis to provide hybrid service. In this situation, taxi companies contract with transit agencies to complement the fixed-route service with one-to-many door-to-door feeder services (Rosenbloom 1985; TCRP 1997; TCRP 2001). In many cases, under this scenario, customers have different options for using the service. For example, as seen with the Sammel-taxi (group taxi) in German cities (TCRP 1997; TCRP 2001), customers can call the transit system dispatcher who will then contact the contracted taxi service dispatcher. These taxis are dynamically scheduled nighttime taxis that meet transit riders at suburban transit

stops and take them directly to their homes after being radioed by operators. Passengers pay a small fare for the extra service which is cross-subsidized by the public transit company (Orski 1995; TCRP 1997). Another option, as exemplified by the Ceder Mill Taxi Shuttle, operated by Portland's transit agency, TriMet (San Francisco Planning and Urban Research Association (SPUR) 2001; Gilbert et al. 2002), is a many-to-one feeder-taxi service where passengers schedule their shared-taxis directly through the taxi company. The Ceder Mill Taxi shuttles take residents from their homes to one of six destinations, including stores, the library and the transit center where there are connections offered to light rail services and the rest of the regional transit network (San Francisco Planning and Urban Research Association (SPUR) 2001)

2.2.3 Private / Market-Based Structure

The literature shows that a completely private, market-driven transit-taxi service can meet the needs for all three taxi transit models: fixed route, flexible fixed route and hybrid/feeder transit-taxi concepts. Laissez-faire transit-taxi service can either take on a jitney-like approach or a more standard privatized, for-profit bus operator approach.

The jitney service approach to transportation is typically privatized, *low cost*, flexible-route and demand-responsive. Riders often rely on jitney services to fill gaps in the mainstream public transportation system (Garnett 2001). While jitneys are not considered mainstream and are often highly regulated, if not illegal, in the United States, typically clandestine jitney services operate successfully in ethnic communities centered in large urban areas including: Los Angeles, New York City and Miami (Garnett 2001). In the developing world, jitneys are much more mainstream and we find an enormous reliance on jitney services by significant portions of the population (Cervero 2001). In "Informal Transport in the Developing World," Robert Cervero presents numerous informal transportation possibilities of varying sizes and vehicle types that arise when public transit agencies do not meet demand. These services can be more "taxi-like," providing door-to-door connections, or "bus-like," following more or less fixed routes. In general, independent operators can be very responsive to alternative markets and demands. Moreover, small, private services can aid mainline bus routes by improving connectivity, adding capacity and absorbing high-cost services (Cervero 2001).

U.S. transit agency decision makers hesitate to allow any jitney-type service that could potentially compete with public transit in the market because they mistakenly believe private informal services undercut the market, a concept known as "cream skimming" (Cervero 2001). To ensure jitney services do not compete with public transit, many regulations and market barriers have been established in most U.S. cities. However, many illegal jitney services still operate their services, including an estimated 400-500 working in the streets of downtown and eastern Los Angeles (Cervero 1992). Garnett (2001) clearly depicts the concern of cream skimming in a discussion of Miami's jitney services. Until they were regulated in 1983 and later prohibited from operating on Miami's main transit Metrobus lines or within a half mile from major transit corridors, jitneys were a legitimized component of Miami's transportation system. While official regulatory conditions have minimized these operations, as shown in a 1992 FTA study, as of 1992, 393 jitneys were still operating in Miami, carrying a passenger volume approximately equal to one-fourth of Miami's Metrobus ridership (Garnett, 2001).

Cervero and others purport that those in charge of public transportation should acknowledge jitneys' potential to fill niche markets and satisfy passenger demand that public transportation agencies cannot address either because such markets are of lower priority or agencies' do not have the capital to provide more capacity (Webber 1994; Cervero 2001). Agencies could follow the path of Houston's public transportation agency, METRO where agency officials capitalized on the opportunities presented by jitney services. In 1995, Houston METRO transit agency had such high ridership demands for their regular in-house full-size buses that they permitted jitneys to operate along service routes with some regulations. The jitneys could only stop near, but not exactly alongside the METRO stops and vehicles could not be older than 5 years. A good market for jitneys and competition led METRO to start FasTrak, a jitney-like service contracted out but controlled by METRO. FasTrak jitneys must operate during peak periods to provide the capacity-adding service needed by METRO, and they can choose if they want to operate during other times of the day (Cervero 1999).

There are also bus and collective taxi services that are completely privatized and operating on a for-profit basis, especially in Western Europe (Orski 1995; TCRP 1997; TCRP 2001). In such

cases as the Dutch Maastricht City Bus service that provides trans-border service between Maastricht in the Netherlands and Hasselt in Belgium using both conventional full-size buses and shared taxis, company officials explained that the 1994 privatization led to a cost savings of more than 40 percent (TCRP 1997). In Germany, we find another option whereby cooperation between transit authorities and local taxi companies occurs through voluntary arrangements during hours when transit service is not available (Orski 1975). In the U.S., official for-profit bus operators offering transit-taxi service are found in very few places. One such case is the 400 Dollar Van commuter minivans servicing the outer Boroughs of New York City. This private service provides feeder service for about 50,000 passengers daily to subway stations in the city since the Metropolitan Transit Authority (MTA) does not adequately meet the local demand. Dollar Vans are prohibited from accepting street hails or operating on bus routes, yet they frequently do both. They have semi-fixed routes with flexibility and are willing, for a small additional fee, to provide door-to-door service, which, for safety reasons, has been highly valued by women working late shifts (Garnett 2001).

In general, privatized bus service in both jitney-style and regular fixed-route could lead to greater mobility during nighttime hours and weekends (Cervero 1992; Cervero 2000; Garnett 2001; Reason Public Policy Institute 2001).

2.3 Logistics

Once a transit agency decides to implement an owl or weekend type service (assuming a private option is either unavailable or not sufficient), it must determine which transit-taxi service concept is most viable and logistically feasible and whether or not that service will be in-house or contracted out. The literature has shown that these decisions will be based on a number of interrelated factors which can be very specific to a country, region or municipality, including: demographic characteristics of the region, agencies' financing sources (operational and capital budgets and resources), political and institutional environments, technological capabilities, as well as availability of external operators (in the case of contracting) and vehicles (TCRP 2001). These factors, which are briefly described below, also help to determine fare structures and service levels.

2.3.1 Demographic and Area Characteristics

There is a range of demographic features important to any of the transit-taxi concepts. The most commonly discussed and relevant features include: population density, age ranges and income levels. Trip generators/attractors (universities, hospitals, entertainment zones, etc.) are also crucial in determining the transit-taxi ridership demand. For example, the majority of night owl services take place in areas with big universities requiring service at night. In the U.S., the majority of nighttime users are either low-income workers or students.

2.3.2 Financing Sources and Fare Levels

Beyond fare revenues, the level of operational and capital subsidies provided by the local, state and federal governments strongly influences the types of services that transit agencies can and cannot provide. We have found cases in the literature where nighttime and weekend transit-taxi services are completely self financing (e.g. Trein-taxi in Netherlands) and therefore tend to have higher levels of service and technological application. On the other hand, as previously discussed in the case of MBTA's night owl service, our research has revealed examples of transit agency officials claiming that the necessary subsidy levels are too high to provide or maintain service (even though passenger trips should not be measured and evaluated as a commodity) (Mac 2005). The funding sources and the general wealth of the transit system will also influence the fare structure for the additional transit-taxi service. Some additional transit-taxi services can charge the same fares as charged for regular service as seen in Germany, Austria and the Netherlands (TCRP 1997); other services require passengers to pay a small fare premium for the extra service. In all cases reviewed, the public transit-taxis charge lower fares than regular taxi services thus providing a financial incentive to use the service. Often, in the case of contracting out, transit agencies will cross subsidize the company providing the night and/or weekend service, as seen in Germany (Orski 1995).

2.3.3 Political and Institutional Environments

The political and institutional environment can greatly influence whether or not a transit agency contracts out service. If, for example, stringent labor laws prohibit an agency from contracting out service, it could lead to the inability to provide additional nighttime and/or weekend service because in-house operations would be too costly. Similarly, research has shown that the size of the agency can affect contracting decisions in the U.S., that is, agency size can be a proxy for heavier regulations placed on an agency; typically the bigger and older the agency, the more likely it will contract out less of its service than a smaller agency (Iseki et al. 2005). This could directly impact the agency's ability to contract out service during lower-demand hours. Labor laws can also influence the type of vehicles and service design used for nighttime since some labor contracts only permit outsourcing of smaller vehicles on lower demand routes or times.

Regulatory constraints, when imposed on the transit agency by the federal, state or municipal governments can prevent the implementation of night services. On a federal level, Section 13(c) of the amended Urban Transportation Act of 1964, an underlying federal regulation to private-sector participation, can possibly prevent contracting.[6] This labor protection clause guarantees that transit employees will not be adversely affected by any program involving federal transit grants. Many smaller California communities that have relied on taxis as substitutes for transit have avoided the potential constraints caused by 13(c) by refusing federal funds (Cervero 1992). At the state level, certain laws can make contracting very difficult, if not impossible. Massachusetts' anti-privatization law, for example, referred to as the "Pacheco law," severely limits the amount of contracting in which MBTA can engage. City and state laws can prevent or support a more laissez-faire market whereby night and weekend demand could be met by private operators. As explained in Section 2.2.3, in the U.S., most municipalities do not allow jitneys into the market because of barriers and regulations created to eliminate "cream skimming" or the undercutting of the subsidized public transit agencies (Cervero 2001). As discussed earlier, in other cases, such as the French *Union des Transports Publics*, there are official partnership agreements with the French National Federation of Taxicab Owners (FNAT) that affirm that both industries share a common goal of providing public transportation service in a non-

[6] It must be noted that while the Urban Transportation Act of 1964 can prevent contracting, evidence of its influence on whether or not contracting occurs at an agency is not strong.

competitive manner. In general, we found that in Europe, agencies are much less concerned about cream skimming than in the U.S. because of their more collaborative relationships with private-sector taxi companies. We also found that the open marketplace where private vehicles complement public transportation services helps enhance overall service levels.

2.3.4 Technological Capabilities

The literature has shown that a variety of technologies applied to the different service concepts exists – ranging from basic dial-in reservation systems technology used to provide nighttime fixed-route skeletal service to more complex technologies that enable dynamically-scheduled automated hybrid shared taxis (Cervero 1992; Orski 1995). Real-time information for operators and passengers, vehicle tracking, real-time reservation systems, rideshare matching systems, Advanced Vehicle Control Systems (AVCS) and wireless communication technology can be and, in many cases, are being applied to alternative services (Cervero 1992; Orski 1995). Satellite vehicle tracking and locating technologies can be used to achieve optimal dispatching and routing. Generally, the more sophisticated and automated the technology is, the greater hope agencies have of achieving efficiencies and cost effectiveness, thereby enabling them to provide or maintain the service.

2.3.5 External Operator and Vehicle Availability

Clearly, the implementation of night bus and/or weekend service, if operated in-house, will depend on vehicle and operator resources available. If the service is contracted out, the type of transit-taxi concept used, its level of sophistication and the choice of vehicle will be determined primarily by which external operators can meet the requirements of the agency and what resources they have available to do so.

Since the logistical characteristics discussed above are very transit agency specific and since each city or agency has its particular objectives, the next section of this review discusses some findings from more in-depth case studies of U.S. and foreign examples of these factors (where available), which are detailed in the appendices. These studies highlight each transit-taxi service type with the different forms of operational strategies to elucidate common characteristics found

in both successful and unsuccessful transit-taxi services. From these cases, we determine some final observations and next research steps.

3.0 OBSERVATIONS FROM CASE STUDIES AND NEXT STEPS

To better understand attributes of successful transit taxi solutions, we conducted and analyzed case studies based on the three transit-taxi concepts discussed in Section 2.0. In-depth examples are drawn from both the United States and abroad as shown in appendices A, B and C. In each case, we use the same structure and provide as much detail possible regarding demographic, operational and logistical criteria necessary to implement or sustain transit-taxi services

We present the material by breaking down the cases according to the three transit-taxi concepts: fixed route, flexible route and hybrid and acknowledge where there is a conceptual overlap.

3.1 Fixed-Route Services[7]

We found several examples of agencies that operate fixed-route skeletal transit-taxi night services, including: 1) The Greater Vancouver Transportation Authority (TransLink), 2) Massachusetts Bay Transportation Authority (MBTA), 3) Bay Area Rapid Transit District (BART) / Alameda-Contra Costa Transit District (AC Transit), 4) Singapore Bus Service (SBS), 5) Orange County (California) Transportation Authority (OCTA), 6) Los Angeles Metropolitan Transportation Authority (LA Metro), and 7) various cities in Germany. Particularly interesting cases include those regarding services that have recently experienced financial difficulties resulting in attempts to eliminate existing night service or prevent it from even beginning. Vancouver Translink's NightBus, Boston's MBTA Night Owl and BART's NightBART services all provide examples of transit agencies that have had to consider at least reducing their transit-taxi services because of cost inefficiencies.

[7] While more fixed-route transit-taxi case studies are presented, it is does reflect that there are more fixed-route services than flexible or hybrid. Rather, the fact that there are more case studies for this section is a result of finding more information regarding fixed-services.

3.2 Fixed-Route with Flexible Routing Services

Several cases appear, especially in cities abroad, whereby fixed-route services can provide some flexibility in their routing by deviating off the direct route in one form or another. The deviation tends to provide enhanced passenger safety and convenience; moreover, most agencies utilizing these types of services rely on smaller vehicles to provide the service. For the purpose of this study, we examined two agencies that provide this kind of flexible-route night service: 1) King County (Seattle) Metro Transit (Metro) and 2) Ontario, Canada (Go Transit)

3.3 Hybrid / Feeder

There are many examples of hybrid feeder services in the literature. Here, we describe a current example, which is in Rimouski, Quebec, Canada. We also highlight a proposed hybrid / feeder service design for the City of Madison in Wisconsin. The Madison case highlights some of the barriers transit agency and city officials can encounter when trying to implement transit-taxi service. In this case, after evaluating the various options, the decision makers decided not to implement the service.

Tables 2 and 3 summarizes the details of the case studies by highlighting the characteristics influencing the transit-taxi services provided or contemplated for each agency or city reviewed. Table 2 summarizes all fixed-route services and Table 3 highlights both fixed-route services with deviation and hybrid/feeder services. Where information is not available, we use “n/a” for not available or leave the cell blank.

TABLE 2 Summary of Transit-Taxi Characteristics for Fixed-Route Service

			Fixed Route Service						
		Agencies	Vancouver Translink	MBTA Nightowl	BART (via AC Transit)	Singapore SBS Transit	OCTA	LA Metro	German Cities
Characteristics									
Operational (for nighttime component)			In-house	In-house	Contracted	Private	In-house	In-house	All
Schedule	Hours		Until 3am	Until 2:30 am	24 hours	12-4 am	12-5am	9pm-5am	
	Headway (min)		30	20	n/a	20	n/a	n/a	n/a
Success			Yes	No	n/a	Yes	Yes	n/a	Yes
Demographics	Population (millions)		1.7	0.6	1.5	4.6 (2003)	3.0	9.6	n/a
	Area (square miles)			48.43	364	268	797	1433	
	Density			12,172	4,121	17,164	3,764	6,699	
	Ridership (millions)		100.9/6 mths (2003)	.356/day	.230/day	2.4/day	0.018/day	307/year	
	Night Ridership			.0012/Night					
Trip Attractors	Large Universities*		UBC, SFU	Many large	Many large	2 Large	Several large (11)	Several (60)	
	Hospitals**		Many	Many	Many		2 Large	Many	
	Commercial Centers**		Many	Many	Many	Many	Many	Many	
	Other		Strong downtowns	Historical Center	Dense centers	Extremely dense			
Financing Sources			Public and Private	public sources	public sources	Private	Public		
Institutional/Policy	Labor Unions		Apply	Apply	Apply	n/a	Apply	Apply	n/a
	Other			Pacheco Law	Regional Measure 2	Structure Change	Measure M		
Technology					Smartcard	Advanced communication			
Other			12 routes	high night subsidy, along rail	Contracts with many operators	Along rail		Also flexible	Also hybrid and flexible

* Large universities have more than 15,000 students and Many means more than five

** Many (in terms of hospitals and commercial centers) means more than five

TABLE 3 Summary of Transit-Taxi Characteristics for Fixed-Route with Deviations/Flexible and Hybrid/Feeder

			Fixed Route with Deviations		Hybrid / Feeder	
		Agencies	King County Metro	Toronto Go Transit	Rimouski, Quebec	City of Madison (Madison Metro)
Characteristics						
Operational (for nighttime component)			In-house	In-house	Contracted	Contracted
Schedule	Hours		8pm-5am	n/a	n/a	n/a
	Headway (min)		n/a	n/a	n/a	n/a
Success			n/a	n/a	Yes	not implemented
Demographics	Population (millions)		1.7	5.0	0.03	.22 (2003)
	Area (square miles)		2134	3000	29	60
	Density		797	1,667	1,034	3,667
	Ridership (millions)		100/year	45/year		
	Night Ridership					
Trip Attractors	Large Universities*		Many large		One	University of Wisconsin
	Hospitals**		Many			University of Wisconsin
	Commercial Centers**		Many			
	Other					Strong downtown
Financing Sources				Public	Public	Public
Institutional/Policy	Labor Unions		n/a	n/a	n/a	Considered in decision
	Other					
Technology						
Other			Also hybrid			City operated

* Large universities have more than 15,000 students and Many means more than five

** Many (in terms of hospitals and commercial centers) means more than five

The general discussion and more detailed case studies of transit-taxi services have revealed that a formulaic "one size fits all" approach to successful nighttime transit-taxi service design and operational strategy is not appropriate nor realistic; our objective has been to identify, to the extent possible, those combinations of characteristics that have contributed to successful and not so successful nighttime transit-taxi services. Agency or city officials need to conduct in-depth, agency-specific evaluations of the operational and financial feasibility to implement transit-taxi services and understand the social and political dimensions to create a successful service.

At this phase in our study, based on our preliminary research, we cannot, in most cases, determine whether or not nighttime transit-taxi service has been successful in terms of fare recovery or passenger levels based on the literature review alone. However, as highlighted in Table 2, most combinations of fixed-route, fixed-route with deviation and hybrid/feeder service concepts and operational strategies have been relied on for providing nighttime transit-taxi service. In the Bay Area and in Singapore, fixed-route services that are contracted to other transit operators have been ideal to follow the rail station paths; in Toronto and Seattle, flexible routing presented the best option for safety and mobility; in Rimouski, hybrid / feeder TAXIBUS was ideal for that medium-sized city. We found that the larger agencies serving large populations and operating hundreds of vehicles, especially in the case where rail is operated, such as, BART, MBTA, Singapore SBS, and LA Metro tend to use fixed-route skeletal service to provide nighttime transit. This could be a result of high densities enabling and necessitating fixed stops or perhaps labor agreements as discussed further below. Based on our case studies, we find that more flexible routing and hybrid/feeder services in the U.S.[8] tend to be used in smaller cities with lower passenger levels and lower densities. Interestingly, the jitney services providing more the flexible and hybrid/feeder services have been taking place in San Francisco, Boston, Los Angeles, and other large U.S. cities suggesting the need for a more hybrid type service design in these places.

In terms of operational strategies, we find successful transit-taxi nighttime service (measured by increased ridership and agency's increased usage of service) operated in-house, as seen at Vancouver's Translink and Orange County's OCTA; contracted out, as seen in German cities

[8] Thus far, we do not have enough data included from our case studies to make this claim for other cities abroad.

and in Rimouski, Quebec; and, privatized as seen in Singapore. Additionally, we have found definitive evidence that in-house and contracted services have also failed with MBTA and the services in Madison, Wisconsin respectively.

Beyond service design options and operational strategies, we also found consistencies in the trip attractors and demographic features of the various network areas where nighttime transit-taxi service was offered. Firstly, as shown in Tables 1 and 2, the majority of night owl services are in cities with large universities in fairly dense areas where students and university workers – typically lower-income – require transit service at night. In fact, in the majority of the cases discussed in Table 2, the cities had several or at least one or two large universities with a student population of at least 15,000. From those agencies/cities providing night service highlighted in Table 1, the only service that does not cater to students specifically is the jitney hybrid Dollar Van in New York City. However, with the high density of universities in the New York metropolitan area, it is likely that many students take advantage of the service. In Madison, Wisconsin, the night-taxi services were initially considered specifically to provide safe public transit systems at night (Multisystems 1979; Englisher 1984). We also find that the majority of the cities examined have either many (at least 5) commercial centers and/or hospitals, both of which could be attracting nighttime workers and users. Higher population densities would in general increase the usage of transit-taxi services offered at night, and from our initial data set, we find quite a wide range – from 797 people per square mile in Seattle to 17,164 people per square mile in Singapore.

While we found trends of demographic and area characteristics where transit-taxi service exists, these features contributing to the success of certain transit-taxi services did not have the same weight in all cases. For example, the population density, as well as the clustering of universities and other trip attractors – all positive attributes for nighttime transit-taxi usage – in Boston could not outweigh the severe budget deficit and heavy subsidies nor compensate for the strict Pacheco anti-privatization laws affecting the MBTA. Whereas, at TransLink ─ an agency similar to the MBTA in terms of providing its nighttime transit-taxi service in-house and on a fixed-route basis – the nighttime service has been very successful despite a vulnerable few years when nighttime service shutdown was a possibility. In the TransLink service area, population densities are lower

with approximately 1,100 people per square mile in Vancouver alone compared to over 12,000 people per square mile in Boston, and initially the nighttime service was losing money. However, in the case of Vancouver, the general economic improvements at the agency greatly contributed to the recent survival and success of the service. The examples of MBTA and Vancouver suggest that regulatory and/or economic conditions of an area will tend to outweigh any positive demographic characteristics and trip attracting facilities. If the political and economic environments do not support and foster nighttime service options, the success of these services will be seriously hindered.

Political and institutional regulations play a very significant role in the ability to provide transit-taxi service. In several cases, transit agencies cannot afford to provide the service using regular full-size in house vehicles since they tend to be more expensive in terms of labor and maintenance than smaller vehicles. The contracting option could enable an agency to provide the service. However, transit labor is often reluctant and unwilling to support any option, which could jeopardize its position; a substitution of contracted night service for in-house operations, regardless of its cost-effectiveness, clearly poses a threat to transit labor job security and working conditions. For example, city officials were so concerned about labor issues in Madison, Wisconsin that they never implemented the transit-taxi service which would have led to cost savings. In the case of MBTA, the regulatory constraints of the Pacheco law appear to provide the largest hurdle to developing a more cost-efficient and cost effective service. Over the last decade, only six state functions have been outsourced. One proposal found in the literature for MBTA to contract out some of its bus routes was estimated to save the agency over $60 million over the first five years of implementation. However, the Pacheco law pre-empted this proposal (Kriss 2004). It will be a rigorous and lengthy process to reform these rules since the anti-privatization climate is not specific to transit. It is pervasive throughout the state; as of 2004, 91 percent of executive branch employees in Massachusetts were unionized, compared to 35 percent of state employees nationally and less than 15 percent of all other workers in the state.

There are also examples in which the regulatory environment encourages and enables transit-taxi nighttime services. In the San Francisco Bay Area where BART operates, the political and institutional environment facilitated the existence of nighttime service to such an extent that

contracting, a strategy not traditionally relied on in this region, was facilitated through legal measures. Regional Measure 2, on the 2004 ballot – a measure aiming to provide Bay Area commuters more alternatives to driving to improve congestion and air quality – not only encouraged, but mandated the availability of nighttime service. Similarly, in Rimouski, the city adopted legal regulations enabling the initiation and expansion of its hybrid TAXIBUS service. From a different perspective of regulatory conditions favoring the use of transit-taxis through contracting or privatized service, in both France and Germany shared taxis are officially accepted in the regulatory vernacular as components of the public transportation network. Hence, we find that the public attitude regarding the role of and potential for taxis in providing shared-ride services is very important in facilitating the use of taxis.

Findings also show that while all operational options are potentially successful, contractual service agreements with taxi companies in the U.S. and abroad and completely private services abroad are most commonly used to provide nighttime service.[9] Agencies that contract out can more readily, efficiently and flexibly provide each specific service type or a combined service. In agencies or cities that are implementing a new service, such as the City of Rimouski, contracting with a taxicab company is a good option because infrastructure and dispatching systems are most often already in place. By relying on taxicabs to provide transportation, authorities can shape the supply of transit so that it meets riders' demand requirements, thus ensuring optimal service levels. With the use of contracting, many agencies have increased ridership levels, lowered their operating costs or both. Transit agencies that have encountered major financial difficulties and those that have attempted to eliminate night service were all agencies that operate the nighttime component in-house. For this reason, we found that most studies discussing nighttime transit taxi service focused on the use of taxis as an operational strategy.

In terms of technological applications used for transit-taxi services, with the exception of Singapore's SBS use of mobile technology and BART's use of an integrated smartcard, the case studies did not elaborate on the most advanced technologies used to facilitate the nighttime transit-taxi services. Rather, most discussions found in the literature focused on more basic call-

[9] While the case studies presented show more in-house than contracted-out or private transit-taxi services, this is only a result of the fact that at this initial stage of investigation, more complete information was available in the literature for in-house services.

in dispatching services, or special communications between shared-taxi services and fixed-route operators in the cases of some hybrid/feeder services, including, those in German cities and in Rimouski, Quebec.

While this review has revealed some findings, as seen in Table 2, gaps still exist. In many cases, it is unclear whether or not transit-taxi nighttime services have been successful or if the service design and operational strategy used have led to more cost savings over other options. Moreover, based on this review alone, there was insufficient data to determine how financing sources and fare levels contribute to the feasibility and cost effectiveness of the services. To more clearly understand future transit-taxi possibilities in California, the next stage of this research will involve detailed assessments using surveys as the primary methodological approach in which agency representatives will be questioned about the agency background and history with transit-taxi services, customer reactions to the service, the operational and conceptual strategies put forth by agency management, characteristics specific to the city where service is provided, the application of technology to facilitate the service[10] and the economic, political and institutional climates providing incentives for or barriers to service options.

[10] Technological application to facilitate transit-taxi services varied a great deal in the agencies reviewed. In most cases, discussions of technology were not found. However, in some instances such as BART and SBS, we found sophisticated technologies applied to the services.

APPENDIX A: TRANSIT-TAXI CASE STUDIES – FIXED-ROUTE SERVICES [11]

Greater Vancouver Transportation Authority (TransLink)

Synopsis

TransLink, the Greater Vancouver Transportation Authority, is a small organization that handles transportation planning; administration of service contracts with subsidiary companies and contractors; the management of capital projects; financial management and planning; public affairs; and, supporting business functions for the Vancouver region (TransLink 2003).

The agency's night owl or NightBus service runs every 30 minutes, 7 nights a week, until 3am. The NightBus network now consists of 12 routes in Vancouver, Burnaby, Richmond, Surrey and North Vancouver, providing a safe, reliable option for getting around Greater Vancouver. According to 2002 reports, expansion to Coquitlam was planned for this year (2005). In 2002, many participated in a Bus Riders Union (BRU) strike, claiming NightBus routes were not serving transit-dependent workers well. Rather, they were serving college kids' night activities and helping subsidize bars. As of April 2004, months after the end of the long Bus Riders Union (BRU) strike, a public relations report claimed that strong finances have made bus service improvements happen more rapidly because of an unexpected rise in property values by 8.9 percent instead of the forecasted 4.2 percent (Luba 2004). TransLink's improved economic situation has led to several service improvements, including the extension of NightBus service.

The board voted to expand late-night bus service and add new Community Shuttle routes and new Express Coach services months earlier than expected also due to strong ridership growth and a healthy financial outlook. Some service improvements were scheduled to be implemented in May 2005. In total, the improvements will provide an additional 42,000 hours of bus service annually (Luba 2004).

[11] All dollar amounts used for case studies discussing agencies in non-US countries have been converted to US Dollars for the date of June 30, 2005 unless otherwise specified.

Description of the Area

Greater Vancouver is Canada's third largest metropolitan area, after Toronto and Montreal and is 140 miles north of Seattle, Washington. Extending over an area of 44 square miles, metropolitan Vancouver contains almost half of British Columbia's population; the city proper has a little more than 470,000 inhabitants and is characterized by a strong downtown with high density neighborhoods and heavy reliance on transit (TCRP 1997). TransLink itself operates within an area with an overall population of 1.7 million (as of 1997) which is rapidly growing (with a net annual population gain of more than 40,000) of which many are transit dependent as many students from the University of British Columbia (UBC) and Simon Fraser University (SFU) as well as low-income workers rely on public transportation (Luba 2004).

With 100.9 million total bus boardings over a six-month period (January to June 2003), overall, TransLink has realized an 11.7% increase in transit ridership over 2002 levels as discussed in the agency's 2003 Annual Report (TransLink 2003). These general ridership increases helped support the agencies expansion of NightBus service. According to a recent TransLink report, the main users of the night bus service would be "young people with modest incomes" needing access to social activities in downtown Vancouver (TransLink 2003).

Financing Sources

TransLink delivers public transit services through subsidiary companies and contracting. The agency receives funding from a combination of the following: transit fares, portions of the provincial motor fuel tax (nine cents per liter in 2004), seven percent provincial sales tax on off-street paid parking, a levy on electricity accounts and property tax (based on assessed value).

Massachusetts Bay Transportation Authority (MBTA)

Synopsis

MBTA is the nation's oldest and 4th largest public transportation system with approximately 792,600 one-way passenger trips per day on MBTA's subway, bus, BRT (the Silver Line),

commuter rail, water, contracted bus, and paratransit services.[12] Buses and trackless trolleys have 162 routes and 9,000 stops and stations (Massachusetts Bay Transportation Authority (MBTA) 2005).

Since 2001, a nighttime bus service called “Night Owl" has been operating on Fridays and Saturdays every half hour until 2:30 a.m. Unlike Vancouver’s TransLink service, Night Owl provides supplemental service to the subway system after it shuts down. The nine bus routes known as “Rail Bus” routes run parallel to subway lines, and five existing local bus routes continue to operate, stopping at convenient MBTA stations and other popular locations in and around the city. According to MBTA’s Web site, operating buses at night allows MBTA to extend service while performing subway maintenance throughout the night to keep the system in safe, clean, working condition (Massachusetts Bay Transportation Authority (MBTA) 2005).

However, as a result of a $16 million budget deficit, the MBTA will eliminate this service that is popular with the late night college crowd. In 2004, it cost about $1.2 million to operate the service, but only $154,000 in revenue was collected. Annually, the service costs an average of $1.4 million, and is not covered by the two dollar fares (Mac 2005).

Financing Sources

The severe financial problems Massachusetts Bay Transportation Authority suffers are symptomatic of federal and state mass transit subsidizing policies and declining transit ridership share seen throughout the country. MBTA’s ongoing attempts to increase ridership by enhancing services and holding fare increases below inflation are just one example of how the agency, like several throughout the U.S., has fallen into a debt-generating viscous cycle (Gomez-Ibanez 1996). In 1990, transit fares recovered only about 25 percent of MBTA’s costs; recovery rates were 80 percent in 1964, the year MBTA was created (Gomez-Ibanez 1996).

[12] Note that the total number of passengers boarding is greater than the total number of passenger trips since many people transfer between lines to make complete trips.

As of 1991, MBTA faced a financial deficit of around $575 million, a 639% increase in 26 years (even after inflation adjustments) (Gomez-Ibanez 1996). In 2005, MBTA faces a $16 million budget shortfall and projects a $10 million deficit for 2006 (Chieppo 2005).

With these facts as a backdrop, it is no surprise that the MBTA board will eliminate Night Owl service, one of its most highly subsidized services at $7.53 per rider compared to $1.37 per rider on average bus routes.[13] According to MBTA spokesman, Joe Pesaturo, Night Owl "only attracts about 1,250 riders on the average weekend night. Night Owl bus drivers cost the agency $53.00 per hour and MBTA cannot afford to pay the outrageous labor costs to serve a limited group of people out on the town" (Meyers 2005). An increase in fares could have been a natural response instead of cutting the service all together, but board members were more in favor of service cuts since just two years earlier, the board had approved a new budget that hiked fares system wide by an average of 25 percent (Mac 2005). Research shows that in larger cities, demand for public transportation is fairly inelastic. Thus, fare increases during both peak and off-peak travel generally will not result in much ridership change as riders, in many cases, do not have options and rely on public transportation to provide essential mobility (Pham and Linsalata 1991). Yet, MBTA, like many other agencies, resists mandating fare increases even when experiencing an economic crisis.

According to the Boston Globe, "cutting the late-night bus service – nine routes running weekends until 2:30 am – will save Massachusetts Bay Transportation Authority an estimated $1 million" (Mac 2005). MBTA may benefit, but there has been major uproar in the community to maintain the service, especially amongst the students at the Boston universities who depend on the service for their weekend night activity and late-night workers who may have few alternatives (Smealie 2005).

Description of the Area:

The city of Boston has an area of 48.4 square miles. It is small and dense, with a 2003 population of 581,616. It is the 20th largest city in the U.S., by population and the10th most crowded city in

[13] MBTA is also increasing parking fares at various subway stations according to The Boston Globe's March 12th 2005 article: "T Keeps Fares the Same, But Nixes Night Owl Service.

the U.S., with 12,172 people per square mile. Within this historic city, there are approximately 30 colleges and universities and many famous tourist and shopping areas.

Additional Information

One of the issues with maintaining nighttime service is the strict regulatory environment in which MBTA finds itself. According to the Boston Herald:

> "MBTA's efficiency falls victim to the commonwealth's anti-privatization law, which all but eliminates the T's ability to open any of its operations to private competition. More than 11 years after passage of the so-called Pacheco law, Massachusetts remains the only state under such restrictions. This is a 10-year-old state law, the only one of its kind in the country, making it virtually impossible to contract out any service now performed by a state employee - a measure that has been called the single most significant budget setback of the last decade" (Kriss 2004).

Not surprisingly, Boston strictly regulates the use of jitney vans and taxis which often serve low-income minority communities. In Boston, they tend to operate illegally along fixed routes for a flat fee and stop anywhere along the route like flexible routing. In the city, they fill a major gap left by a combination of too few legal taxis and not enough flexible service offered by MBTA to make trips to the grocery store and other areas that may be off the beat and track.

Bay Area Rapid Transit District (BART)

Synopsis

BART opened for revenue service in 1972 and was America's first new subway since World War II. It represented the first of a new generation of technologically advanced rail systems and the first heavy-rail system in the Western United States. BART consists of five lines: 1) Richmond-Daly City (with peak service to SFO and Millbrae), 2) Pittsburg/Bay Point-Millbrae (via SFO), 3) Dublin/Pleasanton-Daly City, 4) Fremont-Daly City, and 5) Richmond-Fremont. All but the last serve San Francisco. These lines span four counties: Alameda, Contra Costa, San Francisco, and San Mateo. Fares range from a base of $1.25 (including all trips within the city of San Francisco, which are free with a $45/month BART/Muni "Fast Pass") to $7.45 between Pittsburg/Bay Point and SFO. Headways generally range from between 5 and 15 minutes during

peak periods to 20 minutes during off-peak periods; there is no direct service on the Richmond or Fremont lines to San Francisco at night or on Sundays. The system shuts down between 1 and 5 a.m., with the last trains leaving just after midnight. Daily ridership, which peaked at 340,000 in the Spring of 2000 (before the SFO extension opened) but later fell to around 290,000, has risen back above 320,000 (2005) (San Francisco Cityscape 2005).

BART had intended to provide a 24-hour transit service called NightBART by supplementing the BART metro system with full-size buses and picking up passengers and dropping them off at existing BART stations, using local roads and highways to travel instead of rail. The buses would start running as soon as the BART stations would close for maintenance (from midnight until 4 a.m. with resumed service at 6 a.m. during the weekdays). According to the Regional Measure 2 Ballot,[14] when contemplating how to best organize and implement the nighttime service:

> "BART will contract with a local bus operator to provide this service – preferably using luxury transbay buses. The bus replacement service will be provided seven nights per week, during the hours that the BART trains do not run. An evaluation of demand will be performed, to determine the appropriate frequency of service, which will be at least once per hour, but possibly more often. The bus schedule would be incorporated into BART's overall schedule, with a note indicating the hours of bus replacement service" (Transcoalition 2004).

In 2001, the Metropolitan Transportation Commission (MTC), the Bay Area's metropolitan planning organization, concluded a study to determine whether enough people would use a late-night service to make it feasible. A July 2001 resolution explained that the BART Board of Directors was in favor of creating a late-night bus service that would parallel BART routes and

[14] Spearheaded by Senate Majority Leader Don Perata, Regional Measure 2 aims to reduce traffic congestion on Bay Area bridges and freeways by giving commuters more alternatives to driving. Measure 2 was devised by a coalition of Bay Area commuters, business leaders, labor representatives, transportation officials and representatives from the Transportation Land Use Coalition (TALC) and the Sierra Club. Measure 2 provides annual funding to ensure long-term operation of all new services. Bridge revenue is very stable so it won't be subject to economic cycles that caused recent transit cutbacks. Best of all, politicians and bureaucrats can't raid the funding for other purposes. Transcoalition (2004). Regional Measure 2 Fact Sheet.

serve BART stations in the four counties it services; operating trains and rail stations during late night hours would have been too expensive and inefficient. These additional services would be developed and operated by other transit operators in the BART service area to provide late-night BART service to night shift workers at airports, hotels and restaurants to get to and from their jobs as well as to support the nightlife among cities in BART's service area.

Currently, AC Transit provides late night transbay bus service between the East Bay and San Francisco, and AC Transit has a network of 24-hour routes from Richmond to Fremont, with timed transfers in downtown Oakland. Moreover, other major transit service providers operate late night service including San Francisco Muni with 24-hour service on certain routes, VTA's light rail and Line 22 operate 24-hours a day, and SamTrans Line 397 provides late night service from San Francisco to Palo Alto via SFO on El Camino Real (State Route 82) (Bay Area Transit Information 2003).

Description of the Area

The San Francisco Bay Area consists of nine counties[15] and 100 cities with 6.8 million people residing within its 7,000 square miles, making it the fifth most populous metropolitan area in the country. There are over two dozen transit properties, seven of which are primary ones[16] that together carry an average weekday ridership of about 1.5 million people. Its transportation network is diverse and multi-modal, traveled by single-occupancy vehicles, high-occupancy vehicles such as vanpools and buses, other motorized vehicles and bicycles, as well as light rail, rapid rail, commuter rail, cable cars, and ferries.

Approximately 1.5 million people live in AC Transit's 364 square mile service area. AC Transit's transit-dependent daily riders total approximately 230,000 including, 60,000 school children and 14,000 transbay commuters. Based on ridership information for FY 2001-2002, approximately 68.9 million riders used AC Transit's regular bus service and 575,000 riders used the paratransit service during this period (AC Transit 2003). In the Bay Area there are over 40

[15] Alameda, Contra-Costa, Marin, Napa, Solano, Sonoma, San Francisco, San Mateo, and Santa Clara
[16] BART, AC Transit, SamTrans, Santa Clara VTA, MUNI, Golden Gate Bridge, Highway, and Transportation District, and Caltrain.

college and university campuses accessible by BART, including the University of California, Berkeley, which alone has a student population of 33,000.

Additional Information

Regional Measure 2, the $1 bridge toll increase on the ballot in March 2004, will provide $1.8 million annually to operate express buses along High Occupancy Vehicle (HOV) freeway and major arterial routes and will give riders new late-night transit options. Measure 2 provides annual funding to ensure long-term operation of all new services. Bridge revenue is very stable and is generally not subject to normal business cycles that have, for example, contributed to recent transit cutbacks. Moreover, Regional Measure 2 funds are earmarked for transportation and thus politicians and bureaucrats do not have access to these funds for other purposes.

As far as technology is concerned, BART relies on a coordinated transit-fare system smart card called TransLink. BART along with several other transit agencies in the region including AC Transit, Caltrain, Golden Gate Transit, San Francisco MUNI and Santa Clara Valley Transportation Authority (VTA), uses this smart card technology to integrate their systems, thereby facilitating traveling and transferring regardless of time of day. The "smart card" enables passengers to pay fares on multiple systems by passing their card through a reader, which electronically deducts the fare from a pre-paid account. TransLink incorporates each discount offered by every participating transit operator, and automatically calculates the correct fare for each trip, including transfers. A convenient auto-load option allows passengers to link their card to a checking or credit card account, and a balance protection feature enables cardholders who lose their cards to receive a new one with the balance intact.

Singapore Bus Service (SBS) Transit

Synopsis

SBS Transit Ltd. was formed in 1973 through the merger of three private bus companies and listed on the Singapore Stock Exchange as SBS Transit, Limited. Today, SBS Transit operates approximately 190 routes with a fleet of 2,500 buses. The buses serve 19 bus terminals and more than 3,000 bus stops. SBS Transit also runs the Sengkang LRT system with six stations currently

in operation and the North East Line with 16 stations. As of 2004, SBS Transit carried about 2.4 million passenger trips a day.

The company provides a nighttime service called "Night Owl" which operates every twenty minutes along four routes from midnight until 4:00am. Night Owl provides one-directional services from the city to residential areas using the same daytime station stops. Night Owl services charge a flat rate of $1.50 USD for discount-pass users and $1.80 USD for cash payment (SBS Transit Singapore 2005).

Description of the area

Singapore is 693 square kilometers in area and has a population of approximately 4.3 million. The SBS service area is full of extremely dense shopping centers and hosts two major universities.

Financing Sources

SBS Transit is a private bus service that relies entirely on private revenue sources. Last year in total revenues, the agency earned $325 million (Nelson's Public Company Profiles 2005).

Additional Information

SBS, more than many of the other transit agencies discussed in this review, is implementing the latest technologies. While none of the SBS resources discusses specific technology applied to nighttime services, all reviewed technological developments could be used for all of the company's services regardless of time of day. One communication technology they market as "Send 655" enables customers to receive estimated bus arrival time quickly and easily by using their mobile phones. In October 2004, SBS Transit and Sing Tel – one of the primary Singapore telecommunications agencies – launched a six-month pilot run of this new SMS service (SBS Transit Singapore 2005). To market the pilot run, SBS Transit offered users free access to this *SEND service for a month during the beginning phases of implementation. Thereafter, a review of the trial had to be made to evaluate and extend this feature to other bus services (SBS Transit Singapore 2005).

SBS also has another program called "Send 656" to provide customers bus stop information via WAP-enabled mobile phones, wireless terminals or via SMS. Commuters can check what bus services call at specific bus stops, find out bus route details as well as get point-to-point travel solutions through mobile phones while on the move (SBS Transit Singapore 2005).

Orange County Transportation Authority (OCTA)

Synopsis

In southern California, the Orange County Transportation Authority (OCTA) became the county's primary transportation agency in 1991. OCTA provides funding and delivers public transportation for Orange County. OCTA has responsibility over bus and paratransit service; Metrolink commuter rail service; the planned Center Line rapid transit starter system; the 91 Express Lanes toll road, freeway, street and road improvement projects; motorist services and the regulation of taxi operations (OCTA 2004).

In September 2002, OCTA introduced all-night bus service on the agency's four busiest routes: Routes 43 (Harbor Boulevard), 50 (Katella Avenue), 57 (Bristol Street – State College Boulevard), and 60 (17th Street – Westminster Avenue). The Night Owl program, created to meet late-night and early-morning travel demand in the county, provides transportation for the community between midnight and 5 a.m. According to the OCTA Web site, "OCTA staff will continue to monitor the growth of our late-night service and look for opportunities to improve it." Night Owl serves transit dependent riders who work late night shifts. Two years after implementation, ridership reached 17,998 boardings per month, a 225% increase from the ridership levels of 5,528 per month reported at the end of September 2002 (OCTA 2004).

Description of Service Area

OCTA operates in a 797 square mile area serving 3 million residents in 34 cities and unincorporated areas (OCTA 2004). OCTA services employment, academic, entertainment and activity centers such as the Block at Orange, Edison Field, UC Irvine, and the Disney Resort.

Financing Sources

OCTA relies on public financing, including Measure M, which was the one-half sales tax approved by Orange County residents in November 1990 (OCTA 2004). Transit services specifically receive 25% of this amount.

Los Angeles Metropolitan Transportation Authority (LA Metro)

Synopsis

LA Metro operates over 2,000 peak-hour buses on an average weekday. LA Metro is unique among the nation's transportation agencies because it serves as transportation planner and coordinator, designer, builder and operator, that is, as both the transportation authority and transit agency for the country's most populous county (Los Angeles Metro 2005). For weekday and weekend transportation service, in 2000 there were approximately 307 million total bus boardings.

A form of nighttime transit-taxi has been in place for almost one hundred years in the Greater Los Angeles area. It still operates today through LA Metro with a flat fare of 75 cents per trip – a 50-cent discount from regular fares. To offer safety for late night bus riders (mainly transit-dependent workers) LA Metro has established a new program designed to enhance safety and convenience for its customers who ride Metro buses late at night. The "Night Owl Stops" program allows late night bus riders to disembark along a bus route where it is safe to do so at locations other than signed bus stops by signaling the bus operator at least one stop ahead (Los Angeles Metro 2005). This program is offered daily from 9 p.m. until 5 a.m. Passengers using the Night Owl Stops can only exit the bus by the front door; bus operators will use their professional judgment to determine a safe location to make the stop considering traffic and street conditions (Los Angeles Metro 2005).

Description of the area

More than 9.6 million people – nearly one-third of California's residents – live, work, attend school, and recreate within its 1,433-square-mile service area. In Los Angeles, there are numerous shopping centers, medical centers/hospitals and approximately 60 colleges and

universities which all serve as public transportation trip attractors. More importantly, L.A. has a large percentage of recent Central/Latin American and Asian immigrants, many of whom rely on bus services provided by LA Metro. Evidenced by the existence of around 400 to 500 illegal jitneys in downtown and eastern Los Angeles, the mass transit systems, including LA Metro, do not meet typically low-income transit riders' transportation needs well enough (Cervero 1992).

Financing Sources

For its non-operating revenue, LA Metro mainly relies on a mix of local, state and federal grants, as well as, Propositions A[17] and C[18], and Transportation Development Act (TDA)[19] monies. Passenger fares and route subsidies generally support LA Metro's operating revenue.

Additional Information

In Los Angeles many transit-taxi options would be either heavily regulated or impossible to implement, as statewide and local laws aim to protect taxi firms and public transit agencies from competition, thus imposing strict regulations. Most shared-ride and commuter service fall under the purview of the California Public Utility Commission (CPUC) which in several instances has moved to protect existing operators and imposed stringent insurance and safety requirements on new operators (Cervero 1992).

Various Cities in Germany

Synopsis

In many German communities, we found Nachtbus (evening and night service) used to cover two or three routes during late night/early morning hours. We also found that in many communities

[17] Proposition A is used to account for voter proceeds of the voter-approved ½ percent sales tax that became effective on July 1, 1982. Revenues collected are to be allocated: 25 percent to local jurisdiction for local transit; 35 percent to be used for construction and debt service payments and operation of rail rapid transit systems; 40 percent is allocated at the discretion of Metro Los Angeles Metro (2005). "www.mta.net."

[18] Proposition C – The "Los Angeles County Anti-Gridlock Transit Improvement Fund" is used to account for the proceeds of the voter-approved one-half percent sales tax that became effective on April 1, 1991. Revenues collected are to be allocated: 5 percent to improve and expand rail and bus security; 10 percent for Commuter Rail and construction of Transit Centers, Park-and-Ride lots and Freeway Bus Stops; 20 percent to local jurisdictions for public transit and related services; 25 percent for essential county-wide transit related improvements to freeways and state highways; 40 percent to improve and expand rail and bus transit county-wide.

[19] The Transportation Development Act (TDA) provides two major sources of funding for public transportation: the Local Transportation Fund (LTF) and the State Transit Assistance fund (STA). These funds are for the development and support of public transportation needs that exist in California and are allocated to areas of each county based on population, taxable sales and transit performance (California Department of Transportation 2003).

in Germany, transit agencies are relying on a more innovative, cost efficient means of providing night service as seen with collective Sammel-taxis (scheduled taxi) in Muenster and Bad Salzuflen, They contract out taxi services that solely operate between bus stops (TCRP 1997) or in some cases provide flexible and hybrid/feeder services (Christ 1998; TCRP 2001). Typically, customers call the transit system dispatcher, who contacts a taxi service dispatcher. Customers are given a confirmation time and are required to get into the taxi at a bus stop. An approaching taxi may have other customers when the customer is picked up. Usually, the fare for this service is twice the regular bus route fare, paid to the taxi driver. The taxi contractor is paid the difference between the contract price negotiated with the transit operator and the fare paid by the customer. This system has the beneficial effect of preserving exclusive-ride taxis as a private (unsubsidized) service, while providing some level of mobility during low demand times. Further, the transit operator does not subsidize exclusive-ride taxi customers through this system. In some cases, such as Nachtbus provided by WVG (Westfalishche Verkehrsgesellschaft) bus companies, the same daytime fare structure is applied.

Another example is found in Radolfzell where the nachtbus is operated for the city by the main transit operator, South Baden Regional Bus Company (SBG). This bus is appropriately called the "disco bus" because it travels throughout the downtown area to collect passengers who are patronizing bars and discotheques to ensure safety for weekend and night revelers (TCRP 1997). The desire to increase road safety at night by decreasing accidents resulting from alcohol consumption at discos and bars initiated some of the Nachtbus services (Christ 1998).

Description of the Area

In general, the structure of European cities, including those examined in Germany, are dense and more conducive to transit than most of their American counterparts, since they were usually settled and developed before the automobile became so prevalent. Moreover, fuel prices in Europe are 3-5 times higher than in the U.S. and national governments take more action to discourage auto use and encourage public transit in cities since they are already congested (TCRP 1997) . Also strong national and regional governments in Europe (and Canada) allow for coordination of policies governing land use and the planning of highways and transit, which offers a means of emphasizing the latter (TCRP 1997).

Financing Sources

German transit agencies are increasingly relying on private source funding for public transit in general. However, governments still subsidize several agencies (TCRP 2001).

In the case of WVG companies, even though funds were scarce, the companies could introduce and sustain their night service since according to the company officials, "night buses involve neither major financial risks nor huge subsidies since revenue comes from three sources: fares, sponsors, and compensatory payments from participating districts"(Christ 1998). WVG managed to find sponsorship for all its services via insurance companies that saw the buses operating night service as advertisements for their insurance. After deducting fare and sponsorship revenues, the remaining service costs are passed from the WVG companies to the participating towns and districts. As of 1998, annual costs per participating districts were 60 cents per inhabitant.

Additional Information

In 1993, German lawmakers decided to include taxis in their legal definition of public transit. This could play a partial role in the heightened relationships between taxis and transit agencies to provide hybrid and contracted out services. Where taxis replace or enhance public transportation, they are regarded as forming part of public transit. In over 100 areas in Germany, shared taxi and vans have replaced regular public transit.

In terms of technology, AVL-aided transit-taxi services have flourished in many suburban areas. Microbuses, minibuses and maxibuses equipped with AVL sensors are in constant contact with a central computer that assigns and routes vehicles to handle ride requests. Under this system, normally riders arrive at a suburban rail station (S-Bahn) and then enter a destination code on a call box, which relays this information to a central computer. Average passenger wait times have been approximately seven minutes and operators report recovering 80 percent of full costs through the fare box, two to three times as much as most U.S. suburban transit services (Cervero 1992).

APPENDIX B: TRANSIT-TAXI CASE STUDIES – FIXED-ROUTE WITH FLEXIBLE ROUTING[20]

King County Metro, Seattle

Synopsis

Metro Transit is the public transit agency serving King County in Washington State and operates within Seattle and the surrounding areas. Metro operates a fleet of approximately 1,300 vehicles – including standard and articulated coaches, electric trolleys, dual-powered buses, hybrid diesel-electric buses and streetcars. Metro serves riders who are disabled with accessible fixed route service (all Metro buses have wheelchair lifts or ramps and all routes and trips are accessible), as well as paratransit van service and a taxi scrip program.

Based on a report published by the City of Seattle in the mid-1990s the city restructured its transit system (TCRP 1996). The new concept called LINC (Local Initiative for Neighborhood Circulation) replaced the system that focused on downtown Seattle with a new system using multiple transit hubs located in neighborhood centers throughout the city, since over sixty percent of Seattle's residents live and work outside the city center. Metro's six year operating plan, developed in concert with the newly constituted three-county Central Puget Sound Regional Transit Authority (Sound Transit), called for a web of transit routes that would tie suburban communities to one another. The transit hubs were connected by limited-stop arterial bus service, affording rapid neighborhood connections. At the hubs, transfers would be made to vans or minibuses that would operate as circulators, picking up and dropping off passengers at their homes and other destinations within the neighborhood service area.

During the test phase, two types of neighborhood services were examined: a fixed-route circulator and a flexible routing service. The latter, called "fixed-in/flex-out", is more closely related to the proposed hybrid feeder transit-taxi service described in Section 2.1.1. This service involves vans that would depart the transit hub at scheduled times, delivering passengers to any location they requested within the service zone (the "flex" portion). After dropping off

[20] All dollar amounts used for case studies discussing agencies in non-US countries have been converted to US Dollars for the date of June 30, 2005 unless otherwise specified.

passengers, vans would return to the hub along a fixed route on local streets (the "fixed" portion). Both the circulator and the flexible route service operate without specified bus stops, permitting passengers to hail, board and get off the bus at any location along their travel path. Metro's new plan seeks to place more reliance on feeder systems and transit hubs located at activity centers throughout the county, and the LINC concept, with its combination of fixed and flexible routes, is likely to play a central role in Metro's future service delivery strategy (TCRP 1996).

Metro also offers a Night Stop service similar to the LINC flexible service deviation structure to provide additional safety at nighttime. Available between the hours of 8:00 PM and 5:00 AM, Night Stop allows passengers to ask the driver to disembark at any point along his/her bus route, even if it is not at a Metro bus stop. A passenger just has to come to the front of the bus at least a block ahead of where he/she wants to disembark and request the stop. The driver will decide whether the stop is feasible and safe. Drivers can pick up passengers only at regular Metro bus stops (King County Metro 2005).

Description of the Area

The Seattle area, as is the case with most cities that provide nighttime transit-taxi service, has many universities, approximately fifteen including the University of Washington, and a fairly dense population of 1.7 million residents. The annual ridership of King Metro is around 100 million within a 2,134 square-mile area. Within this area, there is also an abundance of major destination points including: museums, hospitals/medical centers, courthouses, parks and recreation, community service centers and shopping districts (King County Metro 2005).

Financing

King County Metro is a publicly financed service. Until 2001, the system received 30 percent of its funding from Motor Vehicle Excise Tax (MVET) revenues for transit operations. While the MVET revenues have in part been replaced by general sales tax proceeds, as of 2002, the sales tax revenues did not fully compensate for the loss associated with the loss of financing provided by MVET sources.

Toronto, Ontario (GO Transit)

Synopsis

With an extensive network of train and bus services, the Greater Toronto Transit Authority (GTTA), otherwise known as Greater Ontario (GO) Transit, is Canada's first, and Ontario's only, interregional public transit system, linking Toronto with the surrounding regions of the Greater Toronto Area (GTA) (Go Transit 2005). Since operations began in May 1967, more than three-quarters of a billion people have taken the GO Train or the GO Bus (Go Transit 2005?). The system runs 139 trains and provides 1,000 bus trips daily, carrying 120,000 passengers on an average weekday. The bus component includes 184 buses on suburban feeder routes, transporting 29,000 passengers daily. In 1994, GO Transit's ridership totaled 34.5 million.

During periods of light demand, including nighttime, GO Transit stops train service but operates buses along its commuter rail alignment (TCRP 1997) enabling the agency to save costs and not eliminate service (TCRP 1997). Additionally, local buses that service GO Transit commuter rail stations operate flexible routes rather than fixed routes. "In the evening, when demand lessens, the service area in Oakville (a suburb of Toronto with a commuter rail stop) is divided into four quadrants, with one bus operating within each quadrant. Still later in the evening, Oakville bus service quadrants are consolidated into two zones. This reduces the total expense of operation, while providing customers total area coverage that is more like a door-to-door cab service" (TCRP 1997).

Description of Area

With a population of five million in an area of 3,000 square miles, Go Transit has about 45 million passengers a year. From downtown Toronto to Hamilton and Guelph in the west; Orangeville, Barrie, and Beaverton to the north; and Port Perry, Oshawa, and Newcastle in the east, bus service extends for about 60 miles from downtown Toronto, connecting with every municipal transit system in the Greater Toronto and Hamilton areas, including the Toronto Transit Commission (TTC) (Go Transit 2005).

Financing

Explained in the transit agency website:

> "The government of the Province of Ontario is responsible for funding the portion of GO's operating costs that are not recovered through passenger fares and other revenue. It is also responsible for the base capital funding needed for rehabilitation and replacement, to keep our system in a state of good repair. For growth and expansion capital costs, the Province provides one-third of GO's capital funding needs, with the understanding that the Federal and municipal governments will contribute the remaining two-thirds" (Go Transit 2005).

Additional Information

In terms of the political and institutional environment, as evidenced by Go Transit's board of directors, the agency has broad representation from the public and private sectors, including businesses, municipal governments, and the Provincial government. Moreover, being a Crown Agency of the Province means that the Ministry of Transport sets the strategy and policy framework for GO, and the GO Board provides business direction to the staff (Go Transit 2005).

In January 1997, the Province announced it would hand over funding responsibility for GO Transit to the Greater Toronto Area municipalities (which consist of the City of Toronto, and the regions of Halton, Peel, York, and Durham) as well as the neighboring Region of Hamilton-Wentworth (which became the new City of Hamilton on January 1, 2001). In exchange, the province would assume certain other funding responsibilities from municipal governments.

One year later the GTA municipalities and the City of Hamilton began to fund GO Transit, cost-sharing all capital expenses and any operating costs that are not recovered through passenger fares and other revenue. In January 1999, a new municipal agency created by the province came into being: the Greater Toronto Services Board (GTSB), which is composed of regional chairs, municipal mayors, and local councilors from the GTSB's service area. GO Transit transferred over to the municipal sector as an arm of the GTSB in August 1999. On September 27, 2001, the

Provincial government announced that it would be taking back responsibility for GO Transit, and putting around $2.4 billion into public transit in Ontario.

The *GO Transit Act, 2001* was passed by the Ontario Legislature on December 5, 2001. As of January 1, 2002, GO Transit is no longer the responsibility of the municipalities of the Greater Toronto Area and Hamilton. GO has returned to Provincial responsibility as a Crown Agency, and the Greater Toronto Services Board no longer exists.

APPENDIX C: TRANSIT-TAXI CASE STUDIES – HYBRID / FEEDER SERVICES[21]

City of Rimouski, Quebec, Canada[22]

Synopsis

City officials from the Rimouski, Quebec contract taxis to provide public transportation throughout the day until 9:00 p.m. The service is called TAXIBUS and it is a type of demand-responsive system whereby customers call in to request the service provided by taxicabs and later the taxis pick up and drop off riders at specific pre-determined points. The city has relied on these services since 1993, around the time when the former private operator providing public transportation to Rimouski went out of business. Since then, it has proven a cost-effective alternative to traditional bus transit systems as the TAXIBUS service (as it is termed) is on average $9.60 less per capita than cities of similar size (Rouyn-Noranda, Drummondville, Granby, Joliette and Saint-Jérôme) (TCRP 1997; Trudel 1999).

TAXIBUS operates Monday to Friday, serving 300 stops within the city by predetermined schedules and stops indicated by numbers, but vehicles' routes will differ based on the needs of the various users and trips are made only if one or more rides have been booked. The origin, destination and routing of trips depend on the travel needs of each taxi's passengers. Service schedules identify the time at which taxis will pick up their first passenger, meaning that other passengers on the same trip may have to wait several minutes for the taxi to reach them. The system is managed by a software system called Traxibus, which was originally developed by Quebec's Ministry of Transport. Users call in one hour in advance[23] and explain which stops they need. This type of schedule facilitates concentration of demands during common time periods to attain high occupancy rates of the vehicles (Trudel 1999).

Users avoid transfers by starting and ending their trips at any of 300 numbered stops in the urban area. Most residents live within 500 meters of a stop. Rural INTER-Taxibus users are picked up

[21] All dollar amounts used for case studies discussing agencies in non-US countries have been converted to US Dollars for the date of June 30, 2005 unless otherwise specified.

[22] The service offered by the City of Rimouski is not night service, but the service concepts could be applied very well to a nighttime program.

[23] In 1993, riders had to call in 24 hours in advance, but in early 1994 customers' complaints led those in charge to change the advance reservations to one hour in advance.

and dropped off on the road in front of their home, and can travel either within their own service area (east or south) or between their service area and the Taxibus area. Most trips are less than 15 minutes long, a service level that would be difficult to obtain by a fixed-route transit system.

TAXIBUS has become increasingly popular, growing by 37% over four years (current figures are 60,000 trips per year). The number of passengers per ride rose from 1.6 during the first few months of operation to 2.8 by 1996. Service costs per ride have decreased from $4.7 to $3.5 per passenger (21% of which are administrative expenses).

Description of the Area

The city of Rimouski has a variety of commercial activities as well as government and professional services that serve a population of 31,000 (as of 2000). It is a center for marine transportation, commerce, manufacturing, education and tourism. The education sector represents the largest local employer with an influx of 15,000 students per year. The territory is spread out and extends over 76 sq. km. It is located 312 kilometers from Québec City and 570 kilometers from Montréal. Not surprisingly, in this city with relatively low population density of a little over a thousand per square mile, there is not a high demand for public transportation, however demand exists.

Financial arrangements

To determine the most cost efficient service, Rimouski city authorities studied various public transit service scenarios using buses, which all appeared too expensive. Operating deficits for using bus services would have ranged between $269,000 and $434,000 (Trudel 1999). The TAXIBUS service was chosen for economic reasons and for quality of service. TAXIBUS's total costs for 1994 were approximately $216,000, of which $80,600 was devoted to administrative expenses. The ministry contributed a $37,900 subsidy and the municipality's share was $106,300. The municipality's share on a per capita basis amounted to $3.44 as compared to an average of $6.17 for municipalities of approximately the same size that offer public bus transit service (Trudel 1999).

As depicted in Figure 2, TAXIBUS drivers are paid by the City of Rimouski via the Rimouski TAXIBUS Corporation – an organization established by the city to manage the transportation

service – for odometer readings during the trip, subtracting the amount paid in cash by passengers. The *ministère des Transports du Québec* then provides this service with a subsidy according to the Government Assistance Program (40% of the revenues not to exceed 75% of the operating deficit).

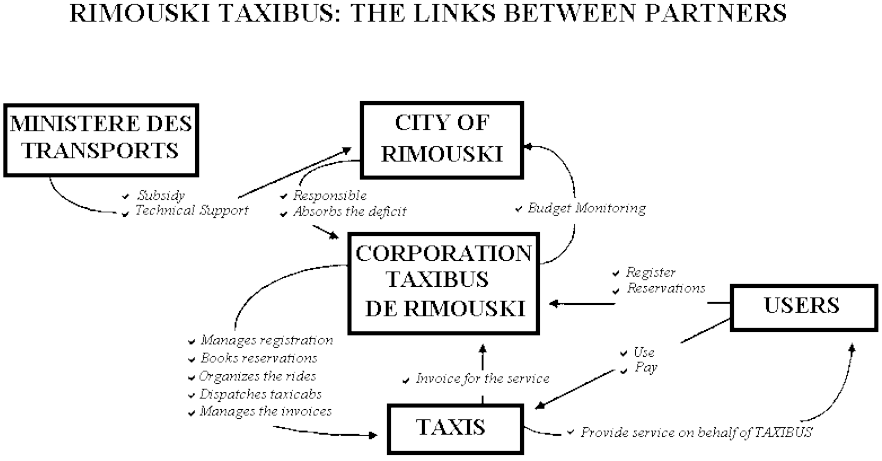

FIGURE 2 Rimouski Taxibus: The Links Between Partners (Source: Trudel 1999)

Additional Information

Part of the success achieved by the TAXIBUS service can be attributed to the fact that taxi drivers had already had some experience in providing this type of demand responsive service in Rimouski (i.e., receiving calls, organizing rides, dispatching taxicabs, controlling services provided by drivers, colleting fees, invoicing rides to TAXIBUS, managing subsidies, etc.) since the city had already commissioned the taxi agency to provide paratransit service to the disabled.

Many benefits came from the implementation of TAXIBUS. According to surveys, TAXIBUS users were very happy with the service they received, especially in terms of vehicle frequency, fee structure, location of stop points, vehicles' cleanliness and comfort, level of driver courtesy (Trudel 1999). Moreover, taxi drivers attracted more customers for their regular taxi service since in this new service, they gained more exposure and passenger' awareness, thus attracting more customers.

In terms of regulatory constraints, in Quebec City and surrounding areas, including Rimouski, contractual agreements between the organizing public authority (ministère des Transports du Québec) and the taxi-permit holder(s) is the most common and formal process to create public transportation services provided by taxi services (Trudel 1999). The city has adopted legal regulations to enable the initiation and expansion of Taxibus, and to identify the terms and conditions of its operations. The first regulation, adopted in 1993, still governs the Taxibus service.

The Taxibus concept is growing in popularity throughout Canadian communities. Many small centers in Quebec have been launched since 1999 in Victoriaville (population 40,000), Charlevoix (population 17,000), Sorel-Tracy (population 35,000), Salaberry-de-Valleyfield (population 26,000) and Vaudreuil-Dorion (population 19,000). Sept-Îles (population 24,000) is slated to launch a Taxibus service late in 2004.

Even large conventional transit systems like the Société de transport de Montréal are finding the Taxibus concept useful in areas where feeder bus services are not economically viable, such as between rapid transit or commuter rail stations and adjacent neighborhoods or business parks.

City of Madison, Wisconsin

Synopsis

The City of Madison's public transportation system is distinct from the other cases described in this paper because in this case, the nighttime hybrid transit-taxi program considered was never implemented. In 1979 a consulting firm conducted feasibility studies for the City of Madison and its Department of Transportation to determine alternative approaches to providing nighttime service. After receiving the consulting firm's recommendations to transition to a hybrid transit-taxi approach, the city officials allegedly decided that the projected cost savings were not great enough to 1) outweigh disruption to the system, and 2) compensate for the potential worsening of the labor union employees' working conditions.

The City of Madison has a diverse public transportation system. The city is one of the few in the U.S. with a privately subsidized shared-ride taxi system which operates in the same area as exclusive-ride taxi services (Multisystems 1979). Also, Madison Metro provides regular fixed-route transit and demand-responsive paratransit services within the City of Madison, Town of Madison, City of Middleton, part of City of Fitchburg and to the University of Wisconsin-Madison (UW) campus. The system is designed to serve the growing peripheral employment and activity centers, and the majority of the routes serve the downtown and UW campus areas, particularly during weekday peak hours. Madison Metro has an average weekday fixed-route ridership of around 38,000 when school is in session and 25,000 during the summer. According to an on-board survey conducted in 2000, 80% of weekday transit trips are for work or school purposes (Multisystems 1979). Total fixed-route ridership was 10.9 million in 2002, a 6.7% increase compared to 2001. Generally, ridership trends have been positive, with ridership increasing 20.4% from 1990 to 2002 (Multisystems 1979). The MPO for the City of Madison has suggested that the factors contributing to the large ridership increases in 2002 were 1) making the UW campus routes free; 2) expanding the UW pass program to staff/faculty and UW Hospital and Clinic employees; and 3) service improvements implemented in August of 2002.

Based on ridership level increases, it is clear that the city has a demand for public transportation. However, in 1979, there was an obvious underutilization of fixed-route public transit service during nighttime hours.[24] Furthermore, providing nighttime service was much more costly with revenue-to-cost ratios at 0.40 during daytime hours and an estimate of approximately 0.18 after 9 p.m. (Multisystems 1979). The City of Madison and the Madison DOT applied for and received a grant under the State of Wisconsin Mass Transit Demonstration program to perform a feasibility study of a transit-taxi service to determine the best approach to provide late night service (Multisystems 1979). The following three options were proposed: 1) replacement of buses with taxis operation on fixed routes, 2) replacement of fixed-route bus service with door-to-door "dial-a-ride" or shared-ride taxi service, and 3) shortening of fixed routes and the provision of neighborhood feeder services whereby fixed-route bus services would be retained along the most heavily traveled portion of each route. Only the third ─ a hybrid transit-taxi

[24] In the case of Madison's night bus, it is more after-evening service, with passenger levels decreasing after 6 p.m., rather than night owl service.

concept ─ was feasible as it was the most cost efficient. For this option most transit routes would be truncated at points several miles from the Capitol Concourse, beyond which the demand for service diminishes. In the areas beyond these points, taxis would be used to bring passengers to the bus lines and to take passengers from the buses to their homes (or other destinations) (Multisystems 1979). Transfer times were to be synchronized so that passengers would not have long wait times.

Consultants conducted feasibility studies to analyze the route revenue or passenger ridership by time of day to measure route productivity, taking into consideration directional and geographic differences. Later, they conducted on-board surveys to estimate the level of customer interest in night transit-taxi service. Next, the consultants found that taxis in Madison would be half to less than half the operating cost of buses taking into consideration ridership levels determined in step one. They also looked at the financial feasibility of this alternative by estimating fixed route savings as well as the number of taxi hours required for replacement services. According to the feasibility studies, the hybrid transit-taxi option was the most feasible from a taxi supply point of view, and could result in cost savings of $136 to $234 per evening. Since fixed-route buses were heavily utilized in main segments of the city even during late hours, it did not make sense to replace the entire bus system with taxis. Moreover, it would be possible to implement this service type in a step-by-step approach, thereby making it easier to refine system operations before the system is fully operational. Finally, the taxi industry was likely to gain both increased revenues and customer exposure by providing late-night transportation. Even though many factors favored implementing the nighttime service, because of significant anticipated institutional constraints from labor, who felt that their positions were threatened, and from customers, who would now have to call for origin service as well as transfers, city officials decided the cost savings achieved would not justify the hybrid transit-taxi service.

Description of Area

As of 2003, the City of Madison had a population of around 218,000 people (Census 2005). The 2000 population within Madison Metro's 60 square mile service area was approximately 234,000 (Multisystems 1979). Madison, the state capital, is home to all such government buildings including the Capitol Concourse, which forms the hub of the downtown area. UW is located

about one mile from the Capitol Concourse and enrolls approximately 38,000 students, 89% of which reside in the Madison city limits (as of 1979). Additionally, many shopping centers are found downtown and, like most cities, residential areas radiate from the center into more suburban areas.

Financing Sources

The city owns public transit in Madison provided by Madison Metro.

In terms of fare structures, had the service been implemented, two factors would have been discussed: 1) level of fare and 2) method of payment. Consultants examined three options for actual fare level; services could be free, the same charge as current fixed route services or extra charges for feeder services providing the door-to-door option. As far as method of payment is concerned, the consultants discerned that the most practical approach would be to pay on-board during the first segment. This would probably be the most direct and least confusing for both passengers and administration. However, on-board payment to taxis (when it is the first mode used for inbound to feed to the bus) could generate resistance from the transit union and it would require closer monitoring of taxi operators. Regardless of the potential problems, the final proposed option was to pay on first mode used when using bus and taxi.

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